Publication No. CSKHPKV/DPGS/2012-2

COURSE CATALOGUE
POSTGRADUATE PROGRAMME

A COMPREHENSIVE PICTURE OF PG PROGRAMMES

PGS

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Foreword

It is a matter of satisfaction that as per the recommendations of fourth Deans' Committee of the Indian Council of Agricultural Research(ICAR), course catalogue for Post Graduate programmes has been updated by the Dean, Post Graduate Studies. This will bring our PG education at par with all other institutions at the national level. I am told that this document has been reviewed and updated as per the local conditions of Himachal Pradesh also.

Our University has also entered into MOU with Punjab Agricultural University, Ludhiana for doctoral students' exchange programme. This will broaden the education base and provide a platform to the PG students to learn many new things in the new environment and help them to further develop their thinking faculty.

I appreciate Dr.K.K.Katoch, Dean, PG Studies for taking initiative to update and print course catalogue. I am sure this document will prove very useful to the teachers and students.

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PREFACE

Education is a key for human beings to prosper and proliferation of the educational institutions is an outcome of the same. Elementary, secondary and higher educations are its various forms which make a man suitable for different levels of his acceptance in the society and ultimately type of livelihood. Specialized knowledge of a subject is essential to support the society in real time in terms of innovations and their upgradation. The main aim of educational institutions is to generate a good quality human resource.

Himachal Pradesh Krishi Vishvavidyalaya came into existence in the year 1978, under the policy of Government of India to have at least one Agricultural University in each state to cater the needs in agricultural education, research and extension. Presently, the University has four colleges i.e. College of Agriculture, Dr. G. C. Negi College of Veterinary and Animal Sciences, College of Home Science and College of Basic Science. The University has a strong postgraduate programme with Masters' Programmes in 32 disciplines: 12 in Agriculture, 13 in Veterinary and Animal Sciences, three in Home Science, and four in Basic Sciences. Likewise, doctoral programme is run in 19 disciplines: 8 in Agriculture, 8 in Veterinary and Animal Sciences, 1 in Home Science and 2 in Basic Science. University is following the semester system and each student plans his own programme of work in consultation with an Advisory Committee.

As per ICAR's 4th Deans' Committee recommendations for Uniform Course Curricula in agriculture throughout the country, this University has also adopted new pattern for different programmes. With the implementation of recommendations, the course contents of each course have been revisited and upgraded to meet the present day needs of the state with uniformity at national level. To promote inter institutional interaction amongst students an MoU has been signed with Punjab Agricultural University, Ludhiana and CSKHPKV, Palampur under which Ph.D. students of one University in the disciplines of Agricultural Economics, Food Science & Nutrition, and Vegetable Science will study during the 1st semester of their degree programmes at the other University.

The contents of the courses were finalized after discussion at various fora and approval by the Academic Council of the University.

I thank all the Deans and Heads of Departments and faculty, who made whole-hearted efforts in preparing / revising the course contents. Special thanks are due to Drs. Vidyasagar, N.K. Gupta, Adarsh Kumar and Neena Vyas for facilitating the job of compilation at University level.

I place on record special thanks to Dr. S.K. Sharma, Hon'ble Vice-Chancellor for constant encouragement and support. Thanks are due to all staff members in my office for assistance.

Hope this course catalogue will certainly help faculty in teaching the various postgraduate courses prudently and students will perform par-excellent at National and International Fora of competitions.

Place : Palampur
Date : November 11, 2012

(Dr.K.K.Katoch)
Dean, Postgraduate Studies
CSKHPKV, Palampur

TABLE OF CONTENTS

AGRICULTURE

AGRICULTURAL BIOTECHNOLOGY

http://hillagric.ac.in/edu/coa/biotech/index.html

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
BIOTECH 551*	CELL AND DEVELOPMENTAL BIOLOGY	2+1	I
BIOTECH 552*/ PL PHYSIOL 502	PLANT BIOLOGY	2+0	I&II
BIOTECH 553*	MOLECULAR BIOLOGY	2+0	I
BIOTECH 554*	LAB ON MOLECULAR AND PLANT BIOLOGY	0+2	I
BIOTECH 561*	TISSUE CULTURE AND TRANSGENIC TECHNOLOGY	2+0	II
BIOTECH 562*	GENETIC ENGINEERING	2+0	II
BIOTECH 563*	LAB ON GENETIC ENGINEERING	0+2	II
BIOTECH 571*/ VMC 606	IMMUNOLOGY & MOLECULAR DIAGNOSTICS	2+1	I
BIOTECH 572	BIOINFORMATICS AND BIOCOMPUTATION	2+1	I
BIOTECH 573*	MOLECULAR BREEDING	2+0	I
BIOTECH 574*	LAB ON PLANT TISSUE CULTURE AND TRANSGENIC TECHNOLOGIES	0+2	I
BIOTECH 591*	MASTER'S SEMINAR	1+0	I&II
BIOTECH 592	SPECIAL PROBLEM IN M.Sc.	0+1	I&II
BIOTECH 599*	MASTER'S RESEARCH	0+20	I&II
BIOTECH 601**	GENE CLONING	1 + 1	II
BIOTECH 602**	METABOLIC PATHWAY ENGINEERING	1 + 0	I
BIOTECH 603**	MOLECULAR MARKER TECHNOLOGY	2 + 1	II
BIOTECH 604**	ADVANCES IN PLANT CELL AND TISSUE CULTURE	2 + 1	II
BIOTECH 605	COMMERCIAL BIOTECHNOLOGY	1 + 1	I
BIOTECH 606	ADVANCES IN GENETIC ENGINEERING FOR STRESS TOLERANCE	3 + 0	I
BIOTECH 607	BIO-SAFETY AND PATENT LAWS	1 + 0	II
BIOTECH 608	TRANSGENIC PLANT TECHNOLOGY	2 + 1	I
BIOTECH 692	SPECIAL PROBLEM IN Ph.D.	0 + 1	I&II
BIOTECH 691**	DOCTORAL'S SEMINAR	1+0	I&II
BIOTECH 699	DOCTORAL RESEARCH	0+45	I&II

* Compulsory for Master's Programme **Compulsory for Doctoral Programme

AGRICULTURAL BIOTECHNOLOGY

Course contents

BIOTECH 551 CELL AND DEVELOPMENTAL BIOLOGY 2+1

Theory

UNIT I: Cell theory and methods of study – microscope and its modifications – light, phase contrast and interference, fluorescence, confocal, electron (TEM and SEM), electron tunneling and atomic force microscopy, etc., membrane structure and function – structural models, composition and dynamics, transport of ions and macromolecules, pumps, carriers and channels, endo- and exocytosis, membrane carbohydrates and their significance in cellular recognition, cellular junctions and adhesions, structure and functional significance of plasmodesmata.

UNIT II: Organelles: nucleus – structure and function of nuclear envelope, lamina and nucleolus, macromolecular trafficking, chromatin organization and packaging, cell cycle and control mechanisms, mitochondria - structure, organization of respiratory chain complexes, ATP synthase, structure-function relationship, mitochondrial DNA and male sterility, origin and evolution, chloroplast-structure-function relationship, chloroplast DNA and its significance, chloroplast biogenesis, origin and evolution.

UNIT III: Endo-membrane system and cellular motility – structure and function of microbodies, golgi apparatus, lysosomes and endoplasmic reticulum, organization and role of microtubules and microfilaments, cell shape and motility, actin-binding proteins and their significance, muscle organization and function, molecular motors, intermediate filaments, extracellular matrix in plants and animals.

UNIT IV: Cellular movements and pattern formation – laying of body axis planes, differentiation of germ layers, cellular polarity, model plants like fucus and volvox, maternal gene effects, zygotic gene effects, homeotic gene effects in drosophila, embryogenesis and early pattern formation in plants, cell lineages and developmental control genes in *Caenorhabditis*.

UNIT V: Differentiation of specialized cells – stem cell differentiation, blood cell formation, fibroblasts and their differentiation, cellular basis of immunity, differentiation of cancerous cells and role of proto-oncogenes, phase changes in salmonella, mating cell types in yeast, surface antigen changes in trypanosomes, heterocyst differentiation in anabaena, sex determination in drosophila.

Plant meristem organization and differentiation – organization of shoot apical meristem (SAM), organization of root apical meristem (RAM), pollen germination and pollen tube guidance, phloem differentiation, self-incompatibility and its genetic control, embryo and endosperm development, heterosis and apomixis.

Practical : Cell biology**:** Microscopy – bright field; dark field; phase contrast; fluorescence microscopy; visit to electron microscope and confocal microscope facilities; histology – hand-sectioning of stem and leaf; saffranin and fast green staining; microtomy - fixing of tissues, dehydration, wax-embedding, sectioning and staining; mitosis – onion root tips; meiosis – insect testes/plants.

BIOTECH 552/ PL PHYSIOL 502 PLANT BIOLOGY/ PLANT DEVELOPMENTAL BIOLOGY-PHYSIOLOGICAL AND MOLECULAR BASIS 2+0

Theory: General aspects – novel features of plant growth and development, concept of plasticity in plant development, analysing plant growth, seed germination and seedling growth – mobilization of food reserves during seed germination, tropisms, hormonal control of seed germination and seedling growth, shoot, leaf and root development – organization of shoot apical meristem (SAM), cell to cell communication, leaf development and differentiation, organization of root apical meristem (RAM), root hair and trichome development, cell fate and lineages, floral induction and development – photoperiodism and its significance, vernalization and hormonal control, inflorescence and floral determination, molecular genetics of floral development and floral organ differentiation, sex determination, seed development and dormancy – embryo and endosperm development, cell lineages during late embryo development, molecular and genetic determinants, seed maturation and dormancy, senescence and programmed cell death (PCD) – senescence and its regulation, hormonal and environmental control of senescence, PCD in

the life cycle of plants, light control of plant development – discovery of photochromes and cryptochromes, their structure, biochemical properties and cellular distribution, molecular mechanisms of light perception, signal transduction and gene regulation, biological clocks and their genetic and molecular determinants, regeneration and totipotency, organ differentiation and development, cell lineages and developmental control genes in maize, special aspects of plant development and differentiation – pollen germination and pollen tube guidance, phloem differentiation, sex determination in plants, embryogenesis and early pattern formation in plants.

BIOTECH 553 MOLECULAR BIOLOGY 2+0

Theory

UNIT I: Genome organization – organization of bacterial genome, structure of eukaryotic chromosomes, role of nuclear matrix in chromosome organization and function, matrix binding proteins, heterochromatin and euchromatin, DNA reassociation kinetics (cot curve analysis), repetitive and unique sequences, satellite DNA, DNA melting and buoyant density.

UNIT II: DNA structure, replication, repair and recombination, structure of DNA - A-,B-, Z- and triplex DNA, replication: initiation, elongation and termination in prokaryotes and eukaryotes, enzymes and accessory proteins, fidelity, replication of single stranded circular DNA, gene stability and DNA repair-enzymes, photoreactivation, nucleotide excision repair, mismatch correction, SOS repair, recombination: homologous and non-homologous, site specific recombination.

UNIT III: Prokaryotic and eukaryotic transcription – prokaryotic transcription, transcription unit, promoters- constitutive and inducible, operators, regulatory elements, initiation, attenuation, termination-rho-dependent and independent, anti-termination, transcriptional regulation-positive and negative, operon concept-lac, trp, ara, his, and gal operons, transcriptional control in lambda phage, transcript processing, processing of tRNA and rRNA, eukaryotic transcription and regulation, RNA polymerase structure and assembly, RNA polymerase I, II, III, eukaryotic promoters and enhancers, general transcription factors, TATA binding proteins (TBP) and TBP associated factors (TAF), activators and repressors, transcriptional and post-transcriptional gene silencing.

UNIT IV: Post transcriptional modifications – processing of hnRNA, tRNA, rRNA, 5'-cap formation, 3'-end processing and polyadenylation, splicing, RNA editing, nuclear export of mRNA, mRNA stability. Translation and transport – translation machinery, ribosomes, composition and assembly, universal genetic code, degeneracy of codons, termination codons, isoaccepting tRNA, wobble hypothesis, mechanism of initiation, elongation and termination, co- and post-translational modifications, transport of proteins and molecular chaperones, protein stability, protein turnover and degradation.

UNIT V: Mutations, oncogenes and tumor suppressor genes – nonsense, missense and point mutations, intragenic and intergenic suppression, frameshift mutations, physical, chemical and biological mutagens, transposition - transposable genetic elements in prokaryotes and eukaryotes, mechanisms of transposition, role of transposons in mutation, viral and cellular oncogenes, tumor suppressor genes from humans, structure, function and mechanism of action of pRB and p53 tumor suppressor proteins, activation of oncogenes and dominant negative effect, suppression of tumor suppressor genes, oncogenes as transcriptional activators.

BIOTECH 554 LAB ON MOLECULAR & PLANT BIOLOGY 0+2

Practical

Unit I: Plant biology - plant DNA extraction, digestion of DNA with restriction enzymes; agarose gel electrophoresis; polymerase chain reaction to amplify a plant gene; homogenization of leaves and sub-cellular fractionation by differential centrifugation, SDS-PAGE analysis of proteins; RNA extraction, agarose gel electrophoresis of RNA, RT-PCR analysis of a plant gene.

Unit II: Molecular biology - plasmid DNA isolation and DNA quantitation: plasmid minipreps, restriction digestion; preparation of competent cells; transformation of *E. coli* with standard plasmids; calculation of transformation efficiency; purification of DNA from an agarose gel, DNA ligation with plasmid vectors; cloning of genomic DNA in standard plasmid vectors; confirmation of the insert, miniprep of

recombinant plasmid DNA; restriction mapping; polymerase chain reaction by using standard 16srRNA eubacterial primers; RFLP analysis of the PCR product.

BIOTECH 561 TISSUE CULTURE & TRANSGENIC TECHNOLOGIES 2+0

Theory

UNIT I: Totipotency, Tissue culture media, plant hormones and morphogenesis, direct and indirect organogenesis, direct and indirect embryogenesis, cell suspension culture, micropropagation – shoot tip culture, somatic embryos, artificial seeds, applications of tissue culture, virus elimination by shoot tip culture, wide hybridization and embryo culture, anther culture and dihaploids.

UNIT II: Large-scale cell suspension culture, production of alkaloids and other secondary metabolites, protoplast culture, plant cell wall structure and cell wall hydrolyzing enzymes, protoplast isolation and purification, protoplast viability test, protoplast fusion, somatic hybrids, cybrids.

Unit III: Direct transformation of protoplasts using PEG, electroporation, transformation by particle bombardment, assembly of particle gun, microprojectile preparation and bombardment, chloroplast transformation by particle bombardment.

UNIT IV: *Agrobacterium* biology, Ti plasmid-based transformation, crown gall and hairy root disease, Ti and Ri plasmids, T-DNA genes, borders, overdrive, chromosomal and Ti plasmid virulence genes and their functions, *vir* gene induction, mechanism of T-DNA transfer, Ti pasmid vectors, *vir* helper plasmid, super virulence and monocot transformation, binary vector, floral dip transformation, promoters and polyA signals, protein targeting signals, plant selectable markers, reporter genes, positive selection, selectable marker elimination, transgene silencing, strategies to avoid transgene silencing.

UNIT V: Genetic engineering of crops, commercial status of transgenic plants, herbicide resistance, glyphosate, sulfonyl urea, phosphinothricin, atrazine, pest resistance, *Bt* toxin, synthetic *Bt* toxin, protease inhibitor, GNA and other lectins, α-amylase inhibitor, nematode resistance, genetic engineering for male sterility- barnase-barstar, delay of fruit ripening, polygalacturanase, ACC synthase, ACC oxidase, improved seed storage proteins, improving and altering the composition of starch and plant oils, golden rice for β-carotene accumulation, production of antibodies and pharmaceuticals in plants, bio-safety concerns of transgenic plants.

BIOTECH 562 GENETIC ENGINEERING 2+0

Theory

UNIT I: Basics concepts – DNA structure and properties, restriction enzymes, DNA ligase, klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase, cohesive and blunt end ligation, linkers, adaptors, homopolymeric tailing, labeling of DNA - nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques - northern, southern and colony hybridization, fluorescence *in situ* hybridization, chromatin immunoprecipitation.

UNIT II: Cloning vectors – plasmids, bacteriophages, M13 mp vectors, PUC19 and bluescript vectors, phagemids, lambda vectors, insertion and replacement vectors, EMBL, cosmids, artificial chromosome vectors (YACs, BACs), expression vectors, pMal, GST, pET-based vectors, protein purification, His-tag, GST-tag, MBP-tag etc., plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.

UNIT III: Cloning methodologies – insertion of foreign DNA into host cells, transformation, construction of libraries, isolation of mRNA and total RNA, cDNA and genomic libraries, cDNA and genomic cloning, expression cloning, jumping and hopping libraries, southwestern and far-western cloning, protein-protein interactive cloning and yeast two hybrid system, phage display, principles in maximizing gene expression.

UNIT IV: PCR and its applications – primer design, fidelity of thermostable enzymes, DNA polymerases, Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products, T vectors, proof reading enzymes, PCR in gene recombination, deletion, addition, overlap extension, and SOEing, site specific mutagenesis, PCR in molecular diagnostics, viral and bacterial detection, PCR based mutagenesis, mutation detection - SSCP, DGGE,

RFLP, oligo ligation assay (OLA), mismatch chemical cleavage (MCC), ASA (allele-specific amplification).
UNIT V: Sequencing methods, enzymatic DNA sequencing, chemical sequencing of DNA, automated DNA sequencing, RNA sequencing, chemical synthesis of oligonucleotides, principle and application of gene silencing, gene knockouts and gene therapy.

BIOTECH 563 LAB ON GENETIC ENGINEERING 0+2

Practical: Isolation of genomic DNA from *Bacillus subtilis** genome; PCR amplification of *scoC* gene and analysis by agarose gel electrophoresis; preparation of plasmid, pET-28a from *E.coli* DH5α and gel analysis; restriction digestion of vector (gel analysis) and insert with *Nco*I and *Xho*I; vector and insert ligation; transformation in *E. coli* DH5α; plasmid isolation and confirming recombinant by PCR and RE digestion; transformation of recombinant plasmid in *E.coli* BL21 (DE3) strain; induction of ScoC protein with IPTG and analysis on SDS-PAGE; purification of protein on Ni-NTA column and analysis of purification by SDS-PAGE; random primer labeling of scoC with Dig-11-dUTP; southern hybridization of *B. subtilis* genome with probe and non-radioactive detection.
**Any other bacterial strain can be used.*

BIOTECH 571/ IMMUNOLOGY & MOLECULAR DIAGNOSTICS 2+1
VMC 606 PRINCIPLES OF IMMUNOLOGY

Theory

UNIT I: History of immunology, immunity types, cardinal features, phylogeny, vertebrate immune system - lymphoid organs and tissues, development of B and T lymphocyte repertoires and other leukocytes, differentiation markers and other distinguishing characters of leukocytes, lymphoid cells trafficking.
UNIT II: Antigens - fundamental features, types, factors affecting immuno-genicity, adjuvants. Antibodies - structure, functions and classification, theories of antibody production, immunoglobulin genes and genetic basis of antibody diversity, complement system - activation pathways and biological activities.
UNIT III: Major histocompatibility complex - structure, functions and gene organization, T lymphocyte subsets, antigen-specific T cell receptors - structure, gene organization and genetic basis of diversity, immune response development - phases of humoral and cell-mediated immune response development, cellular interactions, properties and classification of various cytokines, immunoregulation.
UNIT IV: Immunity against veterinary infectious agents, immunological surveillance and cancer immunity, immunological tolerance, its breakdown and autoimmunity, immuno-deficiencies - types and examples, hypersensitivity - classification, mechanisms of induction and examples.
Practical: Preparation of antigens for laboratory animals immunization; production, collection and preservation of antisera; quantitation of immunoglobulins in antisera by zinc sulphate turbidity and single radial immunodiffusion, examination of lymphoid organs of animals, tests for *in vivo* and *in vitro* phagocytosis; separation and counting of peripheral blood lymphocytes; separation and concentration of immunoglobulin by ammonium sulphate precipitation and dialysis; demonstration of antigen- antibody interactions in serological tests such as agar gel precipitation; immunoelectrophoresis; bacterial agglutination; direct and passive hemagglutination, latex agglutination; complement fixation; enzyme-linked immunosorbent assay; immunoblotting.

BIOTECH 572 BIOINFORMATICS AND BIOCOMPUTATION 2+1

Theory

UNIT I: Introduction to biology – definitions, history, contentions with education, agriculture, medicine, structural biology and pharmaceutical industry, scope of bioinformatics, concepts of entropy, Shannon's formula, equi-probability and independence-application to DNA and protein, introduction to computers and high performance computing (HPC).

UNIT II: Databases - sequence database - concepts of database, key features of database system, history, database management systems, database types, introduction to query language, index, forms and reports, structural databases - biological databases - plant, animal, microbial, viral and organism databases and biodiversity, sequence and structure databases, advanced concepts and approaches in database construction and management, knowledge discovery and data mining, introduction to protein data base (PDB), nucleic acid databases at NCBI.
UNIT III: Genetic algorithms, sequence alignment and search, introduction to genetic algorithms, concepts and approaches, alignment algorithms - global, linear space, map and multiple sequences, evolutionary basis of sequence alignment, score matrices, statistical significance of alignment, low-complexity regions, repetitive elements, motifs and patterns, multiple and progressive alignment methods, Hidden Markov Model (HMM) and threading theory, database similarity searching, FASTA and BLAST, dynamic programming.
UNIT IV: Phylogenetic analysis – elements of phylogenetic models, phylogenetic data analysis, tree building and tree evolution.
UNIT V: Comparative, structural and functional genomics – genome and comparative genome sequencing-methods and platforms, nature of raw genome sequence data, expressed sequence tags (ESTs), SAGE, MPSS and 454 sequence gene tags, polymorphism, DNA chips and comparative genomics, genome annotation-approaches and concepts, genome-wide maps from large community of data, use of sequences in drug design and prediction of forms, cluster analysis, neural networks and artificial intelligence.
Practical: Post sequence analysis; introduction to genomic data and data organization; comparative genome organization; comparative genome analysis and post-genomic biology; homologous sequences and scoring matrices; sequence comparison and multiple sequence alignments; homologous search algorithms; BLAST, FASTA and SENSEI; sequence to trees; metabolic reconstruction; integration of sequence and metabolic data; homologous modeling-protein structure prediction; related software packages.

BIOTECH 573 MOLECULAR BREEDING 2+0

Theory

UNIT I: Plant genome – nuclear and cytoplasmic, significance of organelle genomes, genome size and sequence components, modern gene concept - gene structure, structural and functional genes.
UNIT II: Molecular markers – restriction based and PCR based, DNA profiling using different assays-RFLP, RAPD, AFLP, ISSR, SNP etc., development of SCAR and SSR markers.
UNIT III: Gene flow in plants – development of mapping populations, mapping genes on specific chromosomes, QTL mapping, gene pyramiding, transcript mapping techniques, development of ESTs, marker assisted selection (MAS), screening and validation, trait related markers and characterization of genes involved.
UNIT IV: Molecular markers for plant genotyping and germplasm analysis, fidelity analysis, settling IPR issues, marker assisted breeding in transgenics – herbicide resistance, pest and disease resistance, quality enhancement etc.
UNIT V: Recent advances – non gel based techniques for plant genotyping – homogenous assays – qualitative/real time assays, DNA chip and its technology.

BIOTECH 574 LAB ON PLANT TISSUE CULTURE AND TRANSGENIC TECHNOLOGIES 0+2

Practical: Preparation of Murashige and Skoog medium; stocks of macronutrients; micronutrients; vitamins and hormones; autoclaving; filter sterilization of hormones and antibiotics; surface-sterilization of seeds; establishment of axenic plants; acclimatization of tissue culture plants and establishment in greenhouse; callus induction in tobacco leaf discs, regeneration of shoots, root induction; role of hormones in morphogenesis; isolation of plasmids with reporter (*gus*) gene; preparation of

microprojectiles; transformation using a particle gun; GUS staining; leaf disc transformation using *Agrobacterium*, establishment of transgenic plants, and GUS staining or GFP viewing; DNA extraction from transgenic plants, DNA estimation; PCR analysis; southern blot analysis to prove T-DNA integration, RT-PCR to study transgene expression, western blotting to study the accumulation of transgene-encoded protein.

BIOTECH 591 MASTER'S SEMINAR **1+0**
BIOTECH 592 SPECIAL PROBLEM IN M.Sc. **0+1**
BIOTECH 599 MASTER'S RESEARCH **0+20**

BIOTECH 601 GENE CLONING **1+1**

Theory: Advent of gene cloning-tools and techniques-vehicles, plasmids and phages-purification of DNA from living cells-total cell, plasmid and phage DNAs-polymerase chain reaction (PCR) for DNA amplification, pulsed-field electrophoresis for separation of large DNA molecules, manipulation of DNA-purification of enzymes involved, introduction of DNA into host cells and selection, cloning vectors for *E. coli*, fungi, yeast, higher plants and mammalian cells-Strategies for obtaining the clone of choice-direct selection-selection from gene library, methods of clone identification-restriction mapping-study of cloned gene expression and sequencing, cloning PCR or AFLP product after electrophoresis-positional cloning-uses of gene cloning in research, applications in biotechnology.

Practical: Culturing of plasmid borne bacteria/lambda phage-extraction of plasmid/lambda DNA-restriction analysis of vector DNA-elution of insert of designed DNA product-ligation of exogenous DNA-transformation of *E. coli*-screening for transformants-mass multiplication of transformant-analysis of transformant DNA.

BIOTECH 602 METABOLIC PATHWAY ENGINEERING **1+0**

Theory: Plant cell development and metabolism, manipulation of metabolic partitioning in transgenic plants, manipulation of plant development-flower development, fruit ripening, seed storage proteins, seed oil composition and production, genetic engineering of polyamine metabolism, genetic engineering of metabolic pathway in medicinal plants like *Catharanthus, Atropa belladona* etc., manipulation of chalcone synthase pathway, transgenic plants for the production of biodegradable plastics, metabolic pathway engineering in cotton, biosynthesis of polyhydroxy butyrate fibres, molecular pharming-transgenic plants for the production of recombinant antibodies, vaccines etc.

BIOTECH 603 MOLECULAR MARKER TECHNOLOGY **2+1**

Theory: Composition of genome - molecular dissection of genome, molecular markers for genome analysis, kinds of molecular markers - protein markers, merits and demerits and their applications in different fields of molecular biology - isozyme markers, merits and demerits, their application in molecular biology - DNA markers, different kinds-hybridization based, PCR based markers, methods of high-throughput marker genotyping, genome selection, linkage mapping-development of mapping populations, F2s, backcrosses, NILs, RILs and DH lines - choice of mapping population- linkage map construction, applications of markers in mapping of agronomically important traits, marker assisted selection (MAS) in backcross and heterosis breeding, foreground and background selection, MARS, MAS for gene introgression and pyramiding, MAS for specific traits with examples, application of molecular markers in characterization and management of plant genetic resources-choice of molecular marker for germplasm characterization-examples of markers used in genetic resource management, applications of molecular markers in detection of GMOs, IPR etc.

Practical: Isolation of plant DNA; spectrophotometric and gel quantitation of DNA; restriction digestion; agarose gel electrophoresis; hybridization; autoradiograph development (conventional X-ray film and phosphorimager); extraction of proteins and their characterization through SDS-PAGE and isozyme

analysis; analysis of DNA markers-RAPD, RFLP, AFLP, SSR, STS and SNP markers; other PCR based markers.

BIOTECH 604 ADVANCES IN PLANT CELL AND TISSUE CULTURE TECHNOLOGY 2+1

Theory : Plant cells, tissue and their systems-structure of reproductive and vegetative organs-cell division and Influence on growth and development-nutrition of plant tissues-growth limiting factors, plant growth regulators, mode of action, effects on *in vitro* culture and regeneration, high frequency regeneration and morphogenesis-somatic embryogenesis-molecular aspects-cell suspension culture-cell culture techniques, regeneration techniques, totipotency-recalcitrance-plant cell cloning-cell plating- *in vitro* mutagenesis-production of secondary metabolites-batch culture-single cell culture, histo- and immunochemical techniques, cytogenetic analysis of plant cells-fluorescence staining-autoradiography-protoplast-genetic manipulation and protoplast-fusion-cybrids and hybrids-molecular approaches-*in vitro* toxicity testing related to mutagens-large scale clonal propagation of plants, applications-haploidy breeding, ploidy manipulation-somaclonal and gametoclonal variation, wide hybridization and embryo rescue, *in vitro* fertilization-cryopreservation and germplasm conservation-storage-artificial seed production and applications-automation in *in vitro* culture-prospects.

Practical: Establishment and maintenance of callus and suspension cultures; identification of embryogenic and non-embryogenic calli-embryoids; somatic embryogenesis; haploid induction and characterization; protoplast isolation and fusion techniques; hybrid identification; embryo rescue; multiple shoot induction and calli regeneration and establishment.

BIOTECH 605 COMMERCIAL BIOTECHNOLOGY 1+1

Theory: Microbial technology-fermentation process-fermentors-types-design of equipments-products recovery-methods of production and improvement through biotechnological tools- bioconversion types-applications-industrial production of nucleosides-nucleotides-enzymes-xylanases, heat stable b-glucanase-phytase-antibiotics - biofertilizers-biopesticides-regulation of *B. thuringiensis* protein production-single cell proteins, pharmaceutical proteins-downstream processing of proteins-human blood proteins and human lysosomal proteins expression in transgenic plants-commercialization of transgenic plants producing pharmaceutical proteins-expression of antibody in plants for immunotherapy-microbial control of environmental pollution.

Practical: Isolation and characterization of antibiotic-producing microorganisms; microbial production of IAA/GA; fermentors-design and operation, fermentation techniques for biofertilizers/biopesticides production; microbial enzymes of industrial importance, immobilization techniques,selection of *Thermus aquaticus* and multiplication, production of taq polymerase, production of single cell protein.

BIOTECH 606 ADVANCES IN GENETIC ENGINEERING FOR STRESS TOLERANCE 3+0

Theory: Importance of biotic and abiotic stresses in crop production, biotic stress responses, molecular biology of plant-pathogen interactions, role of programmed cell death in defense, molecular biology of *Rhizobium* and *Agrobacterium*- plant interactions, genetic engineering in stress management- gene isolation techniques-isolation and characterization of resistance genes to biotic stresses (fungal, bacterial and viral diseases), insect resistance genes-plant derived-enzyme inhibitors -protease inhibitors, trypsin inhibitors-α-amylase inhibitors, lectins, terpenes and terpenoids, genes of non plant origin- *Bacillus thuringiensis* endotoxins-mode of action-c*ry* genes-classification and properties, other toxin genes, genes derived from entomophagous viruses, effect of transgenic plants on pest biology and development, genetic engineering for nematode resistance, genetic engineering for herbicide resistance, abiotic stress – water (excess and low), temperature (chilling and heat), salinity, problem soils, stress tolerance mechanisms, genetic engineering for abiotic stress management, N_2 fixing genes-*nif* genes-pyramiding of genes and their expression-problems of expression.

BIOTECH 607 BIOSAFETY AND PATENT LAWS 1+0

Theory: Biological risk assessment-biosafety guidelines for genetically modified microorganisms (GMM)/Plants(GMP)-risk assessment and contained use of GMM and GMPs-guidelines for research activities-import and shipment-quality control of biologicals produced by rDNA technology-guidelines for environmental release of GMM and GMP-safety in the contained use and release of transgenic animals-mechanism of implementation of biosafety guidelines-at institutional, national and international level-DBT guidelines-acts and treaties related to biosafety of GMM and GMPs-public awareness perception and acceptance of products of biotechnology-global scenario of transgenic microorganisms and plants-intellectual property rights-patent laws at national and international level-ethical issues related to biotechnology products-ecological risks of engineered microorganisms and remedies.

BIOTECH 608 TRANSGENIC PLANT TECHNOLOGY 2+1

Theory: Plant genomes-their organisation-variation in genome size-cytosine methylation-methylation-sensitive restriction endonucleases, organization of genome into chromosomes-tandem array of repeats-telomeres-centromeres-origins of replication-cytoplasmic organelle DNA-evolution of repetitive sequences, plant transformation systems-classification-evolution of the systems-expression signals and vectors-selectable marker and reporter genes-*Agrobacterium*-mediated transfer-direct gene transfers-vectors for transformation-molecular genetics of T-DNA transfer from *Agrobacterium* to plants-comparison of vector-mediated and vector-free methods, recombinant DNA technology for enhanced gene expression, use of promoter elements from heterologous sources, plant pathogens as sources of restriction enzymes, promoter elements, retention signals, use of endoplasmic retention signals, KDEL sequences, TMV W-elements for optimized gene expression, transgene transcription-role of post-transcriptional control in transgenic gene design, accumulation of solid proteins in the endomembrane system of plants-downstream processing of proteins from transgenic plants, transgene stability, gene tagging in transgenic plants-analysis of transgenic plants-standard molecular techniques for the analysis of transgenic plants, patents and transgenic plants-release of transgenic plants, regulations and developments.

Practical: *Agrobacterium* plant transformation vector construction using CAMBIA vectors; vector design and construction for biolistic method, gene transfers using both the methods; isolation of genomic DNA from transgenic plants; isolation of total RNA from plant tissues; PCR analyses for transgene detection, southern analyses for transgene detection, northern analyses for transgene detection, western analyses for transgene detection.

BIOTECH 691 DOCTORAL SEMINAR 1+0
BIOTECH 692 SPECIAL PROBLEM IN Ph.D. 0+1
BIOTECH 699 DOCTORAL RESEARCH 0+45

AGRICULTURAL ECONOMICS, EXTENSION EDUCATION & RURAL SOCIOLOGY

http://hillagric.ac.in/edu/coa/AgriEcoExtEduRSocio/index.htm

A. AGRICULTURAL ECONOMICS

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
AG ECON 501*	MICRO ECONOMIC THEORY AND APPLICATIONS	2+0	I
AG ECON 502*	MACRO ECONOMICS AND POLICY	2+0	I
AG ECON 503	EVOLUTION OF ECONOMIC THOUGHT	1+0	I
AG ECON 504*	AGRICULTURAL PRODUCTION ECONOMICS	1+1	I&II
AG ECON 505	AGRICULTURAL MARKETING & PRICE ANALYSIS	2+1	I
AG ECON 506*	RESEARCH METHODOLOGY FOR SOCIAL SCIENCES	1+1	I
AG ECON 507*	ECONOMETRICS	2+1	II
AG ECON 508	LINEAR PROGRAMMING	1+1	II
AG ECON 509	AGRICULTURAL FINANCE AND PROJECT MANAGEMENT	2+1	II
AG ECON 511	INTERNATIONAL ECONOMICS	1+1	I
AG ECON 512	INSTITUTIONAL ECONOMICS	1+0	II
AG ECON 513	AGRICULTURAL DEVELOPMENT AND POLICY ANALYSIS	2+0	I &II
AG ECON 514	NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS	1+1	II
AG ECON 515	INTELLECTUAL PROPERTY MANAGEMENT	1+0	I
AG ECON 517	RURAL MARKETING	2+0	I
AG ECON 518	COMMODITY FUTURES TRADING	2+0	I&II
AG ECON 591	MASTER'S SEMINAR	1+0	I&II
AG ECON 592	SPECIAL PROBLEM IN M.Sc.	0+1	I&II
AG ECON 599	MASTER'S RESEARCH	0+20	I&II
AG ECON 601**	ADVANCED MICRO-ECONOMIC ANALYSIS	2+0	II
AG ECON 602**	ADVANCED MACRO-ECONOMIC ANALYSIS	2+0	II
AG ECON 603**	ADVANCED ECONOMETRICS	2+1	II
AG ECON 604**	ADVANCED PRODUCTION ECONOMICS	2+1	I
AG ECON 605	QUANTITATIVE DEVELOPMENT POLICY ANALYSIS	1+1	II
AG ECON 606	ADVANCED AGRICULTURAL MARKETING AND PRICE ANALYSIS	2+1	II
AG ECON 609	NATURAL RESOURCE MANAGEMENT	1+1	II
AG ECON 610	ENVIRONMENTAL ECONOMICS	2+0	I
AG ECON 611**	OPERATIONS RESEARCH IN AGRICULTURE-I	2+1	II
AG ECON 612	OPERATIONS RESEARCH IN AGRICULTURE-II	2+1	I

AG ECON 691	DOCTORAL SEMINAR I	1+0	I&II
AG ECON 692	DOCTORAL SEMINAR II	1+0	I&II
AG ECON 693	SPECIAL PROBLEM IN Ph.D.	0+1	I&II
AG ECON 699	DOCTORAL RESEARCH	0+45	I&II

*Compulsory for Master's Programme ** Compulsory for Doctoral Programme

A. AGRICULTURAL ECONOMICS

Course contents

AG ECON 501 MICRO ECONOMIC THEORY AND APPLICATIONS 2+0

Theory: Theory of consumer behaviour - cardinal utility approach - ordinal utility approach, income effect and substitution effect – applications of indifference curve approach, revealed preference hypothesis, consumer surplus, derivation of demand curve, elasticity of demand, theory of production, law of diminishing returns, returns to scale and economies of scale, technical progress; theory of costs, cost curves and their relationships, law of supply, producers' surplus; market equilibrium, behaviour of firms in competitive markets, perfect competition, effect of taxation and subsidies on market equilibrium, monopoly, monopolistic and oligopoly, theory of factor markets, general equilibrium theory, welfare economics, Pareto optimality, social welfare criteria - social welfare functions.

AG ECON 502 MACRO ECONOMICS AND POLICY 2+0

Theory: Nature and scope of macro economics, methodology and Keynesian concepts, National income, concepts and measurement, classical theory of employment and Say's law, modern theory of employment and effective demand, consumption function - investment and savings, concept of multiplier and accelerator, output and employment, rate of interest, classical, neo classical and Keynesian version-classical theory Vs Keynesian theory – unemployment and full employment, money, classical theories of money and price, Keynesian theory of money and Friedman restatement theory of money, supply of money, demand for money, inflation, nature, effects and control, IS & LM frame work, general equilibrium of product and money markets, monetary policy, fiscal policy, effectiveness of monetary and fiscal policy, central banking, business cycles, balance of payment, foreign exchange rate determination.

AG ECON 503 EVOLUTION OF ECONOMIC THOUGHT 1+0

Theory: Approaches for the study of history of economic thought, absolutist vs relativist approaches, evolution of economic thought vs economic history, ancient economic thought, medieval economic thought, mercantilism physiocracy, forerunners of classical political economy, development of classical thoughts (Adam Smith, Robert Malthus and David Ricardo), critics of classical thoughts, socialist critics, socialist and Marxian, economic ideas – Austrian school of thought, origin of formal micro economic analysis (William Stanley, Jevons, Cournot and Dupuit), the birth of neoclassical economic thought – Marshall and Walras, general equilibrium theory, welfare theory, Keynesian economics, the era of globalization, experiences of developing world, rigidity of the past vs. emerging realism, the changing path of international institutions to economic growth and development approaches, economic thought in India – Naoroji and Gokhale – Gandhian economics, economic thought of independent India, Nehru's economic philosophy, experiences of the structural adjustment programmes of the post liberalization era.

AG ECON 504 AGRICULTURAL PRODUCTION ECONOMICS 1+1

Theory: Nature, scope and significance of agricultural production economics, methodology of production function, centrality of production functions, assumptions of production functions, forms, properties, limitations, specification, estimation and interpretation of commonly used production functions, factors of production, classification, interdependence, and factor substitution, determination of optimal levels of production and factor application, optimal factor combination and least cost combination of production, theory of product choice, selection of optimal product combination, cost functions and cost curves, components, and cost minimization, duality theory, cost and production functions and its applications, derivation of firm's input demand and output supply functions, economies and diseconomies of scale, technology in agricultural production, nature and effects and measurement, measuring efficiency in agricultural production, technical, allocative and economic efficiencies, yield gap analysis, concepts, types and measurement, nature and sources of risk, modelling and coping strategies.

Practical: Different forms of production functions – specification; estimation and interpretation of production functions – returns to scale, factor shares; elasticity of production - physical optima-economic optima - least cost combination - optimal product choice- cost function estimation, interpretation - estimation of yield gap; incorporation of technology in production functions, measurement of efficiencies - measuring returns to scale and risk analysis.

AG ECON 505 AGRICULTURAL MARKETING AND PRICE ANALYSIS 2+1

Theory: Review of concepts in agricultural marketing, characteristic of agricultural products and production, problems in agricultural marketing from demand, supply and institutions sides, market intermediaries and their role, need for regulation in the present context - marketable & marketed surplus estimation, marketing efficiency, structure, conduct and performance analysis, vertical and horizontal integration, integration over space, time and form, vertical coordination, marketing co-operatives – APMC regulated markets, direct marketing, contract farming and retailing, supply chain management: state trading, warehousing and other government agencies, performance and strategies, market infrastructure needs, performance and government role, value chain finance, role of information technology and telecommunication in marketing of agricultural commodities, market research, market information service, electronic auctions (e-bay), e-*Choupals,* Ag-market and domestic and export market intelligence cell (DEMIC), market extension, spatial and temporal price relationship, price forecasting, time series analysis, time series models, spectral analysis, price policy and economic development, non-price instruments, theory of storage, introduction to commodities markets and future trading, basics of commodity futures, operation mechanism of commodity markets, price discovery - hedging and fundamental analysis , technical analysis, role of government in promoting commodity trading and regulatory measures.

Practical: Supply and demand elasticities in relation to problems in agricultural marketing; price spread and marketing efficiency analysis; marketing structure analysis through concentration ratios; performance analysis of regulated markets and marketing societies; analysis on contract farming and supply chain management of different agricultural commodities, milk and poultry products; chain analysis - quantitative estimation of supply chain efficiency - market intelligence characters, accessibility, and availability; price forecasting; online searches for market information sources and interpretation of market intelligence reports – commodity outlook; technical analysis for important agricultural commodities; fundamental analysis for important agricultural commodities; presentation of the survey results and wrap-up discussion, operational mechanism of future markets.

AG ECON 506 RESEARCH METHODOLOGY FOR SOCIAL SCIENCES 1+1

Theory: Importance and scope of research in agricultural economics, types of research-fundamental vs applied, concept of researchable problem – research prioritization – selection of research problem, approach to research – research process, hypothesis – meaning - characteristics - types of hypothesis, review of literature – setting of objective and hypotheses of research problem - testing of hypothesis, sampling theory and sampling design – sampling error-methods of sampling – probability and non-probability sampling methods - criteria to choose, project proposals – contents and scope – different types of projects to meet different needs – trade - off between scope and cost of the study, research design and techniques – types of research design, data collection – assessment of data needs – sources of data collection – discussion of different situations, mailed questionnaire and interview schedule – structured, unstructured, open ended and closed-ended questions, scaling techniques, preparation of schedule – problems in measurement of variables in agriculture, interviewing techniques and field problems, methods of conducting survey – reconnaissance survey and pre testing, coding, editing – tabulation – validation of data, tools of analysis – data processing, interpretation of results – preparing research report / thesis, universal procedures for preparation of bibliography, writing of research articles.

Practical: Exercises in problem identification; project proposals – contents and scope; formulation of objective and hypotheses; assessment of data needs – sources of data – methods of collection of data;

methods of sampling – criteria to choose – discussion on sampling under different situations; scaling techniques – measurement of scale; preparation of interview schedule - field testing; method of conducting survey; exercise on coding, editing, tabulation and validation of data, preparing for data entry into computer; hypothesis testing – parametric and non-parametric tests; exercises on format for thesis / report writing, presentation of the results.

AG ECON 507 ECONOMETRICS 2+1

Theory: Introduction – relationship between economic theory, mathematical economics, models and econometrics, methodology of econometrics, regression analysis, basic two variable regression – assumptions, estimation and interpretation approaches to estimation – OLS, MLE and their properties, extensions to multi variable models-multiple regression estimation and interpretation, violation of assumptions – identification, consequences and remedies for multicollinearity, heteroscedasticity, autocorrelation – data problems and remedial approaches - model mis-specification, use of dummy variables-limited dependent variables – specification, estimation and interpretation, simultaneous equation models – structural equations - reduced form equations - identification and approaches to estimation.

Practical: Single equation two variable model specification and estimation – hypothesis testing-transformations of functional forms and OLS application - estimation of multiple regression model - hypothesis testing - testing and correcting specification errors - testing and managing multicollinearity - testing and managing heteroscedasticity - testing and managing autocorrelation; estimation of regressions with dummy variables - estimation of regression with limited dependent variable - identification of equations in simultaneous equation systems.

AG ECON 508 LINEAR PROGRAMMING 1+1

Theory: Decision making - concepts of decision making, introduction to quantitative tools, introduction to linear programming, uses of linear programming in different fields, graphic solution to problems, formulation of problems, simplex method, concept of simplex method, solving profit maximization and cost minimizations problems, formulation of problems in agriculture sector as linear programming models and solutions, extension of linear programming models, variable resource and price programming, transportation problems, recursive programming, dynamic programming. Game theory - concepts of game theory, two person's constant sum, zero sum game, saddle point, solution to mixed strategies, the rectangular game as linear programming, basic concepts in assignment model, inventory model, CPM and PERT.

Practical: Graphical and algebraic formulation of linear programming models; solving of maximization and minimization problems by simplex method, formulation of the simplex matrices for typical farm situations; problems related to transportation; game theory and inventory management.

AG ECON 509 AGRICULTURAL FINANCE AND PROJECT MANAGEMENT 2+1

Theory: Role and importance of agricultural finance, financial institutions and credit flow to rural/priority sector, agricultural lending – direct and indirect financing - financing through co-operatives, NABARD and commercial banks and RRBs, district credit plan and lending to agriculture/priority sector, micro - financing and role of MFI's - NGO's, and SHG's, lending to farmers – the concept of 3 R's, 3 C's, and 7 P's of credit, estimation of technical feasibility, economic viability and repaying capacity of borrowers and appraisal of credit proposals, supervisory credit system, credit inclusions – credit widening and credit deepening, financial decisions – investment, financing, liquidity and solvency, preparation of financial statements - balance sheet, cash flow statement and profit and loss account, ratio analysis and assessing the performance of farm/firm, risks in financing agriculture, risk management strategies and coping mechanism, crop insurance programmes – review of different crop insurance schemes – yield loss and weather based insurance and their applications, project approach in financing agriculture, financial,

economic and environmental appraisal of investment projects, identification, preparation, appraisal, financing and implementation of projects, project appraisal techniques – undiscounted measures, time value of money – use of discounted measures, B-C ratio, NPV and IRR, agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects, network techniques – PERT and CPM.

Practical: Study of rural institutional lending - branch expansion; demand and supply of institutional agricultural credit and over dues - an overview, rural lending programmes of commercial banks; preparation of district credit plan; co-operative credit , preparation of financial statements using farm level data; farm credit appraisal techniques and farm financial analysis; performance of micro financing institutions; identification and formulation of investment projects; project appraisal techniques; financial risk and risk management strategies – crop insurance schemes,

AG ECON 511 INTERNATIONAL ECONOMICS 1+1

Theory: Scope and significance of international economics - the role of trade - general equilibrium in a closed economy (autarky equilibrium) – equilibrium in a simple open economy - possibility of world trade - trade gains and trade equilibrium, tariff, producer subsidy, export subsidy, import quota and export voluntary restraints - the case of small country and large country case, Ricardian model of trade - specific factors model- Heckscher - Ohlin model - trade creation and trade diversion – offer curve - export supply elasticity and import demand elasticity - comparative advantage and absolute advantage, official exchange rate and shadow exchange rate – Walras' law and terms of trade – trade blocks, IMF, World Bank, IDA, IFC, ADB – international trade agreements – Uruguay round – the GATT and WTO.

Practical: Producer's surplus; consumer's surplus; national welfare under autarky and free trade equilibrium with small and large country assumption - estimation of trade gains- estimation of competitive and comparative measures like NPC, EPC; ERP and DRC- estimation of offer curve elasticity - estimation of effect of tariff, export subsidy; producer subsidy; import quota and export voluntary restraints on national welfare; estimation of Ricardian model - estimation of effect of trade under specific factor model; estimation of trade equilibrium under Heckscher - Ohlin model - trade creation and diversion.

AG ECON 512 INSTITUTIONAL ECONOMICS 1+0

Theory: Old and new institutional economics-institutional economics vs neo-classical economics, definition of institutions – distinction between institutions and organizations -institutional evolution, institutional change and economic performance - national and international economic institutions, transaction cost economics – transaction costs and the allocation of resources, transaction costs and efficiency, asymmetric information - moral hazard and principal - agent problem, free rider problem – path dependency – interlinked transactions, collective action and the elimination of free - rider problem - the logic of collective action and its role in reducing free rider problem – theory of groups, rent seeking – interest groups and policy formulation, economic analysis of property rights - property rights regimes – private property – state property - common property resources (CPRs) – public goods and club goods, special features of institutional arrangements in agriculture – transaction costs in agriculture - case studies - theories of agrarian institutions - tenancy institutions.

AG ECON 513 AGRICULTURAL DEVELOPMENT AND POLICY ANALYSIS 2+0

Theory: Development economics – scope and importance - economic development and economic growth - divergence in concept and approach - indicators and measurement of economic development – GNP as a measure of economic growth – new measures of welfare – NEW and MEW – PQLI – HDI – green GNP - criteria for under development – obstacles to economic development, economic and non-economic factors of economic growth, economic development – meaning, stages of economic development, determinants of economic growth, theories of economic growth – Ricardian growth model – the Harrod – Domar model – the neo classical model of growth – the Kaldor model – optimal economic

growth – recent experiences of developing country economies in transition – role of state in economic development – government measures to promote economic development, introduction to development planning, role of agriculture in economic /rural development – theories of agricultural development – population and food supply - need for sound agricultural policies – resource policies – credit policies – input and product marketing policies – price policies, development issues, poverty, inequality, unemployment and environmental degradation – models of agricultural development – induced innovation model - policy options for sustainable agricultural development.

AG ECON 514 NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS 1+1

Theory: Concepts, classification and problems of natural resource economics, economy- environment interaction – the material balance principle, entropy law- resources scarcity - limits to growth - measuring and mitigating natural resource scarcity – Malthusian and Recardian scarcity – scarcity indices - resource scarcity and technical change - theory of optimal extraction, renewable resources – economic models of oil extraction - efficiency - time path of prices and extraction - Hotelling's rule, Solow-Harwick's rule, theory of optimal extraction, exhaustible resources – economic models of forestry and fishery, efficiency and markets – market failures - externalities – types - property rights –transaction costs – Coase's theorem and its critique - public goods – common property and open access resource management - collective action, environmental perspectives - biocentrism, sustainability, anthropocentrism - environmental problems and quality of environment - sources and types of pollution - air, water, solid waste, land degradation – environmental and economic impacts - economics of pollution control - efficient reduction in environmental pollution, environmental regulation – economic instruments - pollution charges – Pigovian tax - tradable permits – indirect instruments - environmental legislations in India, concept of sustainable development - economic perspective - indicators of sustainability relation between development and environment stress- environmental Kuznet's curve, environmental accounting – resource accounting methods - international environmental issues – climate change – likely impacts - mitigation efforts and international treaties.

Practical: Exhaustible resource management –optimum rate of oil extraction; renewable resource management – optimum harvest of forestry/fishery, exercise on pollution abatement – I, exercise on pollution abatement – II, concepts in valuing the environment, taxonomy of valuation techniques; productivity change method –substitute cost method - Hedonic price method - travel cost method – contingent valuation methods; discount rate in natural resource management; environment impact assessment; visit to pollution control board.

AG ECON 515 INTELLECTUAL PROPERTY MANAGEMENT 1+0

Theory: World Trade Organization- Agreement on Agriculture (AoA) and Intellectual Property Rights (IPR) - importance of intellectual property management - IPR and economic growth - IPR and bio diversity - major areas of concern in intellectual property management - technology transfer and commercialization-forms of different intellectual properties generated by agricultural research discovery *versus i*nvention - patentability of biological inventions - method of agriculture and horticulture - procedure for patent protections: preparatory work, record keeping, writing a patent document, filing the patent document - types of patent application - patent application under the patent cooperation treaty (PCT), plant genetic resources - importance and conservation - *sui generics* system – plant varieties protection and farmers rights act- registration of extant varieties - registration and protection of new varieties / hybrids / essentially derived varieties - dispute prevention and settlement -farmers' rights, trademark- geographical indications of goods and commodities – copy right - designs – biodiversity protection, procedures for commercialization of technology - valuation, costs and pricing of technology - licensing and implementation of intellectual properties - procedures for commercialization – exclusive and non exclusive marketing rights-research exemption and benefit sharing .

AG ECON 517 RURAL MARKETING 2+0

Theory: Concept and scope of rural marketing, nature, type and characteristics of rural markets, potential of rural markets in India, socio - cultural, economic and institutional factors affecting rural marketing, factors affecting producers' surplus, rural consumer's behaviour - behaviour of rural consumers and farmers, buyer characteristics and buying behaviour, rural vs urban markets, rural marketing strategy - marketing of consumer durable and non-durable goods and services in the rural markets with special reference to product planning, product mix, pricing course objective, pricing policy and pricing strategy, product promotion - media planning, planning of distribution channels and organizing personal selling in rural market in India.

AG ECON 518 Commodity Futures Trading 2+0

Theory: History and evolution of commodity markets – terms and concepts: spot, forward and futures markets – factors influencing spot and future markets, speculatory mechanism in commodity futures, transaction and settlement – delivery mechanism - role of different agents -trading strategies - potential impact of interest rate, foreign exchange, FDI in commodity markets, risk in commodity trading, importance and need for risk management measures - managing market price risk: hedging, speculation, arbitrage, swaps - pricing and their features, important Indian commodity exchanges - contracts traded – special features - regulation of Indian commodity exchanges - FMC and its role, fundamental vs technical analysis – construction and interpretation of charts and chart patterns for analyzing the market trend – market indicators – back testing, introduction to technical analysis software – analyzing trading pattern of different commodity groups.

AG ECON 591 MASTER'S SEMINAR 1+0
AG ECON 592 SPECIAL PROBLEM IN M.Sc. 0+1
AG ECON 599 MASTER'S RESEARCH 0 +20

AG ECON 601 ADVANCED MICRO ECONOMIC ANALYSIS 2+0

Theory: Theory of consumer behaviour – duality in consumer theory – expenditure function and indirect utility function - measurement of income effect and substitution effect, measurement of changes in consumers' welfare – consumer's surplus, compensating variation and equivalent variation – dynamic versions of demand functions – integrability of demand functions, demand models – linear expenditure system, almost ideal demand system, applications of consumer theory – household model and time allocation – labour supply decisions by households, perfect competition – monopoly, monopolistic competition and oligopoly, oligopoly models – collusive and non-collusive models of oligopoly – Cournot model, Chamberlin model, Stackleberg solution, general equilibrium theory – conceptual overview - general equilibrium conditions with production and consumption , existence, uniqueness and stability of general competitive equilibrium, Walrasian general equilibrium – mathematical derivation of conditions for general equilibrium, market failure - incomplete markets - asymmetric information – principal-agent problem, adverse selection and moral hazard, externalities – network externalities - public goods – optimal provision of public goods, welfare economics - concepts, problems, approaches and limitations of welfare economics, Pareto conditions of maximum welfare – criteria for social welfare - social welfare functions, social versus private costs and benefits.

AG ECON 602 ADVANCED MACRO ECONOMICS ANALYSIS 2+0

Theory: Review of macro economics concepts-comparative statistics- Keynesian theory - consumption function and theories of consumption - saving function and theories of saving, theories of investment - savings and investment equality - IS - LM framework and its demand for and supply of money - monetary policy in the static model – inflation, stagflation and supply side economics - theory of unemployment – phillips curve controversy – inflation, productivity and distribution - fiscal policy: effectiveness and

problems, social accounting matrix framework - general equilibrium analysis - neo classical macro economics - stochastic macro economics, BOP & adjustment policies - foreign exchange policy - foreign sector : capital and current account - impact of WTO on Indian economy - impact of IMF & IBRD on Indian economy - review of macroeconomic policies in India.

AG ECON 603 ADVANCED ECONOMETRICS 2+1

Theory: Review of classical regression model – review of hypothesis testing – restrictions on parameters – single equation techniques; ordinary least squares – weighted least squares - generalized least squares – method of principal components – instrumental variables method – maximum likelihood method - errors in variables, non-linearity and specification tests – non spherical error terms; dummy variables - qualitative and truncated dependent variables – limited dependent variables LPM, probit and logit models, their multinomial extensions; autoregressive distributed lag models – panel data fixed and random effects models and their extensions; simultaneous equation methods –identification – estimation by indirect least squares 2SLS, FIML, SURE, 3SLS.

Practical: Estimation of multiple regression model - GLS estimation methods – testing misspecification errors – testing and managing multicollinearity, heteroscedasticity and autocorrelation - estimation of LPM, logit and probit models - comparing two regressions - Chow test - estimation of distributed lag models – panel data random and fixed effects models - indirect least squares; 2SLS; SURE; 3SLS; estimation of simultaneous equation models

AG ECON 604 ADVANCED PRODUCTION ECONOMICS 2+1

Theory: Agricultural production process – relationship between farm planning and production economics-scope of agricultural production and planning- methods/procedures in agro-economic research and planning, production functions, components, assumptions, properties and their economic interpretation - concepts of homogeneity, homotheticity, APP, MPP, elasticities of substitution and their economic relevance – production relations – optimality - commonly used functional forms, nature, properties, limitations, estimation and interpretation -linear, Spillman - Cobb Douglas, quadratic, multiplicative (power) functional forms - translog, and transcendental functional forms - CES, production functional forms - conceptual and empirical issues in specification, estimation and application of production functions - analytical approaches to economic optimum -

determination with constant and varying input and output prices - economic optimum with production function analysis - input use behavior, decision making with multiple inputs and outputs – MRT and product relationship-cost of production and adjustment in output prices - single input and multiple product decisions - multi input, and multi product production decisions - decision making with no risk - cost of wrong decisions - cost curves – principles and importance of duality theory - correspondence of production, cost, and profit functions - principles and derivation of demand and supply functions, technology, input use and factor shares - effect of technology on input use, decomposition analysis - factor shares - estimation methods - economic efficiency in agricultural production – technical, allocative and economic efficiency – measurement -yield gaps analysis – concepts and measurement, risk and uncertainty in agriculture – incorporation of risk and uncertainty in decision making – risk and uncertainty and input use level-risk programming.

Practical: Estimation of different forms of production functions - optimal input and product choice from estimated functions - derivation of demand and supply functions and estimation -estimation of cost function and interpretations - optimal product and input choice under multi input and output system - estimation of factor shares from empirical functions estimated - estimating production functions incorporating technology changes: decomposition analysis and incorporation of technology - estimation of efficiency measures – stochastic; probabilistic and deterministic frontier production functions.

AG ECON 605 QUANTITATIVE DEVELOPMENT POLICY ANALYSIS 1+1

Theory: Policy framework – goals, value, beliefs and welfare maximization, market – policy and state – state vs market failure of policy – failure of markets - rationale for government intervention, role of

quantitative policy analysis, demand analysis for policymaking – alternative approaches to demand analysis – policy implications, supply response – alternative approaches to measurement of supply response – Nerlovian models of supply response – policy implications, household behaviour and policy analysis – household models, partial equilibrium analysis – concept of reference prices – price distortions – indicators and impact, transaction costs – implications for efficiency and productivity – institutional solutions - multi market approach to policy analysis, social accounting matrices and multipliers – computable general equilibrium models to assess economy wide impact of policy changes.

Practical: Review of criteria for policy evaluation – estimation of price elasticities – review of estimation of complete demand systems – estimation of Nerlovian supply response model – review of household models – specification and estimation of household models – partial equilibrium analysis – input–output table – social accounting matrix – construction of a SAM – computation of multipliers – multi market analysis – review of computable general equilibrium models.

AG ECON 606 ADVANCED AGRICULTURAL MARKETING AND PRICE ANALYSIS **2+1**

Theory: Importance of market analysis in the agricultural system - types of marketing- advantages and disadvantages - quantitative estimation - the distinguishing characteristics and role of agricultural prices - data sources for agricultural products and prices - software used in market analysis, role of various formal institutions in agricultural marketing - and functions - measuring their efficiency - public - private partnership – institutional arrangements, successful case studies, multi market estimation, supply response models. market integration and price transmission - supply / value chain management, gap analysis, current trends in information in the changing agrifood system, agricultural commodity marketing - spot and futures - marketing of derivatives - speculation, hedging, swap, arbitrage etc, commodity exchanges - price discovery and risk management in commodity markets, regulatory mechanism of futures trading, lag operators and difference equations, stationary and stochastic processes, unit roots and co integration, conditional heteroscedasticity: ARCH and GARCH models - forecast evaluation, methods of forecasting, price indices and econometric estimation and simulation.

Practical: Estimation of demand/ supply forecasting; supply chain /value chain analysis for different commodities - commodity models - multi market estimation- time series analysis - market integration studies - price discovery; price volatility estimation - commodity price forecasting using econometric softwares.

AG ECON 609 NATURAL RESOURCE MANAGEMENT **1+1**

Theory: Natural resources - definition - characteristics and classification, stock dynamics of renewable and non - renewable resources, equation of motion for renewable and non-renewable resources, fundamental equation of renewable resources, growth curves of fishery and forest resources, the role of time preference in natural resource use, simple two - period model of optimal use of renewable and non - renewable resources, advanced models of optimal resource use – static vs dynamic efficiency in natural resource use, applications of dynamic programming and optimal control, economics of groundwater use - optimal extraction of groundwater, analytical and numerical solutions for optimal inter - temporal allocation of natural resources, optimal harvesting of single rotation and multiple rotation forests, optimal management of fishery, property rights in natural resources and their implication for conservation and management of natural resources, management of common property natural resources – institutional arrangements for conservation and management of common pool fishery, groundwater and forestry resource, resource scarcity – natural resource degradation – poverty and resource degradation – natural resource accounting - pricing and valuation of natural resources – natural resources policy.

Practical: Derivation of the fundamental equation of renewable resources-estimation of growth curves and stock dynamics for fishery and forestry resources; simple two period problem of optimal resource use – numerical solution for simple two period model of dynamic efficiency in natural resource extraction, multi-period dynamic efficiency – using excel solver in solving dynamic natural resource harvesting;

problems using analytical solution procedures for solving natural resource management problems – optimal control.

AG ECON 610 ENVIRONMENTAL ECONOMICS 2+0

Theory: Environmental pollution as a consequence of market failure - causes and consequences of market failure - externalities - public goods and externalities - economics of pollution – private vs social cost of environmental pollution – property rights, environment and development – theory of environmental policy, environmental cost benefit analysis - environmental impact assessment techniques - non-market valuation of environmental resources (WTP / WTA) - environment, market and social welfare, economic growth and environmental cost - growth oriented economic policies and their environmental impacts - population and environmental quality – poverty and environmental degradation – sustainable development – indicators of sustainable development – issues in sustainable development, environment, ecology and environmental accounting - environmental pollution with respect to water and air - land and forest resources related environmental pollution - coastal externalities - urbanization and environment – basic approaches to environmental policy (tax, subsidy, pollution permits, etc.) green taxes - political economy of environmental regulation and management, transboundary environmental problems - economics of global warming, climate change and emission trading - environment, international trade and development.

Practical: Contemporary global environmental issues, movement; policies; programmes; laws and other regulatory mechanisms - criteria for evaluating the environment related projects and review of Environmental Impact Assessment (EIA) techniques; recreation demand models of environmental valuation - contingent valuation techniques - environmental resource accounting techniques - discussion on the techniques dealing with air pollution and review of case studies on air pollution and its impacts - forest environment and wild life conservation - green GDP and green house insurance - practical considerations and comparison of instruments of environmental policy - non-point source pollution control methodologies; environment in macroeconomic modeling - meta-analysis, economic valuation and environmental economics - multi-criteria methods for quantitative, qualitative and fuzzy evaluation problems related to environment - input output analysis, technology and the environment - computable general equilibrium models for environmental economics and policy analysis.

AG ECON 611 OPERATIONS RESEARCH IN AGRICULTURE I 2+1

Theory: Definition, importance and scope of operations research, the problem of decision-making in agriculture, nature and methods of operations research and their use in decision - making and research, mathematical programming and its application in agriculture, extensions of linear, recursive, dynamic and non linear programming, game theory, Markov chain, inventory analysis, simulation and transportation problems

Practical: Estimation of alternative farm plans with the help of various techniques; applications of inventory models to farm and livestock; application of game theory in agriculture decisions

AG ECON 612 OPERATIONS RESEARCH IN AGRICULTURE II 2+1

Theory: Categories of models, system terminology, static and dynamic deterministic models, static and dynamic stochastic models system approach, system analysis, system components, methods and related steps, alternative categories of models, system analysis relationship from empirical data system synthesis, input - output analysis, simulation, simulation methodology, perspective on application, application in agricultural economics model sensitivity, statistical assessment, decision theory, introduction to decision – analysis, concepts of utility and non linear preference, Bernoulli's principle, unidimensional and multidimensional utilities, procedures for decision analysis, Taylor series, approximation of utility functions, portfolio like analysis, risk response analysis

Practical: Computation of input - output models in agriculture; simulation techniques in agriculture; numericals from Bernoulli's principle; estimation techniques of portfolio models especially used in agriculture.

AG ECON 691	**DOCTORAL SEMINAR I**	**1+0**
AG ECON 692	**DOCTORAL SEMINAR II**	**1+0**
AG ECON 693	**SPECIAL PROBLEM IN Ph.D.**	**0+1**
AG ECON 699	**DOCTORAL RESEARCH**	**0+45**

B. EXTENSION EDUCATION

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
EXT 501*	DEVELOPMENT PERSPECTIVES OF EXTENSION EDUCATION	1+1	I
EXT 502*	DEVELOPMENT COMMUNICATION AND INFORMATION MANAGEMENT	2+1	I
EXT 503*	DIFFUSION AND ADOPTION OF INNOVATIONS	2+1	II
EXT 504*	RESEARCH METHODS IN BEHAVIOURAL SCIENCES	2+1	I
EXT 505*	E-EXTENSION	2+1	I
EXT 506*	ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT IN EXTENSION	2+1	II
EXT 507*	HUMAN RESOURCE DEVELOPMENT	2+1	I
EXT 508	VISUAL COMMUNICATION	2+1	I
EXT 509	PARTICIPATORY METHODS FOR TECHNOLOGY DEVELOPMENT AND TRANSFER	1+1	II
EXT 510	GENDER SENSITIZATION FOR DEVELOPMENT	1+1	I
EXT 511	PERSPECTIVES OF DISTANCE EDUCATION	1+1	II
EXT 512	MARKET-LED EXTENSION	1+1	I
EXT 591	MASTER'S SEMINAR	1+0	I&II
EXT 599	MASTER'S RESEARCH	0+20	I&II

*Compulsory Courses for Master's Programme

B. EXTENSION EDUCATION

Course contents

EXT 501 DEVELOPMENT PERSPECTIVES OF EXTENSION EDUCATION 1+1

Theory: Extension education – concepts, objectives, principles, philosophy, and critical analysis of definitions, extension education as a profession, adult education and distance education, pioneering extension efforts and their implications in Indian agricultural extension, analysis of extension systems – ICAR, SAU, State Departments, and NGOs, role of agricultural university in extension, poverty alleviation programmes – SGSY, SGRY, PMGSY, DPAP, DDP, CAPART, employment generation programmes – NREGP, women & child development programmes – ICDS, MSY, RMK, problems in rural development, current approaches in extension – decentralised decision making, bottom-up planning, farming system approach, broad based extension, market-led extension, farm field school, ATIC and kisan call centres.

Practical: Visit to gram panchayat to study on-going rural development programmes; visit to NGO and extension centres of SAU and state departments; bottom-up planning; report preparation and presentations.

EXT 502 DEVELOPMENT COMMUNICATION AND INFORMATION MANAGEMENT 2+1

Theory: Communication process – concept, elements and their characteristics, models and theories of communication, communication skills, fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, barriers in communication, message – meaning, dimensions of a message, characteristics of a good message, message treatment and effectiveness, distortion of message, development communication – meaning and characteristics ,methods of communication – meaning, functions, and classification, forms of communication – oral and written communication, non-verbal communication, interpersonal communication, organisational communication, key communicators – meaning, characteristics and their role in development. media in communication – role of mass media in dissemination of farm technology, effect of media mix for rural people, modern communication media – electronic video, tele text, tele conference, Computer Assisted Instruction, computer technology and its implications, agricultural journalism as a means of mass communication, its form and role in rural development, basics of writing – news stories, feature articles, magazine articles, farm bulletins and folders techniques of collection of materials for journalistic information, readability and comprehension testing procedures, photo journalism and communicating with pictures, radio and TV journalism, writing for farm radio and TV.

Practical: Development of message; development of oral/verbal communication skill; writing skills; distortion in communication; readability of farm literature; script writing for farm radio and TV.

EXT 503 DIFFUSION AND ADOPTION OF INNOVATIONS 2+1

Theory: Diffusion – concept and its elements, traditions and shortcomings of research on diffusion, the generation of innovations – innovation development process, the adoption process – concept, stages, and dynamic nature of stages, types of adoption and its measurement approaches, the innovation-decision process – meaning and critical appraisal, adopter categories – innovativeness, diffusion curve, categories, and characteristics of adopter categories,

innovation and technology cluster, perceived attributes of innovation, rate of adoption and factors influencing its rate of adoption, opinion leadership – measurement, characteristics, monomorphic and polymorphic opinion leadership, multi-step flow of innovation, concepts of homophily and heterophily and their influence on flow of innovations, types of innovation-decisions – optional, collective and authority and contingent innovation decisions, consequences of innovation-decisions – desirable or undesirable, direct or indirect, anticipated or unanticipated consequences.

Practical: Measurement of adoption; content analysis of adoption studies; development of adopter categories on a selected technology; study of attributes of current farm technologies; identification of opinion leaders; working through local leaders, drawing of diffusion curve; study of factors increasing or retarding the rate of adoption.

EXT 504 RESEARCH METHODS IN BEHAVIOURAL SCIENCES 2+1

Theory: Research – meaning, importance, characteristics, behavioural sciences research – concept and problems in behavioural sciences research, types and methods of research – fundamental, applied and action research, scientific methods – meaning, characteristics, and steps, research problem – meaning, formulation and guiding principles in the selection of research problem, criteria in selection of research problem, and development of theoretical orientation of the research problem, objectives – meaning, types and criteria for judging the objectives, theory and facts in behavioural research, variable – meaning, types and their role in research, definition – meaning, characteristics of workable definitions, types and their role in research, hypothesis – meaning, importance and functions of hypothesis in research, its types, problems in formulation and criteria for judging a workable hypothesis, measurement – meaning, levels, and use of appropriate statistics at different levels of measurement, reliability and validity of measuring instruments – meaning, types, and methods of testing, sampling – meaning, types, procedures, basis for sampling, advantages and limitations, and factors affecting the size of the sample, sampling errors – methods of elimination and minimizing, and maximincon principle, research designs – meaning, purpose and criteria for research design, types, advantages and limitations, data collection devices, interview – meaning, types, techniques of interviewing, advantages and limitations, schedule – meaning, types of questions used, steps in construction, its advantages and limitations, questionnaire – meaning, difference between schedule and questionnaire, types of questions to be used, pre-testing of the questionnaire & schedules, rating scales – meaning, types, and hints in construction, observation – meaning, types, tips in observation, advantages and limitations in its use, case studies – meaning, types, steps in conducting, advantages and limitations in its use, social survey – meaning, objectives, and steps in conducting, advantages and limitations, data processing – meaning, coding, preparation of master code sheet, analysis and tabulation of data, Statistical Package for Social Sciences (SPSS) – choosing appropriate statistics for data analysis based on the level of measurement of variables, report writing – guidelines to be followed in scientific report writing, and references in reporting.

Practical: Selection and formulation of research problem and objectives, selection of variables based on objectives; developing the conceptual framework of research; operationally defining the selected variables; development of data collection devices; testing the validity and reliability of the data collection instruments; pre-testing of the data collection instrument; techniques of interviewing and collection of data using the data collection instruments; data processing, hands on experiences on SPSS, coding, tabulation and analysis; formulation of secondary tables based on objectives of research; writing report, and presentation of reports.

EXT 505 E-EXTENSION 2+1

Theory: ICTs – concept, tools and its application in extension education, reorganising the extension efforts using ICTs, advantages, limitations and opportunities, ICTs projects, case studies in India and developing world, different approaches (models) to ICTs, ICT use in field of extension – expert systems on selected crops and enterprises, self learning CDs on package of practices, diseases & pest management, agricultural web sites & portals related crop production, marketing etc, community radio, web, tele, and video conferencing, computer aided extension, knowledge management, information kiosks, multimedia, online, offline extension, tools – mobile technologies, e-learning concepts, ICT extension approaches – pre-requisites, information and science needs of farming community, need integration, human resource information, intermediaries, basic e-extension training issues, ICT enabled extension pluralism, emerging issues in ICT.

Practical: Agril. content analysis of ICT Projects; handling of ICT tools; designing extension content; online extension service; project work on ICT enabled extension; and creation of extension blogs.

EXT 506 ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT IN EXTENSION 2+1

Theory: Entrepreneurship – concept, characteristics, theories, need for enterprises development, agri-entrepreneurship – concept, characteristics, nature, and importance for sustainable livelihoods, traits of entrepreneurs – risk taking, leadership, decision making, planning, organising, coordinating, and marketing, types of entrepreneurs, stages of establishing enterprise – identification of sound enterprise, steps to be considered in setting up an enterprise, feasibility report, product selection, risk and market analysis, legal requirements, project management and appraisal – market, technical, financial, social appraisal of projects, micro enterprises – profitable agri-enterprises in India – agro-processing, KVIC industries, micro financing – meaning, sources of finance, banks, small scale industries development organisations, marketing for enterprises – concept, planning for marketing, target marketing, competition, market survey and strategies, product sales and promotion, gender issues in entrepreneurship development – understanding gender and subordination of women, gender as a development tool, policy approaches for women entrepreneurship development, success and failure stories for enterprises – issues relating to success and failure of enterprises – personal, production, finance, social, marketing, management – concept, nature, importance, functions or process, approaches to management, levels of management, managerial skills, and principles, extension management – concept and importance, planning – meaning, elements, nature, importance, approaches, and steps, decision making – meaning, types of decisions, and steps in DM process, organising – meaning principles, organisational structure, span of management, departmentalisation, authority and responsibility, delegation and decentralisation, line and staff relations, coordination – meaning, need, types, and techniques, staffing – need and importance, manpower planning, recruitment, selection, placement and orientation, training and development, performance appraisal – meaning, and methods, direction – concept, principles, requirements of effective direction, giving orders, and techniques of direction, leadership – concept, characteristics, functions, approaches to leadership, leadership styles, organisational communication – concept, process, types, networks, barriers to communication, managing work motivation – concept, motivation

and performance, approaches to motivation, supervision – meaning, purpose, techniques, and tools of supervision, managerial control – meaning, process, types, techniques of control – budgeting, observation, PERT ,CPM and MIS.

Practical: Field visit to successful enterprises; study of characteristics of successful entrepreneurs; development of project proposal; case studies of success / failure enterprises; exercise on market survey; field visit to financial institutions; simulated exercise to understand management process; field visit to extension organizations to understand the functions of management; group exercise on development of short term and long term plan; simulated exercise on techniques of decision making; designing organisational structure; group activity on leadership development skills.

EXT 507 HUMAN RESOURCE DEVELOPMENT 2+1

Theory: Human resource development – meaning, definition, importance, scope and need for HRD, conceptual framework, interdisciplinary approach, function systems and case studies in HRD, HRD interventions – different experiences, selection, development & growth – selection, recruitment, induction staff training and development, career planning, social and organisational culture, Indian environment perspective on cultural process and social structure, society in transition, organizational and managerial values and ethics, organisational commitment, motivation productivity - job description – analysis and evaluation, performance appraisal,
human resource management – collective bargaining, negotiation skills, human resource accounting (HRA) – meaning and importance, information management for HRA and measurement in HRA, intrapersonal processes – collective behaviour, learning, and perception, stress and coping mechanisms, interpersonal process, helping process – communication and feedback and interpersonal styles, group & inter-group process- group information and group processes, organizational communication, team building process and functioning, conflict management, collaboration and competition, HRD & supervisors, task analysis, capacity building – counselling and mentoring, role of a professional manager – task of professional manager, responsibility of professional manager, managerial skills and soft skills required for extension workers, behavioural dynamics, group dynamics, training – meaning, determining training needs and development strategies, training types, models, methods and evaluation, facilities for training, trainers training, techniques for trainees participation, research studies in training extension personnel, main issues in HRD, HRD culture and climate – organising for HRD – emerging trends and prospective.

Practical: Visit to different training organizations to review on-going activities & facilities; analysis of training methods followed by training institutions for farmers and extension workers; studies on evaluation of training programmes; study of HRD in organization in terms of performance, organizational development, employees welfare and improving quality of work life and human resource information, presentation of reports.

EXT 508 VISUAL COMMUNICATION 2+1

Theory: Role of visuals & graphics in communication, characteristics of visuals & graphics, functions of visuals and graphics, theories of visual perception, classification and selection of visuals, designing message for visuals, graphic formats and devices, presentation of scientific data, principles and production of low cost visuals, photographs – reprographic visuals, PC based visuals, digitized video material in multimedia production, designing visuals for print and TV and video, pre-testing and evaluation of visuals, scanning of visuals.

Practical: Preparation of low cost projected and non-projected visuals; designing and layout of charts, posters, flash cards etc.; power point presentations; generating computer aided presentation graphics; scanning and evaluation of visuals.

EXT 509 PARTICIPATORY METHODS FOR TECHNOLOGY DEVELOPMENT AND TRANSFER 1+1

Theory: Participatory extension – importance, key features, principles and process of participatory approaches, different participatory approaches (RRA, PRA, PLA, AEA, PALM, PAR, PAME, FSR/E, FPR) and successful models, participatory tools and techniques, space related methods – village map (social & resource), mobility services and opportunities map and transect, time related methods – time line, trend analysis, seasonal diagram, daily activity schedule, and dream map, relational methods – cause and effect diagram (problem tree), impact diagram, well being ranking method, venn diagram, matrix ranking, livelihood analysis, preparation of action plans – concept and action plan preparation, participatory technology development and dissemination, participatory planning and management – phases and steps in planning and implementation aspects, process monitoring and participatory evaluation.

Practical: Simulated exercises on space related, time related and relational methods; documentation of PTD and dissemination; preparation of action plan; simulation exercise on participatory monitoring and evaluation of developmental programmes.

EXT 510 GENDER SENSITIZATION FOR DEVELOPMENT 1+1

Theory: Gender concepts, issues and challenges in development, gender roles, gender balance, status, need and scope, gender analysis tools and techniques, national policy for empowerment of women since independence, developmental programmes for women, gender mainstreaming in agriculture and allied sectors – need and relevance, gender budgeting – a tool for empowering women, women empowerment – dimensions, women empowerment through SHG approach, women entrepreneurship and its role in economic development, public private partnership for the economic empowerment of women, building rural institution for women empowerment, women human rights.

Practical: Visits to rural institutions of women for studying in the rural institutions engaged in women empowerment; visits to entrepreneurial unit of women for studying the ways and means of establishing entrepreneurship units for women and their development and also SWOT analysis of the unit; visit to center for women development.

EXT 511 PERSPECTIVES OF DISTANCE EDUCATION 1+1

Theory: Distance education – concept, philosophy, characteristics and its work ethics, evolution and historical view of distance education – theory, methodology, and epistemology, dimensions of distance education, scope and difficulties, open education – non-formal education, continuing education, and education by correspondence, forms and systems of distance and open education, modes of teaching and learning in distance education, methods of distance education, significance of distance education in teacher education, planning distance education – a systems approach student learning – course planning, the target groups – barriers to learning in distance education – planning and management of networked learning, educational technology in distance education – application of information and educational technologies in distance education, development of course and course material, management of resources, processes and forms of instructional material in distance education, media development and production in distance

education – video classroom strategy, strategies for maximizing the reach – services to students, programme evaluation - performance indicators and quality assessment.
Practical: Visit to the university/centre implementing the distance education programmes; detailed study of their programme in relation to educational technology, methodology, curriculum development, evaluation and assessment; exercise on development of curriculum for distance education exclusively for farming community.

EXT 512 MARKET-LED EXTENSION MANAGEMENT 1+1
Theory: Market led extension – meaning, changing scenario of agricultural extension at the national level, market led extension – emerging perspectives, issues and challenges, dimensions of market led extension, agricultural marketing an overview, development of a marketing plan, and pricing strategy, consumer behavior, marketing communication and promotional strategies, the marketing research process, agricultural trade liberalization and its impact, international marketing opportunities, implications of AOA, TRIPS and IPRs agreements on agriculture, agreement on SPS and TBT – an overview, commodity features marketing, public private linkages in market led extension, role of SHG in market led extension, contract farming – a viable approach to meet market challenges, IT enabled approaches for market led extension and communication, weather service and crop modeling – an effective tool in market led extension.
Practical: Identification and analysis of different marketing sources for agricultural commodities; development of strategy for an effective market intelligence system; development of suitable marketing plan to suite rural situation; visit to local agricultural market to study its processes and procedures.

EXT 591 MASTER'S SEMINAR 1+0
EXT 599 MASTER'S RESEARCH 0+20

C. SOCIOLOGY

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
SOC 501	**GENERAL SOCIOLOGY**	**3+0**	I
SOC 502	**SOCIOLOGY OF ECONOMIC DEVELOPMENT**	**3+0**	II
SOC 503	**DYNAMICS OF SOCIAL CHANGE**	**3+0**	I
SOC 511	**RURAL SOCIOLOGY AND RURAL SOCIAL SYSTEM**	**2+0**	II
SOC 512	**IMPACT OF SCIENCE AND TECHNOLOGY ON RURAL DEVELOPMENT**	**2+0**	I
SOC 591	**MASTER'S SEMINAR**	**1+0**	I&II

SOC 501 GENERAL SOCIOLOGY 3+0

Nature and scope of sociology, society, difference between industrial, agrarian and tribal societies, community, difference between community and society, community sentiments, elements of association, differences between association and society, association and community, elements of institution, importance of institution, difference between institution and association, human groups, classification of groups, group integration or cohesiveness, aspects of interaction, conjunctive and disjunctive processes of social interaction, essential elements of social system, types and functions of social system; means of social control, social control in society.

SOC 502 SOCIOLOGY OF ECONOMIC DEVELOPMENT 3+0

Introduction to the concept of development, indicators of development, characteristics of underdevelopment, alternative indicators of development, theories and major issues in development, need and nature of the process of economic and social development, development vis-à-vis environment, environmental degradation, environmental pollution, governmental and voluntary action on environmental pollution, introduction to the concept of wasteland, causes of land degradation, extent and types of wasteland, role of forestry in reclaiming wasteland, wasteland development schemes, concept of social forestry, strategy and scope of social forestry.

SOC 503 DYNAMICS OF SOCIAL CHANGE 3+0

Contemporary change, characteristics of contemporary change, processes of contemporary change, permanent conditions of social change, patterns of change, various concepts of change and their application to rural society, changing techniques and changing society, class and social change, technological explanation of social change, interpretation of social change, hypothesis of cultural lag, culture as determinant of social change, human adjustment and changing culture, social inventions and social change, Social evolution and social progress, place of the concept of progress in sociology, challenge of social change.

SOC 511 RURAL SOCIOLOGY AND RURAL SOCIAL SYSTEM 2+0

A general view of the sociology of rural life, physical structure of rural society, patterns of rural settlement, rural resources, population, social structure of rural society - organization, ecological entities, groups, collectivities, rural social institutions with particular reference to India, characteristics of rural society, social stratification, value and value systems, social interaction and processes, dimensions of social change, social organizations.

SOC 512 IMPACT OF SCIENCE AND TECHNOLOGY ON RURAL DEVELOPMENT 2+0

Concept of rural development, basic elements and objectives of development, strategies of development, dogmas in development, rural development and change, technological explanation of social change, factors associated with science and technology utilization, significance of science and technology for rural development, problems of human adjustment in a changing cultural scenario and cultural lag.

SOC 591 MASTER'S SEMINAR 1+0

AGRICULTURAL ENGINEERING

http://hillagric.ac.in/edu/coa/agengg/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
AG ENGG 501	SOIL AND WATER CONSERVATION ENGINEERING	2+1	I
AG ENGG 502	WATERSHED MANAGEMENT	2+1	I
AG ENGG 503	IRRIGATION ENGINEERING	2+1	I
AG ENGG 504	WATERSHED HYDROLOGY	2+1	II
AG ENGG. 505	STRUCTURES FOR SOIL AND WATER MANAGEMENT	2+0	II
AG ENGG 506	DRAINAGE ENGINEERING	2+0	II
AG ENGG 511	SELECTION AND MANAGEMENT OF FARM MACHINERY	2+0	II
AG ENGG 512	LAND DEVELOPMENT MACHINERY	2+0	I
AG ENGG 513	SEED PROCESSING MACHINERY	2+0	II
AG ENGG 514	PRINCIPLES AND APPLICATION OF ERGONOMICS	2+0	II
AG ENGG 521	FOOD PROCESS ENGINEERING	2+0	II
AG ENGG 522	FARM STRUCTURES	2+0	I
AG ENGG 523	ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS	2+0	II
AG ENGG 531	INTRODUCTION TO RENEWABLE ENERGY SOURCES	2+1	II
AG ENGG 591	MASTER'S SEMINAR	1+0	I&II

AGRICULTURAL ENGINEERING

Course contents

AG ENGG 501 SOIL AND WATER CONSERVATION ENGINEERING 2+1

Theory

UNIT I**:** Soil erosion and factors affecting, universal soil loss equation.

UNIT II**:** Precipitation and runoff, prediction of peak flow.

UNIT III: Erosion control measures-strip cropping, bunding and terracing, stream bank protection, gully control structures.

UNIT IV**:** Earthen embankments and farm ponds.

UNIT V**:** Measures to reduce seepage losses during conveyance and storage.

Practical: Study of rainfall and runoff measuring equipments; Analysis of rainfall data and runoff hydrograph; Design of contour and graded bunds; Design and preparation of estimates for different soil conservation structures; Measurement of seepage losses during conveyance and storage.

AG ENGG 502 WATERSHED MANAGEMENT 2+1

Theory

UNIT I**:** Watershed a need for integrated approach in the hills, role of hydrograph in agricultural productivity, rainfall distribution.

UNIT II**:** Soil erosion - its measurement and control, universal soil loss equation and other soil erosion models, degradation of soil productivity due to soil erosion.

UNIT III**:** Rainfall simulators and scope of their use in soil erosion studies, sedimentation of reservoirs, catchment area treatment in river valley and irrigation projects.

UNIT IV**:** Artificial groundwater recharge, water harvesting- various methods and structures.

UNIT V**:** Morphologic description of watershed, watershed based water management, economics of water management, participatory mode of water management.

Practical: Watershed delineation;Watershed discretisation; Assessment of inflow and outflow; Measurement; calculation and interpretation of geomorphologic parameters; Land and water use planning of watershed.

AG ENGG 503 IRRIGATION ENGINEERING 2+1

Theory

UNIT I: Sources of irrigation water, "kuhl" irrigation in hills.

UNIT II: Water conveyance and control structures, methods of measurement of irrigation water.

UNIT III: Irrigation efficiencies, design of surface, subsurface, sprinkler and drip irrigation systems.

UNIT IV**:** Types of aquifers, construction and development of wells, well hydraulics.

UNIT V: Centrifugal pumps-principles of working, installation, characteristics curves and trouble shooting.

Practical: Measurement of irrigation water; Design of irrigation channels; Estimation of water requirement of crops; Design of irrigation methods; Operation and maintenance of sprinkler and trickle irrigation systems; Installation and maintenance of centrifugal pumps.

AG ENGG 504 WATERSHED HYDROLOGY 2+1

Theory

UNIT I: Hydrologic system, elements of agricultural hydrology, concept of watershed, factors affecting behaviour of a watershed, problems and prospects of watershed management.
UNIT II: Overland flow phenomenon, collection of hydrologic data, runoff hydrograph and its interpretation.
UNIT III**:** Estimation of design runoff, rate and runoff volume from watersheds under different land uses.
UNITIV**:** Water harvesting, design of farm ponds.
Practical: Use of topographic maps for watershed identifications, Preparation and interpretation of land use map, Runoff estimation from rainfall and watershed information, Hydrograph analysis, Development of unit hydrograph and its use, Measurement of stream flow and sediment flow, Planning for watershed development.

AG ENGG 505 STRUCTURES FOR SOIL AND WATER MANAGEMENT 2+0
Theory
UNIT I: Design considerations-hydrologic, hydraulic and structural, soil conservation structures with reference to hills and mountains.
UNIT II: Different types of spillways, diversion, conveyance, regulation and control structures, drainage structures.
UNIT III: Design of water harvesting reservoirs and cost analysis.

AG ENGG 506 DRAINAGE ENGINEERING 2+0
Theory
UNIT I**:** Need for drainage in agriculture, drainage surveys and investigations, drainage coefficient.
UNIT II: Surface drainage systems, design of drainage channels, tile drainage-depth and spacing of tiles, types of tile drainage systems.
UNIT III: Design of gravel envelope, supplemental structures, mole drainage, isobath and water table contour maps, drainage by pumping from wells.

AG ENGG 511 SELECTION AND MANAGEMENT OF FARM MACHINERY 2+0
Theory
UNIT I: Farm tools and machinery for hills, machine performance parameters.
UNIT II: Common field machine operational patterns and their efficiencies.
UNIT III: Costs of using farm machinery-fixed, variable and timeliness.
UNIT IV: Optimum selection of power source and matching implements custom hiring of farm machinery.
UNIT V: Optimal equipment replacement policy, inventory control of spare parts, care, maintenance and repair of farm equipment.

AG ENGG 512 LAND DEVELOPMENT MACHINERY 2+0
Theory
UNIT I: Basic principles of earth moving, relevant properties of soil for earth work.
UNIT II: Methods of levelling, grading and computation of earth work.
UNIT III: Earth moving machines-bulldozers, scrapers, excavators and dumpers, animal/power-tiller/tractor driven land grading equipment.
UNIT IV: Cost estimation, selection, operation and maintenance of land development machinery.

AG ENGG 513 SEED PROCESSING MACHINERY 2+0
Theory
UNIT I: Basic seed flow patterns in seed processing plant.

UNIT II: Drying requirements of different seeds, cleaning and grading.
UNIT III**:** Seed treatment, seed testing and quality control, packaging and storage of seeds.
UNIT IV: Planning and layout of seed processing plant, cost estimation.

AG ENGG 514 PRINCIPLES AND APPLICATION OF ERGONOMICS 2+0
Theory
UNIT I: Human factors in system development, energy liberation and transfer.
UNIT II: Work, energy and mechanical efficiency of human body.
UNIT III: Anthropometry and its applications, biomechanics automation, controls and related devices and their design considerations.
UNIT IV: The man-machine system concept, human behaviour models.
UNIT V: Thermal influences on human performance, case studies on ergonomics.

AG ENGG 521 FOOD PROCESS ENGINEERING 2+0
Theory
UNIT I : Importance of food processing and its present status in the country with special reference to hills.
UNIT II: Engineering principles of underlying processing operations in food (cereals, fruits and vegetables) industry.
UNIT III: Basic principles of food dehydration and drying, freeze drying, evaporation and drying equipment.
UNIT IV: Size reduction, cleaning, mixing and separation, sorting and grading of food materials.
UNIT V: Food preservation, packaging and storage, quality control, selection of equipment and its installation.

AG ENGG 522 FARM STRUCTURES
Theory
UNIT I: Functional planning and layout of farm stead in hills and mountains.
UNIT II: Farm buildings and livestock production facilities.
UNIT III: Storage structures for food, feed, farm machinery and crop inputs application of thermal and structural design principles of farm buildings specifications.
UNIT IV: Cost estimation and economics of structures on the farm.

AG ENGG 523 ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS 2+0
Theory
UNIT I: Biological materials, uniqueness in relation to other materials.
UNIT II: Physical characteristics-shape, size, volume, density, surface area, mechanical, electrical and thermal properties, aerodynamic characteristics and frictional properties.
UNIT III: Stress-strain-time effects, rheological models and applications, application of engineering properties in design and operation of agricultural equipment structures.

AG ENGG 531 INTRODUCTION TO RENEWABLE ENERGY SOURCES 2+1
Theory
UNIT I: Renewable energy sources and their necessity.
UNIT II : Solar radiation, fundamentals of energy transfer, solar water heaters, dryers and cookers.
UNIT III: Photovoltaic cells; wind mills; smokeless chulhas.
UNIT IV: Use in crops vegetables and fruit drying bioconversion of biological wastes, biogas plants-construction, operation and maintenance.

Practical: Measurement of solar radiation; Determination of the efficiency of solar cookers; practical demonstration of different designs of smokeless chulhas; Measurement of power from photovoltaic cells; Evaluation of biogas plants.

AG ENGG 591 MASTER'S SEMINAR 1+0

AGRONOMY, FORAGES & GRASSLAND MANAGEMENT

http://hillagric.ac.in/edu/coa/agronomy/index.html

AGRONOMY

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
AGRON 501*	MODERN CONCEPTS IN CROP PRODUCTION	3+0	I
AGRON-502*	PRINCIPLES AND PRACTICES OF SOIL FERTILITY AND NUTRIENT MANAGEMENT	2+1	I
AGRON 503*	PRINCIPLES AND PRACTICES OF WEED MANAGEMENT	2+1	I
AGRON 504*	PRINCIPLES AND PRACTICES OF WATER MANAGEMENT	2+1	I
AGRON 505	AGROMETEOROLOGY AND CROP WEATHER FORECASTING	2+1	II
AGRON 506	AGRONOMY OF MAJOR CEREALS AND PULSES	2+1	I
AGRON 507	AGRONOMY OF OILSEED, FIBRE AND SUGAR CROPS	2+1	II
AGRON 508	AGRONOMY OF MEDICINAL, AROMATIC AND UNDER-UTILIZED CROPS	2+1	II
AGRON 509	AGRONOMY OF FODDER AND FORAGE CROPS	2+1	I
AGRON 510	AGROSTOLOGY AND AGROFORESTRY	2+1	II
AGRON 511	CROPPING SYSTEMS	2+0	II
AGRON 512	DRYLAND FARMING	2+1	II
AGRON 513	PRINCIPLES AND PRACTICES OF ORGANIC FARMING	2+1	II
AGRON 514	MECHANISM OF HERBICIDE ACTION	2+1	II
AGRON 591*	MASTER'S SEMINAR	1+0	I&II
AGRON 592	SPECIAL PROBLEM IN M. Sc.	0+1	I&II
AGRON 599*	MASTER'S RESEARCH	0+20	I&II
AGRON 601**	CURRENT TRENDS IN AGRONOMY	3+0	I
AGRON 602	CROP ECOLOGY	2+0	II
AGRON 603	CROP PRODUCTION AND SYSTEM MODELING	2+1	II
AGRON 604**	ADVANCES IN CROP GROWTH AND PRODUCTIVITY	2+1	I
AGRON 605	ADVANCES IN IRRIGATION MANAGEMENT	2+1	I
AGRON 606**	ADVANCES IN WEED MANAGEMENT	2+0	I
AGRON 607	ADVANCES IN INTEGRATED FARMING SYSTEMS	2+0	I
AGRON 608	SOIL CONSERVATION AND WATERSHED MANAGEMENT	2+1	II
AGRON 609	STRESS CROP PRODUCTION	2+1	II

AGRON 691**	DOCTORAL SEMINAR I	1+0	I
AGRON 692	DOCTORAL SEMINAR II	1+0	II
AGRON 693	SPECIAL PROBLEM IN Ph. D.	0+1	I&II
AGRON 699**	DOCTORAL RESEARCH	0+45	I&II

*Compulsory for Master's programme **Compulsory for Ph.D. programme

AGRONOMY

Course contents

AGRON 501 MODERN CONCEPTS IN CROP PRODUCTION 3+0

Theory

UNIT I: Crop growth analysis in relation to environment, Agroclimatic zones of Himachal Pradesh and India.

UNIT II: Inverse yield nitrogen law, Mitscherlich's yield equation, its interpretation and applicability, Baule unit.

UNIT III: Effect of lodging in cereals, physiology of grain yield in cereals, optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.

UNIT IV: Scientific principles of crop production, seed production techniques in various crops, crop response production functions, concept of soil plant relations, yield and environmental stress.

UNIT V: Integrated farming systems, organic farming, resource conservation technology including modern concept of tillage, dry farming, determining the nutrient needs for yield potentiality of crop plants, precision agriculture.

AGRON 502 PRINCIPLES AND PRACTICES OF SOIL FERTILITY AND NUTRIENT MANAGEMENT 2+1

Theory

UNIT I: Soil fertility and productivity- factors affecting, features of a good soil management, problems of supply and factors affecting availability of nutrients, relation between nutrient supply and crop growth, organic farming - basic concepts and definitions.

UNIT II: Criteria of essentiality of nutrients, essential plant nutrients – their functions and deficiency symptoms, transformation and dynamics of major plant nutrients in soil.

UNIT III: Preparation and use of farmyard manure, compost, green manures, vermicompost, biofertilizers and other organic concentrates, their composition, availability and crop responses, recycling of organic wastes and residue management.

UNIT IV: Commercial fertilizers, composition, relative fertilizer value and cost, crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades, agronomic, chemical and physiological methods of estimating and techniques of increasing fertilizer use efficiency, nutrient interactions.

UNIT V: Time and methods of manures and fertilizers application, foliar application and its concept, relative performance of organic and inorganic manures, economics of fertilizer use, concept of balanced nutrition and integrated nutrient management, use of vermi-compost and residue wastes in crops.

Practical: Identification of nutrients deficiency symptoms; determination of soil pH; EC; organic C; total N; available N; P; K and S in soils; determination of total N; P; K and S in plants; interpretation of interaction effects and computation of economic and yield optima.

AGRON 503 PRINCIPLES AND PRACTICES OF WEED MANAGEMENT 2+1

Theory

UNIT I: Classification and characteristics of weeds, special weed problems including aquatic and parasitic weeds, ecology and physiology of major weeds, ecophysiology of crop-weed competition including allelopathy.

UNIT II: Principles and methods of weed control, concept of integrated weed management, principles of chemical weed control, weed control through bioherbicides.

UNIT III: Mode and mechanism of action of herbicides, herbicide selectivity, herbicide combinations, adjuvants and safeners, degradation of herbicides in soils and plants, effect of herbicides in relation to environment, herbicide resistance in weeds and crops.

UNIT IV: Weed management in major crops and cropping systems, weed shifts in cropping systems, control of weeds in non-cropped situations including grasslands, pastures, tea gardens, orchards and aquatic ecosystem in hills.
UNIT V: Cost: benefit analysis of weed management, weed indices.
Practical: Identification of important weeds of different crops; preparation of a weed herbarium; weed survey in crops and cropping systems; crop-weed competition studies; calculation of doses of herbicides; preparation of spray solutions of herbicides for high and low volume sprayers; use of various types of spray pumps and nozzles; their calibration and related calculations; economics of weed control.

AGRON 504 PRINCIPLES AND PRACTICES OF WATER MANAGEMENT 2+1

Theory
UNIT I: Water and its role in plants, water resources of India, major irrigation projects, extent of irrigated area under different crops in India and in different states.
UNIT II: Concept of water potential, water movement in soils and plants, transpiration, soil-water-plant relationships, water absorption by plants, crop plants response to water stress, crop plant adaptation to moisture stress condition.
UNIT III: Soil, plant and meteorological factors determining water needs of crops, scheduling of irrigation, depth and methods of irrigation, micro-irrigation systems, fertigation, management of water in controlled environment and polyhouses.
UNIT IV: Water management in crops and cropping systems, quality of irrigation water and management of saline water for irrigation, water use efficiency and practices to enhance water productivity.
UNIT V: Excess of soil water and plant growth, water management in problem soils, drainage requirement of crops and methods of field drainage, their layout and spacing.
Practical: Measurement of soil water potential by using tensiometer, resistance block and pressure plate and membrane apparatus; soil-moisture characteristics curves; determination of FC and PWP; water flow measurements using different devices; determination of infiltration rate; determination of irrigation requirements; calculation of irrigation efficiency; determination of saturated hydraulic conductivity.

AGRON 505 AGROMETEOROLOGY AND CROP WEATHER FORECASTING 2+1
Theory
UNIT I: Agro-meteorology - aim, scope and development in relation to crop environment, composition of atmosphere, distribution of atmospheric pressure and wind.
UNIT II: Characteristics of solar radiation, energy balance of atmosphere system, radiation distribution in crop canopies, radiation utilization by field crops, photosynthesis and efficiency of radiation utilization by field crops, energy budget of plant canopies.
UNIT III: Temperature profile in air, soil, crop canopies, soil and air temperature effects on plant physiological processes, measures of atmospheric temperature, relative humidity, vapour pressure and their relationships, evapo-transpiration and meteorological factors determining evapo-transpiration.
UNIT IV: Modification of plant environment: artificial rain, heat transfer, controlling heat load, heat trapping and shading, protection from cold, sensible and latent heat flux, controlling soil moisture, monsoon- origin, characteristics, onset, progress and withdrawal, weather hazards, drought monitoring and planning for mitigation.
UNIT V: Weather forecasting in India – short, medium and long range, aerospace science and weather forecasting, benefits of weather services to agriculture, remote sensing and its present status in India, atmospheric pollution and its effect on crop production, climate change and its impact on agriculture.
Practical: Recording of meteorological parameters *viz.;* sun-shine duration; wind velocity; wind direction; relative humidity; soil and air temperature; evaporation; precipitation and atmospheric pressure; measurement of solar radiation outside and within crop canopies; measurement/estimation of evapo-transpiration by various methods; measurement/estimation of soil water balance; rainfall variability

analysis; determination of heat-unit requirement for different crops; measurement of crop canopy temperature; measurement of soil temperature at different depths in field crops; remote sensing and familiarization with agro-advisory service bulletins; study of synoptic charts and weather reports, working principle of automatic weather station.

AGRON 506 AGRONOMY OF MAJOR CEREALS AND PULSES 2+1

Theory: Origin and history, adaptability, area and production, classification, improved varieties, climate, soil, nutrition, water and cultural requirements, quality components, post-harvest handling and processing of:

UNIT I: *Kharif* cereals
UNIT II: *Rabi* cereals
UNIT III: *Kharif* pulses
UNIT IV: *Rabi* pulses

Practical: Phenological studies of important crops; estimation of crop yield on the basis of yield attributes; formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities; computation of growth indices (LER, CGR, RGR, NAR, LAD); aggressivity; relative crowding coefficient, monetary yield advantage and area-time equivalent ratio (ATER) of prominent intercropping systems; estimation of protein content in pulses; planning of field experiments on cultural, fertilizer, weed control and water management aspects; layout of field experiments; Intercultural operations in different crops; computation of cost of cultivation of different crops; visit to nearby villages for identification of constraints in crop production.

AGRON 507 AGRONOMY OF OILSEED, FIBRE AND SUGAR CROPS 2+1

Theory: Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, nutrition**,** water and cultural requirements, quality components, post-harvest handling and processing of:

UNIT I: *Kharif* oilseeds - Groundnut, sesame, castor, sunflower, soybean, etc.
UNIT II: *Rabi* oilseeds – Rapeseed and mustard, linseed, safflower, etc.
UNIT III: Fiber crops - Cotton, jute, sunhemp, etc.
UNIT IV: Sugar crops – Sugar-beet and sugarcane.

Practical: Phenological studies of important crops; familiarization with planting and growing techniques of sugarcane; estimation of crop yield on the basis of yield attributes; formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities; computation of growth indices (LER, CGR, RGR, NAR, LAD); aggressivity; relative crowding coefficient, monetary yield advantage and area-time equivalent ratio (ATER) of prominent intercropping systems; Estimation of quality parameters of various crops; planning of field experiments on cultural, fertilizer, weed control and water management aspects; layout of field experiments; intercultural operations in different crops; computation of cost of cultivation of different crops; visit to nearby villages for identification of constraints in crop production.

AGRON 508 AGRONOMY OF MEDICINAL, AROMATIC AND UNDER-UTILIZED CROPS 2+1

Theory

UNIT I: Importance of medicinal and aromatic plants in human health, national and state economy and industry, classification of medicinal and aromatic plants according to botanical characteristics and uses.

UNIT II: Climate and soil requirements, cultural practices, yield and important constituents of medicinal plants (Isabgol, Rauwolfia, Poppy, *Aloe vera*, Satavar, Stevia, Safed Musli, Kalmegh, Asafoetida, *Nux vomica*, Roselle, Aconite**,** Viola, etc).

UNIT III: Climate and soil requirements, cultural practices, yield and important constituents of aromatic plants (Citronella, Palmarosa, Mentha, Basil, Lemon grass, Rose, Patchouli, Geranium, Lavender, Tagetes, Kuth, etc.).
UNIT IV: Climate and soil requirements, cultural practices, yield of under-utilized crops (Ricebean, Lathyrus, Sesbania, Clusterbean, French bean**,** Buckwheat, Chenopodium, Fenugreek, Grain Amaranth, Coffee, Tea and Tobacco, etc.).
Practical: Identification of crops based on morphological and seed characteristics; raising of herbarium of medicinal; aromatic and under-utilized plants; quality characters in medicinal and aromatic plants; methods of analysis of essential oils and other chemicals of importance in medicinal and aromatic plants; visit to herbal garden.

AGRON 509 AGRONOMY OF FODDER AND FORAGE CROPS 2+1
Theory
UNIT I: Adaptation, distribution, improved varieties, agro-techniques and quality aspects including anti-quality factors of important fodder crops like maize, sorghum, *bajra*, *guar*, cowpea, oats, barley, berseem, *senji*, etc.
UNIT II: Adaptation, distribution, improved varieties, agro-techniques and quality aspects including anti-quality factors of important forage crops/grasses & legumes like, Napier grass, setaria, *Panicum, Lasiurus, Cenchrus, clovers, lucerne, fescue grass, brome grass, etc.*
UNIT III: Year-round fodder production and management, preservation and utilization of forage and pasture crops.
UNIT IV: Principles and methods of hay and silage making, chemical and biochemical changes, nutrient losses and factors affecting quality of hay and silage, use of physical and chemical enrichments and biological methods for improving nutritive value, value addition of poor quality fodder.
UNIT V: Economics of forage cultivation and seed production techniques
Practical: Training on raising fodder crops; canopy measurement; yield and quality estimation; *viz.;* crude protein; NDF; ADF; lignin; silica; cellulose; etc. of various fodder and forage crops; anti-quality components like HCN in sorghum and such factors in other crops; hay and silage making and economics of their preparation.

AGRON 510 AGROSTOLOGY AND AGROFORESTRY 2+1
Theory
UNIT I: Agrostology, definition and importance, grassland ecology – community, climax, dominant species, succession, biotype, ecological status of grasslands in India, grass cover of India, problems and management of grasslands.
UNIT II: Importance, classification (various criteria), scope, status and research needs of pastures, establishment, improvement and renovation of natural and cultivated pastures, common pasture grasses.
UNIT III: Agroforestry: definition and importance, agroforestry systems, agrisilviculture, silvipasture, agrisilvipasture, agrihorticulture, aquasilviculture, alley cropping and energy plantation.
UNIT IV: Crop production technology in agro-forestry and agrostology system, silvipastoral system: meaning and importance for wasteland development, selection of species, planting methods and problems of seed germination in agro-forestry systems, irrigation and manuring in agro-forestry systems, associative influence in relation to above ground and underground interferences, lopping and coppicing in agro-forestry systems, social acceptability and economic viability, nutritive value of trees, tender operation, desirable tree characteristics.
Practical: Study of different pastures and agro-forestry systems of India through illustrations; identification of seeds and plants of common grasses, legumes and trees of economic importance with reference to agro-forestry; seed treatment for improved germination; methods of propagation/planting of grasses and trees in silvipastoral system; estimation of nutritional and anti- nutritional components;

estimation of calorie value of wood of important fuel trees; estimation of total biomass and fuel wood; computation of cost of cultivation; visit to important agro-forestry based models.

AGRON 511 CROPPING SYSTEMS 2+0

Theory

UNIT I: Cropping system: definition, indices and its importance, physical resources, soil and water management in cropping systems, assessment of land use.

UNIT II: Concept of sustainability in cropping systems and farming systems, scope and objectives, production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems.

UNIT III: Above and below ground interactions and allelopathic effects, competition relations, multi-storeyed cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies, research need on sustainable agriculture.

UNIT IV: Crop diversification for sustainability, role of organic matter in maintenance of soil fertility, crop residue management, fertilizer use efficiency and concept of fertilizer use in intensive cropping systems.

UNIT V: Plant ideotypes for drylands, plant growth regulators and their role in sustainability.

AGRON 512 DRYLAND FARMING 2+1

Theory

UNIT I: Definition, concept and characteristics of dry land farming areas/regions, dry land versus rainfed farming, significance and dimensions of dry land farming in Indian agriculture.

UNIT II: Soil and climatic parameters with special emphasis on rainfall characteristics, constraints of crop production in dry land areas, types of drought, characterization of environment for water availability, contingent crop planning for erratic and aberrant weather conditions.

UNIT III: Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies, preparation of appropriate crop plans for dry land areas, mid season contingent crop plan for aberrant weather conditions.

UNIT IV: Tillage, tilth, frequency and depth of cultivation, compaction with soil tillage, concept of conservation tillage, tillage in relation to weed control and moisture conservation, techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics), anti-transpirants, soil and crop management techniques, seeding and efficient fertilizer use for increasing water use efficiency.

UNIT V: Watershed- concept, resource management, problems, approach and components.

Practical: Seed treatment, seed germination and crop establishment in relation to soil moisture contents; moisture stress effects and recovery behaviour of important crops; estimation of moisture index and aridity index; spray of anti-transpirants and their effect on crops; collection and interpretation of data for water balance equations; methods of increasing water use efficiency; preparation of crop plans for different drought conditions; study of field experiments relevant to dryland farming; visit to watershed projects.

AGRON 513 PRINCIPLES AND PRACTICES OF ORGANIC FARMING 2+1

Theory

UNIT I: Organic farming - concept and definitions, its relevance to India and global agriculture and future prospects, biodynamic farming, vedic farming, land and water management - land use, minimum tillage, shelter zones, hedges, pasture management, agro-forestry.

UNIT II: Organic farming and water use efficiency, soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers.

UNIT III: Crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.
UNIT IV: Control of weeds, diseases and insect pest management, biological agents and pheromones, biopesticides.
UNIT V: Socio-economic impacts, certification, labeling and accreditation procedures, organic farming and national economy, marketing and export potential.
Practical: Preparation of vermicompost and bioformulations, etc.; aerobic and anaerobic methods of making compost; identification and nursery raising of important agro-forestry trees and trees for shelter belts; efficient use of biofertilizers, technique of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter*, *Azospirillum* and PSB cultures in field; quality standards, inspection, certification**,** labeling and accreditation procedures for farm produce from organic farms; visits to organic experiments/farms.

AGRON 514 MECHANISM OF HERBICIDE ACTION 2+1

Theory

UNIT I: Historical background of herbicides, definitions in herbicide usage, classification of herbicides based on their mode of action.
UNIT II: Mechanism of absorption and translocation of herbicides, their effect on growth and development.
UNIT III: Effect of herbicides on photosynthesis, respiration and protein synthesis, factors modifying the response of herbicides in plants, mechanisms of selectivity of herbicides
UNIT IV: Persistence of herbicides, their residual effect and methods of overcoming the residual effect of herbicides.
UNIT V: Mechanism of herbicide resistance, metabolism of herbicides, mechanism of action of adjuvant and herbicides antidotes.
Practical: Familiarization with herbicides; application of various herbicides with different types of mechanism of action; study on nature of mortality of weeds; study of symptoms of phytotoxicity of herbicides in crop plants; persistence of herbicides in soil by bioassay technique; study of movement of herbicides in soil; studies on herbicides resistance.

AGRON 591 MASTER'S SEMINAR 1+0
AGRON 592 SPECIAL PROBLEM IN M. Sc. 0+1
AGRON 599 MASTER'S RESEARCH 0+20

AGRON 601 CURRENT TRENDS IN AGRONOMY 3+0

Theory

UNIT I: Agro-physiological basis of variation in yield, recent advances in soil plant-water relationship.
UNIT II: Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, marketing and export potential of organic products, certification, labeling and accreditation procedures.
UNIT III: Crop residue management in multiple cropping system, latest developments in plant management, weed management, cropping systems, grassland management, agro-forestry, allelopathy.
UNIT IV: GIS, GPS and remote sensing for crop management, global warming, GM crops, seed production technology, seed certification, seed multiplication, hybrid seed production, etc.
UNIT V: Concepts of system approach in agriculture, holistic approach of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy.

AGRON 602 CROP ECOLOGY 2+0

Theory

UNIT I: Concept of crop ecology, agricultural systems, ecology of cropping systems, principles of plant distribution and adaptation, crops and world food supply.

UNIT II: Ecosystem characteristics, types and functions, terrestrial ecology, flow of energy in ecosystem, ecosystem productivity, biomass, succession and climax concept.
UNIT III: Physiological response of crop plants to light, temperature, CO_2, moisture and solar radiation, influence of climate on photosynthesis and productivity of crops, effect of global climate change on crop production.
UNIT IV: Exploitation of solar energy in crops, vertical distribution of temperature, efficiency in crop production.
UNIT V: Competition in crop plants, environmental pollution and crop production, ecological basis of environmental management and environment manipulation through agronomic practices, improvement of unproductive lands through crop selection and management.

AGRON 603 CROP PRODUCTION AND SYSTEM MODELING 2+1

Theory

UNIT I: Definitions, systems classification, flow charts, modeling techniques and methods of integration - state, rate and driving variables, feedbacks and relational diagrams.
UNIT II: Elementary models for crop growth based on basic methods of classical growth analysis.
UNIT III: Crop modeling methods for crop-weather interaction, climate change and variability components.
UNIT IV: Potential production: leaf and canopy CO_2 assimilation, respiration, dry matter accumulation, crop phenology and dry matter distribution and development in different crops.
UNIT V: Production under stressed and non-stressed conditions of water and nutrients availability, potential evapotranspiration, water balance of the soil.
Practical: Simulation of elementary models for crop growth; simulation of potential production; simulation with limitations of water and nutrient management options; sensitivity analysis using different climatic years and crop management practices; simulation of climate change scenarios for major crops.

AGRON 604 ADVANCES IN CROP GROWTH AND PRODUCTIVITY 2+1

Theory

UNIT I: Plant density and crop productivity, plant distribution, growth and yield in relation to environmental factors, strategies for maximizing solar energy utilization, leaf area, interception of solar radiation and crop growth, photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis, difference in photosynthetic rates among and within species, physiological limitations to crop yield, solar radiation concept and agro-techniques for harvesting solar radiation.
UNIT II: Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR, validity and limitations in interpreting crop growth and development, growth curves: sigmoid, polynomial and asymptotic, root systems, root-shoot relationships, principles involved in inter and mixed cropping systems under rainfed and irrigated conditions, concept and differentiation of inter and mixed cropping, criteria in assessing the yield advantages.
UNIT III: Competitive relationship and competition functions, biological and agronomic basis of yield advantage under intercropping, physiological principles of dry land crop production, constraints and remedial measures, heat unit concept of crop maturity, types of heat units.
UNIT IV: Concept of plant ideotypes: crop physiology and new ideotypes, characteristics of ideotype for wheat, rice, maize, etc., concept and types of growth hormones, their role in field crop production and efficient use of resources.
Practical: Field measurement of root-shoot relationship in crops at different growth stages; estimation of growth evaluating parameters like CGR, RGR, NAR, LAI, etc., at different stages of crop growth; computation of harvest index of various crops; assessment of crop yield on the basis of yield attributing characters; construction of crop growth curves based on growth analysis data; computation of competition functions, *viz.* LER, IER, aggressivity competition index, etc., in intercropping; senescence and abscission indices; analysis of productivity trend in irrigated and un-irrigated conditions.

AGRON 605 ADVANCES IN IRRIGATION MANAGEMENT 2+1

Theory

UNIT I: Water resources and irrigation projects of India, irrigation needs- atmospheric, soil, agronomic, plant and water factors affecting irrigation need, water deficits and crop growth.

UNIT II: Soil-plant-water relationships, transpiration**,** evapotranspiration and their significance, energy utilization in transpiration, physiological processes and crop productivity.

UNIT III: Infiltration- water movement under saturated and unsaturated conditions, management practices for improving water use efficiency of crops.

UNIT IV: Methods of application of irrigation water, conveyance and distribution system, irrigation efficiency, agronomic considerations in the design and operation of irrigation projects, characteristics of irrigation and farming systems affecting irrigation management.

UNIT V: Strategies of using limited water supply, factors affecting ET, control of ET by mulching and use of anti-transpirants, fertilizer use in relation to irrigation, optimizing the use of given irrigation supplies.

UNIT VI: Land suitability for irrigation, land irrigability classification, integrated water management in command areas, farmers' participation in command areas,, irrigation legislation.

Practical: Determination of water infiltration characteristics and water holding capacity of soil profiles; moisture extraction pattern of crops; consumptive use and water requirement of a given cropping pattern for optimum/variable productivity; crop planning at the farm and project level; agronomic evaluation of irrigation projects, case studies; water flow measurement by using different devices; calculation of irrigation efficiency.

AGRON 606 ADVANCES IN WEED MANAGEMENT 2+0

Theory

UNIT I: Crop-weed competition in different cropping situations, changes in weed flora, various causes and effects.

UNIT II: Structural, physiological and biological aspects of herbicides: their absorption, translocation, metabolism and mode of action, selectivity of herbicides and factors affecting them.

UNIT III: Climatic factors and phytotoxicity of herbicides, fate of herbicides in soil and factors affecting them, residue management of herbicides, adjuvants.

UNIT IV: Advances in herbicide application techniques, herbicide resistance, antidotes and crop protection compatibility of herbicides of different groups, compatibility of herbicides with other pesticides.

UNIT V: Development of transgenic herbicide resistant crops, herbicide development and registration procedures.

UNIT VI: Relationship of herbicides with tillage, fertilizer and irrigation, bioherbicides, allelochemicals, herbicide bioassays.

AGRON 607 ADVANCES IN INTEGRATED FARMING SYSTEMS 2+0

Theory

UNIT I: Farming systems: definition and importance, classification of farming systems according to type of rotation, cropping intensity, degree of commercialization, water supply, enterprises, etc.

UNIT II: Concept of sustainability in farming systems, efficient farming systems, natural resources - identification and management.

UNIT III: Production potential of different components of farming systems, mechanism of different production factors and their interaction, sustainable farming systems and future thrusts, eco-physiological approaches in multiple cropping.

UNIT IV: Simulation models for intercropping, soil nutrients in intercropping, preparation of different farming system models, evaluation of different farming systems.

UNIT V: New concepts and approaches of farming systems, cropping systems and organic farming, case studies on different farming systems.

AGRON 608 SOIL CONSERVATION AND WATERSHED MANAGEMENT 2+1

Theory

UNIT I: Soil erosion: definition, nature, extent, types and factors affecting.

UNIT II: Soil conservation: definition and methods, agronomic measures - contour cultivation, strip cropping, cover crops, vegetative barriers, mechanical measures - bunding, gully control, bench terracing, role of grasses and pastures in soil conservation, wind breaks and shelter belts.

UNIT III: Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed development activities, development of cropping systems for watershed areas, improved dry farming practices.

UNIT IV: Land use capability classification, alternate land use systems, agro-forestry, ley farming, jhum cultivation -management and socio-ethnic aspects.

UNIT V: Drainage considerations and agronomic management, rehabilitation of abandoned *jhum* lands and measures to prevent soil erosion.

Practical: On-site study of different types of erosion and soil conservation measures; run-off and soil loss measurements; identification of different grasses and trees for soil conservation; visit to a soil conservation research/ training centre/watershed.

AGRON 609 STRESS CROP PRODUCTION 2+1

Theory

UNIT I: Stress and strain terminology, causes of stress, nature of stress injury and resistance.

UNIT II: Low temperature stress: freezing injury and resistance in plants, measurement of freezing tolerance, chilling injury and resistance in plants, practical ways to overcome the effect of low temperature stress through soil and crop manipulations.

UNIT III: High temperature or heat stress: meaning and its effect on crop plants, heat injury and resistance in plants, practical ways to overcome the effect of heat stress through soil and crop manipulations.

UNIT IV: Water deficit stress: meaning and its effect on crop plants, water deficit injury and resistance in plants, practical ways to overcome effect of water deficit stress through soil and crop manipulations.

UNIT V: Excess water or flooding stress: its meaning, kinds and effects on crop plants, excess water stress injury and resistance, practical ways to overcome excess water stress through soil and crop manipulations.

UNIT VI: Salt stress: meaning and its effect on crop growth, salt stress injury and resistance in plants, practical ways to overcome the effect of salt stress through soil and crop manipulations.

UNIT VII: Mechanical impedance of soil and its impact on plant growth, measures to overcome soil mechanical impedance.

UNIT VIII: Environmental pollution: air, soil and water pollution and their effects on crop growth and quality of produce, ways and means to prevent environmental pollution.

Practical: Determination of electrical conductivity of plant cell sap; determination of osmotic potential and tissue water potential; measurement of transpiration; measurement of water balance in soil; measurement of stomatal frequency; growing of plants in sand culture under salt stress for biochemical and physiological studies; studies on effect of osmotic and ionic stress on seed germination and seedling growth; measurement of low temperature injury under field conditions.

AGRON 691 DOCTORAL SEMINAR I 1+0

AGRON 692 DOCTORAL SEMINAR II 1+0

AGRON 693 SPECIAL PROBLEM IN Ph. D. 0+1

AGRON 699 DOCTORAL RESEARCH 0+45

CROP IMPROVEMENT: PLANT BREEDING & GENETICS

http://hillagric.ac.in/edu/coa/c_imp/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
GP 501*	PRINCIPLES OF GENETICS	2+1	I
GP 502*	PRINCIPLES OF CYTOGENETICS	2+1	II
GP 503*	PRINCIPLES OF PLANT BREEDING	2+1	I
GP 504*	PRINCIPLES OF QUANTITATIVE GENETICS	2+1	II
GP 505	MUTAGENESIS AND MUTATION BREEDING	1+1	II
GP 506	POPULATION GENETICS	2+1	I
GP 507	HETEROSIS BREEDING	1+1	II
GP 508*	CELL BIOLOGY AND MOLECULAR GENETICS	2+1	I
GP 509*	BIOTECHNOLOGY FOR CROP IMPROVEMENT	2+1	II
GP 510	BREEDING FOR BIOTIC AND ABIOTIC STRESS RESISTANCE	2+1	I
GP 511	BREEDING CEREALS, MILLETS, FORAGES AND SUGARCANE	2+1	I
GP 512	BREEDING LEGUMES, OILSEEDS AND FIBRE CROPS	2+1	II
GP 513	BREEDING FOR QUALITY TRAITS	2+1	II
GP 514	GENE REGULATION AND EXPRESSION	2+0	I
GP 515	MAINTENANCE BREEDING AND CONCEPTS OF VARIETY RELEASE AND SEED PRODUCTION	1+1	II
GP 516	GERMPLASM COLLECTION, EXCHANGE AND QUARANTINE	2+1	I
GP 517	DATA BASE MANAGEMENT, EVALUATION & UTILIZATION OF PGR	2+1	II
GP 591	MASTER'S SEMINAR	1+0	I&II
GP 592	SPECIAL PROBLEM IN M.Sc.	0+1	I&II
GP 599	MASTER'S RESEARCH	0+20	I&II
GP 601	PLANT GENETIC RESOURCES AND THEIR UTILIZATION	2+0	II
GP 602	ADVANCES IN QUANTITATIVE GENETICS	2+1	I
GP 603**	GENOMICS IN CROP IMPROVEMENT	2+1	II
GP 604**	MOLECULAR AND CHROMOSOMAL MANIPULATIONS FOR CROP IMPROVEMENT	2+0	I
GP 605**	ADVANCED PLANT BREEDING SYSTEMS	2+0	II
GP 606	CROP EVOLUTION	2+0	I
GP 607	BREEDING DESIGNER CROPS	1+1	I
GP 608	ADVANCES IN BREEDING OF MAJOR FIELD CROPS	3+0	II
GP 609	MICROBIAL GENETICS	2+1	II
GP 610	*IN SITU* AND *EX SITU* CONSERVATION OF GERMPLASM	2+1	I
GP 691	DOCTORAL SEMINAR-I	1+0	I&II
GP 692	DOCTORAL SEMINAR-II	1+0	I&II
GP 693	SPECIAL PROBLEM IN Ph.D.	1+0	I&II
GP 699**	DOCTORAL RESEARCH	0+45	I&II

* Compulsory for Maser's Programme ** Compulsory for Doctoral Programme

PLANT BREEDING & GENETICS

GP 501 PRINCIPLES OF GENETICS 2+1

Theory

UNIT I: Beginning of genetics, cell structure and cell division, early concepts of inheritance, Mendel's laws, discussion on Mendel's paper, chromosomal theory of inheritance.

UNIT II: Multiple alleles, gene interactions, Sex determination, differentiation and sex-linkage, sex-influenced and sex-limited traits, linkage-detection, estimation, recombination and genetic mapping in eukaryotes, somatic cell genetics, extra chromosomal inheritance.

UNIT III: Population, Mendelian population, random mating population, frequencies of genes and genotypes, causes of change, Hardy-Weinberg equilibrium.

UNIT IV: Structural and numerical changes in chromosomes, nature, structure and replication of the genetic material, organization of DNA in chromosomes, genetic code, protein biosynthesis.

UNIT V: Genetic fine structure analysis, allelic complementation, split genes, transposable genetic elements, overlapping genes, pseudogenes, oncogenes, gene families and clusters.

UNIT VI: Regulation of gene activity in prokaryotes, molecular mechanisms of mutation, repair and suppression, bacterial plasmids, insertion (IS) and transposable (Tn) elements, molecular chaperones and gene expression, gene regulation in eukaryotes, RNA editing.

UNIT VII: Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning, positional cloning, nucleic acid hybridization and immunochemical detection, DNA sequencing, DNA restriction and modification, anti-sense RNA and ribozymes, micro-RNAs (miRNAs).

UNIT VIII: Genomics, structural and functional proteomics, pharmacogenomics, metagenomics.

UNIT IX: Methods of studying polymorphism at biochemical and DNA level, transgenic bacteria and bioethics, gene silencing, genetics of mitochondria and chloroplasts.

UNIT X: Concepts of eugenics, epigenetics, behavioural genetics, and gnetic disorders.

Practical: Laboratory exercises in probability and chi-square; demonstration of genetic principles using laboratory organisms; chromosome mapping using three point test cross; tetrad analysis; induction and detection of mutations through genetic tests; DNA; extraction and PCR amplification, electrophoresis, basic principles and running of amplified DNA; extraction of proteins and isozymes; use of *agrobacterium* mediated method and biolistic gun; practical demonstrations, detection of transgenes in the exposed plant material; visit to transgenic glasshouse and learning the practical considerations.

GP 502 PRINCIPLES OF CYTOGENETICS 2+1

Theory

UNIT I: History of cytogenetics , architecture of chromosome in prokaryotes and eukaryotes, chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere, artificial chromosome construction and its uses, Special types of chromosomes.

UNIT II: Chromosomal theory of inheritance, cell cycle and cell division, mitosis and meiosis, differences, significance and deviations, synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over- recombination models, cytological basis, variation in chromosome structure, evolutionary significance, introduction to techniques for karyotyping, chromosome banding and painting , *in situ* hybridization and various applications.

UNIT III: Structural and numerical variations of chromosomes and their implications, symbols and terminologies for chromosome numbers, euploidy, haploids, diploids and polyploids , utilization of aneuploids in gene location, variation in chromosome behaviour, somatic segregation and chimeras, endomitosis and somatic reduction, evolutionary significance of chromosomal aberrations, balanced lethals and chromosome complexes.

UNIT IV: Inter-varietal chromosome substitutions, polyploidy and role of polyploids in crop breeding, evolutionary advantages of autopolyploids *vs* allopolyploids, role of aneuploids in basic and applied

aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer, alien addition and substitution lines, creation and utilization, apomixis, evolutionary and genetic problems in crops with apomixis.

UNIT V: Reversion of autopolyploids to diploids, genome mapping in polyploids, interspecific hybridization and allopolyploids, synthesis of new crops (wheat, triticale and brassica), hybrids between species with same chromosome number, alien translocations, hybrids between species with different chromosome number, gene transfer using amphidiploids, bridge species.

UNIT VI: Fertilization barriers in crop plants at pre-and post-fertilization levels, *In vitro* techniques to overcome the fertilization barriers in crops, Chromosome manipulations in wide hybridization, case studies, Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

Practical: Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc., microscopy: various types of microscopes, observing sections of specimen using electron microscope; preparing specimen for observation, fixative preparation and fixing specimen for light microscopy studies in cereals, studies on the course of mitosis in wheat, pearl millet, studies on the course of mitosis in onion and *Aloe vera* **,** studies on the course of meiosis in cereals, millets and pulses, studies on the course of meiosis in oilseeds and forage crops, using micrometers and studying the pollen grain size in various crops, various methods of staining and preparation of temporary and permanent slides, pollen germination in vivo and in vitro*;* microtomy and steps in microtomy; agents employed for the induction of various ploidy levels; solution preparation and application at seed, seedling level, identification of polyploids in different crops, induction and identification of haploids; anther culture and ovule culture, morphological observations on synthesized autopolyploids, observations on c-mitosis, learning on the dynamics of spindle fibre assembly, morphological observations on alloployploids - morphological observations on aneuploids, cytogenetic analysis of interspecific and intergeneric crosses, maintenance of Cytogenetic stocks and their importance in crop breeding, Various ploidy levels due to somaclonal variation ; polyploidy in ornamental crops. Fluorescent *in situ* hybridization (FISH), genomic *in situ* hybridization (GISH).

GP 503 PRINCIPLES OF PLANT BREEDING 2+1

Theory

UNIT I: History of plant breeding (Pre and post-Mendelian era), objectives of plant breeding, characteristics improved by plant breeding, patterns of evolution in crop plants, centres of origin, biodiversity and its significance.

UNIT II: Genetic basis of breeding self- and cross - pollinated crops including mating systems and response to selection, nature of variability, components of variation, heritability and genetic advance, genotype environment interaction, general and specific combining ability, types of gene actions and implications in plant breeding, plant introduction and role of plant genetic resources in plant breeding.

UNIT III: Self-incompatibility, male sterility and apomixis in crop plants and their commercial exploitation.

UNIT IV: Pure line theory, pure line selection and mass selection methods, line breeding, pedigree, bulk, backcross, single seed descent and multiline method, population breeding in self-pollinated crops (diallel selective mating approach).

UNIT V: Breeding methods in cross pollinated crops, population breeding-mass selection and ear-to-row methods, S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and interpopulation improvement and development of synthetics and composites, hybrid breeding, genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance, seed production of hybrid and their parent varieties/inbreds.

UNIT VI: Breeding methods in asexually/clonally propagated crops, clonal selection apomixis, clonal selection.

UNIT VII: Concept of plant ideotype and its role in crop improvement, transgressive breeding, polyploidy wide hybridization and their significance in crop improvement, double hapolidy breeding following androgenesis, gynogenesis and chromosome elimation-mediated approaches.
UNIT VIII: Special breeding techniques- mutation breeding, breeding for abiotic and biotic stresses.
UNIT IX: Cultivar development- testing, release and notification, maintenance breeding, participatory plant breeding, plant breeders' rights and regulations for plant variety protection and farmers rights.
Practical: Floral biology in self and cross pollinated species, selfing and crossing techniques. Selection methods in segregating populations and evaluation of breeding material; analysis of variance (ANOVA); estimation of heritability and genetic advance; maintenance of experimental records; learning techniques in hybrid seed production using male-sterility in field crops.

GP 504 PRINCIPLES OF QUANTITATIVE GENETICS 2+1

Theory

UNIT I: Mendelian traits *vs* polygenic traits, nature of quantitative traits and its inheritance, multiple factor hypothesis, analysis of continuous variation, variations associated with polygenic traits, phenotypic, genotypic and 16 environmental, non-allelic interactions, nature of gene action, additive, dominance, epistatic and linkage effects.
UNIT II: Principles of analysis of variance (ANOVA), expected variance components, random and fixed models, MANOVA, biplot analysis, comparison of means and variances for significance.
UNIT III: Application of CRD, CRBD alpha designs, LSD , spilit plot, strip plot, progeny row, compact family block, simple and balance lattice, augumented and honey comb designs for plant breeding experiments, principles and applications, genetic diversity analysis, metroglyph, cluster and D^2 analyses , association analysis, phenotypic and genotypic correlations, path analysis and Parent, progeny regression analysis, discriminant function and principal component analyses, selection indices, selection of parents, simultaneous selection models, concepts of selection - heritability and genetic advance.
UNIT IV: Scaling tests and generation mean analysis, mating designs, diallel, partial diallel, line x tester analysis, NCDs and TTC, concepts of combining ability and gene action, analysis of genotype x environment interaction - adaptability and stability, models for GxE analysis and stability parameters, AMMI analysis, principles and interpretation.
UNIT V: QTL mapping, strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in genetic analysis, marker assisted selection (MAS) - approaches to apply MAS in plant breeding - selection based on marker - simultaneous selection based on marker and phenotype - factors influencing MAS.
Practical: Problems on multiple factors inheritance, partitioning of variance, estimation of heritability and genetic advance, covariance analysis, metroglyph analysis, D^2 analysis, grouping of clusters and interpretation, cluster analysis, construction of cluster diagrams and dendrograms, interpretation, correlation analysis, path analysis, parent-progeny regression analysis, diallel analysis: griffing's methods I and II, diallel analysis: hayman's graphical approach, diallel analysis: interpretation of results, NCD and their interpretations, line x tester analysis and interpretation of results, estimation of heterosis : standard, mid-parental and better-parental heterosis, estimation of inbreeding depression , generation mean analysis: Analytical part and Interpretation, estimation of different types of gene actions. Partitioning of phenotypic variance and co-variance into components due togenotypes, environment and genotype x environment interactions . Construction of saturated linkage maps and QTL mapping . Strategies for QTL mapping; statistical methods in QTL mapping; phenotype and marker linkage studies . Working out efficiency of selection methods in different populations and interpretation, biparental mating, triallel analysis, quadriallel analysis and triple Test Cross (TTC).Use of softwares in analysis and result interpretation, advanced biometrical models for combining ability analysis, models in stability analysis additive Main Effect and Multiplicative Interaction (AMMI) model. Principal**,** component analysis model . Additive and multiplicative model shifted 17 multiplicative model, analysis and

selection of genotypes . Methods and steps to select the best model and selection systems, biplots and mapping genotypes.

GP 505 MUTAGENESIS AND MUTATION BREEDING 1+1

Theory

UNIT I : Mutation and its history, nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations, detection of mutations in lower and higher organisms, paramutations.

UNIT II: Mutagenic agents: physical, radiation types and sources, ionising and non-ionizing radiations *viz*., X rays, γ rays, α and β particles, protons, neutrons and UV rays, radiobiology: mechanism of action of various radiations, (photoelectric absorption, Compton scattering and pair production) and their biological effects, RBE and LET relationships.

UNIT III: Effect of mutations on DNA - repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects, dosimetry, objects and methods of treatment, factors influencing mutation: dose rate, acute *vs* chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects, radiation sensitivity and modifying factors: external and internal sources- oxygen, water content, temperature and nuclear volume.

UNIT IV: Chemical mutagens- classification, base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action, dose determination and factors influencing chemical mutagenesis, treatment methods using physical and chemical mutagens, combination treatments, other causes of mutation, direct and indirect action, comparative evaluation of physical and chemical mutagens.

UNIT V: Observing mutagen effects in M1 generation: plant injury, lethality, sterility, chimeras *etc*., observing mutagen effects in M2 generation, estimation of mutagenic efficiency and effectiveness , spectrum of chlorophyll and viable mutations. Mutations in traits with continuous variation.

UNIT VI: Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage *etc*. - individual plant based mutation analysis and working out effectiveness and efficiency in M3 generation - comparative evaluation of physical and chemical mutagens for creation of variability in the same species – case studies.

UNIT VII: Use of mutagens in creating oligogenic and polygenic variations, case studies, *in vitro* mutagenesis, callus and pollen irradiation, handling of segregating genrations and selection procedures, validation of mutants, mutation breeding for various traits (disease resistance, insect resistance, quality improvement etc.) in different crops- procedures for micromutations breeding /polygenic mutations. Achievements of mutation breeding- varieties released across the world- problems associated with mutation breeding.

UNIT VIII: Use of mutagens in genomics, allele mining, tilling.

Practical: Learning the precautions on handling of mutagens; dosimetry - studies of different mutagenic agents: physical mutagens; studies of different mutagenic agents: chemical mutagens; learning on radioactivity; production of source and isotopes at BRIT; Trombay; Learning about gamma chamber; radiation hazards; monitoring, safety regulations and safe transportation of radioisotopes; visit to radio isotope laboratory; learning on safe disposal of radioisotopes. Hazards due to chemical mutagens, treating the plant propagules at different doses of physical and chemical mutagens; Learning combined mutagenic treatments; raising the crop for observation. Mutagenic effectiveness and efficiency; calculating the same from earlier literature. Study of M1 generation, parameters to be observed; study of M2 generation, parameters to be observed; mutation breeding in cereals and pulses; Achievements made and an analysis, mutation breeding in oilseeds and cotton. Achievements and opportunities, mutation breeding in forage crops and vegetatively propagated crops; procedure for detection of mutations for polygenic traits in M2 and M3 generations.

GP 506 POPULATION GENETICS 2+1

Theory

UNIT I: History of population genetics, properties of population, Mendelian population, genetic constitution of a population through time, space, age structure etc. Mating systems, random mating population, frequencies of genes and genotypes, causes of change: population size, differences in fertility and viability, migration and mutation.

UNIT II: Hardy-Weinberg equilibrium, Hardy-Weinberg law, proof, applications of the Hardy, Weinberg law, test of Hardy-Weinberg equilibrium, mating frequencies, non-dominance, codominance, snyder's ratio, importance and its effect over random mating in succeeding generations.

UNIT III: Multiple alleles, more than one locus, sex linked genes, use of gene and genotypic frequencies evaluation in field population level, lnterpretations, changes of gene frequency, migration, mutation, recurrent and nonrecurrent, Selection, balance between selection and mutation, selection favouring heterozygotes, overdominance for fitness.

UNIT IV: Non random mating: selfing, inbreeding coefficient, panmictic index, sibmating, assortative mating and disassortative mating, pedigree populations and close inbreeding, estimation of selection, estimation of disequilibrium, estimation of linkage - correlation between relatives and estimation of F, Effect of inbreeding and sibbing in cross pollinated crops.

UNIT V: Gene substitution and average effects, breeding value, genetic drift, genetic slippage, co-adapted gene complexes, homoeostasis, adapative organization of gene pools, polymorphism, balanced and non-balanced polymorphism, heterozygous advantage, survival of recessive and deleterious alleles in populations.

Practical: Genetic exercise on probability**;** estimation of gene frequencies; exercises on factors affecting gene frequencies; estimation of average affect of gene substitution and breeding value; exercises on inbreeding and linkage disequilibrium, cavalli's joint scaling test; exercises of different mating designs; estimation of different population parameters from experimental data; measurement of genotype-environment interaction; genetic divergence.

GP 507 HETEROSIS BREEDING 1+1

Theory

UNIT I: Historical aspect of heterosis, nomenclature and definitions of heterosis, heterosis in natural population and inbred population, evolutionary aspects, genetic consequences of selfing and crossing in self-and cross-pollinated and asexually propagated crops.

UNIT II: Pre-Mendelian and Post-Mendelian ideas, genetic theories of heterosis, physiological, biochemical and molecular factors underlining heterosis, theories and their estimation, evolutionary concepts of heterosis.

UNIT III: Prediction of heterosis from various crosses, Inbreeding depression, frequency of inbreeding and residual heterosis in F2 and segregating populations, importance of inbreeding in exploitation of heterosis, case studies, relationship between genetic distance and expression of heterosis, case studies, divergence and genetic distance analyses-morphological and molecular genetic distance in predicting heterosis, development of heterotic pools in germplasm/genetic stocks and inbreds, their improvement for increasing heterosis.

UNIT IV: Types of male sterility and use in heterosis breeding, maintenance, transfer and restoration of different types of male sterility, use of self incompatibility in development of hybrids, hybrid seed production system: 3-line, 2-line and 1-line system, development of inbreds and parental lines- A, B and R lines – functional male sterility, commercial exploitation of heterosis- maintenance breeding of parental lines in hybrids.

UNIT V: Fixation of heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops, male sterile line creation and diversification in self pollinated, cross pollinated and asexually propagate 21 crops, problems and prospects, apomixis in fixing heterosis-concept of single line hybrid.

UNIT VI: Organellar heterosis and complementation, creation of male sterility through genetic engineering and its exploitation in heterosis.
UNIT VII: Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum and oilseed crops.

Practical: Selection indices and selection differential; calculations and interpretations; Male sterile line characterization in millets; using morphological descriptors; restorer line identification and diversification of male sterile sources; Male sterile line creation in dicots comprising oilseeds, pulses and cotton ; problems in creation of CGMS system; ways of overcoming them; Male sterile line creation; diversification and restoration in forage crops; understanding the difficulties in breeding apomicts; estimation of heterotic parameters in self, cross and asexually propagated crops; estimation from the various models for heterosis parameters; Hybrid seed production in field crops; an account on the released hybrids; their potential; problems and ways of overcoming it; hybrid breeding at National and International level; opportunities ahead.

GP 508 CELL BIOLOGY AND MOLECULAR GENETICS 2+1

Theory

UNIT I: Ultrastructure of the cell, differences between eukaryotic and prokaryotic cells, macromolecules, Structure and function of cell wall, nuclear membrane and plasma membrane, cellular organelles, nucleus, plastidschloro/ chromoplast, mitochondria endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes.
UNIT II: Bioenergetics, ultrastructure and function of mitochondria and biological membranes, chloroplast and other photosynthetic organelles, Interphase nucleus- structure and chemical composition, cell division and physiology of cell division.
UNIT III: Historical background of molecular genetics, genetic material in organisms, structure and properties of nucleic acid, DNA transcription and its regulation, transcription factors and their role, genetic code, regulation of protein synthesis in prokaryotes and eukaryotes, ribosomes, t-RNAs and translational factors.
UNIT IV: Transposable elements, mechanisms of recombination in prokaryote, DNA organization in eukaryotic chromosomes, DNA content variation, types of DNA sequencing, unique and repetitive sequences, organelle genomes, gene amplification and its significance, proteomics and protein-protein interaction, signal transduction, genes in development, cancer and cell aging.

Practical: Morphological and gram staining of natural bacteria; cultivation of bacteria in synthetic medium; determination of growth rate and doubling time of bacterial cells in culture; demonstration of bacteriophage by plaque assay method; determination of soluble protein content in a bacterial culture. Isolation, purification and raising clonal population of a bacterium; biological assay of bacteriophage and determination of phage population in lysate; study of lytic cycle of bacteriophage by one step growth experiment; determination of latent period and burst size of phages per cell; quantitative estimation of DNA, RNA and protein in an organism; numericals: problems and assignments.

GP 509 BIOTECHNOLOGY FOR CROP IMPROVEMENT 2+1

Theory

UNIT I: Biotechnology and its relevance in agriculture, definitions, terminologies and scope in plant breeding.
UNIT II: Tissue culture history, callus, suspension cultures, cloning, regeneration, somatic embryogenesis, anther culture, somatic hybridization techniques, meristem, ovary and embryo culture, cryopreservation.
UNIT III : Techniques of DNA isolation, quantification and analysis, genotyping, sequencing techniques, vectors, vector preparation and cloning, biochemical and molecular markers, morphological, biochemical and DNA based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F2s, back crosses, RILs, NILs and DH).

UNIT IV: Molecular mapping and tagging of agronomically important traits, statistical tools in marker analysis, robotics, marker-assisted selection for qualitative and quantitative traits, QTLs analysis in crop plants, gene pyramiding.
UNIT V: Marker assisted selection and molecular breeding, genomics and genoinformatics for crop improvement, integrating functional genomics information on agronomically/economically important traits in plant breeding, marker-assisted backcross breeding for rapid introgression, generation of EDVs.
UNIT VI: Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer, production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. and their commercial releases.
UNIT VII : Biotechnology applications in male sterility/hybrid breeding, molecular farming.
UNIT VIII: MOs and related issues (risk and regulations), GMO, international regulations, biosafety issues of GMOs, regulatory procedures in major countries including India, ethical, legal and social issues, intellectual property rights
UNIT IX: Bioinformatics & bioinformatics tools.
UNIT X: Nanotechnology and its applications in crop improvement programmes.
Practical: Requirements for plant tissue culture laboratory; techniques in plant tissue culture, media components and media preparation. Aseptic manipulation of various explants ; observations on the contaminants occurring in media, interpretations, inoculation of explants; callus induction and plant regeneration; standardizing the protocols for hardening of regenerated plants; establishing a greenhouse and hardening procedures. Visit to commercial micropropagation unit; transformation using *Agrobacterium* strains, GUS assay in transformed cells/ tissues; DNA isolation, DNA purity and quantification tests; gel electrophoresis of proteins and isozymes; PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.

GP 510 BREEDING FOR BIOTIC AND ABIOTIC STRESS RESISTANCE 2+1

Theory
UNIT I: Importance of plant breeding with special reference to biotic and abiotic stress resistance, classification of biotic stresses, major pests and diseases of economically important crops, concepts in insect and pathogen resistance, analysis and inheritance of resistance variation, host defence responses to pathogen invasions, biochemical and molecular mechanisms, acquired and induced immunity and systemic acquired resistance (SAR), host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions, concept of signal transduction and other host-defense mechanisms against viruses and bacteria.
UNIT II: Types and genetic mechanisms of resistance to biotic stresses, horizontal and vertical resistance in crop plants. Quantitative resistance/Adult plant resistance and slow rusting resistance, classical and molecular breeding methods, measuring plant resistance using plant fitness, behavioural, physiological and insect gain studies.
UNIT III: Phenotypic screening methods for major pests and diseases, recording of observations, correlating the observations using marker data , gene pyramiding methods and their implications.
UNIT IV: Classification of abiotic stresses, stress inducing factors, moisture stress/drought and water logging & submergence, acidity, salinity/alkalinity/sodicity, high/low temperature, wind, etc. Stress due to soil factors and mineral toxicity, physiological and phenological responses, emphasis of abiotic stresses in developing breeding methodologies.
UNIT V: Genetics of abiotic stress resistance, genes and genomics in breeding cultivars suitable to low water regimes and water logging & submergence, high and low/freezing temperatures, utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton etc,

breeding for resistance to stresses caused by toxicity, deficiency and pollutants/contaminants in soil, water and environment.

UNIT VI: Exploitation of wild relatives as a source of resistance to biotic and abiotic factors in major field crops . Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitnases and Bt for diseases and insect pest management- achievements.

Practical: Phenotypic screening techniques for sucking pests and chewing pests; traits to be observed at plant and insect level; phenotypic screening techniques for nematodes and borers; ways of combating them; Breeding strategies, weeds, ecological, environmental impacts on the crops; breeding for herbicide resistance. Evaluating the available populations like RIL; NIL etc. for pest resistance; use of standard MAS procedures; phenotypic screening methods for diseases caused by fungi and bacteria; symptoms and data recording; use of MAS procedures. Screening forage crops for resistance to sewage water and tannery effluents; quality parameters evaluation, screening crops for drought and flood resistance; factors to be considered and breeding strategies. Screening varieties of major crops for acidity and alkalinity, their effects and breeding strategies; understanding the climatological parameters and predisposal of biotic and abiotic stress factors- ways of combating them.

GP 511 BREEDING CEREALS, MILLETS, FORAGES AND SUGARCANE 2+1

Theory

UNIT I: Rice: Evolution and distribution of species and forms, wild relatives and germplasm, genetics, cytogenetics and genome relationship, breeding objectives, yield, quality characters, biotic and abiotic stress resistance *etc.*, hybrid rice breeding, potential and outcome, aerobic rice, its implications and drought resistance breeding.

UNIT II: Wheat: Evolution and distribution of species and forms-wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives yield, quality characters, biotic and abiotic stress resistance, exploitation of heterosis etc, Sorghum: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives, yield, quality characters, biotic and abiotic stress resistance etc, pearl millet: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives, yield, quality characters, biotic and abiotic stress resistance etc.

UNIT III: Maize: Evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc., QPM and Bt maize, strategies and implications, heterosis breeding attempts taken in sorghum, pearl millet and maize, minor millets: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, minor millets: breeding objectives yield, quality characters, biotic and abiotic stress resistance etc.

UNIT IV: Sugarcane: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc., forage grasses: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives- yield, quality characters and palatability studies, biotic and abiotic stress resistance etc., synthetics, composites and apomixis.

UNIT V: Forage grasses and legumes: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives, yield, quality characters, biotic and abiotic stress resistance etc., tree fodders: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives, yield, quality characters, biotic and abiotic stress resistance *etc*, palatability studies.

UNIT VI: Distinguishing features of popular released varieties in rice and sorghum, wheat, pearl millet, maize and other millets, sugarcane, forage grasses and legumes and their application to DUS testing, maintenance of seed purity, nucleus and breeder seed production.

Practical: Floral biology, emasculation, pollination techniques; study of range of variation for yield and yield components; Study of segregating populations and their evaluation, trait based screening for stress

resistance in crops of importance; Use of descriptors for cataloguing germplasm maintenance; learning on the standard evaluation system (SES) and descriptors; Use of softwares for database management and retrieval; practical learning on the cultivation of fodder crop species on sewage water; analysing them for yield components and palatability; laboratory analysis of forage crops for crude protein, digestibility percent and other quality attributes; visit to animal feed producing factories; learning the practice of value addition; visiting the animal husbandry unit and learning the animal experiments related with palatability and digestibility of fodder.

GP 512 BREEDING LEGUMES, OILSEEDS AND FIBRE CROPS 2+1

Theory

UNIT I: Pigeonpea: Evolution and distribution of species and forms, wild relatives and germplasm, genetics, cytogenetics and genome relationship, morphological and molecular descriptors used for differentiating the accessions, breeding objectives, yield, quality characters, biotic and abiotic stress *etc* - hybrid technology, maintenance of male sterile, fertile and restorer lines, progress made at ICRISAT and other Institutes.

UNIT II: Chickpea: Evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives, yield, quality characters, biotic and abiotic stress etc, protein quality improvement, conventional and modern plant breeding approaches, progress made, breeding for anti nutritional factors.

UNIT III: Other pulses: greengram, blackgram, fieldpea, lentil,, lathyrus, cowpea, commen bean (*rajmash)* lablab, mothbean: evolution, cytogenetics and genome relationship, learning the descriptors, breeding objectives, yield, quality characters, biotic and abiotic stress etc, interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

UNIT IV: Groundnut: Evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, pod and kernel characters, breeding objectives- yield, quality characters, biotic and abiotic stress etc.

UNIT V: Rapeseed and mustard: breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress etc, oil quality, characteristics in different oils, evolution and distribution of species and forms, wild relatives and germplasm, genetics, cytogenetics and genome relationship.

UNIT VI: Soybean: Breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress etc., oil quality, characteristics, evolution and distribution of species and forms, wild relatives and germplasm, genetics, cytogenetics and genome relationship.

UNIT VII: Other oilseed crops: sunflower, sesame, linseed, safflower, niger: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives, yield, quality characters, biotic and abiotic stress.

UNIT VIII: Castor: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives yield, quality characters, biotic and abiotic stress *etc* - hybrid breeding in castor, opportunities, constraints and achievements.

UNIT IX: Cotton: evolution of cotton, breeding objectives, yield, quality characters, biotic and abiotic stress etc, development and maintenance of male sterile lines, hybrid development and seed production, scenario of Bt cottons, evaluation procedures for Bt cotton. Jute: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship; breeding objectives, yield, quality characters, biotic and abiotic stress etc, mesta and minor fibre crops: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives- yield, quality characters, biotic and abiotic stress etc.

UNIT X: Distinguishing features of the released varieties in pulses, oilseeds and cotton, maintenance of seed purity and seed production.

Practical: Use of descriptors for cataloguing, floral biology; emasculation; pollination techniques; study of range of variation for yield and yield components; study of segregating populations in redgram, greengram; blackgram and other pulse crops; attempting crosses between blackgram and greengram; use of descriptors for cataloguing; floral biology; emasculation; pollination techniques of oilseed crops like sesame; groundnut; sunflower and castor; cotton: use of descriptors for cataloguing; floral biology; learning on the crosses between different species; cotton: study of range of variation for yield and yield components; study of segregating populations; evaluation; trait based screening for stress resistance; cotton fibre quality evaluation; conventional and modern approaches; analysing the lint samples of different species; interspecific and interracial derivatives for fibre quality and interpretation; development and maintenance of male sterile lines; evaluation of cotton cultures of different species for insect and disease resistance; learning the mechanisms of resistance; quantifying the resistance using various parameters; evaluating the germplasm of cotton for yield; quality and resistance parameters; learning the procedures on development of bt cotton; visit to cotton technology laboratory and spinning mills; learning on cotton yarn production; its quality evaluation and uses.

GP 513 BREEDING FOR QUALITY TRAITS 2+1

Theory

UNIT I: Developmental biochemistry and genetics of carbohydrates, proteins, fats, vitamins, aminoacids and anti-nutritional factors, nutritional improvement, a human perspective, breeding for grain quality parameters in rice and its analysis, golden rice and aromatic rice, breeding strategies, achievements and application in Indian context, molecular basis of quality traits and their manipulation in rice, post harvest manipulation for quality improvement.

UNIT II: Breeding for baking qualities in wheat, characters to be considered and breeding strategies, molecular and cytogenetic manipulation for quality improvement in wheat, Breeding for quality improvement in barley and oats.

UNIT III: Breeding for quality improvement in Sorghum and pearl millet, quality protein maize, concept and breeding strategies, breeding for quality improvement in forage crops, genetic resource management for sustaining nutritive quality in crops.

UNIT IV: Breeding for quality in pulses, in groundnut, sesame, sunflower and minor oilseeds, molecular basis of fat formation and manipulation to achieve more PUFA in oil crops, genetic manipulation for quality improvement in cotton.

UNIT V: Genetic engineering protocols for quality improvement, achievements made, value addition in crops, classification and importance, nutritional genomics and second generation transgenics.

Practical: Grain quality evaluation in rice; correlating ageing and quality improvement in rice; quality analysis in millets; estimation of antinutritional factors like tannins in different varieties/hybrids; a comparison; quality parameters evaluation in wheat; quality parameters evaluation in pulses, quality parameters evaluation in oilseeds; value addition in crop plants; post harvest processing of major field crops; quality improvement in crops through tissue culture techniques; evaluating the available populations like RIL, NIL etc. for quality improvement using MAS procedures.

GP 514 GENE REGULATION AND EXPRESSION 2+0

Theory

UNIT I: Introduction: Gene regulation-purpose, Process and mechanisms in prokaryotes and eukaryotes, levels of gene controls.

UNIT II: Coordinated genetic regulation-examples, anthocyanin and gene families and maize, genetic and molecular basis depending on tissue specificity.

UNIT III: Gene expression, transposons in plant gene expression, cloning-transposon tagging, light regulated gene expression, model systems in *arabidopsis* and maize, paramutations and imprinting of genes and genomes.

UNIT IV: Transgene expression and gene silencing mechanisms, regulatory geneshorizontal and vertical homology, transformation, regulatory genes as visible markers, reporter systems to study gene expression, combinatorial gene control.
UNIT V: Eukaryotic transcriptional control, translational and post-translational regulation, signal transduction, stress-induced gene expression, gene traps and enhancer traps.

GP 515 MAINTENANCE BREEDING AND CONCEPTS OF VARIETY RELEASE AND SEED PRODUCTION 1+1

Theory

UNIT I: Variety development and maintenance, definition- variety, cultivar,extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid and population, Variety testing, release and notification systems in India and abroad.
UNIT II: DUS testing- DUS Descriptors for major crops, Genetic purity concept and maintenance breeding.
UNIT III: Factors responsible for genetic deterioration of varieties, safeguards during seed production, maintenance of varieties in self and cross-pollination crops, isolation distance, principles of seed production, methods of nucleus and breeder seed production.
UNIT IV: Generation system of seed multiplication, nucleus, breeders, foundation, certified, quality seed production technology of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearlmillet, sorghum, maize and ragi etc.), pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil), oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard), fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne)., seed certification procedures, seed laws and plant variety protection regulations in India and international systems.
Practical: Identification of suitable areas/locations for seed production; ear-to-row method and nucleus seed production, main characteristics of released and notified varieties; hybrids and parental lines; identification of important weeds/objectionable weeds; determination of isolation distance and planting ratios in different crops; seed production techniques of varieties in different crops; hybrid seed production technology of important crops.

GP 516 GERMPLASM COLLECTION, EXCHANGE AND QUARANTINE 2+1

Theory

UNIT I: History and importance of germplasm exploration, distribution and extent of prevalent genetic diversity, phyto-geographical regions/ecological zones and associated diversity, mapping eco-geographic distribution of diversity, threatened habitats, use of flora.
UNIT II: Concept of population and gene pool, variations in population and their classification, gene frequencies in populations, rare and common alleles, gene pool sampling in self and cross pollinated and vegetatively propagated species, non-selective, random and selective sampling strategies, strategies and logistics of plant exploration and collection, coarse and fine grid surveys, practical problems in plant exploration, use of *in vitro* methods in germplasm collection.
UNIT III: Ethnobotanical aspects of PGR, crop botany, farming systems, collecting wild relatives of crop plants, collection and preservation of specimens, importance and use of herbaria and preparation of herbarium specimens.
UNIT IV: Post-exploration handling of germplasm collections, present status and future strategies in collection of major crops of Indian origin such as rice, maize, sorghum, sesame, *brassica*, okra, eggplant, cotton, mango etc, approaches for collection including indigenous knowledge.
UNIT V: History, principles, objectives and importance of plant introduction, prerequisites, conventions, national and international legislations and policies on germplasm collection , exchange and IPR issues, documentation and information management, plant quarantine- introduction, history, principles,

objectives and relevance, regulations and plant quarantine set up in India, pest risk analysis, pest and pathogen information database, quarantine in relation to integrated pest management, economic significance of seed-borne pests (insects, mites, non-insect pests, nematodes, fungi, bacteria, viruses, phytoplasma etc.).
UNIT VI: Detection and identification of pests including use of recent techniques like ELISA, PCR etc., symptoms of pest damage, salvaging techniques for infested/infected germplasm, post-entry quarantine operation, seed treatment and other prophylactic treatments and facilities, domestic quarantine, seed certification, international linkages in plant quarantine, weaknesses and future thrust.
UNIT VII: Genetically modified organisms (GMOs) or genetically engineered plants (GEPs), concepts of biosafety, risk analysis and consequences of spread of GE crops on the environment, treaties and multilateral agreements governing trans-boundary movement of GEPs or GMOs, Indian regulatory system for biosafety.
Practical: Plant exploration and collection; techniques of coarse and fine grid surveys; identification of wild relatives of crop plants; example of collection; cataloguing and preservation of specimens; sampling techniques of plant materials; visiting ports, airports to study the quarantine regulations; techniques for the detection of insects; mites; nematodes; bacteria; weeds; pathogens and viruses on seed and planting materials and salvaging; use of visual; qualitative; quantitative; microscopic; molecular and plant growth related techniques(controlled green houses/growth chambers, etc); detection of GMOs and GEPs; study of post-entry quarantine operation; seed treatment and other prophylactic treatments.

GP 517 DATA BASE MANAGEMENT, EVALUATION AND UTILIZATION OF PGR 2+1

Theory
UNIT I: Statistical techniques in management of germplasm, core identification, estimation of sample size during plant explorations, impact of sampling on population structure, sequential sampling for viability estimation, introduction of binomial, normal and negative cumulative normal, use of probit scales, viability equations and numograms, estimation of sample size for storage and viability testing.
UNIT II: Germplasm documentation, basics of computer and operating systems, database management system, use of statistical softwares, pictorial and graphical representation of data, introduction to communication network.
UNIT III: Germplasm management system- global scenario, genetic variation in crop plants and management of germplasm collection, limitations in use of germplasm collections, necessity of germplasm evaluation, predictive methods for identification of useful germplasm, characterization of germplasm and evaluation procedures including specific traits, gene markers and their use in PGR management.
UNIT IV: Management and utilization of germplasm collections, concept of core collection, molecular markers and their use in characterization, evaluation and utilization of genetic resources, pre-breeding/ genetic enhancement, utilizing wild species for crop improvement, harmonizing agro biodiversity and agricultural development crop diversification participatory plant breeding.
Practical: Basics of computer and operating systems; identification of useful germplasm, evaluation of crop germplasm; statistical techniques in management of germplasm, estimation of sample size for storage and viability testing; evaluation procedure and experimental protocols (designs and their analysis), assessment of genetic diversity; techniques of characterization of germplasm; molecular markers and their use in characterization.

GP 591 MASTER'S SEMINAR 1+0
GP 592 SPECIAL PROBLEM IN M.Sc. 0+1
GP 599 MASTER'S RESEARCH 0+20

GP 601 PLANT GENETIC RESOURCES AND THEIR UTILIZATION 2+0

Theory

UNIT I: Historical perspectives and need for PGR conservation, importance of plant genetic resources, taxonomical classification of cultivated plants, gene pool: primary, secondary and tertiary, centres of origin and global pattern of diversity, basic genetic resources and transgenes.

UNIT II: Principles, strategies and practices of exploration, collection, characterization, evaluation and cataloging of PGR, Plant quarantine and phytosanitary certification, germplasm introduction and exchange, principles of *in vitro* and cryopreservation.

UNIT III: Germplasm conservation- *in situ, ex situ*, and on-farm, short, medium and long term conservation strategies for conservation of orthodox seed and vegetatively propagated crops, registration of plant genetic resources.

UNIT IV: PGR data base management, multivariate and clustering analysis, descriptors, national and international protocols for PGR management, PGR for food and agriculture (PGRFA), PGR access and benefit sharing, role of CGIAR system in the germplasm exchange, PBR, farmers rights and privileges, seed Act, *sui generis* system, geographical indicators, intellectual property, patents, copyrights, trademarks and trade secrets.

UNIT V: Journey from wild to domestication, genetic enhancement- need for genetic enhancement, genetic enhancement in pre Mendelian era and 21st century, genetic enhancement and plant breeding, reasons for failure in genetic enhancement, sources of genes/ traits- novel genes for quality.

UNIT VI: distant hybridization: inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations, gene transfer tools and techniques into cultivated species, validation of transferred genes and their expression.

UNIT VII: Post-genomic tools for genetic enhancement of germplasm, prebreeding through chromosome manipulation, application of biotechnology for genetic enhancement-achievements.

UNIT VIII: Utilization of genetic resources, concept of core and mini-core collections, genetic enhancement /pre-breeding for crop improvement including hybrid development.

GP 602 ADVANCES IN QUANTITATIVE GENETICS 2+1

Theory

UNIT I: Basic principles of biometrical genetics, selection of parents, advanced biometrical models for combining ability analysis, simultaneous selection models, use of multiple regression analysis in selection of genotypes, designs and systems, selection of stable genotypes.

UNIT II: Models in stability analysis, pattern analysis, additive main effect and multiplicative Interaction (AMMI) analysis and other related models, principal component analysis.

UNIT III: Additive and multiplicative model, shifted multiplicative model, analysis and selection of genotypes, methods and steps to select the best model, biplots and mapping genotypes.

UNIT IV: Genetic architecture of quantitative traits, conventional analyses to detect gene actions including higher order interactions, partitioning of phenotypic/genotypic variance, construction of saturated linkage maps, concept of framework map development, QTL mapping, strategies for QTL mapping, desired populations, statistical methods, marker assisted selection (MAS), approaches to apply MAS in Plant breeding, selection based on markers, simultaneous selection based on marker and phenotype, factors influencing MAS, heritability of the trait, proportion of genetic variance, linkage disequilibrium between markers and traits and selection methods.

Practical: Working out efficiency of selection methods in different populations and interpretation; biparental mating; use of softwares in analysis and result interpretation; triallel analysis; use of softwares in analysis and result interpretation; quadriallel analysis; use of softwares in analysis and result interpretation; triple test cross (TTC), use of softwares in analysis and result interpretation; advanced biometrical models for combining ability analysis; selection of stable genotypes using stability analysis; models in stability analysis; Additive main effect and multiplicative interaction (AMMI) model, principal component analysis model; additive and multiplicative model; shifted multiplicative model; analysis and

selection of genotypes; methods and steps to select the best model; selection systems;Biplots and mapping genotypes; Construction of linkage maps and QTL mapping, strategies for QTL mapping; statistical methods in QTL mapping; phenotype and marker linkage studies.

GP 603 GENOMICS IN CROP IMPROVEMENT 2+1

Theory

UNIT I: Introduction to the plant genome, plant nuclear genomes and their molecular description , the chloroplast and the mitochondrial genomes in plants, genome size and complexity.

UNIT II: Establishment of plant genome mapping projects, genome mapping and use of molecular markers in plant breeding, strategies for mapping genes of agronomic traits in plants, approaches for mapping quantitative trait loci, map based cloning of plant genes.

UNIT III: Regulation of plant gene expression, functional genomics, expression analysis using microarrays , transposon tagging and insertional mutagenesis, methods and significance, diversity array technology.

UNIT IV: Genome sequencing in plants, principles and techniques, applications of sequence information in plant genome analyses, comparative genomics, genome comparison techniques, classical and advanced approaches.

UNIT V: Detection of single nucleotide polymorphism, tilling and eco-tilling, role of transcriptomics, proteomics and metabolomics in linking genome and phenome, importance of understanding the phenotypes for exploiting the outcome of genomic technologies, knock out mutant studies and high throughput phenotyping.

UNIT VI: Concept of database development, management and bioinformatics, plant genome projects and application of bioinformatics tools in structural and functional genomics.

Practical: Chromosome analysis in major field crops; fluorescence *in situ* hybridization; comparative genomic hybridization; comparative analysis of plant genomes using molecular markers; genetic map construction using molecular markers; mapping major genes using molecular markers; QTL mapping in plants; comparison across mapping populations; understanding the need genetic algorithms in QTL mapping; plant genome databases, computational tools to explore plant genome databases; comparative genomics; comparison of genome sequences using tools of bioinformatics; advanced genomic technologies; TILLING and Eco-TILLING – DNA Array Technology; linking genome sequences to phenotypes: tools of transcriptomics; proteomics and metabolomics.

GP 604 MOLECULAR AND CHROMOSOMAL MANIPULATIONS FOR CROP IMPROVEMENT 2+0

Theory

UNIT I: Organization and structure of genome, genome size, organization of organellar genomes, nuclear DNA organization, nuclear and cytoplasmic genome interactions and signal transduction; transcriptional and Translational changes, inheritance and expression of organellar DNA, variation in DNA content, C value paradox; sequence complexity, introns and exons, repetitive sequences, role of repetitive sequence.

UNIT II: Karyotyping , chromosome banding and chromosome painting, tracking introgressions using FISH, GISH, localization and mapping of genes/genomic segments, distant hybridization, role of polyploids in crop evolution and breeding, auto and allopolyploids.

UNIT III: Applications of cytogenetical methods for crop improvement, location and mapping of genes on chromosomes: deficiency method, interchange genetic consequence, identification of chromosomes involved and gene location, balanced lethal systems, their maintenance and utility, multiple interchanges, use in producing inbreds, transfer of genes, linked marker methods, duplication, production and use, inversions and location of genes, B/A chromosome translocations and gene location.

UNIT IV: Trisomics- types, production, breeding behavior and location of genes, use of balanced tertiary trisomics in hybrid seed production, monosomics methods of production, breeding behavior and location of genes, inter varietal substitutions-allelic and non-allelic interactions, telocentric method of mapping.

UNIT V: barriers to interspecific and intergeneric hybridization, behaviour of interspecific and intergeneric crosses, totipotency of cells, morphogenesis: *in vivo* and *in vitro, m*eristem culture, anther and pollen culture, ovule, ovary, embryo and endosperm culture, protoplast isolation and culture, protoplast fusion, different pathways of *in vitro* morphogenesis, organogenesis and somatic embryogenesis, *in vitro* mutant/somaclone selection for biotic and abiotic stresses.

GP 605 ADVANCED PLANT BREEDING SYSTEMS 2+0

Theory

UNIT I: Facts about plant breeding before the discovery of Mendelism, evolutionary concepts of genetics and plant breeding, flower development and its importance, genes governing the whorl formation and various models proposed, mating systems and their exploitation in crop breeding, types of pollination, mechanisms promoting cross pollination.

UNIT II: Self- incompatibility and sterility, types of self incompatibility: homomorphic (sporophytic and gametophytic) and heteromorphic, breakdown of incompatibility, floral adaptive mechanisms, spatial and temporal, genetic and biochemical basis of self incompatibility, sterility: male and female sterility, types of male sterility: genic, cytoplasmic and cytoplasmic-genic, exploitation in monocots and dicots, difficulties in exploiting CGMS system in dicots, case studies and breeding strategies, nucleocytoplasmic interactions with special reference to male sterility, genetic , biochemical and molecular basis.

UNIT III: Population formation by hybridization, types of populations, Mendelian population, gene pool, composites, synthetics etc., principles and procedures in the formation of a complex population, genetic basis of population improvement.

UNIT IV: Selection in self fertilizing crops, creation of genetic variability selection methods: mass selection, pureline selection, pedigree method (selection in early generations *vs* advanced generations), backcross, polycross and test cross.

UNIT V: Selection in cross fertilizing crops, polycross and topcross selections, mass and recurrent selection methods and their modifications, mass selection: grid mass selection, ear to row selection, modified ear to row selection, convergent selection, divergent selection, recurrent selection: simple recurrent selection and its modifications (restricted phenotypic selection, selfed progeny selection and full sib recurrent selection), recurrent selection for general combining ability (GCA), concepts and utilization, recurrent selection for specific combining ability (SCA), usefulness in hybrid breeding programmes , reciprocal recurrent selection (half sib reciprocal recurrent selection, half sib reciprocal recurrent selection with inbred tester and full sib reciprocal recurrent selection), selection in clonally propagated crops, assumptions and realities.

UNIT VI: Genetic engineering technologies to create male sterility, prospects and problems, use of self-incompatability and sterility in plant breeding, case studies, fertility restoration in male sterile lines and restorer diversification programmes, conversion of agronomically ideal genotypes into male steriles, concepts and breeding strategies, case studies, generating new cytonuclear interaction system for diversification of male steriles, stability of male sterile lines, environmental influence on sterility, environmentally Induced Genic Male Sterility (EGMS), types of EGMS, influence on their expression, genetic studies, photo and thermo sensitive genetic male sterility and its use in heterosis breeding, temperature sensitive genetic male sterility and its use heterosis breeding, apomixis and its use in heterosis breeding, incongruity, factors influencing incongruity, methods to overcome incongruity mechanisms.

GP 606 CROP EVOLUTION 2+0

Theory

UNIT I: Origin and evolution of species, centres of diversity/origin, diffused centres, time and place of domestication, patterns of evolution and domestication, examples and case studies.

UNIT II: Domestication and uniformity, characteristics of early domestication and changes, concept of gene pools and crop evolution, selection and genetic drift, consequences.

UNIT III: Speciation and domestication, the process of speciation, reproductive isolation barriers, genetic differentiation during speciation, hybridization, speciation and extinction.
UNIT IV: Exploitation of natural variation, early attempts to increase variation, distant hybridization and introgression, inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations, gene transfer into cultivated species, tools and techniques, validation of transferred genes and their expression, controlled introgressions.
UNIT V: Processes in crop evolution and stabilization of polyploids, cytogenetic and genetic stabilization, genome organization, transgenesis in crop evolution, multifactorial genome, intragenomic interaction, intergenomic interaction, genome introgression.
UNIT VI: Methods to study crop evolution, contemporary methods, based on morphological features, cytogenetic analysis, allozyme variations and crop evolution, DNA markers, genome analysis and comparative genomics.
UNIT VII: Evolutionary significance of polyploidy, evolution of crop plants through ploidy manipulations, polyploids: methods, use of autopolyploids, haploidy-method of production and use, allopolyploids- synthesis of new crops, case studies, cereals, pulses, oilseeds, vegetables, fibre crops, plantation crops, forage crops, tuber crops, medicinal plants.

GP 607 BREEDING DESIGNER CROPS 1+1

Theory

UNIT I: Breeding of crop ideotypes, genetic manipulations through recombination breeding, genomics and transgenics for physiological efficiency, nutritional enhancement, special compounds, proteins, vaccines, gums, starch and fats.
UNIT II: Physiological efficiency as a concept, parametric and whole plant physiology in integrated mode, physiological mechanism of improvement in nutrient use efficiency, water use efficiency, osmotic adjustment, photosynthetic efficiency, stay green trait and its significance in crop improvement.
UNIT III: Improvement in yield potential under sub-optimal conditions by manipulating source and sink, canopy architecture, plant-water relationships, effect of suboptimal conditions on cardinal plant growth and development processes, enhancing input use efficiency through genetic manipulations.
UNIT IV: Breeding for special traits viz. oil, protein, vitamins, amino acids etc., concept of biopharming and development of varieties producing targeted compounds, nutraceuticals and industrial products, Success stories in vaccines, modified sugars, gums and starch through biopharming.
UNIT V: Biosafety management, segregation and isolation requirements in designer crop production and post-harvest management.
Practical: Demonstration of plant responses to stresses through recent techniques; water use efficiency; transpiration efficiency; screening techniques under stress conditions such as electrolyte leakage; TTC; chlorophyll fluorescence; canopy temperature depression; stomatal conductance; chlorophyll estimation; heat/drought/salt shock proteins.

GP 608 ADVANCES IN BREEDING OF MAJOR FIELD CROPS 3+0

Theory

UNIT I: History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species of major cereals, millets and non cereal crops like rice, wheat, maize, pearl millet, sorghum , pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc.
UNIT II: Breeding objectives in rice, wheat, maize, pearl millet, sorghum, pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc., genetic resources and their utilization, genetics of quantitative and qualitative traits.
UNIT III: Breeding for value addition and resistance to abiotic and biotic stresses.
UNIT IV: Conventional (line breeding, population improvement, hybrids) and other approaches (DH populations, marker assisted breeding, development of new male sterility systems), transgenics.

UNIT V: National and International accomplishments in genetic improvement of major field crops and their seed production.

GP 609 MICROBIAL GENETICS 2+1

Theory

UNIT I: Nature of bacterial variation, molecular aspects of mutation, episomes and plasmids, gene mapping in bacteria, life cycle of bacteriophages, genetic fine analysis of rII locus, circular genetic map of phage T4, transposable elements, gene manipulation, biochemical genetics of *neurospora and sacharomyces* , one gene, one enzyme hypothesis.

UNIT II: Regulation of gene activity in prokaryotes, molecular mechanisms of mutation, repair and suppression, molecular chaperones and gene expression, genetic basis of apoptosis.

UNIT III: Transgenic bacteria and bioethics, genetic basis of nodulation, nitrogen fixation and competition by rhizobia, genetic regulation of nitrogen fixation and quorum sensing in rhizobia, genetics of mitochondria and chloroplasts.

Practical: Preparation and sterilization of liquid and agar bacterial nutrient media; assessment of generation time in the log-phage bacterial cultures. handling of microorganisms for genetic experiments; isolation of rhizo biafrom nodules; gram staining of rhizobial cells; examination of polyhydroxy butyrate (PHB) production in rhizobia; demonstration of N_2-fixing nodules/bacterial inoculation in the legume-*Rhizobium* symbiotic system. induction, isolation and characterization of auxotrophic and drug resistant mutants in bacteria; determination of spontaneous and induced mutation frequencies; discrete bacterial colony counts for the preparation of survival curves and determination of LD_{50} of a mutagen; Tn-mediated mutagenesis; analysis and isolation of plasmid DNA; curing of plasmids.

GP 610 *IN SITU* AND *EX SITU* CONSERVATION OF GERMPLASM 2+1

Theory

UNIT I: Concept of natural reserves and natural gene banks, *In situ* conservation of wild species in nature reserves: *in situ* conservation components, factors influencing conservation value, national plan for *in situ* conservation, *in situ* conservation of agro-biodiversity on-farm, scientific basis of *in situ* conservation on-farm, building on-farm conservation initiatives, implementation of on farm conservation, management of *in situ* conserved genetic diversity on-farm, enhancing benefits for farmers from local crop diversity.

UNIT II: *Ex situ* conservation: components, plant genetic resources conservation in gene banks, national gene banks, gene repositories, preservation of genetic materials under natural conditions, *perma-frost* conservation, guidelines for sending seeds to network of active/ working collections, orthodox, recalcitrant seeds, differences in handling , clonal repositories, genetic stability under long term storage condition.

UNIT III: *In vitro* storage, maintanence of *in vitro* culture under different conditions, *in vitro* bank maintanence for temporate and tropical fruit crop species, spices, tubers, bulbous crops, medicinal and endangered plant species, conservation of embryos and ovules, cell/suspension cultures, protoplast and callus cultures, pollen culture, micropropagation techniques, problems, prospects of *in vitro* gene bank.

UNIT IV: Cryopreservation- procedure for handling seeds of orthodox and recalcitrants-cryoprotectants, dessication, rapid freezing, slow freezing, vitrification techniques, encapsulation/dehydration techniques, national facilities, achievements, application of cryopreservation in agriculture, horticulture and forestry crops, problems and prospects, challenges aheads.

Practical: *In situ* conservation of wild species –case studies at national and international levels- *ex situ* techniques for active and long-term conservation of collections- Preparation and handling of materials, packaging, documentation; design of cold storage modules- Conservation protocols for recalcitrant and orthodox seeds; cytological studies for assessing genetic stability, *in vitro* cultures- embryo, cell/suspension cultures, pollen cultures, study of cryotank facility and vitrification techniques, visit to NBPGR/NBAGR -study using fruit crops and other horticultural crops.

GP 619	**DOCTORAL SEMINAR I**	**1+0**
GP 692	**DOCTORAL SEMINAR II**	**1+0**
GP 693	**SPECIAL PROBLEM IN Ph.D.**	**0+1**
GP 699	**DOCTORAL RESEARCH**	**0+45**

ENTOMOLOGY

http://hillagric.ac.in/edu/coa/entomology/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
ENT 501*	INSECT MORPHOLOGY	1+1	I
ENT 502*	INSECT ANATOMY, PHYSIOLOGY AND NUTRITION	2+1	II
ENT 503	PRINCIPLES OF TAXONOMY	2+0	I&II
ENT 504*	CLASSIFICATION OF INSECTS	2+1	I
ENT 505*	INSECT ECOLOGY	1+1	II
ENT 506	INSECT PATHOLOGY	1+1	I&II
ENT 507*	BIOLOGICAL CONTROL OF CROP PESTS AND WEEDS	1+1	II
ENT 508*	TOXICOLOGY OF INSECTICIDES	2+1	I
ENT 509	PLANT RESISTANCE TO INSECTS	1+1	I&II
ENT 510*	PRINCIPLES OF INTEGRATED PEST MANAGEMENT	1+1	I
ENT 511*	PESTS OF FIELD CROPS	1+1	I
ENT 512*	PESTS OF HORTICULTURAL AND PLANTATION CROPS	1+1	I&II
ENT 513	STORAGE ENTOMOLOGY	1+1	I&II
ENT 514	INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS	1+1	I&II
ENT 515	GENERAL ACAROLOGY	1+1	I&II
ENT 516	SOIL ARTHROPODS AND THEIR MANAGEMENT	1+1	I&II
ENT 517	VERTEBRATE PEST MANAGEMENT	1+1	I&II
ENT 518*	TECHNIQUES IN PLANT PROTECTION	0+1	II
ENT 519	COMMERCIAL ENTOMOLOGY	1+1	I&II
ENT 520	PLANT QUARANTINE	2+0	I&II
ENT 591	MASTER'S SEMINAR	1+0	I&II
ENT 592	SPECIAL PROBLEM IN M.Sc.	0+1	I&II
ENT 599	MASTER'S RESEARCH	0+20	I&II
ENT 601	ADVANCED INSECT SYSTEMATICS	1+2	I&II
ENT 602	IMMATURE STAGES OF INSECTS	1+1	I&II
ENT 603**	ADVANCED INSECT PHYSIOLOGY	2+0	I&II
ENT 604**	ADVANCED INSECT ECOLOGY	1+1	I
ENT 605	INSECT BEHAVIOUR	1+1	I&II
ENT 606**	RECENT TRENDS IN BIOLOGICAL CONTROL	1+1	I
ENT 607**	ADVANCED INSECTICIDE TOXICOLOGY	2+1	II
ENT 608	ADVANCED HOST PLANT RESISTANCE	1+1	I&II
ENT 609	ADVANCED ACAROLOGY	1+1	I&II
ENT 610	AGRICULTURAL ORNITHOLOGY	1+1	I&II
ENT 611**	MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH	1+1	I
ENT 612**	ADVANCED INTEGRATED PEST MANAGEMENT	2+0	II
ENT 613	PLANT BIOSECURITY AND BIOSAFETY	2+0	I&II
ENT 691	DOCTORAL SEMINAR I	1+0	I&II
ENT 692	DOCTORAL SEMINAR II	1+0	I&II
ENT 693	SPECIAL PROBLEM IN Ph.D.	0+1	I&II
ENT 699	DOCTORAL RESEARCH	0+45	I&II

***** Compulsory for Master's Programme ** Compulsory for Doctoral Programme

ENTOMOLOGY

Course contents

ENT 501 INSECT MORPHOLOGY 1+1

Theory

UNIT I: Principles, utility and relevance: insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation.

UNIT II: Head- origin, structure and modification, types of mouthparts and antennae, tentorium and neck sclerites.

UNIT III: Thorax- areas and sutures of tergum, sternum and pleuron, pterothorax, wings: structure and modifications,venation,wing coupling apparatus and mechanism of flight,legs:structure and modifications.

UNIT IV: Abdomen-segmentation and appendages, genitalia and their modifications, embryonic and post-embryonic development, types of metamorphosis, insect sense organs (mechano-, photo- and chemo- receptors).

Practical: Study of insect segmentation; various tagmata and their appendages; preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia; sense organs.

ENT 502 INSECT ANATOMY, PHYSIOLOGY AND NUTRITION 2+1

Theory

UNIT I: Scope and importance of insect anatomy and physiology.

UNIT II: Structure, modification and physiology of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands.

UNIT III: Thermodynamics, physiology of integument, moulting, growth, metamorphosis and diapause.

UNIT IV: Extra and intra-cellular micro- organisms and their role in physiology.

Practical: Dissection of different insects to study comparative anatomical details of different systems; preparation of permanent mounts of internal systems; chromatographic analysis of free amino acids of haemolymph; determination of chitin in insect cuticle; examination of insect haemocytes; determination of respiratory quotient.

ENT 503 PRINCIPLES OF TAXONOMY 2+0

Theory

UNIT I: Introduction to history and principles of systematics and importance of taxonomy, functions of systematic, identification, purpose, methods of identification, taxonomic keys, levels of systematic with special reference to insect-pests of agricultural crops, descriptions- subjects of descriptions, characters, nature of characters, analogy vs homology, parallel vs convergent evolution, intraspecific variation in characters, polythetic and polymorphic taxa, sexual dimorphism.

UNIT II: Classification of animals: schools of classification- phenetics, cladistics and evolutionary classification. components of biological classification: hierarchy, rank, category and taxon. Species concepts, cryptic, sibling and etho-species, infra-specific categories, introduction to numerical, biological and cytogenetical taxonomy.

UNIT III: Nomenclature,common vs scientific names, international code of zoological nomenclature, criteria for availability of names, validity of names, categories of names under consideration of ICZN, publications, principles of priority, and homonymy, synonymy, type concept in zoological nomenclature, speciation, anagenesis vs cladogenesis, allopatric, sympatric and parapatric processes.

ENT 504 CLASSIFICATIONS OF INSECTS 2+1

Theory

UNIT I: Brief evolutionary history of insects-introduction to phylogeny of insects and major classification of superclass hexapoda – classes – ellipura (collembola, protura), diplura and insecta-orders contained.

UNIT II: Distinguishing characters, general biology, habits and habitats of insect orders and economically important families contained in them, collembola, protura, diplura, class insecta: subclass apterygota–archaeognatha,thysanura,subclass:pterygota,divisionpalaeoptera–odonataand phemeroptera, division: neoptera: subdivision: orthopteroid and blattoid orders (=oligoneoptera: plecoptera, blattodea, isoptera, mantodea, grylloblattodea, dermaptera, orthoptera, phasmatodea, mantophasmatodea, embioptera, zoraptera), subdivision: hemipteroid orders (=paraneoptera): psocoptera, phthiraptera, thysanoptera and hemiptera.

UNIT III: Distinguishing characters, general biology, habits and habitats of insect orders and economically important families contained in them, division neoptera – subdivision endopterygota, section neuropteroid- coleopteroid orders: strepsiptera, megaloptera, raphidioptera, neuropteraand coleoptera, section panorpoid orders mecoptera, siphonaptera, diptera, trichoptera, lepidoptera, and section hymenopteroid orders: hymenoptera.

Practical: Study of orders of insects and their identification using taxonomic keys; keying out families of insects of different major orders;odonata;orthoptera;blattodea;mantodea;isoptera;hemiptera; thysanoptera;phthiraptera;neuroptera;coleoptera; diptera; lepidoptera and hymenoptera. field visits to collect insects of different orders.

ENT 505 INSECT ECOLOGY 1+1

Theory

UNIT I: History and definition. basic concepts. organisation of the biological world, plato's natural balance vs ecological dynamics as the modern view, abundance and diversity of insects- estimates and causal factors, study of abundance and distribution and relation between the two, basic principles of abiotic factors and their generalised action on insects, implications for abundance and distribution of organisms including insects- law of the minimum, law of tolerance, and biocoenosis, systems approach to ecology.

UNIT II: Basic concepts of abundance- model vs real world, population growth- basic models – exponential vs logistic models, discrete vs continuous growth models, concepts of carrying capacity, environmental resistance and optimal yield, vital statistics- life tables and their application to insect biology, survivorship curves, case studies of insect life tables, population dynamics- factors affecting abundance- environmental factors, dispersal and migration, seasonality in insects- classification and mechanisms of achieving different seasonality- diapause (quiescence) - aestivation, hibernation.

UNIT III: Biotic factors- food as a limiting factor for distribution and abundance, nutritional ecology, food chain-web and ecological succession. interspecific interactions- basic factors governing the interspecific interactions - classification of interspecific interactions - the argument of cost-benefit ratios, competition- lotka-volterra model, concept of niche- ecological homologues, competitive exclusion, prey-predator interactions- basic model- lotka-volterra model, volterra's principle, functional and numerical response. defense mechanisms against predators/parasitoids- evolution of mimicry, colouration, concept of predator satiation, evolution of life history strategies.

UNIT IV: Community ecology-concept of guild, organisation of communities- hutchinson ratio, may's d/w: relation between the two and their association with dyar's law and przibram's law, relative distribution of organisms, concept of diversity- the wallacian view, assessment of diversity, diversity-stability debate relevance to pest management, pest management as applied ecology.

Practical: Types of distributions of organisms;methods of sampling insects;estimation of densities of insects and understanding the distribution parameters-measures of central tendencies;poisson distribution; negative binomial distribution;determination of optimal sample size;learning to fit basic population

growth models and testing the goodness of fit; fitting holling's disc equation, assessment of prey-predator densities from natural systems and understanding the correlation between the two;assessing and describing niche of some insects of a single guild; calculation of niche breadth;activity breadthand diagramatic representation of niches of organisms; calculation of some diversity indices- shannon's; simpson's and avalanche index and understanding their associations and parameters that affect their values;problem solving in ecology;field visits to understand different ecosystems and to study insect occurrence in these systems.

ENT 506 INSECT PATHOLOGY 1+1

UNIT I: History of insect pathology, introduction to different groups of insect pathogens like bacteria, fungi, viruses, protozoa, rickettsiae, spiroplasma and nematodes.

UNIT II: Epizootiology,symptomatology and etiology of diseases caused by the above and the factors controlling these, defense mechanisms in insects against pathogens.

UNIT III: Examples of successful instances of exploitation of pathogens for pest management and mass production techniques of pathogenism,safety and registration of microbial pesticides,use of insect pathogens in integrated management of insect pests.

Practical: Familiarization with equipments used in insect pathology laboratory; identification of different groups of insect pathogens and symptoms of infection; isolation, culturing and testing pathogenicity of different groups of pathogens; testing koch's postulates; estimation of pathogen load; extraction of pathogens from live organisms and soil; bioassays to determine median lethal doses.

ENT 507 BIOLOGICAL CONTROL OF CROP PESTS AND WEEDS 1+1

Theory

UNIT I: History, principles and scope of biological control, important groups of parasitoids, predators and pathogens, principles of classical biological control- importation, augmentation and conservation.

UNIT II: Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects.

UNIT III: Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation, role of natural enemies in integrated pest management with special reference to hill agriculture.

UNIT IV: Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

Practical: Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers;visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of egg; egg-larval; larval; larval-pupal and pupal parasitoids; common predators; microbes and their laboratory hosts;phytophagous natural enemies of weeds; field collection of parasitoids and predators;hands-on training in culturing;identification of common insect pathogens;quality control and registration standards for biocontrol agents.

ENT 508 TOXICOLOGY OF INSECTICIDES 2+1

Theory

UNIT I: Definition and scope of insecticide toxicology, history of chemical control, pesticide use and pesticide industry in india.

UNIT II: Classification of insecticides and acaricides based on mode of entry,mode of action and chemical nature,structure and mode of action of organo-chlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, etc.

UNIT III: Principles of toxicology, evaluation of insecticide toxicity, joint action of insecticides-

synergism, potentiation and antagonism, factors affecting toxicity of insecticides, insecticide compatibility, selectivity and phytotoxicity,principles and application of bioassay in toxicological studies.
UNIT IV: Insecticide metabolism, pest resistance to insecticides, mechanisms and types of resistance, insecticide resistance management and pest resurgence.
UNIT V: Insecticide residues, their significance and environmental implications, insecticide act, registration and quality control of insecticides, safe use of insecticides, diagnosis and treatment of insecticide poisoning.
Practical: Insecticide formulations and mixtures; quality control of pesticide formulations; laboratory and field evaluation of bioefficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action; toxicity to beneficial insects; pesticide appliances; working out doses and concentrations of pesticides; visit to toxicology laboratories; good laboratory practices.

ENT 509 PLANT RESISTANCE TO INSECTS 1+1

Theory

UNIT I: History and importance of resistance, principles, classification, components, types and mechanisms of resistance.
UNIT II: Insect-host plant relationships, theories and basis of host plant selection in phytophagous insects.
UNIT III: Chemical ecology, tritrophic relations, volatiles and secondary plant substances,basis of resistance,induced resistance - acquired and induced systemic resistance.
UNIT IV: Factors affecting plant resistance including biotypes and measures to combat them.
UNIT V: Screening techniques, breeding for insect resistance in crop plants, exploitation of wild plant species, gene transfer, successful examples of resistant crop varieties in india and world.
UNIT VI: Role of biotechnology in plant resistance to insects.
Practical: Screening techniques for measuring resistance; measurement of plant characters and working out their correlations with plant resistance; bioassay of plant extracts of susceptible/resistant varieties; demonstration of antibiosis; tolerance and antixenosis.

ENT 510 PRINCIPLES OF INTEGRATED PEST MANAGEMENT 1+1

Theory

UNIT I: History and origin, definition and evolution of various related terminologies.
UNIT II:Concept and philosophy,ecological principles,economic threshold concept and economic consideration.
UNIT III:Tools of pest management and their integration- legislative, cultural, physical and mechanical methods, pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys, political, social and legal implications of ipm, pest risk analysis, pesticide risk analysis, cost-benefit ratios and partial budgeting, case studies of successful ipm programmes.
Practical: Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessment- direct losses; indirect losses, potential losses; avoidable losses; unavoidable losses; computation of eil and etl; designing and implementing ipm system.

ENT 511 PESTS OF FIELD CROPS 1+1

Theory

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors.
UNIT I: Insect pests of cereals and millets and their management,insect pests of pulses, tobacco, oilseeds and their management.
UNIT II: Insect pests of fibre crops, forages, sugarcane and their management.
UNIT III: Polyphagous pests and non insect-pests, grasshoppers, locusts, termites, white grubs, cutworms, hairy caterpillars, and non-insect pests (mites, birds, rodents, snails, slugs etc.).
Practical: Field visits;collection and identification of important pests and their natural enemies;

detection and estimation of infestation and losses in different crops; study of life history of important insect pests.

ENT 512 PESTS OF HORTICULTURAL AND PLANTATION CROPS 1+1

Theory

Systematic position, identification, distribution, host range, bionomics and seasonal abundance, nature and extent of damage and management of insect pests of various crops.

UNIT I: Fruit crops- mango, guava, banana, jack, papaya, pomegranate, litchi, grapes, *ber*, fig, citrus, *aonla*, pineapple, apple, peach and other temperate fruits.

UNIT II: Vegetable crops- tomato, potato, radish, carrot, beetroot, cole crops, french beans, brinjal, okra, all gourds, garden pea, capsicum, leafy vegetables etc.

UNIT III: Plantation crop-coffee, tea, rubber, coconut, arecanut, cashew, cocoa etc., spices and condiments- pepper, cardamom, clove, nutmeg, chillies, turmeric, ginger, beetlevine etc.

UNIT IV: Ornamental, medicinal and aromatic plants and pests in polyhouses/ protected cultivation.

Practical: Collection and identification of important pests and their natural enemies on different crops; study of life history of important insect pests and non- insect pests.

ENT 513 STORAGE ENTOMOLOGY 1+1

Theory

UNIT I: Introduction, history of storage entomology, conceptsof storage entomology and significance of insect pests. Post-harvest losses *in toto vis- à-vis* total production of food grains in India, scientific and socio-economic factors responsible for grain losses.

UNIT II: Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products, traditional storage structures, association of stored grain insects with fungi and mites, their systematic position, identification, distribution, host range, biology, nature and extent of damage,role of field and cross infestations and natural enemies,type of losses in stored grains and their effect on quality including biochemical changes.

UNIT III: Ecology of insect pests of stored commodities/grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities,stored grain deterioration process, physical and biochemical changes and consequences,grain storage-types of storage structures i.e., traditional, improved and modern storage structures in current usage, ideal seeds and commodities' storage conditions.

UNIT IV: Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows,role of bird pests and their management,control of grain infestation by insect pests, mites and microorganisms,preventive measures-hygiene/ sanitation, disinfestations of stores/ receptacles,legal methods, curative measures-non-chemical control measures, ecological, mechanical, physical, cultural, biological and engineering,chemical control-prophylactic and curative, characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants,integrated approaches to stored grain pest management.

Practical: Collection;identification and familiarization with the stored grains/seed insect pests and nature of damage caused by them; detection of insect infestation in stored food grains; estimation of losses in stored food grains; determination of moisture content in stored food grains; familiarization of storage structures;demonstration of preventive and curative measures including fumigation techniques; treatment of packing materials and their effect on seed quality;field visits to save grain campaign; central warehouse and FCI warehouses and institutions engaged in research or practice of grain storage like CFTRI, IGSMRI, hapur etc.(only where logistically feasible).

ENT 514 INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS 1+1

Theory

UNIT I: History of developments in the area of insects as vectors of plant pathogens,important insect vectors and their characteristics, mouth parts and feeding processes of important insect vectors, efficiency of transmission.

UNIT II: Transmission of plant viruses and fungal pathogens,relation between viruses and their vectors.

UNIT III: Transmission of plant viruses by aphids, leaf hoppers, whiteflies, mealy bugs and thrips.

UNIT IV: Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.

UNIT V: Transmission of plant viruses by psyllids, beetles and mites, epidemiology and management of insect transmitted diseases through vector management.

Practical: Identification of common vectors of plant pathogens- aphids;leafhoppers; whiteflies;thrips; beetles;nematodes; culturing and handling of vectors; demonstration of virus transmission through vectors- aphids;leafhoppers and whiteflies.

ENT 515 GENERAL ACAROLOGY 1+1

Theory

UNIT I: History of acarology, importance of mites as a group, habitat, collection and preservation of mites.

UNIT II: Introduction to morphology and biology of mites and ticks,broad classification-major orders and important families of acari including diagnostic characteristics.

UNIT III: Economic importance,seasonal occurrence, nature of damage,host range of mite pests of important crops of the region,mite pests in polyhouses,mite pests of stored products and honeybees, management of mites using acaricides,phytoseiid predators,fungal pathogens *etc*. culturing of phytophagous, parasitic and predatory mites.

Practical: Collection of mites from plants; soil and animals; extraction of mites from soil; plants and stored products; preparation of mounting media and slide mounts; external morphology of mites; identification of mites up to family level using keys; studying different rearing techniques for mites.

ENT 516 SOIL ARTHROPODS AND THEIR MANAGEMENT 1+1

Theory

UNIT I: Soil arthropods and their classification, habitats and their identification.

UNIT II: Estimation of populations, sampling and extraction methods.

UNIT III:Role of soil arthropods in detritus feeding,litter breakdown and humus formation,soil arthropods as bio-indicators of habitat qualities,effect of soil arthropod activity on soil properties.

UNIT IV:Harmful and beneficial soil arthropods and their management,inter- relationship among arthropods and other soil invertebrates and soil microorganisms,anthropogenic effects on soil arthropods.

Practical: Sampling; extraction methods and identification of various types of soil fauna; estimation and assessment of soil arthropod population; techniques and culturing soil invertebrates.

ENT 517 VERTEBRATE PEST MANAGEMENT 1+1

Theory

UNIT I: Vertebrate pests of crops and their biology,beneficial birds and their biology.

UNIT II: Population dynamics and assessment, patterns of pest damage and assessment, roosting and nesting systems in birds.

UNIT III: Management strategies- physical (trapping, acoustics and visual), chemical (poisons, repellents, fumigants and anticoagulants),biological (predators, parasites),cropping practices,alteration of habitats, diversion baiting and other eco-friendly methods- operational practices- baiting, bioassays (ld_{50} studies), equipments and educative programmes.

Practical: Identification of important rodent and other vertebrate pests of agriculture;food preference and hoarding; social behavior;damage assessment;field survey;population estimation;control operation and preventive methods.

ENT 518 TECHNIQUES IN PLANT PROTECTION 0+1

Practical

UNIT I: Pest control equipments;principles;operation; maintenance;selection;application of pesticides and biocontrol agents; seed dressing;soaking;root-dip treatment;dusting;spraying;application through irrigation water.

UNIT II: Soil sterilization;solarization;deep ploughing;flooding;techniques to check the spread of pests through seed;bulbs;corms;cuttings and cut flowers.

UNIT III: Use of light;transmission and scanning electron microscopy.

UNIT IV: Protein isolation from the pest and host plant and its quantification using spectrophotometer and molecular weight determination using SDS/PAGE.

UNIT V:Use of tissue culture techniques in plant protection;computer application for predicting/ forecasting pest attack and identification.

ENT 519 COMMERCIAL ENTOMOLOGY 1+1

Theory

UNIT I: Bee keeping-general colony management during different seasons,seasonal management, managing colonies for honey production and pollination,artificial queen rearing,pests and diseases of honey bees,bee poisoning,production and marketing of quality honey and value added honey products, establishment and maintenance of apiaries.

UNIT II: Study of different species of silkworms, characteristic features, moriculture, silk and its uses, pests and diseases of silkworms, rearing and management of silkworms.

UNIT III: Introduction to the insect-pests of household and public health importance.

Practical: Assessing pest status in dwellings (labs;canteen or hostel);implementation of pest control against flies;mosquitoes;bed bugs;cockroaches and rodents;pre- and post-construction termite proofing methods;control of silverfishes in the library;visit to poultry units and assessing pest status in poultries; evaluation of commercially available domestic insect pest control products through bioassays; identification of honey bee species;bee castes and familiarization with beekeeping equipments and bee products; handling of honey bees colonies; visit to bee nursery and commercial apiaries; silkworm rearing and management.

ENT 520 PLANT QUARANTINE 2+0

Theory

UNIT I: Definition of pest, pesticides and transgenics as per govt. notification, relative importance, quarantine–domestic and international,quarantine restrictions in the movement of agricultural produce, seeds and planting material, case histories of exotic pests/diseases and their status.

UNIT II: Plant protection organization in india,acts related to registration of pesticides and transgenics, history of quarantine legislations, pq order 2003,environmental acts,industrial registration, apeda,import and export of bio-control agents.

UNIT III: Identification of pest/disease free areas, contamination of food with toxigens, microorganisms and their elimination, symptomatic diagnosis and other techniques to detect pest/pathogen infestations, VHT and other safer techniques of disinfestation/salvaging of infected material.

UNIT IV: WTO regulations, non-tariff barriers, pest risk analysis, good laboratory practices for pesticide laboratories, pesticide industry, sanitary and phytosanitary measures.

ENT 591 MASTER'S SEMINAR 1+0
ENT 592 SPECIAL PROBLEM IN M.Sc. 0+1
ENT 599 MASTER'S RESEARCH 0+20

ENT 601 ADVANCED INSECT SYSTEMATICS 1+2

Theory

UNIT I:Detailed study of three schools of classification-numerical,evolutionary and cladistics, methodologies employed,development of phenograms,cladograms,molecular approaches for the classification of organisms,methods in identification of homology,species concepts and speciation processes and evidences,the polytypic species, population systematic and infra specific category, zoogeography

UNIT II: Study of different views on the evolution of insects- alternative phylogenies of insects, kukalova peck and kristensen,fossil insects and evolution of insect diversity over geological times.

UNIT III: Detailed study of international code of zoological nomenclature, including appendices to ICZN- Ethics.

UNIT IV: Concept of phylocode and alternative naming systems for animals, a detailed study of selected representatives of taxonomic publications - small publications of species descriptions, revisionary works, monographs, check lists, faunal volumes, etc. websites related to insect systematics and databases. molecular taxonomy, barcoding species.

Practical: Collection; curation and study of one taxon of insects; including preservation of larvae pupae and genetalic studies; literature search; compilation of a checklist; study of characters; development of character table;construction of viable taxonomic keys for the selected group;development of descriptions; photographing;writing diagrams; and preparation of specimens for "type like" preservation; submission of the collections made of the group; multivariate analysis techniques for clustering specimens into different taxa, and development of phenograms;rooting and character polarization for developing cladograms and use of computer programmes to develop cladograms.

ENT 602 IMMATURE STAGES OF INSECTS 1+1

Theory

UNIT I:Types of immature stages in insect orders, morphology of egg, nymph/larva and pupa, identification of different immature stages of crop pests and stored product insects

UNIT II: Comparative study of life history strategies in hemi-metabola and holo- metabola, immature stages as ecological and evolutionary adaptations, significance of immature stages for pest management.

Practical: Types of immature stages; their collection;rearing and preservation; identification of immature insects to orders and families; in endopterygote orders viz.; dipteral; Lepidoptera; hymenoptera and coleoptera using key.

ENT 603 ADVANCED INSECT PHYSIOLOGY 2+0

Theory

UNIT I: Physiology and biochemistry of insect cuticle and moulting process, biosynthesis of chitin, chitin-protein interactions in various cuticles, types of sclerotization.

UNIT II: Digestive enzymes, digestive physiology in phytophagous, wood boring and wool feeding insects, efficiency of digestion and absorption, role of endosymbionts in insect nutrition, nutritional effects on growth and development, physiology of excretion and osmoregulation, water conservation mechanisms.

UNIT III: Detailed physiology of nervous system, transmission of nerve impulses, neurotransmitters and modulators, production of receptor potentials in different types of sensilla, pheromones and other semiochemicals in insect life, toxins and defense mechanisms.

UNIT IV: Endocrine system and insect hormones, physiology of insect growth and development-metamorphosis, polyphenism and diapauses, energetics of muscle contractions.

ENT 604 ADVANCED INSECT ECOLOGY 1+1

Theory

UNIT I:Characterisation of distribution of insects-indices of dispersion, taylor's power law,island biogeography,population dynamics-life tables, leslie matrix, stable age distribution, population projections, predator-prey models-lotka-volterra and nicholson-bailey model, crop modeling-an introduction.

UNIT II: Insect plant interactions,role of insects in the environment,adaptations to terrestrial habitats, evolution of insect diversity and role of phytophagy as an adaptive zone for increased diversity of insects, evolution of resource harvesting organs, resilience of insect taxa and the sustenance of insect diversity-role of plants,herbivory,pollination,predation,parasitism,modes of insect-plant interaction,tri-trophic interactions,evolution of herbivory, monophagy vs polyphagy,role of plant secondary metabolites,host seeking behaviour of parasitoids, meaning of stress-plant stress and herbivory,consequences of herbivory to plant fitness and response to stress,constitutive and induced plant defenses.

UNIT III: Biodiversity and conservation- RET species, ecological indicators,principles of population genetics,hardy weinberg law,computation of allelic and phenotypic frequencies, fitness under selection, rates of evolution under selection,foraging ecology- optimal foraging theory, marginal value theorem, and patch departure rules,central place foraging, mean-variance relationship and foraging by pollinators, nutritional ecology.

UNIT IV: Reproductive ecology- sexual selection,mating systems, reproductive strategies-timing,egg number,reproductive effort,sibling rivalry and parent-offspring conflict,agro-ecological *vs* natural ecosystems-characterization, pest control as applied ecology-case studies.

Practical: Methods of data collection under field conditions; assessment of distribution parameters; taylor's power law; iwao's patchiness index;index of dispersion; etc. calculation of sample sizes by different methods;fitting poisson and negative binomial distributions and working out the data transformation methods;hardy-weinberg law;computation of allelic and phenotypic frequencies - calculation of changes under selection;demonstration of genetic drift;assessment of patch departure rules;assessment of resource size by female insects using a suitable insect model;fruit flies/*Goniozus*/Female bruchids etc.- a test of reproductive effort and fitness;construction of life tables and application of leslie matrix–population projections;stable age distribution;exercises in development of algorithms for crop modeling.

ENT 605 INSECT BEHAVIOUR 1+1

Theory

UNIT I: Defining behaviour- concept of umwelt, instinct, fixed action patterns, imprinting, complex behaviour, inducted behaviour, learnt behaviour and motivation. history of ethology-development of behaviorism and ethology,contribution of darwin,frisch,tinbergen and lorenz,studying behaviour-proximate and ultimate approaches, behavioural traits under natural selection, genetic control of behavior and behavioural polymorphism.

UNIT II: Orientation-forms of primary and secondary orientation including taxes and kinesis, communication- primary and secondary orientation, responses to environmental stimuli, role of visual, olfactory and auditory signals in inter and intra-specific communication, use of signals in defense, mimicry, polyphenism, evolution of signals.

UNIT III: Reproductive behaviour- mate finding,courtship,territoriality,parental care,parental investment,sexual selection and evolution of sex ratios,social behaviour- kin selection, parental manipulation and mutualism, self- organization and insect behaviour.

UNIT IV: Foraging- role of different signals in host searching (plant and insects) and host acceptance, ovipositional behaviour, pollination behaviour, co- evolution of plants and insect pollinators. behaviour in IPM- concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semio-chemicals, auditory stimuli and visual signals in pest management.

Practical: Quantitative methods in sampling behavior;training bees to artificial feeders; sensory adaptation and habituation in a fly or butterfly model;physical cues used in host selection in a phytophagous insect; chemical and odour cues in host selection in phytophagous insect (dbm or gram pod borer);colour discrimination in honey bee or butterfly model;learning and memory in bees;role of self-organization in resource tracking by honeybees;evaluation of different types of traps against fruit flies with respect to signals; use of honey bees/*Helicoverpa armigera* to understand behavioural polymorphism with respect to learning and response to pheromone mixtures;respectively.

ENT 606 RECENT TRENDS IN BIOLOGICAL CONTROL 1+1

Theory

UNIT I: Scope of classical biological control and augmentative biocontrol, introduction and handling of natural enemies, nutrition of entomophagous insects and their hosts, dynamics of biocontrol agents *vis-à-vis* target pest populations.

UNIT II: Mass culturing techniques, insectary facilities and equipments, basic standards of insectary, viable mass-production unit, designs, precautions, good insectary practices.

UNIT III: Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, effect of insecticides on natural enemies, large-scale production of biocontrol agents, bankable project preparation.

UNIT IV: Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections, breeding techniques of biocontrol agents.

Practical: Mass rearing and release of some commonly occurring indigenous natural enemies; assessment of role of natural enemies in reducing pest populations; testing side effects of pesticides on natural enemies; effect of semiochemicals on natural enemies; breeding of various biocontrol agents; performance of efficiency analyses on target pests; project document preparation for establishing a viable mass-production unit /insectary.

ENT 607 ADVANCED INSECTICIDE TOXICOLOGY 2+1

Theory

UNIT I: Penetration and distribution of insecticides in insect systems,insecticide selectivity,factors affecting toxicity of insecticides.

UNIT II: Biochemical and physiological target sites of insecticides in insects, developments in biorational pesticides,biopesticides and newer molecules, their modes of action and structural – activity relationships, advances in metabolism of insecticides.

UNIT III: Joint action of insecticides, activation, synergism and potentiation.

UNIT IV: Problems associated with pesticide use in agriculture:pesticide resistance in hill and mountainous agro-eco region crop pests, resistance mechanisms and resistant management strategies, pest resurgence and outbreaks, persistence and pollution, health hazards and other side effects.

UNIT V: Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods, maximum residue limits (MRLs) and their fixation, insecticide laws and standards, and good agricultural practices.

Practical: Sampling; extraction; clean-up and estimation of insecticide residues by various methods; calculations and interpretation of data; biochemical and biological techniques for detection of insecticide resistance in insects; extraction and assay of biopesticides.

ENT 608 ADVANCED HOST PLANT RESISTANCE 1+1

Theory

UNIT I: Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance, assembly of plant species - gene pool, insect sources – behaviour in relation to host plant factors.

UNIT II: Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance, biochemistry of induced resistance – signal transduction pathways, methyl jasmonate pathways, polyphenol oxidase pathways, salicylic acid pathways, effects of induced resistance, exogenous application of elicitors.

UNIT III: Biotechnological approaches in host plant resistance- genetic manipulation of secondary plant substances, incorporation of resistant gene in crop varieties, marker-aided selection in resistance breeding.

UNIT IV: Estimation of plant resistance based on plant damage-screening and damage rating, evaluation based on insect responses, techniques and determination of categories of plant resistance, breakdown of resistance in crop varieties.

Practical: Understanding mechanisms of resistance for orientation;feeding;oviposition etc.*;* allelochemical bases of insect resistance; macroculturing of test insects like aphids;leaf/plant hoppers; mites and stored grain pests; field screening-microplot techniques;infester row technique;spreader row technique and plant nurseries; determination of antixenosis index; antibiosis index; tolerance index; plant resistance index.

ENT 609 ADVANCED ACAROLOGY 1+1

Theory

UNIT I: Comparative morphology of acari, phylogeny of higher categories in mites, knowledge of commonly occurring orders and families of acari in india, diagnostic characteristics of commonly occurring species from families tetranychidae, tenuipalpidae, eriophyidae, tarsonemidae, phytoseiidae, bdellidae, cunaxidae, stigmaeidae, pymotidae, cheyletidae, acaridae, pyroglyphidae, orthogalumnidae, argasidae, ixodidae, sarcoptidae, soil mites in india.

UNIT II: Management of economical important species of mites in agriculture, veterinary and public health, storage acarology.

UNIT III: Mites as vectors of plant pathogens, mode of action, structure-activity relationships of different groups of acaricides, problem of pesticide resistance in mites, resurgence of mites.

UNIT IV: Predatory mites, their mass production and utilization in managing mite pests, acaropathogenic fungi- identification, isolation and utilization.

Practical: Identification of commonly occurring mites up to species;preparation of keys for identification; collection of specific groups of mites and preparing their identification keys;rearing phytoseiid mites and studying their role in suppression of spider mites; management of mite pests of crops using acaricides; phytoseiid predators; fungal pathogens *etc.*

ENT 610 AGRICULTURAL ORNITHOLOGY 1+1

Theory

UNIT I: Status of agricultural ornithology in india, groups of birds associated with agro-ecosystems, habitat associations of birds in both wet and dry agricultural systems, association of birds with different cultivation practices and crop stages, their seasonality and succession, pestiferous and beneficial birds associated with different crops, their general biology and ecology, food and feeding habits of birds in crop fields.

UNIT II: Nature of damage caused by birds in different crops,foraging ecology of birds in agricultural fields,birds affecting stored grains in houses and godowns,beneficial role of birds in agriculture and attracting them to field,use of bird excreta in agriculture,management of bird pests in agriculture, physical, cultural, ecological and chemical methods.

Practical: Study of different groups of birds associated with agriculture;their morphology and field identification;field visits to different agro- ecosystems; study of bird associations with different crop stages;study of nesting and roosting habits of birds in agricultural habitats;study of the feeding habits; nature and types of damage caused by birds in selected crops; visits to godowns; analysis and study of the use of bird excreta in agriculture at a bird sanctuary; field visits to paddy growing command areas to study birds in crop fields; assignments on assessing bird damage; estimation of populations etc.

ENT 611 MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH 1+1

Theory

UNIT I: Introduction to molecular biology, techniques used in molecular biology.

UNIT II: DNA and RNA analysis in insects-transcription and translocation mechanisms,DNA recombinant technology, identification of genes/nucleotide sequences for characters of interest,genetic improvement of natural enemies,cell lines,genetic engineering in baculoviruses, *Bt* and entomopathogenic fungi.

UNIT III: Genes of interest in entomological research- marker genes for sex identification, peptides and neuropeptides, JH esterase, St toxins and venoms, chitinase, Bt toxin, CPTI, trypsin inhibitors, lectins and proteases, neuropeptides,transgenic plants for pest resistance.

UNIT IV: Insect gene transformation, biotechnology in relation to silkworms and honey bees, introduction of lectin genes for pest suppression, DNA finger printing for taxonomy and phylogeny, genetic improvement of inebriate tolerance of natural enemies.

UNIT V: DNA-based diagnostics, insect immune systems incomparisonto vertebrates, molecular basis of metamorphosis, Sf transgenic technology and implications, molecular biology of baculoviruses, insecticide resistance, resistance management strategies in transgenic crops.

Practical: Isolation of DNA/RNA; purity determinations; base pair estimation; agarose gel electrophoresis; restriction mapping of DNA; demonstration of PCR, RFLP and RAPD techniques.

ENT 612 ADVANCED INTEGRATED PEST MANAGEMENT 2+0

Theory

UNIT I: Principles of sampling and surveillance, database management and computer programming, simulation techniques and system analysis and modeling.

UNIT II: Case histories of national and international programmes, their implementation, adoption and criticisms, global trade and risk of invasive pests.

UNIT III: Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management- case studies, scope and limitations of bio-intensive and ecological based IPM programmes,Application of IPM to farmers' real- time situations.

UNIT IV: Challenges, needs and future outlook, dynamism of IPM under changing cropping systems and climate, insect pest management under protected cultivation, strategies for pesticide resistance management.

ENT 613/ PL PATH 606 PLANT BIOSECURITY AND BIOSAFETY 2+0

Theory

UNIT I: History of biosecurity, concept of biosecurity, components of biosecurity, quarantine, invasive alien species, biowarfare, emerging/ resurgence of pests and diseases.

UNIT II: national regulatory mechanism and international agreements/ conventions viz., agreement on application of sanitary and phytosanitary (SPS) measures/World Trade Organization (WTO), convention on biological diversity (CBD), international standards for phytosanitary measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of global positioning system (GPS) and geographic information system (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agro-

terrorism event, mitigation planning, integrated approach for biosecurity.
UNIT III: Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

ENT 691	**DOCTORAL SEMINAR I**	**1+0**
ENT 692	**DOCTORAL SEMINAR II**	**1+0**
ENT 693	**SPECIAL PROBLEM IN Ph.D.**	**0+1**
ENT 699	**DOCTORAL RESEARCH**	**0+45**

HORTICULTURE (FRUIT SCIENCE)

http://hillagric.ac.in/edu/coa/horticulture/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
FSC 501	TROPICAL AND DRY LAND FRUIT PRODUCTION	2+1	II
FSC 502	SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION	2+1	I
FSC 503	BIODIVERSITY AND CONSERVATION OF FRUIT CROPS	2+1	II
FSC 504	CANOPY MANAGEMENT IN FRUIT CROPS	1+1	II
FSC 505	PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS	2+1	II
FSC 506	BREEDING OF FRUIT CROPS	2+1	I
FSC 507	POST HARVEST TECHNOLOGY FOR FRUIT CROPS	2+1	I
FSC 508	GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS	2+1	II
FSC 509	BIOTECHNOLOGY OF HORTICULTURAL CROPS	2+1	I
FSC 510	ORGANIC HORTICULTURE	1+1	II
FSC 511	PROTECTED FRUIT CULTURE	2+1	I
FSC 512	GAP FOR HORTICULTURAL CROPS	1+0	II
FSC 513	CLIMATE MANAGEMENT IN HORTICULTURAL PRODUCTION	1+0	I
FSC 591	MASTER'S SEMINAR	1+0	I&II
FSC 601	ADVANCES IN BREEDING OF FRUIT CROPS	2+1	II
FSC 602	ADVANCES IN PRODUCTION OF FRUIT CROPS	2+1	I
FSC 603	ADVANCES IN GROWTH REGULATION OF FRUIT CROPS	2+1	I
FSC 604	GENOMICS AND BIOINFORMATICS IN HORTICULTURE	2+1	II
FSC 605	BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS	2+1	I
FSC 691	DOCTORAL SEMINAR	1+0	I&II

FRUIT SCIENCE

Course contents

FSC 501 TROPICAL AND DRY LAND FRUIT PRODUCTION 2+1

Theory: Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination, fruit set and development, honeybees in cross pollination, physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri-Export Zones (AEZs) and industrial supports.

Crops:

UNIT I: Mango and Banana
UNIT II: Citrus and Papaya
UNIT III: Guava, Sapota and Pineapple
UNIT IV**:** Aonla, Pomegranate, Ber and minor fruits of tropics.

Practical : Identification of important cultivars; observations on growth and development; practices in growth regulation; malady diagnosis; analyses of quality attributes; visit to tropical and arid zone orchards; project preparation for establishing commercial orchards.

FSC 502 SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION 2+1

Theory: Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones(AEZ) and industrial support.

Crops:

UNIT I: Apple, pear, grapes
UNIT II: Plums, peach, apricot, cherries,
UNIT III: Litchi, loquat, persimmon, kiwifruit, strawberry
UNIT IV: Nuts- walnut, almond, pecan,
UNIT V: Minor fruits- jamun, bael, fig,

Practical: Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical, subtropical, humid tropical and temperate orchards, Project preparation for establishing commercial orchards.

FSC 503 BIODIVERSITY AND CONSERVATION OF FRUIT CROPS 2+1

Theory

UNIT I: Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.
UNIT II: Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ.*
UNIT III: Germplasm conservation- problem of recalcitrancy - cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.
UNIT IV: Intellectual property rights, regulatory horticulture.Detection of genetic constitution of germplasm and maintenance of core group.
UNIT V: GIS and documentation of local biodiversity, Geographical indication.

Crops: Mango, sapota, citrus, guava, banana, papaya, grapes, ber, aonla, Malus, *Prunus* sp, litchi, nuts, tea, persimmon, kiwifruit, strawberry

Practical : Documentation of germplasm-maintenance of passport data and other records of accessions; field exploration trips; exercise on *ex situ* conservation – cold storage, pollen/seed storage, cryopreservation; visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

FSC 504 CANOPY MANAGEMENT IN FRUIT CROPS 1+1

Theory:

UNIT I: Canopy management - importance and advantages, factors affecting canopy development.

UNIT II: Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light, light interception and distribution in different types of tree canopies.

UNIT III: Spacing and utilization of land area - canopy classification, canopy management through rootstock and scion.

UNIT IV: Canopy management through plant growth inhibitors, training and pruning and management practices.

UNIT V: Canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, mango, guava, citrus and ber.

Practical: Study of different types of canopies, training of plants for different canopy types, canopy development through pruning, use of plant growth inhibitors, geometry of planting, study on effect of different canopy types on production and quality of fruits.

FSC 505 PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS 2+1

Theory

UNIT I: Introduction, life cycles in plants, cellular basis for propagation, sexual propagation, apomixis, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.

UNIT II: Seed quality, treatment, packing, storage, certification, testing, asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators, rooting of cuttings in hotbeds, physiological, anatomical and biochemical aspects of root induction in cuttings, layering – principle and methods.

UNIT III: Budding and grafting – selection of elite mother plants, methods, establishment of bud wood bank, stock, scion and inter stock, relationship – incompatibility, rejuvenation through top working - progeny orchard and scion bank.

UNIT IV: Micro-propagation - principles and concepts, commercial exploitation in horticultural crops, techniques - *in vitro* clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture, hardening, packing and transport of micro-propagules.

UNIT V: Nursery-types, structures, components, planning and layout, nursery management practices for healthy propagule production.

Practical: Anatomical studies in rooting of cutting and graft union, construction of propagation structures; study of media and PGR; hardening – case studies; micropropagation; explant preparation; media preparation; culturing – *in vitro* clonal propagation; meristem culture; shoot tip culture; axillary bud culture; direct organogenesis; direct and indirect embryogenesis; micro grafting; hardening; Visit to TC labs and nurseries.

FSC 506 BREEDING OF FRUIT CROPS 2+1

Theory: Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop

improvement-introduction, selection, hybridization, mutation breeding, polyploidy breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.

Crops

UNIT I: Mango, banana and pineapple

UNIT II: Citrus, grapes, guava and sapota

UNIT III: Papaya, aonla, and ber

UNIT IV: Litchi and nut crops

UNIT V**:** Apple, pear, plums, peach, apricot, cherries and strawberry

Practical : Characterization of germplasm; blossom biology; study of anthesis; estimating fertility status; practices in hybridization; ploidy breeding; mutation breeding; evaluation of biometrical traits and quality traits; screening for resistance; developing breeding programme for specific traits; visit to research stations working on tropical; subtropical and temperate fruit improvement

FSC 507 POST HARVEST TECHNOLOGY FOR FRUIT CROPS 2+1

Theory:

UNIT I: Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration.

UNIT II: Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

UNIT III: Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage ventilated, refrigerated, MAS, CA storage, physical injuries and disorders.

UNIT IV: Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies.

UNIT V: Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

Practical : Analyzing maturity stages of commercially important horticultural crops; improved packing and storage of important horticultural commodities; physiological loss in weight of fruits and vegetables; estimation of transpiration, respiration rate, ethylene release and study of vase life extension in cut flower using chemicals; estimation of quality characteristics in stored fruits and vegetables; cold chain management - visit to cold storage and CA storage units; visit to fruit and vegetable processing units; project preparation; evaluation of processed horticultural products.

FSC 508 GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS 2+1

Theory :

UNIT I: Growth and development- definition, parameters of growth and development, growth dynamics, morphogenesis.

UNIT II: Annual, semi-perennial and perennial horticultural crops, environmental impact on growth and development, effect of light, photosynthesis and photoperiodism, vernalisation, effect of temperature, heat units, thermoperiodism.

UNIT III: Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscissic acid, ethylene, brasssinosteroids, growth inhibitors, morphactins, role of plant growth promoters and inhibitors.

UNIT IV: Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development.

UNIT V: Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

Practical : Understanding dormancy mechanisms in seeds, tubers and bulbs and stratification of seeds, tubers and bulbs; visit to arid, subtropical and temperate horticultural zones to identify growth and development patterns; techniques of growth analysis, evaluation of photosynthetic efficiency under different environments; study of growth regulator functions, hormone assays; understanding ripening phenomenon in fruits and vegetables; study of impact of physical manipulations on growth and development; study of chemical manipulations on growth and development; understanding stress impact on growth and development.

FSC 509 BIOTECHNOLOGY OF HORTICULTURAL CROPS 2+1

Theory:

UNIT I: Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.

UNIT II: Callus culture - types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis.

UNIT III: Use of bioreactors and *in vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, *ex vitro*, establishment of tissue cultured plants.

UNIT IV: Physiology of hardening - hardening and field transfer, organ culture –meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion.

UNIT V: Construction and identification of somatic hybrids and cybrids, wide hybridization, *in vitro* pollination and fertilization, haploids, *in vitro* mutation, artificial seeds, cryopreservation, rapid clonal propagation, genetic engineering in horticulture crops, use of molecular markers, *in vitro* selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.

Practical : An exposure to low cost, commercial and homestead tissue culture laboratories; media preparation; inoculation of explants for clonal propagation, callus induction and culture; regeneration of plantlets from callus, sub-culturing, techniques on anther, ovule, embryo culture, somaclonal variation; *in vitro* mutant selection against abiotic stress; protoplast culture; fusion technique; development of protocols for mass multiplication; project development for establishment of commercial tissue culture laboratory.

FSC 510 ORGANIC HORTICULTURE 1+1

Theory

UNIT I: Organic horticulture-definition, synonyms and misnomers, principles, methods, merits and demerits.

UNIT II: Organic farming systems, components of organic horticultural systems, different organic inputs, their role in organic horticulture, role of biofertilizers, biodynamics and the recent developments.

UNIT III: EM technology and its impact in organic horticulture, indigenous practices of organic farming, sustainable soil fertility management, weed management practices in organic farming, biological/natural control of pests and diseases, organic horticulture in quality improvement.

UNIT IV: GAP - Principles and management, HACCP exercise, certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies.

UNIT V: Constraints in certification, organic horticulture and export, IFOAM and global scenario of organic movement, post-harvest management of organic produce.

Practical : Features of organic orchards; working out conversion plan; Input analysis; manures, nutrient status assessment of manures, biocomposting, biofertilizers and their application; panchagavya preparation and other organic nutrients application; methods of preparation of compost, vermicompost, green manuring, preparation of neem products and application; BD preparations and their role; EM

technology and products; biological/natural control of pests and diseases; soil solarisation; frame work for GAP, case studies, HACCP analysis; residue analysis in organic products; documentation for certification; visit to fields cultivated under organic practices

FSC 511 PROTECTED FRUIT CULTURE 2+1

Theory:

UNIT I: Greenhouse - world scenario, Indian situation: present and future, different agro-climatic zones in India, environmental factors and their effects on plant growth.

UNIT II: Basics of greenhouse design, different types of structures - glasshouse, shade net, poly tunnels - Design and development of low cost greenhouse structures.

UNIT III: Interaction of light, temperature, humidity, CO_2, water on crop regulation, greenhouse heating, cooling, ventilation and shading.

UNIT IV: Types of ventilation- forced cooling techniques - glazing materials – microirrigation and fertigation.

UNIT V: Automated greenhouses, microcontrollers, waste water recycling, management of pest and diseases – IPM.

Practical: Designs of greenhouse; low cost poly tunnels; net house- regulation of light, temperature, humidity in greenhouses, media, greenhouse cooling systems; ventilation systems; fertigation systems, special management practices; project preparation for greenhouses; visit to greenhouses.

FSC 512 GAPS FOR HORTICULTURAL CROPS 1+0

Theory:

UNIT I: Genesis of GAP – definition/description, components listed by FAO, frame work.

UNIT II: Management of site history and soil, crop and fodder production, IPM, INM, IWM, irrigation water, crop production and protection, identification of ways of improving the productivity profitability, and resource efficiency, harvest and post-harvest handling.

UNIT III: Animal production, product certification, animal waste management, animal health and welfare, harvest.

UNIT IV: On farm processing, storage, energy and waste management, human health, welfare, safety, wild life benefits.

UNIT V: Institutions involved in GAP certification, Indian agencies, EUREPGAP (European Retail Producers Group- Good Agricultural Practices), EUREP etc.

FSC 513 CLIMATE MANAGEMENT IN HORTICULTURAL PRODUCTION 1+0

Theory

UNIT I: Introduction to climate change. Factors directly connected to climate change, average temperature, change in rainfall amount and patterns, rising atmospheric concentrations of CO_2, pollution levels such as tropospheric ozone, change in climatic variability and extreme events like receding of glaciers in Himalayas.

UNIT II: Sensors for climate registration and crop monitoring, phytomonitoring and biosensors, plants response to the climate changes, premature bloom, marginally overwintering or inadequate winter chilling hours, insect pests, longer growing seasons and shifts in plant hardiness for perennial fruit crops, flowering plants and other plant species.

UNIT III: Impact of climate changes on invasive insect, disease, weed, pests, horticulture yield, quality and sustainability, climate management in field production – mulching - use of plastic- windbreak-

spectral changes- frost protection. Climate management in greenhouse- heating - vents - CO2 injection - screens - artificial light.
UNIT IV: Climate management for control of pests, diseases, quality, elongation of growth and other plant processes- closed production systems around the world. Special protected cultivation now and in the future, growth chambers, production in space, biosphere, future aspects of closed production, future greenhouse, use of LED as artificial light, future sensor types etc. clean development mechanism, role of tropical trees.

FSC 591 MASTER'S SEMINAR 1+0

FSC 601 ADVANCES IN BREEDING OF FRUIT CROPS 2+1

Theory:

Evolutionary mechanisms, adaptation and domestication, Genetic resources, cytogenetics, cytomorphology, chemotaxonomy, genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility systems in fruits, recent advances in crop improvement efforts- introduction and selection, chimeras, apomixis, clonal selections, intergeneric, interspecific and intervarietal hybridization, mutation and polyploid breeding, resistance breeding to biotic and abiotic stresses, breeding for improving quality, molecular and transgenic approaches in improvement of selected fruit crops.

Crops

UNIT I: Mango and banana
UNIT II: Papaya, grapes and citrus
UNIT III: Guava and sapota
UNIT IV: Apple and pear
UNIT V**:** Plums, peaches, apricot, cherries and Strawberry

Practical : Description and cataloguing of germplasm, pollen viability tests, pollen germination-isozyme techniques-survey and clonal selection, observations on pest, disease and stress reactions in inbreds and hybrids, use of mutagenes and colchicine for inducing mutation and ploidy changes, practices in different methods of breeding fruit crops and in-vitro breeding techniques.

FSC 602 ADVANCES IN PRODUCTION OF FRUIT CROPS 2+1

Theory:

National and international scenario in fruit production, recent advances in propagation - root stock influence, planting systems, high density planting, crop modelling, precision farming, decision support systems - aspects of crop regulation- physical and chemical regulation effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, total quality management(TQM) - current topics.

Crops

UNIT I: Mango and banana
UNIT II: Papaya, grapes and citrus
UNIT III: Guava, sapota, pomegranate and aonla
UNIT IV: Pineapple and fig
UNIT V**:** Apple, pear, plums, strawberry, peach, apricot, cherries and nut crops

Practical : Survey of existing fruit cropping systems and development of a model cropping system; estimating nutrient deficiency; estimation of water use efficiency; soil test-crop response correlations; practices in plant growth regulation; studying physiological and biochemical responses; quality analysis.

FSC 603 ADVANCES IN GROWTH REGULATION OF FRUIT CROPS 2+1

Theory:

UNIT I: Ecophysiological influences on growth and development of fruit crops flowering, fruit set- crop load and assimilate partitioning and distribution.

UNIT II: Root and canopy regulation, study of plant growth regulators in fruit culture- structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants.

UNIT III: Absorption, translocation and degradation of phytohormones – internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, canopy management for fertigated orchards.

UNIT IV: Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production.

UNIT V: Flower drop and thinning, fruitset and development, fruit drop, parthenocarpy, fruit maturity and ripening and storage, molecular approaches in crop growth regulation- current topics.

Practical: Root - shoot studies, quantifying the physiological and biochemical effects of physical and chemical growth regulation, bioassay and isolation through chromatographic analysis for auxins, gibberellins, experiments on growth regulation during propagation, dormancy, flowering, fruitset and fruit development stages.

FSC 604 GENOMICS AND BIOINFORMATICS IN HORTICULTURE 2+1

Theory

UNIT I: Primer on bioinformatics and computational genomics, database fundamentals – biological databases, horticultural genome and protein databases, functional genomics.

UNIT II: Dynamic Programming Sequence Alignment, BLAST search engine, FASTA search engine, Microarrays- Microarray Clustering and Classification, Terminologies and Ontologies - EcoCYC knowledge base of E. coli metabolism - Description of UMLS Semantic Network.

UNIT III: Multiple Sequence Alignment, MSA algorithm descriptions, Clustal W, 1D Motifs, Algorithms and Databases, methods for sequence weighting, BLOCKS database, Making BLOCK motifs, PROSITE database, 3D structure alignment, SCOP, DALI, LOCK, MUSTA algorithm for geometric hashing and multiple alignment.

UNIT IV: Hidden Markov models , Molecular energetics and dynamics , Protein structure prediction, Genetic networks - Modelling and Simulation of Genetic Regulatory Systems- KEGG database of genes and gene pathways/networks - EcoCYC database of metabolic pathways in E. Coli - EGF-signal pathway modelling, Gene finding algorithms – Genome Annotation Assessment Project for Arabidopsis, Comparative genomics algorithms, Genome Alignment.

UNIT V: 3D structure computations, NMR, Xtallography, NMR Structure Determination, X-ray Crystallography Structure Determination, Distance Geometry Description, RNA secondary structure, Molecular Modelling and Drug discovery programs.

UNIT VI: Phylogenetic algorithms - Treebase database of phylogenetic information for plants mostly, Tree of Life Page, Samples from the Tree of Life, Ribosomal Database Project, Natural Language Processing , Proteomics, 3D Motifs, Applications and Integration with Horticulture, Final Thoughts.

Practical: Computers - operating systems and programming language; internet resources, horticultural genome and protein databases; BLAST/RNA structure; sequence alignment; microarray data analysis; ontology; MSA; HMMs; identification of functional sites in structures, protein structure prediction - phylogenetics - gene finding - molecular modeling and drug discovery software – assignments.

FSC 605 BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS 2+1

Theory:

UNIT I: Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.).

UNIT II: Pollution - increased level of CO_2, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations.

UNIT III: Crop modelling for stress situations, cropping system, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stress and their impact on crop growth and productivity.

UNIT IV: Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers.

UNIT V: Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, cropping systems, stability and sustainability indices.

Practical: Seed treatment / hardening practices; container seedling production; analysis of soil moisture estimates (FC, ASM, PWP); analysis of plant stress factors, RWC, chlorophyll fluorescence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate etc. under varied stress situations; influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices; economics of stress management; visit to orchards and water shed locations.

FSC 691 DOCTORAL SEMINAR 1+0

PLANT PATHOLOGY

http://hillagric.ac.in/edu/coa/ppath/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
PL PATH 501*	MYCOLOGY	2+1	I
PL PATH 502*	PLANT VIROLOGY	2+1	I
PL PATH 503*	PLANT BACTERIOLOGY	2+1	I
PL PATH 504*	PRINCIPLES OF PLANT PATHOLOGY	3+0	I
PL PATH 505*	DETECTION AND DIAGNOSIS OF PLANT DISEASES	0+2	I
PL PATH 506	PRINCIPLES OF PLANT DISEASE MANAGEMENT	2+1	II
PL PATH 507	DISEASES OF FIELD AND MEDICINAL CROPS	2+1	II
PL PATH 508	DISEASES OF FRUITS, PLANTATION AND ORNAMENTAL CROPS	2+1	II
PL PATH 509	DISEASES OF VEGETABLE AND SPICES CROPS	2+1	II
PL PATH 510	SEED HEALTH TECHNOLOGY	2+1	II
PL PATH 511	CHEMICALS IN PLANT DISEASE MANAGEMENT	2+1	II
PL PATH 512	ECOLOGY OF SOIL-BORNE PLANT PATHOGENS	2+1	I
PL PATH 513	DISEASE RESISTANCE IN PLANTS	2+0	II
PL PATH 514/ ENT 514	INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS	1+1	I
PL PATH 515	BIOLOGICAL CONTROL OF PLANT DISEASES	2+1	II
PL PATH 516	INTEGRATED DISEASE MANAGEMENT	2+1	II
PL PATH 517	MUSHROOM PRODUCTION TECHNOLOGY	2+1	I
PL PATH 518	EPIDEMIOLOGY AND FORECASTING OF PLANT DISEASES	2+1	I
PL PATH 519	POST HARVEST DISEASES	2+1	II
PL PATH 520/ ENT 520	PLANT QUARANTINE	2+0	I
PL PATH 591*	MASTER'S SEMINAR	1+0	I &II
PL PATH 599*	MASTER'S RESEARCH	20	I &II
PL PATH 601**	ADVANCED MYCOLOGY	2+1	II
PL PATH 602**	ADVANCED VIROLOGY	2+1	II
PL PATH 603**	ADVANCED BACTERIOLOGY	2+1	II
PL PATH 604**	MOLECULAR BASIS OF HOST-PATHOGEN INTERACTION	2+1	I
PL PATH 605**	PRINCIPLES AND PROCEDURES OF CERTIFICATION	1+0	I
PL PATH 606**	PLANT BIOSECURITY AND BIOSAFETY	2+0	I
PL PATH 691**	DOCTORAL SEMINAR I	1+0	I &II
PL PATH 692**	DOCTORAL SEMINAR II	1+0	I &II
PL PATH 699	DOCTORAL RESEARCH	45	I &II

*Compulsory for Master's Programme **Compulsory for Doctoral Programme

PLANT PATHOLOGY

Course contents

PL PATH 501 MYCOLOGY 2+1

Theory

UNIT I: Introduction, definition of different terms, basic concepts.

UNIT II: Importance of mycology in agriculture, Importance of fungi to man, history of mycology.

UNIT III: Concepts of nomenclature and classification, fungal biodiversity, reproduction in fungi.

UNIT IV: The comparative morphology, ultrastructure, characters of different groups of fungi up to generic level: (a) Myxomycota and (b) Eumycota- i) Mastigomycotina ii) Zygomycotina, iii) Ascomycotina, iv) Basidiomycotina, v) Deuteromycotina. Lichens, variability in fungi.

Practical: Detailed comparative study of different groups of fungi; collection; identification and preservation of specimens; isolation and identification of plant pathogenic fungi.

PL PATH 502 PLANT VIROLOGY 2+1

Theory

UNIT I: History of plant viruses, composition and structure of viruses.

UNIT II: Symptomatology of important plant viral diseases, transmission, chemical and physical properties, virus-host interaction, virus-vector relationship.

UNIT III: Virus nomenclature and classification, genome organization, replication and movement of viruses.

UNIT IV: Virus isolation and purification, electron microscopy, protein and nucleic acid based diagnostics.

UNIT V: Mycoviruses, phytoplasma, arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, prions, principles of the working of electron-microscope and ultra-microtome.

UNIT VI: Virus origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses.

Practical: Study of symptoms caused by viruses; transmission; assay of viruses; physical properties; purification; and method of raising antisera; serological tests; electron microscopy and ultratomy; PCR.

PL PATH 503 PLANT BACTERIOLOGY 2+1

Theory

UNIT I: History and introduction to phytopathogenic procarya, viz., bacteria, MLOs, spiroplasmas and other fastidious procarya. Importance of phytopathogenic bacteria.

UNIT II: Evolution, classification and nomenclature of phytopathogenic procarya and important diseases caused by them.

UNIT III: Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic procarya.

UNIT IV: General biology of bacteriophages, L form bacteria, plasmids and bdellovibrios.

UNIT V: Procaryotic inhibitors and their mode of action against phytopathogenic bacteria.

UNIT VI: Survival and dissemination of phytopathogenic bacteria.

Practical: Isolation, purification; identification and host inoculation of phytopathogenic bacteria; staining methods; biochemical and serological characterization; isolation of plasmid and use of antibacterial chemicals/antibiotics.

PL PATH 504 PRINCIPLES OF PLANT PATHOLOGY 3+0

Theory

UNIT I: Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes and classification of plant diseases.

UNIT II: Pathogenesis- survival, growth, reproduction, and dispersal of important plant pathogens, role of environment and host nutrition on disease development.
UNIT III: Host parasite interaction, recognition concept and infection, symptomatology, mechanism of infection- role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors, altered plant metabolism as affected by plant pathogens.
UNIT IV: Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.
UNIT V: Disease management strategies.

PL PATH 505 DETECTION AND DIAGNOSIS OF PLANT DISEASES 0+2
Practical
UNIT I: Methods to prove Koch's postulates with biotroph and necrotroph pathogens; pure culture techniques;use of selective media to isolate pathogens.
UNIT II: Preservation of plant pathogens and disease specimens; use of haemocytometer; micrometer; centrifuge; pH meter; camera lucida.
UNIT III: Microscopic techniques and staining methods; phase contrast system; chromatography; use of electron microscope; spectrophotometer; ultracentrifuge and electrophoretic apparatus;disease diagnostics; serological and molecular techniques for detection of plant pathogens; evaluation of fungicides; bactericides etc.; field experiments; data collection and preparation of references.

PL PATH 506 PRINCIPLES OF PLANT DISEASE MANAGEMENT 2+1
Theory
UNIT I: Principles of plant disease management through cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures (IDM- module) of plant diseases, disease resistance and molecular approach for disease management.
UNIT II: Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-à-vis environmental hazards, residual effects and safety measures.
UNIT III: History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.
Practical: *In vitro* and *in vivo* evaluation of chemicals against plant pathogens; ED and MIC values; study of structural details of sprayers and dusters.

PL PATH 507 DISEASES OF FIELD AND MEDICINAL CROPS 2+1
Theory
UNIT I: Diseases of Cereal crops- wheat, barley, rice, pearl millet, sorghum and maize.
UNIT II: Diseases of Pulse crops- gram, common bean, urdbean, mungbean, lentil, pigeonpea, soybean.
UNIT III: Diseases of Oilseed crops- rapeseed and mustard, sesame, linseed, sunflower, groundnut, castor.
UNIT IV: Diseases of Cash crops- cotton, sugarcane.
UNIT V: Diseases of Fodder legume crops- berseem, oats, guar, lucerne, cowpea.
UNIT VI: Medicinal crops- plantago, liquorice, mulathi,, sacred basil, mentha, ashwagandha, *Aloe vera.*
Practical: Detailed study of symptoms and host-parasite relationship of important diseases of above mentioned crops; collection and dry preservation of diseased specimens of important crops.

PL PATH 508 DISEASES OF FRUITS, PLANTATION AND ORNAMENTAL CROPS 2+1

Theory

UNIT I: Introduction, symptoms, etiology, epidemiology and management of different diseases of fruits like apple, pear, peach, plum, apricot, cherry, walnut, almond, strawberry, citrus, mango, grapes, guava, *ber,* banana, pineapple, papaya, fig, pomegranate, date palm.

UNIT II: Introduction, symptoms, etiology, epidemiology and management of different diseases of plantation crops such as tea, coffee, rubber and coconut.

UNIT III: Introduction, symptoms, etiology, epidemiology and management of different diseases of ornamental plants such as roses, gladiolus, tulip, carnation, orchids, marigold, chrysanthemum.

Practical: Detailed study of symptoms and host parasite relationship of representative diseases of plantation crops; collection and dry preservation of diseased specimens of important crops.

PL PATH 509 DISEASES OF VEGETABLE AND SPICES CROPS 2+1

Theory

UNIT I: Nature, prevalence, symptoms, factors affecting disease development and management of bulb crops, leafy vegetables, crucifers, cucurbits and solanaceaous vegetables.

UNIT II: Nature, prevalence, symptoms, factors affecting disease development and management under protected cultivation.

UNIT III: Symptoms, epidemiology and management of diseases of different spice crops such as black pepper, saffron, cumin, coriander, turmeric, fennel, fenugreek and ginger.

Practical: Detailed study of symptoms and host pathogen interaction of important diseases of vegetable and spice crops.

PL PATH 510 SEED HEALTH TECHNOLOGY 2+1

Theory

UNIT I: History and economic importance of seed pathology in seed industry, plant quarantine and SPS under WTO, morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds.

UNIT II: Recent advances in the establishment and subsequent cause of disease development in seed and seedling, localization and mechanism of seed transmission in relation to seed infection, seed to plant transmission of pathogens.

UNIT III: Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds, evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens, epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection.

UNIT IV: Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing, methods for detecting microorganism.

Practical: Conventional and advanced techniques in the detection and identification of seed-borne fungi; bacteria and viruses; relationship between seed-borne infection and expression of the disease in the field.

PL PATH 511 CHEMICALS IN PLANT DISEASE MANAGEMENT 2+1

Theory

UNIT I: History and development of chemicals; definition of pesticides and related terms, advantages and disadvantages of chemicals.

UNIT II: Classification of chemicals used in plant disease control and their characteristics.

UNIT III: Chemicals in plant disease control, viz., fungicides, bactericides, nematicides, antiviral chemicals and botanicals.

UNIT IV: Formulations, mode of action and application of different fungicides, chemotherapy and phytotoxicity of fungicides.
UNIT V: Handling, storage and precautions to be taken while using fungicides, compatibility with other agrochemicals, persistence, cost-benefit ratio, factor affecting fungicides.
UNIT VI: General account of plant protection appliances, environmental pollution, residues and health hazards, fungicidal resistance in plant pathogens and its management.
Practical: Acquaintance with formulation of different fungicides and plant protection appliances; Formulation of fungicides; bactericides and nematicides; *in vitro* evaluation techniques; preparation of different concentrations of chemicals including botanical pesticides based on active ingredients against pathogens; persistence; compatibility with other agro-chemicals; detection of naturally occurring fungicide resistant mutants of pathogen; methods of application of chemicals.

PL PATH 512 ECOLOGY OF SOIL-BORNE PLANT PATHOGENS 2+1
Theory
UNIT I: Soil as an environment for plant pathogens, nature and importance of rhizosphere and rhizoplane, host exudates, soil and root inhabiting fungi, types of biocontrol agents.
UNIT II: Inoculum potential and density in relation to host and soil variables, competition, predation, antibiosis and fungistasis.
UNIT III: Suppressive soils, biological control- concepts and potentialities for managing soil borne pathogens.
Practical: Quantification of rhizosphere and rhizoplane microflora with special emphasis on pathogens; pathogenicity test by soil and root inoculation techniques, correlation between inoculum density of test pathogens and disease incidence; demonstration of fungistasis in natural soils; suppression of test soil-borne pathogens by antagonistic microorganisms; isolation and identification of different biocontrol agents.

PL PATH 513 DISEASE RESISTANCE IN PLANTS 2+0
Theory
UNIT I: Introduction and historical development, dynamics of pathogenicity, process of infection, variability in plant pathogens, gene centre's as sources of resistance, disease resistance terminology.
UNIT II: Disease escapes, disease tolerance, disease resistance, types of resistance, identification of physiological races of pathogens, disease progression in relation to resistance, stabilizing selection pressure in plant pathogens.
UNIT III: Host defense system, morphological and anatomical resistance, preformed chemicals in host defense, post infectional chemicals in host defense, phytoalexins, hypersensitivity and its mechanisms.
UNIT IV: Gene-for-gene concept, protein-for-protein and immunization basis, management of resistance genes, strategies for gene deployment.

PL PATH 514/ INSECT VECTORS OF PLANT VIRUSES 1+1
ENT 514 AND OTHER PATHOGENS
Theory
UNIT I: History of developments in the area of insects as vectors of plant pathogens. Important insect vectors and their characteristics, mouth parts and feeding processes of important insect vectors. Efficiency of transmission.
UNIT II: Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors.
UNIT III: Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips.
UNIT IV: Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.
UNIT V: Transmission of plant viruses by psyllids, beetles and mites.
UNIT VI: Epidemiology and management of insect transmitted diseases through vector management.

Practical: Identification of common vectors of plant pathogens- aphids; leafhoppers; whiteflies; thrips; beetles; nematodes; culturing and handling of vectors; demonstration of virus transmission through vectors- aphids, leafhoppers and whiteflies.

PL PATH 515 BIOLOGICAL CONTROL OF PLANT DISEASES 2+1

Theory

UNIT I: Concept of biological control, definitions, importance, principles of plant disease management with bioagents, history of biological control, merits and demerits of biological control.

UNIT II: Types of biological interactions, competition, mycoparasitism, exploitation for hypovirulence, rhizosphere colonization, competitive saprophytic ability, antibiosis, induced resistance, mycorrhizal associations, operational mechanisms and its relevance in biological control.

UNIT III: Factors governing biological control, role of physical environment, agroecosystem, operational mechanisms and cultural practices in biological control of pathogens, pathogens and antagonists and their relationship, biocontrol agents, comparative approaches to biological control of plant pathogens by resident and introduced antagonists, control of soil-borne and foliar diseases, compatibility of different bioagents.

UNIT IV: Commercial production of antagonists-mass multiplication and preparation of formulation, their delivery systems, application and monitoring, biological control in IDM, IPM and organic farming system, biopesticides available in market, quality control system of biocontrol agents.

Practical: Isolation; characterization and maintenance of antagonists; methods of study of mechanisms of antagonism *in vitro;* application of antagonists against pathogen *in vivo* conditions; enumeration of antagonists.

PL PATH 516 INTEGRATED DISEASE MANAGEMENT 2+1

Theory

UNIT I: Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications.

UNIT II: Development of IDM- basic principles, biological, chemical and cultural disease management.

UNIT III: IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed mustard, pearlmillet, *kharif* pulses, vegetable crops and fruit crops.

Practical: Application of biological; cultural; chemical and biocontrol agents; their compatibility and integration in IDM; demonstration of IDM in certain crops as project work.

PL PATH 517 MUSHROOM PRODUCTION TECHNOLOGY 2+1

Theory

UNIT I: Historical development of mushroom cultivation and present status, taxonomy, classification, uses of mushrooms, edible and poisonous mushrooms.

UNIT II: Maintenance of pure culture, preparation of spawn and facilities required for establishing commercial spawn laboratory strain improvement.

UNIT III: Preparation of substrate for mushroom cultivation, long, short and indoor composting methods, formulae for different composts and their computation, qualities and testing of compost, uses of spent mushroom compost/substrate, spawning and spawn run, casing preparation and its application.

UNIT IV: Setting up mushroom farm for seasonal and environmentally control cultivation, requirement and maintenance of temperature, relative humidity, CO_2, ventilation in cropping rooms, cultivation technology of *Agaricus bisporus*, *Pleurotus* sp., *Calocybe indica*, *Lentinus edodes* and *Ganoderma lucidum.*

UNIT V: Insect pests, diseases and abnormalities of cultivated mushroom and their management, post harvest processing and value addition, economics of mushroom cultivation, biotechnology and mushroom cultivation.

Practical: Preparation of spawn; compost, spawning; casing; harvesting and postharvest handling of edible mushroom; identification of various pathogens; competitors of various mushrooms.

PL PATH 518 EPIDEMIOLOGY AND FORECASTING OF PLANT DISEASES 2+1

Theory

UNIT I: Epidemic concept and historical development, pathometry and crop growth stages, epidemic growth and analysis.

UNIT II: Common and natural logrithms, function fitting area under disease progress curve and correction factors, inoculum dynamics, population biology of pathogens, temporal spatial variability in plant pathogens.

UNIT III: Survey, surveillance and vigilance, crop loss assessment and models for prediction of crop losses.

UNIT IV: Principles and pre-requisites of forecasting, systems and factors affecting various components of forecastings, some early forecasting, procedures based on weather and inoculum potential, modeling disease growth and disease prediction.

Practical: Measuring diseases; spore dispersal and trapping; weather recording; survey; multiplication of inoculums; computerized data analysis; function fitting; model preparation and validation.

PL PATH 519 POST HARVEST DISEASES 2+1

Theory

UNIT I: Concept of post harvest diseases, definitions, importance with reference to environment and health, principles of plant disease management as preharvest and post-harvest, merits and demerits of biological/phytoextracts in controlling post-harvest diseases.

UNIT II: Types of post harvest problems both by biotic and abiotic causes, rhizosphere colonization, competitive, saprophytic ability, antibiosis, induced resistance, microbial associations, concept, operational mechanisms and its relevance in control.

UNIT III: Factors governing post harvest problems both as biotic and abiotic, role of physical environment, agro-ecosystem leading to quiescent infection, operational mechanisms and cultural practices in perpetuation of pathogens, pathogens and antagonist and their relationship, role of biocontrol agents and chemicals in controlling post-harvest diseases, comparative approaches to control plant pathogens by resident and introduced antagonists, isolation, characterization and maintenance of pathogens, role of different storage.

UNIT IV: Integrated approach in controlling diseases and improving the shelf life of produce, control of aflatoxigenic and mycotoxigenic fungi, application and monitoring for any health hazard, knowledge of Codex Alimentarious for each product and commodity.

Practical: Isolation, characterization and maintenance of pathogens; role of different storage conditions on disease development; application of antagonists against pathogens *in vivo* and *in vitro* conditions; comparative efficacy of different chemicals; fungicides; phytoextracts and bioagents.

PL PATH 520/ ENT 520 PLANT QUARANTINE 2+0

Theory

UNIT I: Definition of pest, pesticides and transgenics as per Government notification, relative importance, quarantine – domestic and international, quarantine restrictions in the movement of agricultural produce, seeds and planting material, case histories of exotic pests/diseases and their status.

UNIT II: Plant protection organization in India, Acts related to registration of pesticides and transgenics, history of quarantine legislations, PQ Order 2003, Environmental Acts, Industrial registration; APEDA, import and export of bio-control agents.

UNIT III: Identification of pest/disease free areas; contamination of food with toxigens and microorganisms, and their elimination, symptomatic diagnosis and other techniques to detect pest/pathogen infestations, VHT and other safer techniques of disinfestations/salvaging of infected material.
UNIT IV: WTO regulations; non-tariff barriers; pest risk analysis (PRA), good practices for pesticide laboratories; pesticide industry; sanitary and phytosanitary measures.

PL PATH 591	**MASTER'S SEMINAR**	**1+0**
PL PATH 592	**SPECIAL PROBLEM IN M.Sc.**	**0+1**
PL PATH 599	**MASTER'S RESEARCH**	**0+20**

PL PATH 601 ADVANCED MYCOLOGY 2+1

Theory

UNIT I: General introduction, historical development and advances in mycology.
UNIT II: Recent taxonomic criteria, morphological, chemical (chemotaxonomy) and molecular.
UNIT III: Interaction between groups: phylogeny, conidiogenesis and sporulating structures of fungi imperfecti, morphology and reproduction of representative plant pathogenic genera from differentgroups of fungi, sexual reproduction.
UNIT IV: Population biology, pathogenic variability/vegetative compatibility.
UNIT V: Heterokaryosis and parasexual cycle, sex hormones in fungi, pleomorphism and speciation in fungi, mechanism of nuclear inheritance, mechanism of extra-nuclear inheritance, biodegradation.
Practical: Study of conidiogenesis-phialides; porospores, arthospores; study of fruit bodies in ascomycotina; identification of fungi up to species level;study of hyphal anastomosis; morphology of representative plant pathogenic genera from different groups of fungi.

PL PATH 602 ADVANCED VIROLOGY 2+1

Theory

UNIT I: Recent advances in plant virology, virus-vector relationship, bimodal transmission and taxonomy of vectors and viruses, mechanism of virus transmission by vectors, vector specificity for classes of viruses, virus replication, assembly and architecture, ultrastructural changes due to virus infection, variation, mutation and virus strains.
UNIT II: Immunoglobulin structure and functions of various domains, methods of immune-diagnosis, hybridoma technology and use of monoclonal antibodies in identification of viruses and their strains, polymerase chain reaction.
UNIT III: Genome organization, replication, transcription and translational strategies of pararetroviruses and gemini viruses, satellite viruses and satellite RNA, genome organization in tobamo-, poty-, bromo, cucumo, ilar, gemini and tospoviruses.
UNIT IV: Gene expression and regulation, viral promoters, molecular mechanism of host-virus interactions, virus induced gene, molecular mechanism of vector transmission, symptom expression, viroids and prions.
UNIT V: Genetic engineering with plant viruses, viral suppressors, a RNAi dynamics, resistant genes. Viruses potential as vectors, genetically engineered resistance, transgenic plants.
UNIT VI: Techniques and application of tissue culture, origin, evolution and interrelationship with animal viruses.
Practical: Purification of virus(es); SDS-PAGE for molecular weight determination; production of polyclonal antiserum; purification of IgG and conjugate preparation; serological techniques (i) DAC-ELISA (ii) DAS -ELISA (iii) DIBA (iv) Western blots (v) (ab) 2-ELISA, vector transmission (one each with aphid; leaf hopper and whitefly); methods for collecting vectors and their maintenance; nucleic acid isolation; DOT-blot; southern hybridization; probe preparation and autoradiography; PCR application and viral genome cloning; sequencing annotation of genes.

PL PATH 603 ADVANCED BACTERIOLOGY 2+1

Theory

UNIT I: Current approaches for the characterization and identification of phytopathogenic bacteria, ultrastructures and biology of bacteria.

UNIT II: Current trends in taxonomy of phytopathogenic procarya.

UNIT III: Role of enzyme, toxin, exopolysaccharide, polypeptide signals in disease development, mechanism of wilt (*Ralstonia solanacearum*) development, mechanism of soft rot (*Erwinia* spp.) development, mechanism of crown gall formation (*Agrobacterium tumifaciens*).

UNIT IV: Host-bacterial pathogen interaction, quorum-sensing phenomenon, type III secretion system, HR/SR reactions, R-genes, Avr-genes, hrp genes, Effector protein.

UNIT V: Molecular variability among phytopathogenic procarya and possible host defense mechanism(s), genetic engineering for management of bacterial plant pathogens-gene silencing, RNAi technology.

UNIT VI: Epidemiology in relation to bacterial plant pathogens, development of diagnostic kit.

UNIT VII: Beneficial prokaryotes- endophytes, PGPR, phylloplane bacteria and their role in disease management, endosymbionts for host defense.

Practical: Pathogenic studies and race identification; plasmid profiling of bacteria; fatty acid profiling of bacteria; RAPD profiling of bacteria and variability status; endospore, flagellar staining; test for secondary metabolite production, cyanides; EPS; siderophore; specific detection of phytopathogenic bacteria using species/pathovar specific primers; basic techniques in diagnostic kit development; molecular tools to identify phytoendosymbionts.

PL PATH 604 MOLECULAR BASIS OF HOST-PATHOGEN INTERACTION 2+1

Theory

UNIT I: Importance and role of biotechnological tools in plant pathology-basic concepts and principles to study host pathogen relationship.

UNIT II: Molecular basis of host-pathogen interaction- fungi, bacteria and viruses, recognition system, signal transduction.

UNIT III: Induction of defense responses-pathogenesis related proteins, HR, reactive oxygen species, phytoalexins and systemic acquired resistance, programmed cell death, viral induced gene silencing.

UNIT IV: Molecular basis of gene-for-gene hypothesis, R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes.

UNIT V: Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops.

Practical: Protein; DNA and RNA isolation; Plasmids extraction; PCR analysis; DNA and Protein electrophoresis; bacterial transformation.

PL PATH 605 PRINCIPLES AND PROCEDURES OF CERTIFICATION 1+0

Theory

UNIT I: Introduction to certification, international scenario of certification and role of ISTA, EPPO, OECD etc. in certification and quality control.

UNIT II: Case studies of certification systems of USA and Europe, national regulatory mechanism and certification system including seed certification, minimum seed certification standards, national status of seed health in seed certification, methods for testing genetic identity, physical purity, germination percentage, seed health etc.

UNIT III: Fixing tolerance limits for diseases and insect pests in certification and quality control programmes, methods used in certification of seeds, vegetative propagules and *in vitro* cultures, accreditation of seed testing laboratories, role of seed/ planting material health certification in national and international trade.

PL PATH 606 PLANT BIOSECURITY AND BIOSAFETY 2+0

Theory

UNIT I: History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases.

UNIT II: National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event and its mitigation planning and integrated approach for biosecurity, biosafety, policies and regulatory mechanism, cartagena protocol on Biosafety and its implications, issues related to release of genetically modified crops.

PL PATH 691	**DOCTORAL SEMINAR I**	**1+0**
PL PATH 692	**DOCTORAL SEMINAR II**	**1+0**
PL PATH 693	**SPECIAL PROBLEM IN Ph.D.**	**0+1**
PL PATH 699	**DOCTORAL RESEARCH**	**0+45**

SEED SCIENCE & TECHNOLOGY

http://hillagric.ac.in/edu/coa/spu/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
SST 501*	FLORAL BIOLOGY, SEED DEVELOPMENT AND MATURATION	1+1	I
SST 502*	PRINCIPLES OF SEED PRODUCTION	2+1	II
SST 503	SEED PRODUCTION IN FIELD CROPS	2+1	II
SST 504/ VSC 506	SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS	2+1	I
SST 505	SEED PRODUCTION IN FORAGES AND PASTURE CROPS	1+1	I
SST 506*	SEED LEGISLATION AND CERTIFICATION	2+1	I
SST 507*	SEED PROCESSING AND STORAGE	2+1	I
SST 508*	SEED QUALITY TESTING	2+1	II
SST 509	SEED PHYSIOLOGY	2+1	II
SST 510	CULTIVAR PURITY AND QUALITY TESTING	0+1	I
SST 511	EMERGING TRENDS IN SEED QUALITY ENHANCEMENT	2+1	I
SST 512/ PL PATH 510	SEED HEALTH TECHNOLOGY	2+1	II
SST 591*	M.SC.SEMINAR	1+0	I&II
SST 592	SPECIAL PROBLEM IN M.Sc.	0+1	I&II
SST 599*	MASTER'S RESEARCH	0+20	I&II

*Compulsory for Master's Programme

SEED SCIENCE & TECHNOLOGY

Course contents

SST 501 FLORAL BIOLOGY, SEED DEVELOPMENT AND MATURATION 1+1

Theory

UNIT I: Floral types, structure and biology in relation to pollination mechanisms, sporogenesis: microsporogenesis and megasporogenesis, gametogenesis -development of male and female gametes and their structures, effect of environmental factors on floral biology.

UNIT II: Fertilization – embryo sac structure, process, barriers to fertilization, incompatibility and male sterility, factors affecting fertilization, embryogenesis - development of typical monocot and dicot embryos, endosperm development, modification of food storage structures with reference to crop plants, different types of embryos, endosperm and cotyledons, development and their structure in representative crop plants with reference to food storage, external and internal features of monocot and dicot seed, seed coat structure and development in representative crop plants.

UNIT III: Apomixis – identification, classification, significance and its utilization in different crops for hybrid seed production, polyembryony - types and significance, haplontic and diplontic sterility, causes of embryo abortion, embryo rescue and synthetic seeds.

Practical: Study of floral biology of monocots and dicots; microsporogenesis and megasporogenesis; study of pollen grains - pollen morphology, pollen germination and pollen sterility; types of monocot and dicot embryos; external and internal structures of monocot and dicot seeds; seed coat structure, preparation of seed albums and identification.

SST 502 PRINCIPLES OF SEED PRODUCTION 2+1

Theory

UNIT I: Introduction to seed industry, classification of seed crops in relation to mode of reproduction, varieties: definition, type, development, release system and notification, objectives of seed production, generation system, factors affecting seed production, site selection, isolation and rouging, compact area approach, variety maintenance, nucleus and breeder seed production in different crop groups.

UNIT II: Hybrid seed production, heterosis, inbreeding depression, genetic, physiological and biochemical basis of heterosis, two and three-line system of hybrid seed production, development of A, B and R lines, male sterility, its kind and use in hybrid seed production, self-incompatibility, its genesis and use in hybrid seed production, gametocides, seed production planning.

Practical: Seed production planning in different crops with special reference to land and isolation requirements; agronomic management; rouging; harvesting and threshing; characters of important varieties and its maintenance; nucleus; breeder; foundation and certified seed production in crops like rice; maize; potato; soybean; kulthi; mash; mung; wheat; chickpea; lentil; and mustard; seed production planning in cross pollinated crops with special reference to land and isolation requirements; planting ratio of male and female parental lines; synchronization between male and female parental lines; methods to achieve synchronization; pollen collection; supplementary pollination; pollen storage; rouging; detasseling; pollination in corn; pollen shedders identification; gametocide application and observation of results; pollen collection; storage; viability and stigma receptivity; application of GA3 and supplementary pollination in hybrid rice; visit to seed production plots of different *kharif* and *rabi* crops.

SST 503 SEED PRODUCTION IN FIELD CROPS 2+1

Theory

UNIT I: Agronomic practices for seed production of important cereals, pulses, oilseeds, fibre and fodder crops, seed industry in the country and the role of various agencies.

UNIT II: Seed morphology of different crops; seed multiplication chain, seed quality-purity, viability, dormancy, vigour, etc., hybrid seed production, seed treatment; physiology of seed germination, seed

testing for germination and seedling vigour, seed certification-processing, grading, storage, distribution and marketing, store grain pests.

Practical: Seed quality on the basis of purity and germination; rouging; detasseling; familiarization with seed processing equipments; materials and precautions for seed storage; comparison of farmer's saved seed with certified seed.

SST 504 / VSC 506 SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS 2+1

Theory

UNIT I: Definition of seed and its quality, history, importance and present status of vegetable seed industry in India and World.

UNIT II: Genetical and agronomical principles of seed production, methods of seed production, use of growth regulators and chemicals in vegetable seed production, floral biology, pollination, breeding behavior, development and maturation; methods of hybrid seed production.

UNIT III: Categories of seed, production and maintenance of nucleus, foundation and certified seed, certification and seed standards, plant quarantine and quality control.

UNIT IV: Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic technology, seed laws, IPR and WTO.

UNIT V: Agro techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetable crops, bulb crops, leafy vegetables, okra, vegetatively propagated vegetables.

Practical: Seed sampling; seed testing (genetic purity, seed viability, seed vigour, physical purity evaluation, release and notification procedures of varieties in India; floral biology; practices in rouging; methods of hybrid seed production in important vegetable crops; seed extraction techniques; handling of seed processing and seed testing equipments; testing of vegetable seeds for seed purity; germination; vigour and health; visit to seed processing units; seed testing laboratory and seed production farms.

SST 505 SEED PRODUCTION IN FORAGES AND PASTURE CROPS 1+1

Theory

UNIT I: Important pasture and forage crops in India, seed requirement and production, flower structure, floral biology and pollination behavior, maintenance of varietal purity, genetic shifts in generation system of seed multiplication, kind of variety, pure line, synthetic or hybrid, apomictic grasses.

UNIT II: Improvement of apomictic grasses, selection of seed production areas, influence of season, seed rate and spacing, sowing methods, direct seed sowing, transplanting pelleting, fertilizer and manure requirement, isolation distances, weed control, pollination and seed setting, seed shattering, stage of harvest, seed collection, seed processing, seed treatment, seed storage, seed viability of grasses.

Practical: Study of flower structure; seed identification; characteristics of released varieties; maturity indices for harvest; laboratory analysis of parameters; laboratory germination methods.

SST 506 SEED LEGISLATION AND CERTIFICATION 2+1

Theory

UNIT I: Development of Seed Industry in India, seed quality: concept and factors affecting seed quality during different stages of production, processing and handling, seed quality control- concept and objectives, Central Seed Certification Board (CSCB).

UNIT II: Regulatory mechanisms of seed quality control- organizations involved in seed quality control programmes, seed legislation and seed law enforcement as a mechanism of seed quality control, the Seed Act (1966), Seed Rules (1968), Seed (Control) Order 1983, Essential Commodities Act (1955), Plants, Fruits and Seeds Order (1989), National Seed Development Policy (1988) and EXIM Policy regarding seeds, plant materials, PVP&FR,2001 Act, New Seed Bill-2004 etc., introduction, objectives and relevance of plant quarantine, regulations and plant quarantine set up in India.

UNIT III: Seed Certification- history, concept and objectives of seed certification, seed certification agency/organization and staff requirement, legal status and phases of seed certification, formulation, revision and publication of seed certification standards, Indian minimum seed certification Standards (I.M.S.C.S.)- general and specific crop standards including GM varieties, field and seed standards, planning and management of seed certification programmes- eligibility of a variety for certification, area assessment, cropping history of the seed field, multiplication system based on limited generation concept, isolation and land requirements etc, field Inspection- principles, stages and procedures of field inspection, reporting and evaluation of observations, pre and post-harvest control tests for genetic purity evaluation (grow-out tests), post harvest inspection and evaluation, seed sampling, testing, labeling, sealing and grant of certificate, types and specifications for tags and labels, maintenance and issuance of certification records and reports, certification fee and other service charges, training and liaison with seed growers. OECD seed certification schemes.
UNIT IV: Introduction to WTO and IPRs, plant variety protection and its significance, UPOV and its role DUS testing- principles and applications.
Practical: General procedure of seed certification for a seed grower; identification of weed and other crop plants in specific crops; field inspection at different stages of a crop and observations recorded on contaminants and reporting of results; inspection and sampling at harvesting/threshing; processing and after processing for seed law enforcement; testing physical purity; germination and moisture; specifications for tags and labels to be used for certification purpose; grow-out tests for pre and post-harvest quality control; visits to regulatory seed testing laboratory; including plant quarantine lab and seed certification agency.

SST 507 SEED PROCESSING AND STORAGE 2+1

Theory

UNIT I: Introduction and importance of seed processing, different methods of seed drying, including dehumidification and its impact on seed quality, relative humidity and equilibrium moisture content of seed, preparing seed for processing: scalper, debearder, scarifier, huller, seed cleaner and grader, screen cleaners, specific gravity separators, indented cylinder, separator, velvet separator, spiral separator, disc separator, colour sorter.
UNIT II: Seed treatments: methods of seed treatment, seed treating compounds, seed disinfestations, packaging: principles and practices and materials, processing plant design and layout, delinting machines.
UNIT III: Seed storage, importance and factors affecting it, changes during seed storage, concepts and significance of moisture equilibrium, method of maintaining safe seed moisture content, thumb rule and its relevance, loss of viability in important agricultural and horticultural crops, viability equation and nomograph, conservation of orthodox and recalcitrant seeds, methods to minimize the loss of seed vigour and viability.
UNIT IV: Storage losses due to pests. Factors influencing storage losses, storage methods and godown sanitation, storage structure, storage pests and their control.
Practical: Operation and performance evaluation of various seed processing equipments such as pre cleaner; scalpers; air screen cleaner; indented cylinder, gravity separator; pneumatic separator; colour sorter and other equipments; seed treater; conveyors and elevators, bag closers; different types of dryers; design and layout of seed processing plant and its economics; analysis of cost of operation and processing; determination of seed moisture; seed germination and vigour.

SST 508 SEED QUALITY TESTING 2+1

Theory

UNIT I: Introduction, structure of monocot and dicot seeds, seed quality, objectives, concept and components and their role in seed quality control, instruments, devices and tools used in seed testing. ISTA and its role in seed testing, seed sampling: definition, objectives, seed-lot and its size, types of samples, sampling devices, procedure of seed sampling, sampling intensity, methods of preparing

composite and submitted samples, sub-sampling techniques, dispatch, receipt and registration of submitted sample in the laboratory, sampling in the seed testing laboratory.
UNIT II: Physical purity: definition, objective and procedure, weight of working samples for physical purity analysis, components of purity analysis and their definitions and criteria, pure seed definitions applicable to specific genera and families, multiple seed units, general procedure of purity analysis, calculation and reporting of results, prescribed seed purity standards, determination of huskless seeds, determination of weed seed and other seed by number per kilogram, determination of other distinguishable varieties (ODV), determination of test weight and application of heterogeneity test.
UNIT III: Seed moisture content: importance of moisture content, equilibrium moisture content, principles and methods of moisture estimation - types, instruments and devices used, pre-drying and grinding requirements, procedural steps in moisture estimation,
UNIT IV: Germination: importance, definitions, requirements for germination, instrument and substrata required, principle and methods of seed germination testing, working sample and choice of method, general procedure for each type of method, duration of test, seedling evaluation, calculation and reporting of results, dormancy: definition, importance, causal mechanisms, types and methods for breaking dormancy.
UNIT V: Viability and vigour testing: definition and importance of viability tests, different viability tests, quick viability test (TZ- test) - advantages, principles, procedure, vigour testing: concept, historical development, definitions, principles and procedures of different methods used for testing vigour.
UNIT VI: Genetic purity testing, objective and criteria for genetic purity testing, types of test, seedling and mature plant morphology, principles and procedures of chemical, biochemical and molecular tests.
UNIT VII: Seed health testing, field and seed standards , designated diseases, objectionable weeds - significance of seed borne disease vis-a-vis seed quality - seed health testing and detection methods for seed borne fungi, bacteria, viruses and nematodes, testing of GM seeds and trait purity, load of detection (LOD).
Practical: Structure of monocot and dicot seeds of important plant species; identification and handling of instruments used in seed testing laboratory; identification of seeds of weeds and crops; physical purity analysis of samples of different crops; estimation of seed moisture content (oven method) ; seed dormancy breaking methods requirements for conducting germination test, specifications and proper use of different substrata for germination; seed germination testing in different crops; seedling evaluation; viability testing by tetrazolium test(TZ) in different crops; seed and seedling vigour tests in various crops;
species & cultivar identification; genetic purity testing by chemical, biochemical and molecular methods;
seed health testing for designated diseases, blotter methods, agar method and embryo count methods;
testing coated/pelleted seeds.

SST 509 SEED PHYSIOLOGY 2+1

Theory

UNIT I: Chemical composition of seed and its significance in seed quality, synthesis and accumulation of food reserve, physiology of seed maturation, factors affecting seed germination, role of different organs of seed in germination, biochemical changes during germination, role of promoters and inhibitors, effect of age, size and position of seed on germination.
UNIT II: Seed dormancy-types, mechanism, endogenous and exogenous factors affecting dormancy, role of phytochrome, methods of breaking and inducing dormancy, seed vigour and its concept, factors affecting seed vigour, physiological and genetical basis of seed vigour, vigour tests, seed vigour and crop performance and yield, seed invigoration, seed viability and longevity, pre and post harvest factors affecting seed viability, loss of viability, physiology of seed ageing and viability theories, chemical composition and structural architecture of the bio-membranes and its impact on seed viability.
Practical: Proximate analysis of chemical composition of seed; germination metabolism; methods of breaking and inducing dormancy in various crop species; vigour tests; kinetics of imbibitions and leakages of solutes from hydrated seeds; volatile aldehyde test accelerated ageing tests; quantitative

tetrazolium test; activity of enzymes, respiratory rates; position; weight and size of seed in relation to germination.

SST 510 CULTIVAR PURITY AND QUALITY TESTING 0+1

Practical: Objectives of cultivar purity test; general principles and methods; use and limitations of laboratory; greenhouse and field plot methods; morphological characters of seed; seedling and adult plants of major crops; physiological; chemical and biochemical tests for varietal purity such as phenol and peroxidase; electrophoresis of protein and isozymes; DNA fingerprinting and their use in varietal registration and purity; use of computer based machine vision for varietal identification; DUS testing;
varietal purity testing by grow-out test in different cereals; pulses; oilseeds and vegetable crops of the state; study of diagnostic seed traits in different crops; electrophoresis in hybrid seeds and its comparison with GOT; use of other laboratory tests viz.; KOH-Bleach; $FeSO_{4;}$ fluroescence tests etc.

SST 511 EMERGING TRENDS IN SEED QUALITY ENHANCEMENT 2+1

Theory

UNIT I: Concept and significance of quality enhancement, seed treatments, history, principles and methods of seed treatment, seed treatment machinery, film coating, seed tapes, mats, pelleting, seed colouring, seed priming, priming agents, physical seed treatment.

UNIT II: Synthetic seeds- concept of synthetic seed, importance, historical development, somatic embryogenesis, embryo encapsulation systems, hardening of artificial seeds.

UNIT III: Cryopreservation, storage, desiccation tolerance, somaclonal variation and their control, use of botanicals in improving seed quality.

Practical: Seed treating equipments- slurry and mist-o-matic; film coating; priming- hydration and dehydration; study on the effect of priming; method for hydrogel encapsulation on artificial endosperms; hydrophobic coating.

SST 512/ PL PATH 510 SEED HEALTH TECHNOLOGY 2+1

Theory

UNIT I: History and economic importance of seed pathology in seed industry, plant quarantine and SPS under WTO, morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds.

UNIT II: Recent advances in the establishment and subsequent cause of disease development in seed and seedling, localization and mechanism of seed transmission in relation to seed infection, seed to plant transmission of pathogens.

UNIT III: Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds, evolutionary adaptations of crop plants to defend seed invasion by seed borne pathogens, epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection.

UNIT IV: Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing, methods for detecting microorganisms.

Practical: Conventional and advanced techniques in detection and identification of seed-borne fungi; bacteria and viruses; relationship between seed-borne infection and expression of the disease in the field.

SST 591 MASTER'S SEMINAR 1+0

SST 592 SPECIAL PROBLEM IN M.Sc. 0+1

SST 599 MASTER'S RESEARCH 0+20

SOIL SCIENCE

http://hillagric.ac.in/edu/coa/soilscience/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
SOILS 501*	SOIL PHYSICS	2+1	I
SOILS 502*	SOIL FERTILITY AND FERTILIZER USE	3+1	II
SOILS 503*	SOIL CHEMISTRY	2+1	I
SOILS 504*	SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY	2+1	I
SOILS 505	SOIL EROSION AND CONSERVATION	2+1	II
SOILS 506*	SOIL BIOLOGY AND BIOCHEMISTRY	2+1	I
SOILS 507	GEOMORPHOLOGY AND GEOCHEMISTRY	2+0	II
SOILS 508	RADIOISOTOPES IN SOIL AND PLANT STUDIES	1+1	I
SOILS 509	SOIL,WATER AND AIR POLLUTION	2+1	II
SOILS 510	REMOTE SENSING AND GIS TECHNIQUES FOR SOIL AND CROP STUDIES	2+1	II
SOILS 511	ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS	0+2	II
SOILS 512	SYSTEM APPROACHES IN SOIL AND CROP STUDIES	2+1	I
SOILS 513	MANAGEMENT OF PROBLEMATIC SOILS AND WATER	2+1	I
SOILS 514	FERTILIZER TECHNOLOGY	1+0	I
SOILS 515	LAND DEGRADATION AND RESTORATION	1+0	I
SOILS 591*	MASTER'S SEMINAR	1+0	I
SOILS 599	MASTER'S RESEARCH	0+20	I&II
SOILS 601	ADVANCES IN SOIL PHYSICS	2+0	II
SOILS 602	ADVANCES IN SOIL FERTILITY	2+0	II
SOILS 603	PHYSICAL CHEMISTRY OF SOILS	2+0	II
SOILS 604	SOIL GENESIS AND MICROPEDOLOGY	2+0	I
SOILS 605	BIOCHEMISTRY OF SOIL ORGANIC MATTER	2+0	I
SOILS 606	LAND USE PLANNING AND WATERSHED MANAGEMENT	2+0	II
SOILS 691	DOCTORAL SEMINAR I	1+0	I
SOILS 692	DOCTORAL SEMINAR II	1+0	II
SOILS 699	DOCTORAL RESEARCH	0+45	I&II

* Compulsory for Master's programme

SOIL SCIENCE

Course contents

SOILS 501 SOIL PHYSICS 2+1

Theory

UNIT I: Scope of soil physics and its relation with other branches of soil science, soil as a three phase system.

UNIT II : Soil texture, textural classes, mechanical analysis, specific surface.

UNIT III : Soil consistence, dispersion and workability of soils, soil compaction and consolidation, soil strength, swelling and shrinkage - basic concepts.

UNIT IV: Soil structure-genesis, types, characterization and management soil structure, soil aggregation, aggregate stability,soil tilth, characteristics of good soil tilth, soil crusting-mechanism, factors affecting and evaluation,soil conditioners, puddling,its effect on soil physical properties, clod formation.

UNIT V: Soil water,content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve, hysteresis, measurement of soil-moisture potential.

UNIT VI: Water flow in saturated and unsaturated soils, Poiseuille's law, Darcy's law, hydraulic conductivity, permeability and fluidity, hydraulic diffusivity, measurement of hydraulic conductivity in saturated and unsaturated soils.

UNIT VII: Infiltration, internal drainage and redistribution, evaporation, hydrologic cycle, field water balance, soil-plant-atmosphere continuum, hypotheses of soil water availability.

UNIT IX: Composition of soil air, renewal of soil air - convective flow and diffusion, measurement of soil aeration, aeration requirement for plant growth, soil air management.

UNIT X: Modes of energy transfer in soils, energy balance, thermal properties of soil, measurement of soil temperature, soil temperature in relation to plant growth, soil temperature management.

Practical: Mechanical analysis by international pipette method; measurement of Atterberg limits; aggregate analysis-dry and wet; measurement of soil-water content by different methods; measurement of soil-water potential by using tensiometer and gypsum blocks; determination of soil-moisture characteristics curve and computation of pore-size distribution, determination of hydraulic conductivity under saturated and unsaturated conditions;determination of infiltration rate of soil; determination of aeration porosity and oxygen diffusion rate;soil temperature measurements by different methods; estimation of water balance components in bare and cropped fields.

SOILS 502 SOIL FERTILITY AND FERTILIZER USE 3+1

Theory

UNIT I: Soil fertility and soil productivity, nutrient sources – fertilizers and manures, essential plant nutrients – functions and deficiency symptoms, laws of soil fertility.

UNIT II: Soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification, biological nitrogen fixation-types, mechanism, microorganisms and factors affecting, nitrogenous fertilizers and their fate in soils, management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency, leaf colour chart for N recommendations

UNIT III: Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils, factors affecting phosphorus availability in soils, phosphatic fertilizers - behavior in soils and management under field conditions.

UNIT IV: Potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions.

UNIT V: Sulphur - source, forms, fertilizers and their behavior in soils, calcium and magnesium– factors affecting their availability in soils, management of sulphur, calcium and magnesium fertilizers.

UNIT VI: Micronutrients – critical limits in soils and plants, factors affecting their availability and correction of their deficiencies in plants, role of chelates in nutrient availability.

UNIT VII: Common soil test methods for fertilizer recommendations, quantity intensity relationships, soil test crop response correlations and response functions.
UNIT VIII: Fertilizer use efficiency, blanket fertilizer recommendations – usefulness and limitations, site-specific nutrient management,plant need based nutrient management,integrated nutrient management.
UNIT IX: Soil fertility evaluation - biological methods, soil, plant and tissue tests, soil quality in relation to sustainable agriculture.
Practical: Principles of colorimetry; flame-photometry and atomic absorption spectroscopy; chemical analysis of soil for total and available nutrients; analysis of plants for essential elements.

SOILS 503 SOIL CHEMISTRY 2+1

Theory
UNIT I: Chemical (elemental) composition of the earth's crust.
UNIT II: Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.
UNIT III: Soil colloids, inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils, diffuse double layer theories of soil colloids, zeta potential, stability, electrometric properties of soil colloids, sorption properties of soil colloids, soil organic matter – characterization of organic matter, fractionation of soil organic matter and different fractions, clay-organic interactions.
UNIT IV: Ion exchange processes in soil, cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnan-membrane equilibrium concept, Different approaches to describe cation exchange equilibria, law of mass action and solubility product, factors affecting cation exchange equilibria in soils, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition.
UNIT V: Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption, precipitation-dissolution equilibria, management aspects.
UNIT VI: Chemistry of acid soils and their management, active and potential acidity, lime potential, sub-soil acidity.
UNIT VII: Chemistry of salt-affected soils and amendments, soil pH, ECe, ESP, SAR and important relations, soil management and amendments.
UNIT VIII: Chemistry and electrochemistry of submerged soils.
Practical: Determination of CEC and AEC of soils; analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH meter and conductivity meter; determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method; adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm; determination of titratable acidity of an acid soil by $BaCl_2$-TEA method, determination of lime requirement of an acid soil by buffer method; determination of gypsum requirement of an alkali soil.

SOILS 504 SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY 2+1

Theory
UNIT I: Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.
UNIT II: Classification, structure, chemical composition and properties of clay minerals, genesis and transformation of crystalline and non-crystalline clay minerals, identification techniques, amorphous soil constituents and other non-crystalline silicate minerals and their identification, clay minerals in Indian soils.
UNIT III: Factors of soil formation, soil formation models, soil forming processes, weathering of rocks and mineral transformations, soil profile, weathering sequences of minerals with special reference to Indian soils.

UNIT IV: Concept of soil individual, soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy, soil classification, soil mineralogy and soil maps–usefulness.
UNIT V: Soil survey and its types, soil survey techniques - conventional and modern, soil series – characterization and procedure for establishing soil series, benchmark soils and soil correlations, soil survey interpretations, soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.
UNIT VI: Landform – soil relationship, major soil groups of India with special reference to respective states, land capability classification and land irrigability classification, land evaluation and land use type (LUT) – concept and application, approaches for managing soils and landscapes in the framework of agro-ecosystem.
Practical: Identification and quantification of minerals in soil fractions; morphological properties of soil profile in different landforms; classification of soils using soil taxonomy; calculation of weathering indices and its application in soil formation; grouping soils using available data base in terms of soil quality; aerial photo and satellite data interpretation for soil and land use; cartographic techniques for preparation of base maps and thematic maps; processing of field sheets; compilation and obstruction of maps in different scales; land use planning exercises using conventional and RS tools.

SOILS 505 SOIL EROSION AND CONSERVATION 2+1

Theory

UNIT I: History, distribution, identification and description of soil erosion problems in India.
UNIT II: Forms of soil erosion, effects of soil erosion and factors affecting soil erosion, types and mechanisms of water erosion, raindrops and soil erosion, rainfall erosivity - estimation as EI30 index and kinetic energy, factors affecting water erosion, empirical and quantitative estimation of water erosion, methods of measurement and prediction of runoff, soil losses in relation to soil properties and precipitation.
UNIT III: Wind erosion- types, mechanism and factors affecting wind erosion, extent of problem in the country.
UNIT IV: Principles of erosion control, erosion control measures – agronomical and engineering, erosion control structures - their design and layout.
UNIT V: Soil conservation planning, land capability classification, soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands.
UNIT VI: Watershed management - concept, objectives and approach, water harvesting and recycling, flood control in watershed management, socioeconomic aspects of watershed management, case studies in respect to monitoring and evaluation of watersheds, use of remote sensing in assessment and planning of watersheds.
Practical: Determination of different soil erodibility indices - suspension percentage; dispersion ratio; erosion ratio; clay ratio; clay/moisture equivalent ratio; percolation ratio; raindrop erodibility index; computation of kinetic energy of falling rain drop; computation of rainfall erosivity index using rain gauge data; visits to a watershed.

SOILS 506 SOIL BIOLOGY AND BIOCHEMISTRY 2+1

Theory

UNIT I: Soil biota, soil microbial ecology, types of organisms in different soils, soil microbial biomass, microbial interactions, un-culturable soil biota.
UNIT II: Microbiology and biochemistry of root-soil interface, phyllosphere; soil enzymes, origin, activities and importance, soil characteristics influencing growth and activity of microflora.
UNIT III: Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil, biochemical composition and biodegradation of soil organic matter and crop residues, humus formation, cycles of important organic nutrients.

UNIT IV: Biodegradation of pesticides, organic wastes and their use for production of biogas and manures, biotic factors in soil development, microbial toxins in the soil.
UNIT V: Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost.
UNIT VI: Biofertilizers – definition, classification, specifications, method of production and role in crop production.
Practical: Determination of soil microbial population; soil microbial biomass; elemental composition; fractionation of organic matter and functional groups; decomposition of organic matter in soil; soil enzymes, measurement of important soil microbial processes such as ammonification; nitrification; N_2 fixation, S oxidation;P solubilization and mineralization of other micronutrients; study of rhizosphere effect.

SOILS 507 GEOMORPHOLOGY AND GEOCHEMISTRY 2+1

Theory

UNIT I: General introduction to geology and geochemistry, major and minor morphogenic and genetic landforms, study of schematic landforms and their elements with special reference to India.
UNIT II: Methodology of geomorphology, its agencies, erosion and weathering, soil and physiography relationships, erosion surface of soil landscape.
UNIT III: Geochemical classification of elements, geo-chemical aspects of weathering and migration of elements, geochemistry of major and micronutrients and trace elements.

SOILS 508 RADIOISOTOPES IN SOIL AND PLANT STUDIES 1+1

Theory

UNIT I: Atomic structure, radioactivity and units, radioisotopes - properties and decay principles, nature and properties of nuclear radiations, interaction of nuclear radiations with matter.
UNIT II: Principles and use of radiation monitoring instruments - proportional, Geiger Muller counter, solid and liquid scintillation counters, neutron moisture meter, mass spectrometry, auto radiography.
UNIT III: Isotopic dilution techniques used in soil and plant research, use of stable isotopes, application of isotopes in studies on organic matter, nutrient transformations, ion transport, rooting pattern and fertilizer use efficiency, carbon dating.
UNIT IV: Doses of radiation exposure, radiation safety aspects regulatory aspects, collection, storage and disposal of radioactive wastes
Practical: Storage and handling of radioactive materials; determination of half life and decay constant; preparation of soil and plant samples for radioactive measurements; setting up of experiment on fertilizer use efficiency and cation exchange equilibria using radioisotopes; determination of A, E and L values of soil using $^{32}P/^{65}Zn$, use of neutron probe for moisture determination; sample preparation and measurement of ^{15}N enrichment by mass spectrophotometery/emission spectrometry.

SOILS 509 SOIL, WATER AND AIR POLLUTION 2+1

Theory

UNIT I: Soil, water and air pollution problems associated with agriculture, nature and extent.
UNIT II: Nature and sources of pollutants – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc., air, water and soil pollutants - their CPC standards and effect on plants, animals and human beings.
UNIT III: Sewage and industrial effluents – their composition and effect on soil properties/health, and plant growth and human beings, soil as sink for waste disposal.
UNIT IV: Pesticides – their classification, behavior in soil and effect on soil microorganisms.
UNIT V: Toxic elements – their sources, behavior in soils, effect on nutrients availability, effect on plant and human health.

UNIT VI: Pollution of water resources due to leaching of nutrients and pesticides from soil, emission of greenhouse gases – carbon dioxide, methane and nitrous oxide.
UNIT VIII: Remediation/amelioration of contaminated soil and water, remote sensing applications in monitoring and management of soil and water pollution.
Practical: Sampling of sewage waters; sewage sludge; solid/liquid industrial wastes; polluted soils and plants; estimation of dissolved and suspended solids; chemical oxygen demand (COD); biological oxygen demand (BOD); nitrate and ammonical nitrogen and phosphorus; heavy metal content in effluents; heavy metals in contaminated soils and plants.

SOILS 510 REMOTE SENSING AND GIS TECHNIQUES FOR SOIL, WATER AND CROP STUDIES 2+1

Theory
UNIT I: Introduction and history of remote sensing, sources, propagation of radiations in atmosphere, interactions with matter.
UNIT II: Sensor systems - camera, microwave radiometers and scanners, fundamentals of aerial photographs and image processing and interpretations.
UNIT III: Application of remote sensing techniques - land use soil surveys, crop stress and yield forecasting, prioritization in watershed and drought management, wasteland identification and management.
UNIT IV: Significance and sources of the spatial and temporal variability in soils, variability in relation to size of sampling, classical and geo-statistical techniques of evaluation of soil variability.
UNIT V: Introduction to GIS and its application for spatial and non-spatial soil and land attributes.
Practical: Familiarization with different remote sensing equipments and data products; interpretation of aerial photographs and satellite data for mapping of land resources; analysis of variability of different soil properties with classical and geostatistical technique; creation of data files in a database program; use of GIS for soil spatial simulation and analysis; to enable the students to conduct soil survey and interpret soil survey reports in terms of land use planning.

SOILS 511 ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS 0+2

Practical
UNIT I: Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation-reduction and complexometric titration, soil, water and plant sampling techniques, their processing and handling.
UNIT II: Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium, estimation of phosphorus, ammonium and potassium fixation capacities of soils.
UNIT III: Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry, chromatographic techniques, mass spectrometry and X-ray defractrometery, identification of minerals by X-ray by different methods.
UNIT IV: Electrochemical titration of clays, determination of cation and anion exchange capacities of soils, estimation of exchangeable cations (Na, Ca, Mg, K), estimation of root cation exchange capacity.

SOILS 512 SYSTEM APPROACHES IN SOIL AND CROP STUDIES 2+1

Theory
UNIT I: Systems concepts - definitions, general characteristics, general systems theory, systems thinking, systems dynamics, systems behavior and systems study.
UNIT II: Model, definition and types-empirical and mechanistic, mathematical models and their types, modeling, concepts, objectives, processes, simulation models, their verification and validation, calibration, representation of continuous systems simulation models - procedural
UNIT III: Simulation - meaning and threats, simulation experiment, its design and analysis.

UNIT IV: Application of simulation models in understanding system behavior, optimizing system performance, evaluation of policy options under different soil, water, nutrient, climatic and cultural conditions, decision support system, use of simulation models in decision support system.

Practical: Use of flow chart in the program writing; writing a small example simulation model program; conducting simulation experiments in DSSAT; conducting simulation experiments in WOFOST; conducting simulation experiments in EPIC with requirement of report and conclusion; computation of fertilizer equations using STCR Model.

SOILS 513 MANAGEMENT OF PROBLEMATIC SOILS AND WATERS 2+1

Theory

UNIT I: Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils, origin and basic concept of problematic soils, and factors responsible.

UNIT II: Morphological features of saline, sodic and saline-sodic soils, characterization of salt-affected soils - soluble salts, ESP, pH, physical, chemical and microbiological properties.

UNIT III: Management of salt-affected soils, salt tolerance of crops-mechanism and ratings, monitoring of soil salinity in the field, management principles for sandy, clayey, red lateritic and dry land soils.

UNIT IV: Acid soils - nature of soil acidity, sources of soil acidity, effect on plant growth, lime requirement of acid soils, management of acid soils, biological sickness of soils and its management, Acid sulphate soils and their management, calcareous soils-problems and management and waterlogged soils-problems and management.

UNIT V: Quality of irrigation water, management of brackish water for irrigation, salt balance under irrigation, characterization of brackish waters, area and extent, relationship in water use and quality.

UNIT VI: Agronomic practices in relation to problematic soils, cropping pattern for utilizing poor quality ground waters.

Practical: Characterization of acid; acid sulfate; salt-affected and calcareous soils; determination of cations (Na^+, K^+, Ca^{++} and Mg^{++}) in ground water and soil samples; determination of anions (Cl^-, SO_4^{--}, $CO_3^{--}$and HCO_3^-) in ground waters and soil samples; lime and gypsum requirements of acid and sodic soils.

SOILS 514 FERTILIZER TECHNOLOGY 1+0

Theory

UNIT I: Fertilizers – production, consumption and future projections with regard to nutrient use in the country and respective states, fertilizer control order.

UNIT II: Manufacturing processes for different fertilizers using various raw materials, characteristics and nutrient contents.

UNIT III: Recent developments in secondary and micronutrient fertilizers and their quality control as per fertilizer control order.

UNIT IV: New and emerging issues in fertilizer technology – production and use of slow and controlled release fertilizers, supergranules fertilizers and fertilizers for specific crops/situations, fortified and customized fertilizers.

SOILS 515 LAND DEGRADATION AND RESTORATION 1+0

Theory

UNIT I: Type, factors and processes of soil/land degradation and its impact on soil productivity, including soil fauna, biodegradation and environment.

UNIT II: Land restoration and conservation techniques - erosion control, reclamation of salt-affected soils, mine land reclamation, afforestation, organic products.

UNIT III: Extent, diagnosis and mapping of land degradation by conventional and modern RS-GIS tools, monitoring land degradation by fast assessment, modern tools, land use policy, incentives and

participatory approach for reversing land degradation, global issues for twenty first century, USLE equation and its importance

SOILS 591 MASTER'S SEMINAR 1+0
SOILS 599 MASTER'S RESEARCH 0+20

SOILS 601 ADVANCES IN SOIL PHYSICS 2+0

Theory

UNIT I: Soil-water interactions, soil water potential, free energy and thermodynamic basis of potential concept, chemical potential of soil water and entropy of the system.

UNIT II: Fundamentals of fluid flow, Poiseuilles law, Laplace's equation, Darcy's law in saturated and unsaturated flows, development of differential equations in saturated and unsaturated water flow, capillary conductivity and diffusivity, limitations of Darcy's law, numerical solution for one dimensional water flow.

UNIT III: Theories of horizontal and vertical infiltration under different boundary conditions.

UNIT IV: Movement of salts in soils, models for miscible-immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations, break-through curves.

UNIT V: Soil air and aeration, mass flow and diffusion processes, thermal properties of soil, heat transfer in soils, differential equation of heat flow, measurement of thermal conductivity of soil.

UNIT VI: Soil crust and clod formation, structural management of puddled rice soils, soil conditioning concept, soil conditioners - types, characteristics, working principles, significance in agriculture.

UNIT VII: Solar and terrestrial radiation measurement, dissipation and distribution in soil-crop systems, prediction of evapotranspiration using aerodynamic and canopy temperature-based models, canopy temperature and leaf diffusion resistance in relation to plant water deficit, evaluation of soil and plant water status using infra-red thermometer, determination of plant water- RLWC & XWP.

SOILS 602 ADVANCES IN SOIL FERTILITY 2+0

Theory

UNIT I: Modern concepts of nutrient availability, soil solution and plant growth, nutrient response functions and availability indices.

UNIT II: Nutrient movement in soils, nutrient absorption by plants, mechanistic approach to nutrient supply and uptake by plants, transformation and movement of major micronutrients in soils.

UNIT III: Chemical equilibria (including solid-solution equilbria) involving nutrient ions in soils, particularly in submerged soils.

UNIT IV: Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.

UNIT V: Modern concepts in fertilizer application, soil fertility evaluation techniques, role of soil testing in fertilizer use recommendations, site-specific nutrient management for precision agriculture, STCR approach.

UNIT VI: Monitoring physical, chemical and biological changes in soils, permanent manurial trials and long-term fertilizer experiments, soil productivity under long-term intensive cropping, direct, residual and cumulative effect of fertilizer use.

SOILS 603 PHYSICAL CHEMISTRY OF SOILS 2+0

Theory

UNIT I: Colloidal chemistry of inorganic and organic components of soils – their formation, clay organic interaction.

UNIT II: Predictive approaches for cation exchange equilibria-thermodynamics, empirical and diffuse double layer theory (DDL) - relationships among different selectivity coefficients, structure and properties of diffuse double layer.

UNIT III: Thermodynamics of nutrient transformations in soils, cationic and anionic exchange and their models, molecular interaction, chemical potential of cations and anions in soil system, ion uptake by plants- different theories.
UNIT IV: Adsorption/desorption isotherms - Langmuir adsorption isotherm, Freundlich adsorption isotherm, normalized exchange isotherm, BET equation; selective and non-selective adsorption of ions on inorganic surfaces and organic surfaces of soil materials (citation of utility in agricultural system).
UNIT V: Common solubility equilibria - carbonates, iron oxide and hydroxides, aluminum silicate, aluminum phosphate, electrochemical properties of clays (citation of examples from agricultural use).

SOILS 604 SOIL GENESIS AND MICROPEDOLOGY 2+0

Theory

UNIT I: Pedogenic evolution of soils, soil composition and characterization.
UNIT II: Weathering and soil formation – factors and pedogenic processes, stability and weathering sequences of minerals.
UNIT III: Assessment of soil profile development by mineralogical and chemical analysis.
UNIT IV: Micro-pedological features of soils – their structure, fabric analysis, role in genesis and classification.

SOILS 605 BIOCHEMISTRY OF SOIL ORGANIC MATTER 2+0

Theory

UNIT I: Organic matter pools in soil and its functions, composition and distribution of organic matter in soil and its functions, environmental significance of humic substances; decomposition of organic residues in soil in relation to organic matter pools.
UNIT II: Biochemistry of the humus formation, different pathways for humus synthesis in soil, soil carbohydrates and lipids, polysaccrhides, lipids, vitamins, enzymes, antibiotics, hormones etc.
UNIT III: Nutrient transformation – N, P, S, C, trace metal interaction with humic substances, significance of chelation reactions in soils.
UNIT IV: Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes, clay-organic matter complexes.
UNIT V: Humus - pesticide interactions in soil, mechanisms.

SOILS 606 LAND USE PLANNING AND WATERSHED MANAGEMENT 2+0

Theory

UNIT I: Concept and techniques of land use planning, factors governing present land use.
UNIT II: Land evaluation methods and soil-site suitability evaluation for different crops, land capability classification and constraints in application.
UNIT III: Agro-ecological regions/sub-regions of India and their characteristics in relation to crop production.
UNIT IV: Water harvesting - concept, significance, types, methodology, use of harvested water in agriculture to increase water productivity.
UNIT V: Watershed development/management - concept, objectives, characterization, planning, execution, community participation and evaluation, rehabilitation of watershed, PRA, developing economically and ecologically sustainable agro-forestry systems for watershed, case studies.

SOILS 691 DOCTORAL SEMINAR I 1+0
SOILS 692 DOCTORAL SEMINAR II 1+0
SOILS 699 DOCTORAL RESEARCH 0+45

TEA HUSBANDRY AND AGROFORESTRY

http://hillagric.ac.in/edu/coa/tea/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
THT 501*	BOTANICAL CLASSIFICATION OF TEA	1+1	I
THT 502	TEA BREEDING	2+1	I
THT 503	CLIMATE AND SOIL FOR TEA PRODUCTION	2+1	II
THT-504	TEA PROPAGATION AND NURSERY MANAGEMENT	1+1	I
THT 505 *	LAND PLANNING AND YOUNG PLANTATION MANAGEMENT	2+1	I
THT 506 *	MANAGEMENT OF MATURE TEA PLANTATIONS	2+0	II
THT 507*	INTEGRATED NUTRIENT MANAGEMENT IN TEA PLANTATIONS	2+1	II
THT 508	TEA PHYSIOLOGY	1+1	II
THT 509	INTEGRATED TEA DISEASES AND INSECT PEST MANAGEMENT	2+1	I
THT 510	CHEMISTRY AND PHARMACOLOGY OF TEA	2+1	I
THT 511*	TEA PROCESSING TECHNOLOGY	1+2	II
THT 512	QUALITY STANDARDS, LEGISLATION AND WORLD TEA TRADE	2+0	II
THT 591	MASTER'S SEMINAR	1+0	I&II
THT 592	SPECIAL PROBLEM IN M.Sc.	0+1	I&II
THT 600	MASTER'S RESEARCH	1-18	I&II

TEA HUSBANDRY AND AGROFORESTRY

Course contents

THT 501 BOTANICAL CLASSIFICATION OF TEA 1+1

Theory

UNIT I: Origin, taxonomy and classification of tea, morphological, anatomical and chemical basis of classification, genetics of quantitative and qualitative traits.

UNIT II: History and methods of tea breeding, selection criteria yield and quality, selection of vegetative clones, cross breeding, breeding of seed varieties, tissue culture in tea.

UNIT III: Preservation of tea germplasm and registration of tea cultivars.

Practical: morphological and anatomical characteristics to differentiate between tea clones/ varieties; emasculation and pollination in tea; selection criteria in the fields; seed collection; classification and grading; acquaintance with the existing breeding materials.

THT 502 TEA BREEDING 2+1

Theory

UNIT I: History of tea breeding and cytogenetics, cytology, objectives and methods of tea breeding, seed versus clones, selection criteria for yield and quality.

UNIT II: Vegetative propagation, development of clones and seed varieties, genetics and quantitative and qualitative traits, interspecific hybridization, non-conventional breeding techniques.

UNIT III: Preservation of tea germplasm and registration of tea cultivars.

Practical: Emasculation and pollination in tea; selection criteria in the field, seed selection; classification and grading; acquaintance with the existing breeding material; differentiation of tea varieties using morphological markers.

THT 503 CLIMATE AND SOIL FOR TEA PRODUCTION 2+1

Theory

UNIT I: Principles of ecology in relation to crop pattern and ecological conditions, physical and soil factors in distribution of tea areas.

UNIT II: Climate wise classification of tea growing areas, physical and chemical properties of tea soils, causes and effects of soil erosion, methods of soil conservation, physical and biological conservation measures.

UNIT III: Role of tea crop in soil conservation soils of major tea growing areas, water management, conservation and disposal, influence of climate and soil factors on growth, development, dormancy and productivity of tea; economic aspects.

Practical : Study of climatic factors on the growth behavior and crop distribution; soil types, moisture availability and root distribution of different cultivars; study of mulching materials and technology of mulching; special management practices relevant to the prevailing climatic and soil conditions.

THT 504 TEA PROPAGATION AND NURSERY MANAGEMENT 1+1

Theory

UNIT I: Methods of tea propagation, propagation by seed berries, flowering and fruit setting, seed collection, seed size and its significance, grading, sorting and packaging of seeds, seed nursery.

UNIT II: Propagation by cuttings, source of cuttings, nature of cuttings, use of hormones for rooting of cuttings; grafting and budding techniques; stock-scion relationship.

UNIT III: Nursery management, manuring, control of diseases and pests, weed control, shade regulation of nursery and irrigation.

Practical: Collection of tea seeds; sorting and grading; viability test, storage and packaging; nursery bed preparations; polythene sleeves filling; seed sowing; shade management; watering, manuring and raising tea nursery; use of growth regulators; planting cutting to polythene sleeves and maintenance of humidity.

THT-505 LAND PLANNING AND YOUNG TEA MANAGEMENT 2+1

Theory

UNIT I: Land characteristics for tea planting, land preparation for planting.

UNIT II: Planting of shade trees and their management, catchment planning, terracing, uprooting and rehabilitation

UNIT III: Layout, spacing, pits and trenches for tea planting; planting material, planting techniques; management of young tea, mulching, manuring, weed control, irrigation and drainage; pest-diseases and their control.

Practical : Study of different layout plans; techniques of planting; methods of brining up of young tea; suitable shade species for tea; prevalent pest-diseases of tea and the control measures.

THT 506 MANAGEMENT OF MATURE TEA PLANTATIONS 2+0

Theory

UNIT I: Tea pruning; objectives, balance of growth and carbohydrate economy, time of pruning, type of pruning, vs. quality.

UNIT II:Physiology of pruning, pruning cycles adopted in important tea growing countries and impact on yield and quality.

UNIT III: Rejuvenation pruning, infilling, interplanting; tipping and plucking; role of maintenance foliage; time and height of plucking, plucking of unpruned tea.

UNIT IV: Plucking standards, plucking systems and plucking rounds; mechanical plucking – problems and prospects

UNIT V: Weeds in tea estates and their control, important shade species in tea plantations and their management.

Practical: Study on different types of pruning, growth under different pruning cycles and crop distribution under different pruning cycles; study on plucking systems and standards; growth and yield of tea under different kinds of shade species; collection; identification and study of important weed species in tea estates;weed management in tea plantations.

THT 507 INTEGRATED NUTRIENT MANAGEMENT IN TEA PLANTATIONS 2+1

Theory

UNIT I: Soil fertility, basic principles of manuring; foliar analysis as a diagnostic tool.

UNIT II: Mineral composition, nutrient up take and removal, effects of individual nutrients, mineral deficiency and excess, interaction with other nutrients.

UNIT III: Organic fertilizers, mulch materials etc., practical fertilization, mineral fertilizers in common use, profitable fertigation; frequency, method and time of fertilizer application, effect of cessation/ reduction on crop productivity; nutrient-shade interactions.

UNIT IV: Effect of fertilizers on tea quality.

Practical: Field identification of deficiencies and toxic symptoms; leaf sampling techniques; preparation of leaf samples and determination of macro and micronutrients; compost preparation and analysis; soil and foliar application of fertilizers; qualitative analysis of tea products.

THT 508 TEA PHYSIOLOGY 1+1

Theory

UNIT I: Tea crop development and components of yield; pattern of shoot development, size of harvested shoot, size of developing shoot population within plucking table.

UNIT II: Dormancy in tea shoots; rhythmic growth in unpruned tea; dormancy cycle in harvested tea.

UNIT III: Relationship between physiology and yield; photorespiration and dark respiration; effect of day length on shoot growth; effect of air temperature, soil temperature and dry air on shoot growth.

Practical: Experiment pertaining to the photosynthesis, respiration, growth hormones, seed germination, dormancy; viability and movement of metabolites in tea plants.

THT 509 INTEGRATED TEA DISEASES AND INSECT PEST MANAGEMENT 2+1

Theory

UNIT I: Occurrence and distribution of insect–pest, and diseases of tea.

UNIT II: Biology and nature of damage caused by major insect pests, diseases of tea- biotic and abiotic, biotic - foliar, stem and root diseases.

UNIT III: Physical and chemical stresses; integrated tea pest and disease management through different approaches like cultural practices, use of chemicals, host resistance and biological control.

Practical: Identification of insect-pests and diseases of tea; monitoring techniques involved in integrated tea diseases and insect-pests management.

THT 510 CHEMISTRY AND PHARMACOLOGY OF TEA 2+1

Theory

UNIT I: Chemical composition of tea leaf; inorganic constituents, nitrogen compounds, carbohydrate and other associated compounds, enzymes, polyphenols, aromatic compounds vitamins, chlorophyll, carotenoides and volatile compounds.

UNIT II: Biochemical changes during withering, rolling, fermentation and firing, biochemical basis of quality and pharmaceutical aspects of tea.

Practical: Estimation of chemical constituents of tea leaf and made tea; preparation of tea samples from different experiments and their chemical analysis in the laboratory; evaluation of quality from the tea tasters.

THT 511 TEA PROCESSING TECHNOLOGY 1+2

Theory

UNIT I: Handling and treatment of tea leaf from field to factory, production of black tea, principle stages of processing, withering, rolling, fermentation, drying, sorting and fibre removal, grading and packing.

UNIT II: Green and semi-fermented teas, introduction to green tea production of steamed, unshaded green tea, production of pan-fired green tea (chinese green tea), characters of green tea and semi fermented tea (Oolong tea), specialty and herbal tea, instant tea and organic tea.

Practical: General layout plan of tea factory; estimation of moisture content in green leaf; estimation of withering percentage, methods of withering, rolling, fermentation and drying; study on processing of black tea, different types of green tea, herbal tea, instant tea and organic tea; grading, sorting, packing and storage of tea product in commercial tea factory.

THT 512 QUALITY STANDARDS, LEGISLATION AND WORLD TEA TRADE 2+0

Theory

UNIT I : Impurities- adulteration of tea, adventitious impurities, standards- international standards issued by international organization for standardization, standards issued by other authorities, legislation and international tea export, laws etc., history of world tea trade, international tea committee, price and auction.

THT 591	**MASTER'S SEMINAR**	**1+0**
THT 592	**SPECIAL PROBLEM IN M.Sc.**	**0+1**
THT 600	**MASTER'S RESEARCH1**	**0+18**

VEGETABLE SCIENCE AND FLORICULTURE

http://hillagric.ac.in/edu/coa/vegetables/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
VSC 501*	PRINCIPLES OF VEGETABLE PRODUCTION	2+1	I
VSC 502*	PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS	2+1	I
VSC 503*	PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS	2+1	II
VSC 504*	PRINCIPLES OF BREEDING VEGETABLE AND SPICE CROPS	2+1	I
VSC 505	BREEDING OF SELF, OFTEN AND CROSS POLLINATED VEGETABLE AND SPICE CROPS	2+1	II
VSC 506*	SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS	2+1	I
VSC 507	SYSTEMATICS OF VEGETABLE CROPS	1+1	I
VSC 508	PRODUCTION TECHNOLOGY OF UNDEREXPLOITED VEGETABLE CROPS	2+1	II
VSC 509	ORGANIC VEGETABLE PRODUCTION TECHNOLOGY	1+1	I
VSC 591*	MASTER'S SEMINAR	1+0	I&II
VSC 592	SPECIAL PROBLEM IN M.Sc.	0+1	I&II
VSC 599*	MASTER'S RESEARCH	0+20	I&II
VSC 601**	ADVANCES IN VEGETABLE PRODUCTION	2+1	II
VSC 602**	ADVANCES IN BREEDING OF VEGETABLE CROPS	2+1	II
VSC 603**	PROTECTED CULTIVATION OF VEGETABLE CROPS	1+1	I
VSC 604**	ADVANCES IN VEGETABLE SEED PRODUCTION	2+1	II
VSC 605	ABIOTIC STRESS MANAGEMENT IN VEGETABLE CROPS	2+1	II
VSC 606**	BIOTECHNOLOGY IN VEGETABLE CROPS	2+1	I
VSC 691**	DOCTORAL SEMINAR I	1+0	I&II
VSC 692	DOCTORAL SEMINAR II	1+0	I&II
VSC 693	SPECIAL PROBLEM IN Ph.D.	0+1	I&II
VSC 699**	DOCTORAL RESEARCH	0+45	I&II

* Compulsory for Master's programme **Compulsory for Doctoral programme

VEGETABLE SCIENCE

Course contents

VSC 501 PRINCIPLES OF VEGETABLE PRODUCTION 2+1

Theory

UNIT I**:** Introduction, economic and nutritive value of vegetable and spice crops, production and productivity in India, classification of vegetables and spices, tropical and temperate vegetables.

UNIT II: Effect of temperature, photoperiod, light and relative humidity on production.

UNIT III: Nutrients essential for plant growth and development, chemical and biofertilizers, irrigation and water requirements.

UNIT IV: Crop rotation, crop succession, inter and mixed cropping, weed control, mulching and role of plant growth substances.

UNIT V: Management of diseases, insects and nematodes.

UNIT VI: Harvesting, handling, grading, packing, transport, storage and marketing of vegetable produce and vegetable processing.

UNIT VII: Organic farming, protected cultivation and export of vegetable produce.

Practical: Identification of vegetable crops; important diseases and insect-pests; exposure to various operations related to vegetable cultivation in open field; net houses and polyhouses; visit to commercial storage and protected cultivation farms.

VSC 502 PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS 2+1

Theory: Introduction, origin, evolution, taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, and harvesting, post-harvest management and plant protection measures:

UNIT I: Potato

UNIT II: Cole crops: cabbage, cauliflower, knol-khol, broccoli,

UNIT III: Root crops: carrot, radish, turnip and beetroot

UNIT IV: Bulb crops: onion and garlic

UNIT V: Peas and broad bean, green leafy (Spinach, spinach beet, fenugreek) cool season vegetables

UNIT VI: Salad and perennial vegetables: Lettuce and Asparagus

Practical: Cultural operations (sowing/transplanting; fertilizer application mulching; irrigation; weed control) of winter vegetable crops and their economics; experiments to demonstrate the role of mineral elements; plant growth substances and herbicides; study of physiological disorders; important insect-pest and diseases and their control; preparation of cropping scheme for commercial farms; visit to commercial greenhouses/ polyhouses.

VSC 503 PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS 2+1

Theory: Introduction, origin, evolution and taxonomy, climatic and soil requirements, commercial varieties/ hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management and plant protection measures:

UNIT I: Tomato, eggplant, hot and sweet peppers

UNIT II: Okra, beans, cowpea and cluster bean

UNIT III: Cucurbitaceous crops

UNIT IV: Tapioca and sweet potato

UNIT V: Green leafy warm season vegetables: Amaranth, Portulaca and Indian spinach

UNIT VI: Spice and other root crops: Ginger, turmeric, tapioca, colocasia and elephant foot yam

Practical : Cultural operations (sowing/transplanting; fertilizer application; mulching; irrigation; weed control) of summer vegetable crops and their economics; study of physiological disorders and deficiency of mineral elements; preparation of cropping schemes for commercial farms; experiments to demonstrate the role of mineral elements; physiological disorders; plant growth substances and herbicides; identification of important pests and diseases and their control; visit to commercial poly houses and net houses.

VSC 504 PRINCIPLES OF BREEDING VEGETABLE AND SPICE CROPS 2+1

Theory

UNIT I: Importance and objectives of vegetable breeding, history of vegetable crop improvement with a special reference to India

UNIT II: Sources of genetic variability, centres of origin and breeding systems

UNIT III: Breeding methods, heterosis breeding and resistance breeding

UNIT IV: Male sterility, self-incompatibility, concepts of qualitative and quantitative characters, induced mutations and polyploidy

UNIT V: Host-parasite relationship, mechanisms of resistance and sources of resistance

UNIT VI: Biotechnological approaches for genetic improvement, varietal evaluation, release and notification procedures in India

Practical: Study of floral biology and breeding systems; emasculation and pollination procedures; hybrid seed production methods in vegetable crops; use of chi-square, working out genetic variability and hybrid vigour from recorded data.

VSC 505 BREEDING OF SELF, OFTEN AND CROSS POLLINATED VEGETABLE AND SPICE CROPS 2+1

Theory: Origin, distribution, cytogenetics, genetics, breeding objectives, breeding methods used for the improvement of self, often and cross pollinated vegetable crops viz.,

UNIT I: Tomato, brinjal, capsicum,

UNIT II: Garden pea, French bean, Dolichos bean, cow pea, cluster bean

UNIT III: Okra and broad bean

UNIT IV: Cole crops

UNIT V: Cucurbits

UNIT VI: Bulb crops

UNIT VII: Root vegetables,

UNIT VIII: Lettuce and leafy vegetables

UNIT IX: Spices viz., black pepper, cardamom, nut mug, cinnamon, clove, allspice, garcinia, vanilla, cumin, fennel, coriander and fenugreek.

Practical: Practices in emasculation and cross pollination; procedures for maintenance of genetic stocks; selection in segregating population of vegetable and spice crops; maintenance of male sterile and self-incompatible lines; estimation of heterosis; combining ability and gene action for line × tester and diallel crosses and generation means.

VSC 506 SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS 2+1

Theory

UNIT I: Definition of seed and its quality, history, importance and present status of vegetable seed industry in India and world.

UNIT II: Genetical and agronomical principles of seed production, methods of seed production, use of growth regulators and chemicals in vegetable seed production, floral biology, pollination, breeding behaviour, seed development and maturation, methods of hybrid seed production.

UNIT III: Categories of seed, production and maintenance of nucleus, foundation and certified seed, seed certification and seed standards, plant quarantine and quality control.
UNIT IV: Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology, seed laws, IPR and WTO.
UNIT V: Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra, vegetatively propagated vegetables.
Practical: Seed sampling; seed testing (genetic purity; seed viability; seed vigour; physical purity) and evaluation; release and notification procedures of varieties in India; floral biology; practices in rouging; methods of hybrid seed production in important vegetable crops; seed extraction techniques; handling of seed processing and seed testing equipments; testing of vegetable seeds for seed purity; germination; vigour and health; visit to seed processing units; seed testing laboratory and seed production farms.

VSC 507 SYSTEMATICS OF VEGETABLE CROPS 1+1

Theory

UNIT I: Principles of classification, different methods of classification, salient features of international code of nomenclature of vegetable crops.
UNIT II: Origin, history, evolution and distribution of vegetable crops, botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables.
UNIT III: Cytological level of various vegetable crops, descriptive keys for important vegetables.
UNIT IV: Importance of molecular markers in evolution of vegetable crops; molecular markers as an aid in characterization and taxonomy of vegetable crops.
Practical: Identification; description; classification and maintenance of vegetable species and varieties; survey; collection of allied species and genera locally available; preparation of keys to the species and varieties; methods of preparation of herbarium and specimens.

VSC 508 PRODUCTION TECHNOLOGY OF UNDEREXPLOITED VEGETABLE CROPS 2+1

Theory: Introduction, origin and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed production of:
UNIT I: Asparagus, artichoke and leek
UNIT II: Brussels' sprout, Chinese cabbage, broccoli, kale and artichoke.
UNIT III: Amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinach, basella, bathu (chenopods) and chekurmanis.
UNIT IV: Elephant foot yam, lima bean, winged bean, vegetable pigeon pea, jack bean and sword bean.
UNIT V: Sweet gourd, spine gourd, pointed gourd, Oriental pickling melon and little gourd (kundru).
Practical: Identification of seeds; botanical description of plants; layout and planting; cultural practices; short-term experiments of underexploited vegetables.

VSC 509 ORGANIC VEGETABLE PRODUCTION TECHNOLOGY 1+1

Theory

UNIT I: Importance, principles, perspective, concept and component of organic production of vegetable crops.
UNIT II: Organic production of vegetables crops, *viz.*, solanaceous crops, cucurbits, cole crops, root and tuber crops.
UNIT III: Managing soil fertility, pests and diseases and weed problems in organic farming system; crop rotation in organic horticulture; processing and quality control for organic foods.

UNIT IV: Methods for enhancing soil fertility, mulching, raising green manure crops, indigenous methods of compost, *Panchagavvya*, biodynamics, preparation etc., pest and disease management in organic farming, ITK's in organic farming, role of botanicals and bio-control agents.
UNIT V: GAP and GMP- Certification of organic products; organic production and export - opportunity and challenges.
Practical: Method of preparation of compost; vermicomposting; biofertilizers; soil solarization; bio pesticides in horticulture; green manuring, mycorrhizae and organic crop production; waster anagement; organic soil amendment for root disease; weed management in organic horticulture; visit to organic fields and marketing centers.

VSC 591 MASTER'S SEMINAR 1+0
VSC 592 SPECIAL PROBLEM IN M.Sc. 0+1
VSC 599 MASTER'S RESEARCH 0+20

VSC 601 ADVANCES IN VEGETABLE PRODUCTION 2+1
Theory: Present status and prospects of vegetable cultivation, organic gardening, emerging trends in biofertilizers use, protected cultivation (polyhouse and net house production), precision farming and current problems associated with production and post harvest handling and marketing of:
UNIT I: Tomato, brinjal, chilli, sweet pepper and potato
UNIT II: Cucurbits, cabbage, cauliflower and knol-khol
UNIT III: Okra, onion, peas and beans, *Amaranthus* and drumstick
UNIT IV: Carrot, beet root and radish
UNIT V: Sweet potato, tapioca, elephant foot yam and taro
Practical: Familiarization with operations related to organic and protected cultivation and precision farming; visit to commercial farms of vegetables under protected environments; vegetable and fruit mals and packaging houses.

VSC 602 ADVANCES IN BREEDING OF VEGETABLE CROPS 2+1
Theory: Genetic, biochemical and physiological basis of heterosis, interspecific and intergeneric hybridization, *in vitro* techniques in vegetable crop improvement, breeding for disease and insect-pest resistance and abiotic stress tolerance of:
UNIT I: Tomato, brinjal, chilli, sweet pepper and potato
UNIT II: Cucurbits, Cabbage, cauliflower and knol-khol
UNIT III: Okra, onion, peas and beans, *Amaranthus* and drumstick
UNIT IV: Carrot, beet root, radish and turnip
UNIT V: Sweet potato, tapioca, elephant foot yam and taro
Practical : Designing of breeding experiments; screening techniques for abiotic stresses; screening and rating for diseases and insect-pests and nematode resistance; estimation of heterosis and combining ability; distant hybridization and embryo rescue techniques.

VSC 603 PROTECTED CULTIVATION OF VEGETABLE CROPS 1+1
Theory: Crops - Tomato, capsicum, cucumber, melons and lettuce
UNIT I: Importance and scope of protected cultivation of vegetable crops, principles used in protected cultivation, energy management, low cost structures; training methods; engineering aspects.
UNIT II: Regulatory structures used in protected structures, types of greenhouses/polyhouses/nethouses, hot beds, cold frames, effect of environmental factors, *viz.* temperature, light, CO_2 and humidity on growth of different vegetables, manipulation of CO_2, light and temperature for vegetable production, fertigation.

UNIT III: Nursery raising in protected structures like poly-tunnels, types of benches and containers, different media for growing nursery under cover.
UNIT IV: Regulation of flowering and fruiting in vegetable crops, technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, training and staking in protected crops, varieties and hybrids for growing vegetables in protected structures.
UNIT V: Problem of growing vegetables in protected structures and their remedies, insect and disease management in protected structures; soil-less culture, use of protected structures for seed production.
Practical: Study of various types of structures; methods to control temperature; $CO_{2;}$ light; media; training and pruning; maintenance of parental lines and hybrid seed production of vegetables; fertigation and nutrient management; control of insect-pests and disease in greenhouse; economics of protected cultivation; visit to established green/polyhouse/net house/shade house in the region.

VSC 604 ADVANCES IN VEGETABLE SEED PRODUCTION 2+1

Theory: History of vegetable seed industry, current status and development in seed industry, seed legislation in India, problems associated with seed production, certification, processing, storage and marketing of vegetable seeds of
UNIT I: Cole crops and root vegetables
UNIT II: Bulb crops and cucurbits
UNIT III: Solanaceous fruit vegetables
UNIT IV: Peas, beans and okra
UNIT V: Leafy and vegetatively propagated vegetable crops
Practical: Practices in rouging; maintaining isolation distances; seed germination; seed vigour; biochemical tests; seed priming and pelleting; visit to seed testing laboratories; seed processing units and ware houses of commercial seed companies (public as well as private)

VSC 605 ABIOTIC STRESS MANAGEMENT IN VEGETABLE CROPS 2+1

Theory
UNIT I: Environmental stress and its types, soil parameters including pH, classification of vegetable crops based on susceptibility and tolerance to various types of stress; use of wild species as root stock, use of antitranspirants.
UNIT II: Mechanism and measurements of tolerance to drought, water logging, soil salinity, frost and heat stress in vegetable crops.
UNIT III: Soil-plant-water relations under different stress conditions in vegetable crops production and their management practices.
UNIT IV: Techniques of vegetable growing under water deficit, water logging, salinity and sodicity.
UNIT V: Techniques of vegetable growing under high and low temperature conditions, use of chemicals in alleviation of different stresses.
Practical: Identification of susceptibility and tolerance symptoms to various types of stress in vegetable crops; measurement of tolerance to various stresses in vegetable crops; short term experiments on growing vegetable under water deficit; water-logging, salinity and sodicity; high and low temperature conditions and use of chemicals for alleviation of different stresses.

VSC 606 BIOTECHNOLOGY IN VEGETABLE CROPS 2+1

Theory: Crops - Tomato, eggplant, hot and sweet pepper, potato, cabbage, cauliflower, tapioca, onion and cucurbits
UNIT I: *In vitro* culture methods and molecular approaches for crop improvement in vegetables, production of haploids, disease elimination in horticultural crops, micro grafting, somoclones and identification of somaclonal variants, *in vitro* techniques to overcome fertilization barriers, *in vitro* production of secondary metabolites.

UNIT II: Protoplast culture and fusion, construction, identification and characterization of somatic hybrids and cybrids, wide hybridization, embryo rescue of recalcitrant species, *in vitro* conservation.
UNIT III: *In vitro* mutation for biotic and abiotic stresses, recombinant DNA methodology, gene transfer methods, tools, methods, applications of rDNA technology.
UNIT IV: Quality improvement, improvement for biotic and abiotic stresses, transgenic plants.
UNIT V: Role of molecular markers in characterization of transgenic crops, fingerprinting of cultivars etc., achievements, problems and future thrusts in horticultural biotechnology.

Practical : Establishment of axenic explants; callus initiation and multiplication; production of suspension culture; cell and protoplast culture; fusion; regeneration and identification of somatic hybrids and cybrids; identification of embryonic and non-embryonic calli; development of cell lines; *in vitro* mutant selection for biotic and abiotic stresses; i*n vitro* production and characterization of secondary metabolites; isolated microspore culture; isolation and amplification of DNA; gene transfer methods; molecular characterization of transgenic plants.

VSC 691	**DOCTORAL SEMINAR I**	**1+0**
VSC 692	**DOCTORAL SEMINAR II**	**1+0**
VSC 693	**SPECIAL PROBLEM IN Ph.D.**	**0+1**
VSC 699	**DOCTORAL RESEARCH**	**0+45**

BASIC SCIENCES

BIOLOGY AND ENVIRONMENTAL SCIENCES

http://hillagric.ac.in/edu/cobs/bioenv.html

A. BIOLOGY

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
BIO 501*	CELL BIOLOGY	2+0	I
BIO 502*	DEVELOPMENTAL BIOLOGY	2+1	I
BIO 503	PLANT MORPHOGENESIS AND EMBRYOLOGY	2+1	II
BIO 504*	BIOCHEMISTRY	2+1	I
BIO 505	ANIMAL PHYSIOLOGY	2+1	II
BIO 506	PLANT PHYSIOLOGY	2+1	II
BIO 507	TAXONOMY AND ECONOMIC BOTANY	2+1	II
BIO 508	FUNCTIONAL ORGANIZATION OF ANIMALS	3+1	II
BIO 509	MOLECULAR PARASITOLOGY	2+1	II
BIO 510	NEUROPHYSIOLOGY	2+1	II
BIO 511*	RADIATION BIOLOGY	2+0	I
BIO 512	CRYPTOGAMS	2+1	II
BIO 513	IMMUNOLOGY	2+0	II
BIO 514*	RESEARCH TECHNIQUES IN BIOLOGY	2+1	I
BIO 515	ECOLOGY AND BIODIVERSITY	2+0	II
BIO 516	MORPHOPHOLOGY AND PLANT ANATOMY	2+1	II
BIO 517	FREERADICALS IN BIOLOGY	2+0	II
BIO 518	GENETICS AND GENETIC ENGINEERING	2+0	II
BIO 519	HORMONE ACTION AND METABOLIC DISORDERS	2+1	II
BIO 520	PLANT CELL CULTURE	2+0	II
BIO 521	APPLIED ZOOLOGY	2+1	II
BIO 522	GYMNOSPERMS	2+1	II
BIO 531	CELLULAR PHYSIOLOGY AND PLANT WATER RELATIONS	2+1	I
BIO 532	INORGANIC NUTRITION: PHYSIOLOGICAL AND MOLECULAR ASPECTS	2+1	I
BIO 533	PLANT GROWTH, DEVELOPMENT AND REGULATORS	2+1	II
BIO 534	PLANT METABOLISM AND PRODUCTIVITY: PHYSIOLOGICAL AND MOLECULAR ASPECTS	2+1	I
BIO 535	CROP P PHYSIOLOGY	2+0	I
BIO 536	PHYSIOLOGICAL ASPECTS OF FIELD CROPS	2+0	II
BIO 537	ABIOTIC STRESS RESPONSES IN PLANTS	2+0	II
BIO 591	MASTER'S SEMINAR	1+0	I&II
BIO 600	MASTER'S RESEARCH	0+20	I&II

***Compulsory for Master's programme**

A. BIOLOGY

Course contents

BIO 501 CELL BIOLOGY 2+0

Theory

UNIT I: Cell Signaling, general principles, G-linked cell surface receptors, Ca^{2+} signaling system, enzyme linked cell surface receptors, target cell adaptations; localization signals and protein; cell division cycle, general strategy of cell cycle, molecular basis of cell cycle control, M- phase, mitosis and cytokinesis.

UNIT II: Energy conversion, mitochondria and chloroplasts, the respiratory chain and ATP synthesis, photosynthesis, evolution of electron transport chain, the genome of mitochondria and chloroplasts, Cell junction, cell-cell adhesion, the extra cellular matrix of animals, extra cellular matrix receptors and integrins.

UNIT III : Excitable cell/tissue, neuron structure, type, properties, function, transmembrane potential, action potential, conduction of impulse, channels (active and passive), voltage and chemical sensitive, exoplasmic flow, communication between excitable tissue/neurons, cellular and molecular basis of synaptic transmission, properties.

BIO 502 DEVELOPMENTAL BIOLOGY 2+1

Theory

UNIT I: Cell differentiation and development, introduction, cell differentiation and morphogenesis in *Dictyostellum*,

UNIT II: Fertilization, early development stages of invertebrate and vertebrate embryos, morphogenetic cell movements, cell-cell interactions during development, cell recognitition and selective cell adhesions, inductive tissue interactions, organogenesis (limb/eye/brain any one), nuclear cytoplasmic interactions in cell differentiation.

UNIT III: The process, phases and dynamics of plant growth, growth measurement and analysis, physiological and genetical correlations, the concept of polarity, totipotency and symmetry, growth and differentiation, differentiation expression with and without growth, factors affecting growth, abnormal growth.

Practical: Study of whole mounts and serial sections of frog and chick embryo at different level of development; window preparation and identification of stages of development in chick egg; cell differentiation and morphogenesis in *Dictyostellum*; growth measurement and analysis; bioassay of auxin; studies on senescence and abscission of leaf; studies on ontogeny and structure of plant organs.

BIO 503 PLANT MORPHOGENESIS AND EMBRYOLOGY 2+1

Theory

UNIT I: Morphogenesis of plant organs, morphogenetic factors including light, water, temperature, physical factors like tension, compression, balancing and swaying, ultrasonic, gravity, biochemical effects, genetic factors, chemical factors (hormones) in general;

UNIT II: Development and structure of micro-and megasporangium, male and female gametophytes, pollen physiology, preservation and sterility;

UNIT III: Development of embryo, endosperm and ovule, parthenocarpy, *in vitro* culture of embryo and pollen, pollination, artificial pollination and fertilization, production of androgenic plants, somatic hybridization, self incompatibility.

Practical

Study of morphological characters in relation to development; micro-and megasporogenesis; embryo; endosperm and ovule through dissection and microtomy; embryo and anther culture.

BIO 504 BIOCHEMISTRY 2+1

Theory

UNIT I: Metabolism and its regulation, metabolism- an overview, metabolic diversity, catabolism and anabolism, tightly regulated intermediary metabolism, integrated processes, experimental methods to reveal metabolic pathways, vitamins as coenzymes.

UNIT II: Molecular basis of hormone action, classes of hormones and second messengers.

UNIT III: Glycolysis overview, regulatory enzymes, allosteric and covalent modification, first and second phase of glycolysis, tricarboxylic acid cycle, reactions of the cycle including pyruvate dehydrogenase, regulation of TCA cycle, glyoxylate cycle, electron transport and oxidative phosphorylation, coupling factors, mechanism of ATP synthesis, mitochondrial shuttle, transporters in mitochondria, gluconeogenesis, glycogen metabolism and the pentose phosphate pathway.

UNIT IV: Fatty acid catabolism, oxidation of fatty acids, ketone bodies, lipid biosynthesis, fatty acid synthesis, phospholipids and other complex lipids, cholesterol biosynthesis, sterol biosynthesis and regulation.

UNIT V: Amino acid metabolism, degradative pathways, amino acid biosynthesis, synthesis and degradation of nucleotides, Salvage pathway.

Practical: Protein estimation; separation of proteins by electrophoresis; estimation of reducing and non-reducing sugars; estimation of oil; iodine value; saponification and acid values; isolation and quantification of nucleic acids; enzyme kinetics; separation of amino acids by TLC; bioassay of auxin; cytokinin; GA; ABA and ethylene using appropriate plant material; study of the enzyme activity of catalase and peroxidase as influenced by pH and temperature.

BIO 505 ANIMAL PHYSIOLOGY 2+1

Theory

UNIT I: Digestive system, digestion, absorption, anabolism and catabolism.

UNIT II: Excitable, non-excitable tissue, muscle, structure, neuro-muscular junction, contraction.

UNIT III: Blood and circulation, blood corpuscles, formed elements, plasma, functions, blood volume, blood volume regulation, blood groups;

UNIT IV: Respiratory system, anatomical considerations, transport of gases, exchange of gases, waste elimination, regulation of respiration;

UNIT V: Cardio-vascular system, heart structure, myogenic heart, specialized tissue, blood vessels, ECG-basis, principle of recording, significance,cardiac cycle, cardiac output, blood pressure, regulation of heart, blood pressure, cardiac output.

UNIT VI: Excretory system, kidney, nephron, urine formation, urine concentration, waste elimination, micturition, role of kidney in the regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base maintenance.

UNIT VII: Thermoregulation, comfort zone, physical, chemical, neural body temperature regulation and acclimatization.

UNIT VII: Endocrinology and reproduction-endocrine glands, hormone action, reproductive processes.

Practical: Estimation of salivary amylase activity; hematological and biochemical analysis of blood; recording of pulse rate; heart rate and blood pressure (pulsatory and ausculatory methods); urine tests; kymographic recording of muscle contraction and effect of temperature, drugs, pH on it; histology of various endocrine glands; study of estrous cycle by vaginal smear preparations.

BIO 506 PLANT PHYSIOLOGY 2+1

Theory

UNIT I: Water relation in plants, properties of water and solution, determination of vapour pressure, osmotic and chemical potential; plant-soil-atmosphere continuum, response of plants to water deficit, inorganic nutrition.

UNIT II: Photosynthesis, light absorption and emission, primary processes of photosynthesis, chloroplast membrane architecture, structure, function relationship of thylakoid membrane proteins, CO_2 fixation, C_3, C_4 and CAM photosynthesis.
UNIT III: Respiration, architecture of plant mitochondrial membrane, electron transfer complexes and components of plant mitochondria, cyanide resistant pathway, phytochrome and photomorphogenesis, the structure and optical properties of phytochrome, cryptochrome and their role in photomorphogenesis,
UNIT IV: Plant hormones, auxins, gibberellins, cytokines, ethylene, structure, biosynthesis and their role in plant growth and development, role of abscissic acid and salicylic acid in physiological processes, mineral nutrition.
UNIT V: Phototropism, gravitotropism, short-day and long- day plants, senescence and abscission, dormancy, viability and germination, vernalization.
UNIT VI: Physiology of flowering and sex expression, phytochromes.
Practical: Preparation of different osmotic solutions; demonstration of diffusion; osmosis and imbibition; membrane permeability; root pressure and guttation; ascent of water; transpiration and experiments related to photosynthesis; leaf pigments and respiration; tropism; techniques of solution culture; mineral deficiencies; bioassay of hormones; photoperiodism and vernalization experiments; methods of breaking dormancy and testing viability of seeds; presoaking treatment for improving germination.

BIO 507 TAXONOMY AND ECONOMIC BOTANY 2+1

Theory

UNIT I: General characters of angiosperms, nomenclature, principles and rules, taxonomic ranks, type concept, principle of priority, salient features of Bentham and Hooker's, Hutchinson's and Engler and Prantl's system of classification (details of Bentham and Hooker's system only), brief account of chemotaxonomy, herbarium.
UNIT II: General account and diagnostic features of Ranunculaceae, Brassicaceae, Rutaceae, Malvaceae, Fabaceae, Apiaceae, Asteraceae, Solanaceae, Labiatae, Euphorbiaceae, Liliaceae and Gramineae.
UNIT III: The importance and nature of plant products, Plants as source of food, fibres, fodder, spices, condiments, beverages, drugs, narcotics, insecticides, timber, gums and resins, dyes, latex, cellulose, starch and their products, perfumery.
UNIT IV: Importance of ethnobotany in Indian context.
Practical: Study of characters of representative genera in the laboratory and field; herbarium collection; study of plants of economic use and utility and their importance with their products; study of hand sections of mustard and staining of oil droplets by Sudan Black and Sudan III; tests for oil and iodine number; simple tests for tannins and dyes.

BIO 508 FUNCTIONAL ORGANIZATION OF ANIMALS 3+1

Theory

UNIT I: Locomotary mechanisms, contractile proteins, fibrils, microtubules, basis of ciliary and flagellar movements, role of microfilaments in cell, amoeboid movements, muscle and mechanism of muscle contraction.
UNIT II: Evolution of coelom bilateral symmetry, metamerism and their role in locomotion.
UNIT III: Skeleton, its role and structure, aerodynamics in relation to flight in birds.
UNIT IV: Feeding mechanisms, mechanism of digestion and regulation of secretions in chordates.
UNIT V: Open and closed type of circulatory systems, chambered, neurogenic and myogenic hearts.
UNIT VI: Respiratory organs in invertebrates and vertebrates, respiratory pigments.
UNIT VII: Osmoregulation in non-chordates, structural organization of chordate kidney, role of kidney in body water regulation, nitrogen excretion, adaptation to terrestrial environment and desert living.
UNIT VIII: Pattern of reproduction in non-chordates, larval forms.

UNIT IX: Evolution of urinogenital systems in chordates with special reference to the separation of the two systems, reproductive cycles in mammals.
UNIT X: Endocrine organs and hormonal regulation in chordates.
UNIT XI: Physiology of nervous system, evolution of functional anatomy of chordates brain, receptors.
Practical: Study of mouth parts of butterfly; housefly; radula of Pila; study of the respiratory structures in bivalves (gills); book lungs (scorpion); trachea and spiracles (cockroach); nephridia in annelids; reproductive organs in earthworm; cockroach and Pila; comparative study of heart and blood vascular system in fish, frog; lizard; pigeon and rat; histology of ovary; uterus; testis in different vertebrate groups; brain and cranial nerves in fish; frog; lizard; pigeon and rat; histology of endocrine glands.

BIO 509 MOLECULAR PARASITOLOGY 2+1

Theory
UNIT I: Classification of parasites, diversity of parasites causing human and plant diseases.
UNIT II: Biology of protozoan parasites (Plasmodium, Leishmania, enteric protozoan parasites), genome organization, structure of genes, and gene expression of selected protozoan parasites.
UNIT III: Immunology of the protozoan parasites, molecular biology and immunology.
UNIT IV: Biology of selected nematode parasites.
Practical: Study of slides of parasites for their morphological details; collection; fixation; preservation and staining of protozoan parasites; morphological studies of specimens and slides of nematodes and their developmental stages; collection; fixation; preservation and clearing of nematodes for their identification.

BIO 510 NEUROPHYSIOLOGY 2+1

Theory
UNIT I: Neurogenesis, neuron cell, glia, structure, function, role of growth factor, transmembrane potential, action potential; properties of neurons, nerve impulse conduction, myelination, neurotransmitter synthesis, axoplasmic transport, synapse-types, synapse properties, neurotransmitter receptors types, molecular and cellular basis of synaptic transmission, neuro-muscular junction.
UNIT II: Mechano, thermo, kinesthetic, pressure, chemo and photoreceptors.
UNIT III: Anatomy and organization of spinal cord, ascending and descending tracts, brain, cerebrum, cerebellum, brainstem, anatomy, connections, sensory, motor, association areas, cytoarchitecture, reticular formation, blood-brain barrier, CSF, reflex types, properties, myotatic reflex, muscle tone maintenance, posture regulation, decerebrate rigidity, sensation, modalities, coding of information, touch
UNIT IV: Pain, methods to study lesion stimulation, inactivation, gross and specific, single unit and molecular level, biochemical, functional, anatomical, histological study and micro dialysis.
Practical: Comparative study of brains of different vertebrates; study of brain and spinal cord at various levels (prepared and permanent slides); evaluation of anaesthetics using intact preparations; preparation of neuron slides; histology of sense organs.

Bio 511 RADIATION BIOLOGY 2+0

Theory
UNIT I: Introduction, interaction of radiation with matter, radiation chemistry of water,
UNIT II: Chemical mechanism of radiation induced DNA and membrane damage.
UNIT III: Survival curve and its significance, sensitivity of tissues, acute effects of whole-body irradiation, radiation effect on development; radiation induced apoptosis.
UNIT IV: Lethal, potentially lethal (PLD) and sub-lethal (SLD) damage, high LET radiation effect, Relative Biological Effectiveness (RBE) and oxygen effect;
UNIT V: Role of radiation in initiation, propagation and progression of carcinogenesis, radiation mutagenesis and clastogenesis.
UNIT VI: Chemical and biological factors modulating the genetic effects of radiation, radiation therapy of cancer, significance and limitations.

UNIT VII: Chemical modification of radio response, mechanism and usefulness, radiation induced lesions in DNA and their repair.
UNIT VIII: Radiation effects in space; effects of low dose radiation, food irradiation, ionizing radiation-risk vs. benefits.

BIO 512 CRYPTOGAMS 2+1

Theory

UNIT I: Habitat, habit, organization of thallus, structure of algal cell, algal pigments and photosynthetic apparatus, algal flagella, nutrition, reproductive diversity, life history patterns.
UNIT II: Classification, study of Cyanophyta, Chlorophyta, Charophyta, Euglenophyta, Phaeophyta, Chrysophyta, Pyrrophyta, Rhodophyta and Cryptophyta up to order level.
UNIT III: Origin and evolution of sex in algae, economic importance of algae, algae as indicator of water pollution.
UNIT IV: History, classification, study of structure, development, reproduction, life history of the Gymnomycota, Myxomycota, Mastigomycota, Amastigomycota, Ascomycetes, Basidiomycetes, Deuteromycetes.
UNIT V: Principles and methods for the prevention and control for plant diseases, plant quarantine, defense mechanisms of plants against pathogens;
UNIT VI: Symptomatology, identification, etiology and control measures of late blight of potato, white rust of crucifers, powdery scab of potato, powdery mildew of wheat, apple scab habitat and habit of bryophytes (including fossil record), primitive vs advanced /derived characters, economic importance.
UNIT VII: Comparative, morphological account of gametophytes and sporophytes of Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Andreales and Bryales.
UNIT VIII: origin of land habit and land floras, differentiation of organs in vascular plants-telome Theory, significance of shortcomings, monophyletic vs polyphyletic origin of pteridophytes, pteidophytic life cycle with reference to alternation of generations, homologous and antithetic theories of sporophytes, evolutionary trends in pteriophytes, organization and evolution of sorus in ferns, role of polyploidy and hybridization in speciation in ferns, apomictic life cycle, apogamy, apospory, heterospory and seed habit,
UNIT IX: Classification of pteridophytes, comparative organography, systematics, reproduction and life cycle in Psilophytales, Zosterophyllates, Psilotales, Lycopodiales, Filicales, Sphenophyllates, Marseliales, Lepidodendrales and Salviniales.

Practical : Collection and study of the representatives of algae; separation of algal pigments; measurements of the activity of enzymes of fungal pathogens; cellulases and pectinases; demonstration of biological control of pathogenic fungi *in vitro*; measurement of radial growth of fungi in petri plates morphological and structural study of representative members of the bryophytes using whole mounts preparations and sections; morphology and anatomy of vegetative and reproductive tissues and organs using whole mounts; sections and permanent slides of pteridophytes.

BIO 513 IMMUNOLOGY 2+0

Theory

UNIT I: Introduction, types and functions of leukocytes, natural Immunity, polymorphonuclear leukocytes, neutrophils, molecular mechanisms in activation and diapedesis, mechanisms of opsonization and phagocytosis, intracellular microbicidal action.
UNIT II: Role of eosinophils in antihelminthic immunity and asthma, basophils/mast cells, immediate hypersensitivity, inflammatory response.
UNIT III: Structure and function of immunoglobulins, isotypes, allotypes, idiotypes, Ig domains, primary and secondary immune response, immunoglobulin genes, generation of diversity and affinity maturation, Ig receptors, B-cells and their maturation, T-dependent and independent antigens, isotype switching, idiotypic network, hybridoma and monoclonal antibodies, classical and alternate pathways of complement activation, regulation of complement activation pathways.

UNIT IV: Major histocompatibility complex (MHC) antigens, allograft rejection, inbred and cogenic mice, MHC locus in mice and humans, types of MHC antigens, their structures and genes, HLA typing and disease association, cell activation, MHC restrictions and their molecular basis.
UNIT V: T-cell receptor complex and genes, signal transduction in T-cells, T-cell differentiation, thymic selection, antigen processing and presentation on class I and class II MHC molecules, super antigens, cytokines and cytokine receptors; natural killer cells, mechanisms of NK and T- cell cytotoxicity.
UNIT VI: Hypersensitivity reactions and autoimmunity.

BIO 514 RESEARCH TECHNIQUES IN BIOLOGY 2+1

Theory

UNIT I: Microscopy, study of light, phase contrast, fluorescence, electron, polarization, dark field and X-ray diffraction microscopes.
UNIT II: Histological and histochemical techniques, microtome, cryostat, histochemical localization of carbohydrates, proteins, lipids and enzymes (acid phosphatase, alkaline phosphatase, succinate dehydrogenase, glucose-6-phosphate dehydrogenase).
UNIT III: Biochemical techniques, pH, buffers, centrifugation, chromatography.
UNIT IV: General principles, types of electrophoresis, general principles, factors affecting electrophoresis, isoelectric focusing.
UNIT V: Spectroscopy, general principles, types of spectroscopy (visible, UV, infrared, atomic, ESR, NMR and mass spectroscopy).
UNIT VI: Radioactive techniques.
UNIT VII: Animal culture techniques, plant cell culture.

Practical: Preparation of buffers; fractionation of cell organelles; estimation of sugars by colorimetric methods; histochemical localization of carbohydrates; proteins; lipids and some selected enzymes in cells/tissues; separation of amino acids by thin layer chromatography; separation of isozymes by PAGE; culture of protozoans; rearing of nematodes and maintenance of mammalian colonies; plant tissue culture.

BIO 515 ECOLOGY AND BIO-DIVERSITY 2+0

Theory

UNIT I: General ecology and ecological considerations, biodiversity, spatial and temporal dimensions, population biology, theoretical aspects of genetic issues at population level.
UNIT II: Fragmentation of habitat, consequences for ecology and biodiversity, eco-functions of biodiversity at community/eco-system/landscape level, inventorying and monitoring of biodiversity, conservation of biodiversity, problems in protected areas.
UNIT III: Problems of rehabilitation of degraded eco-systems, problems and principles of i*n situ* and *ex situ* biodiversity conservation.
UNIT IV: Biodiversity and agriculture/fisheries/industrial development,biodiversity conservational practices and ethnic cultures, biodiversity and global natural and cultural changes.

Bio 516 MORPHOLOGY AND PLANT ANATOMY 2+1

Theory

UNIT I: Origin of angiosperms, relation of angiosperms to gymnosperms.
UNIT II: Morphology of root, stem, leaf, inflorescence, flower and fruit.
UNIT III: Structure of seed, seed and fruit dispersal.
UNIT IV: Cell structure, cell wall, meristem, tissue and tissue systems.
UNIT V: Primary and secondary xylem and phloem, vascular cambium, periderm.
UNIT VI: Internal structure of monocot and dicot root, stem, leaf, fruit and seed, secondary growth-normal and anomalous, storage region in root and tuber crops, origin of lateral and adventitious roots.
UNIT VII: Healing of wounds, grafting and abscission, ecological anatomy, leaf anatomy of C_3, C_4 and CAM plants.

Practical: Simple and double staining to study different types of simple and permanent tissues; leaf; root; stem; fruit and seed; study of normal; anomalous and secondary growth; morphological studies of root; stem; leaf; types of inflorescence; structure of flower; types of fruits; seed structure.

BIO 517 FREE RADICALS IN BIOLOGY 2+0

Theory

UNIT I: Introduction, free radicals in tissue injury and cell death.

UNIT II: Generation of free radicals in biological systems through physical, chemical and biochemical processes.

UNIT III: Detection of free radicals, chemical and physico-chemical methods, properties of free radicals, mechanism of DNA damage by free radicals, lipid peroxidation, free radical chain reaction, detoxification.

UNIT IV: Cellular and biochemical events in oxidative injury, oxidative stress, role of oxidants, antioxidants and their redox potential.

UNIT V: Protection against oxidative damage by enzymes, transition metals, involvement of iron, copper and other metals in free radical reactions.

UNIT VI: Free radicals as useful species, free radicals in ageing, cancer and other diseases.

BIO 518 GENETICS AND GENETIC ENGINEERING 2+0

Theory

UNIT I: Mendelian laws of inheritance and gene interaction.

UNIT II: Sex determination and sex-linked inheritance, chromosomal aberrations: nature and mechanism, linkage, Analysis and gene mapping in eukaryotes, multiple alleles.

UNIT III: Complementation analysis and fine structure of gene, concept of gene mutations.

UNIT IV: Extra-chromosomal inheritance.

UNIT V: Population genetics.

UNIT VI: Introduction to molecular genetics and its importance in biology, changing concept of gene, transcription control regions of eukaryotic and prokaryotic genes.

UNIT VII: Molecular biology of Plasmids and Lambda M13 and P1 phages, transposable elements, cloning vectors, cDNA synthesis and cDNA library, construction of genomic library, Identification and analysis of recombinant clones including functional and positioning cloning).

UNIT VIII: Methodology of DNA sequencing, Polymerase Chain Reaction (PCR), site directed mutagenesis and transgenics.

BIO 519 HORMONE ACTION AND METABOLIC DISORDERS 2+1

Theory

UNIT I: Characteristics of hormone system, classification, molecular basis of hormone action, hormone receptors, cAMP, protein kinase and other intracellular messengers like calcium and phosphoinositides, GTP binding proteins, phospholipase, inositol triphosphate and diacyl glycerol, assay of hormones.

UNIT II: Mechanism of action of insulin, receptors and tyrosine kinase, growth factors, diabetes, regulation of insulin/glucagons and its significance, hormonal regulation of carbohydrate, fat and protein metabolism.

UNIT III: The hypothalamus and pituitary, over and under secretion of pituitary hormones.

UNIT IV: Hormones and cancer; thyroid hormones, mechanism of action and pathophysiology, hormones regulating calcium metabolism, calcium as a second messenger,calmodulin, classification and mechanism of action of catecholamines, neurohormones and substance P, biomedical importance.

UNIT V: Hormones of the gonads, testosterone and estrogens, mechanism of action and pathophysiology, gastrointestinal and neural hormones (secretin, substance P, neurotensin) and their mechanism of action.

Practical: Histology of various endocrine glands; study of male and female reproductive organs, study of estrous cycle by vaginal smear preparations.

BIO 520 PLANT CELL CULTURE 2+0

Theory

UNIT I: Reflections on aseptic culture, *in vitro* pollination and fertilization, embryogenesis.

UNIT II: Organogenesis and plant regeneration, clonal multiplication, meristem, shoot-tip.

UNIT III: Maintenance and manipulation of development in embryogenic suspension cultures.

UNIT IV: Protoplast isolation and culture, somatic hybridization, fatty protoplasts, fusogens and mechanism of fusion.

UNIT V: Selection of hybrids, cytoplasmic hybridization, genetic and breeding applications, manipulations with cells and protoplasts in culture, somaclonal variation, induction and selection of mutants.

UNIT VI: Genetic transformation of plants, direct DNA uptake, liposome mediated DNA delivery, Ti plasmids particle gun mediated transformation.

UNIT VII: Secondary plant products ;cryopreservation.

BIO 521 APPLIED ZOOLOGY 2+1

Theory

UNIT I: Animal groups of economic importance.

UNIT II: Apiculture, sericulture, lac culture, aquaculture, pisciculture, poultry, fur industry, leather industry, wool industry, dairy farming, piggery, pharmaceuticals from animals.

UNIT III: Invertebrates groups of economic importance.

UNIT IV: Parasitic protozoans, parasitic worms, leeches, earthworms.

UNIT V: Pest management, endocrinology, toxicology.

Practical: Aquaculture; identification of cultivable prawns, lobsters, food fishes; analysis of gut contents of fishes to study their food habits; sericulture; different stages of silkworm; dissection of silkworm and mounting of silk gland; apiculture; identification of members of bee colony; mounting of mouth parts and sting apparatus of honey bee; beehives; identification of major crop pests; household pests; identification of common breeds of fowl; grading; handling and candling of eggs; morphometric measurement of fishes; measurement of fish age by scales; identification of common aquarium fishes; slides of parasites of fishes; histological observation of endocrine glands; hematological parameters in toxicity experiments; determination of LD_{50}.

BIO 522 GYMNOSPERMS 2+1

Theory

UNIT I: Classification and distribution of gymnosperms.

UNIT II: Salient features of Cycadales, Coniferales and Gnetales, their structure and reproduction.

UNIT III: General account of Cycadofilicales, Bennettitales and Cordaitales.

Practical:Study of the representative genera and fossil plants.

BIO 531 CELLULAR PHYSIOLOGY AND PLANT WATER RELATIONS 2+1

Theory

UNIT I: Cell organelles and their physiological functions.

UNIT II: Structure and functions of cell wall and cell membrane.

UNIT III: Water - its properties and functions in plants,water potential and its role in agriculture, mechanism of water uptake by roots and its translocation, physical phenomena, imbibition, plasmolysis, osmosis, water loss from plants, energy balance, solar energy input, energy dissipation at crop canopy level.

UNIT IV: Evapotranspiration, transpiration, factors influencing transpiration rate, stomata, structure, function, mechanism of stomatal movement, antitranspirants.

UNIT V: Physiology of water stress in plants, influence of water stress at cell, organ, plant and canopy levels, indices for assessment of drought resistance.

Practical: Measurement of plant water status; relative water content; water saturation deficits; chardakov's test; Theory and principles of pressure bomb, hydraulic jack; measurement of transpiration rate; stomatal physiology; ABA and stomatal closing.

BIO 532 INORGANIC NUTRITION: PHYSIOLOGICAL AND MOLECULAR ASPECTS 2+1

Theory

UNIT I: The role of mineral nutrients in plant metabolism,essential elements, classification based on function of elements in plants, uptake of mineral elements in plants, mechanisms of uptake, translocation of minerals in plants.

UNIT II: Physiological and metabolic functions of mineral elements, critical levels, nutrient deficiency and toxicity, foliar nutrition, hydroponics and aeroponics, nitrogen metabolism.

UNIT III: Inorganic nitrogen species (N_2, NO_3, NH_3) and their reduction toamino acids, protein synthesis and nucleic acids, concept of nutrient use efficiency, mineral nutrition under adverse soil situations, drought, salinity acidity etc.

UNIT IV: Heavy metal toxicity and concept of phytoremediation.

UNIT V: Molecular aspects, uptake and transport, role of transporter genes, genetics of nutrient uptake, identification and transfer of genes for tolerance to nutrient deficiencies etc.

Practical: Growing plants in sand culture; hydroponic culture; demonstration of deficiency and toxicity symptoms of nutrients; preparation of synthetic nutrient solutions; demonstration of energy requirement for ion uptake; differential uptake of ions; tissue analysis for nutrients.

BIO 533 PLANT GROWTH, DEVELOPMENT AND REGULATORS 2+1

Theory

UNIT I: The process, phases and dynamics of growth, growth measurement and analysis, growth and differentiation, reproductive growth, external and internal factors affecting growth, growth correlation, interrelations between growth and differentiation.

UNIT II: Seed physiology, hormonal concept of growth and differentiation.

UNIT III: Plant growth hormones and new growth regulators,biosynthesis, their metabolism and physiological role, mechanisms of action.

UNIT IV: Synthetic growth regulators, growth retardants, herbicides, allelochemicals and their significance in agriculture.

UNIT V: Apical dominance, senescence, fruit growth, abscission, photomorphogenesis, phytochrome, cryptochrome, photoperiodism and vernalization.

Practical: Growth measurement in different types of plants; Bioassay; auxins effect on abscission; apical dominance; gibberellins bioassay; GA_3 effect on germination of dormant seeds; cytokinin bioassay-effect on apical dominance and senescence; ABA bioassay; ABA effect on stomatal movement; ethylene bioassay, effect on breaking dormancy.

Bio 534 PLANT METABOLISM AND PRODUCTIVITY: PHYSIOLOGICAL AND MOLECULAR ASPECTS 2+1

Theory

UNIT I: Plant pigments, photosynthesis, translocation and the respiration as key processes regulating carbon metabolism and plant growth, photochemical process, chloroplast structure, photochemical reactions, CO_2 reduction in Calvin cycle, supplementary pathway of C fixation in C_4 and CAM plants and its significance, RUBISCO assembly and regulation.

UNIT II: Chloroplast genome organization, expression and regulation of plastid genes, antisense and gene expression studies, photorespiration and its relevance, effect of environmental factors on photosynthetic rates, photosynthesis and productivity, chlorophyll fluorescence.
UNIT III: Mitochondrial respiration, growth and maintenance respiration, cyanide resistant respiration and its significance, lipid metabolism.

Practical: Separation and quantification of chlorophylls; measurement of rate of photosynthesis; O_2 evolution during photosynthesis; Warburg's and oxygen electrode measurements; measurement of gas exchange parameters; conductance; measurement of radiation; light use efficiency; respiration rates.

BIO 535 CROP PHYSIOLOGY 2+0

Theory

UNIT I: Role of crop physiology in different branches of agriculture, crop physiological processes influencing crop growth and productivity,crop growth models describing yield (Duncan/Passioura), Duncan's model, phenology.
UNIT II: Crop productivity, growth factors related to biomass-concept of crop growth rates, canopy photosynthesis (leaf area and net assimilation rates as determining factors), light interception as a major function of leaf area, LAI, LAD, canopy architecture, light extinction coefficient, NAR, CGR, variation in photosynthetic rates within and between the species, Passioura's model.
UNIT III: Interrelation between total transpiration-WUE-plant growth, role of VPD, biomass and yield relations, partitioning of photosynthates at different growth stages of crop, harvest index, yield and yield structure analysis, concept of source-sink and productivity.
UNIT IV: Environmental factors determining crop growth, effect of photoperiod and thermoperiod on duration of growth stages, ideotype concept, selection indices for improving crop productivity.

BIO 536 PHYSIOLOGICAL ASPECTS OF FIELD CROPS 2+0

Theory

UNIT I: Crop physiology of rice, wheat, maize, oilseed and pulse crops, their phenological developments,
UNIT II: Crop production constraints and strategies for increasing crop productivity in these crops, characteristics of old and new plant ideotypes, source sink relationships and productivity,
UNIT III: Role of CO_2 enrichment in crop growth and development, photoperiodism, vernalization and thermophotoperiodisms.

BIO 537 ABIOTIC STRESS RESPONSES IN PLANTS 2+0

Theory

UNIT I: Response of plants to abiotic stresses, abiotic stresses affecting plant productivity, basic principles of a crop improvement programme under stress.
UNIT II: Interactions between biotic and abiotic stresses, injury and mechanisms of resistance to water, radiation, temperature, salt, saline, alkaline and pollution stress.
UNIT III: Experimental measures for increased resistance to environmental stresses.
UNIT IV: Molecular responses to water deficit, stress perception, expression of regulatory and functional gene and significance of gene products; stress and hormones, ABA as a signaling molecule.
UNIT V: Oxidative stress, reactive oxygen species (ROS), crucial role of membrane lipids, frost and chilling stress, effects on physiological processes.

BIO 591 MASTER'S SEMINAR 1+0
BIO 600 MASTER'S RESEARCH 0+20

B. ENVIRONMENTAL SCIENCES

http://hillagric.ac.in/edu/cobs/envsci/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
ENV 501*	DEFINITIONS AND CONCEPTS IN ENVIRONMENTAL SCIENCES	2+0	I
ENV 502	STUDY AND NALYSIS OF AGRO-ECOSYSTEMS	2+1	II
ENV 503*	ENVIRONMENTAL POLLUTION	2+1	I
ENV 504*	ENVIRONMENTAL IMPACT ASSESSMENT	2+1	I
ENV 505	ENVIRONMENTAL CHEMISTRY	2+1	II
ENV 506*	GLOBAL CLIMATE CHANGE	2+0	I
ENV 507	STRESS PHYSIOLOGY	2+1	I
ENV 508	RENEWABLE SOURCES OF ENERGY	2+1	II
ENV 509	PESTICIDES AND ENVIRONMENT	2+1	II
ENV 510*	ENVIRONMENT CONSERVATION	2+0	II
ENV 511	PROTECTED CULTIVATION OF HORTICULTURAL CROPS	1+2	I
ENV 512	BIODIVERSITY/WILDLIFE CONSERVATION AND HIMALAYAN ECOSYSTEM	2+0	II
ENV 591	CREDIT SEMINAR	1+0	I&II
ENV 592	SPECIAL PROBLEM IN M.Sc.	0+1	I&II
ENV 600	M.Sc. RESEARCH	0+20	I&II

* Compulsory for Master's programme

B. ENVIRONMENTAL SCIENCES

Course contents

ENV 501 DEFINITIONS AND CONCEPTS IN ENVIRONMENTAL SCIENCES 2+0

Unit I: Definitions and Concepts in Environmental Sciences.
Unit II: Components of atmosphere, hydrosphere, pedosphere, biosphere and their interactions,
Unit III: Ecosystem of the world, energy flow in ecosystems, biogeographic regions, biological building block, nutrients and nutrient cycling in different ecosystems.
Unit IV: Climate and its impact on agriculture, agroclimatic regions, soils and cropping patterns of India and agricultural productivity, biotic and abiotic interactions, soil-plant-atmospheric interactions.
Unit V: Agriculture and environmental pollution, green house gases and global climatic changes, environmental issues.

ENV 502 STUDY AND NALYSIS OF AGRO-ECOSYSTEMS 2+1

Unit I: Agro-ecosystems, ecological and social attributes, interaction amount chemical,physical, biological and socio-economic components agro-ecosystems.
Unit II: Trophic systems, kin agriculture, nutrients cycling, carrying capacity, community concepts, competition, biodiversity, characteristics and functions.
Unit III: Agro-environmental resources (soil, water, climatic factors, living organisms, farm chemicals, rural infrastructure), energy movements.
Unit IV: Biogeochemical cycles, integrated management of agro-ecosystems, adaptation.
Unit V: Assessment of the impact of environmental variation on agro-ecosystems, option for sustainable development.
Practical: Study of community characters in different ecosystems; studies on edaphic and climatic components; quality parameters in aquatic ecosystem; productivity studies.

ENV 503 ENVIRONMENTAL POLLUTION 2+1

Unit I: Definition and source of pollution, different types of pollution- air, water and soil, pollution and their sources and effects on biosphere, fuel and atmospheric pollutants, sources and diffusion of SO_2, CO, CO_2, CFC, CH_4 and NO in atmosphere, particulates and heavy metals in air.
Unit II: Sampling and analysis technique, type and sources of water pollution, waste water and its treatments, nitrate, heavy metals and pesticide residues in surface and sub-surface waters, samples analysis techniques.
Unit III: Sources of soil pollution, nature of pollution and their harmful effects, solid wastes and their disposal, use of land for waste treatment and disposal, inter-relationship of crop and animal production systems.
Unit IV: Air, water and soil pollution in different ecosystems, environmental quality and standards.
Practical: Sampling of industrial effluents and municipal wastes water; estimation of dissolved and suspended solids; chemical oxygen demand(COD); biological oxygen demand (BOD); nitrate and ammonical nitrogen; inorganic and organic phosphorus; analysis of soil and water for heavy metal contamination; nitrate in water.

ENV 504 ENVIRONMENTAL IMPACT ASSESSMENT 2+1

Unit I: EIA introduction, methodologies, monitoring tools for EIA surveys, spatial databases, experiments, models.
Unit II: GIS, remote sensing, decision support systems.
Unit III: EIA of physical, chemical, biological, socio-economic factors, integrated impact assessment,
Unit IV: Policy, legislative implications, case studies for various sectors.
Practical: Familiarization with GIS;GPS and remote sensing data products; database creation; creating a new project and adding themes; geo-referencing; registration and interpretation of different types of data

;Geographical information systems and their utility in land use planning; table operations and query analyses; making charts; layouts and reports; DEM;preparation of thematic maps.

ENV 505 ENVIRONMENTAL CHEMISTRY 2+1

Unit I: Introduction, concept and scope of environmental chemistry, nature cycles of the environment such as hydrological, oxygen, nitrogen, phosphate and sulphur.

Unit II: Chemical and photochemical reactions in the atmosphere, photolytic and radiolytic scavengers and their transformations, chlorofluorocarbons (CFCs) and ODSs, chemical toxicology in the environment, PAN.

Unit III: Classification and nature of environmental pollutants and analytical techniques for the detection of major pollutants, Mechanism of organic reactions, fate of organic molecules in the atmosphere, reactive intermediates and isomerism, acid-base Theory, concept of pH and redox reactions involving pollutants in soil.

Unit IV: Chemistry of metals and non-metals with reference to agricultural production.

Practical : Measurement of dustfall; total suspended particulates in air; sampling and analysis of NO_2, SO_2 and O_3 in air; analysis of equilibrium soil solution for Eh, pH; Ec and partial pressure of CO_2; determination of ion activity.

ENV 506 GLOBAL CLIMATE CHANGE 2+0

Unit I: Global climate change, history and future, international conventions, characterization.

Unit II: Green house gases, ozone depletion and UV radiation effects, interaction with weather.

Unit III: Effects of global climate change on food production, trade and regional development, integrated assessment methodology.

ENV 507 STRESS PHYSIOLOGY 2+1

Unit I: Problems of water, temperature, salt, water logging and pollution stress, internationally and nationally, drought, magnitude, frequency and severity, impact on agriculture and society.

Unit II: Response of wild population and crops to drought, drought resistance in crops, various mechanisms, Some case studies, molecular and genetic basis of drought resistance, breeding for drought resistance.

Unit III: Salt stress-alkalinity and salinity, morphological, physiological and biochemical responses to various salts, mechanism of resistance to salt and selection through tissue culture, breeding for salt resistance.

Unit IV: Temperature and crop productivity, tolerance to heat and frost, growth metabolic processes and tolerance to water logging.

Unit V: Pollution and crop productivity, pollution indicators, genetic engineering for various stresses, light stress (cloudy days)-a problem for kharif crops.

Practical: Creation of abiotic stress-pH; temperature induced stress and recording observations; temperature stress; quantification of the stress levels; molecular aspects of stress response; stress responsiveness proteins; their expression; Western and Northern analysis; Stress measurement parameters; study of different physiological processes.

ENV 508 RENEWABLE SOURCES OF ENERGY 2+1

Unit I: Concepts of energy, definition, units, forms, conservation of energy, fossil fuels, coal, petroleum, natural gas, LPG, wood, smokeless chullahs.

Unit II: Power generation and environmental pollution caused by thermal, hydroelectric, nuclear power plants, energy consumption patterns in urban and rural sector.

Unit III: Solar energy, solar radiation, concept of heat and mass transfer, design of solar thermal systems, and application in heating, cooling, distillation, drying and dehydration etc., design of solar voltaic systems, power generation for rural electrification, water pumping, solar ponds, wind energy, wind

patterns of different regions of India, wind energy of mechanical and electrical power generation, types of wind mills, geothermal and tidal energy.
Unit IV: Biogas, from animal and agricultural wastes, design and types of biogas plants, utilization of biogas for heating, cooking, lighting and power generation, characteristics of biogas slurry and its utilization, liquid fuels from petro crops, energy plantation crops, integrated rural energy programme.
Unit V: Recycling of agro-industrial wastes for materials for producer gas, design and types of gasifiers, animal draft power and its efficient utilization in rural sector.

ENV 509 PESTICIDES AND ENVIRONMENT 2+1

Unit I: Adverse effects of pesticides on microflora, fauna and on other non-target organisms.
Unit II: Pesticides pollution in ecosystem, pesticide decontamination and disposal- chemical, physical, Microbial and biotechnological techniques, photo decontamination, enzymatic decontamination, physical and chemical methods of pesticide disposal, incineration and soil treatment.
Unit III: Ground water decontamination, disposal of industrial effluents and related xenobiotics, FAO code of conduct for pesticide distribution in environment.
Practical: Preparation of WDP; DWT and EC formulations of different insecticides and analysis for active ingredients; residue analysis of different insecticides and gas liquid chromatography; isolation and characterization of microflora from polluted environments; microbiological analysis of water; waste water; sewage and sludge; industrial effluents; biogas plant slurry; measurement of BOD;COD and total solids.

ENV 510 ENVIRONMENT CONSERVATION 2+0

Unit I: Conservation, life support systems, the concept of conservation, why to conserve? Objectives and aims of conservation.
Unit II: Renewable and non-renewable resources, strategies of conservation, environment degradation and conservation issues, conservation and preservation.
Unit III: Response of ecosystem to exploitation, convergence and divergence in species, health and conservation, diversity and food chains, sustainable exploitation and development, forests, water and mineral resource conservation.
Unit IV: Wildlife conservation, biodiversity strategies, gene pool, conservation-depletion rates model using petroleum as example, limit to growth, Gadgil-Joshi model.

ENV 511 PROTECTED CULTIVATION OF HORTICULTURAL CROPS 1+2

Unit I: Introduction, history, definition, world scenario, greenhouse effects, uses of green houses, status and scope of greenhouse technology in India.
Unit II: Choice of crops for cultivation under greenhouses, problems/constraints of greenhouse cultivation and future strategies.
Unit III: Planning and designing for greenhouse -site selection, greenhouse orientation, plan, layout, greenhouse utilities-water, electricity etc.
Practical : Types of greenhouses-classification based on the shapel; material utility and covering material;consideration for greenhouse establishment; design load calculations; material for construction; construction of greenhouse-fabrication of frame, covering/cladding of frame and environmental control system, management of greenhouse- temperature; light; relative humidity; ventilation; carbon dioxide; irrigation, nutrition; pests and diseases; methods of greenhouse cooling- ventilation; methods of ventilation-natural and forced ventilation; roof shading; lathe shades and evaporative-cooling with fans; high pressure and low pressure misting system; fog cooling system and maintenance of greenhouse equipment; greenhouse heating system; heating distribution system and heat conservation practice; carbon dioxide enrichment-method of enrichment-combustion; liquid carbon dioxide and solid carbon dioxide; light control in greenhouse-shading; selection of light source, growing media-soil culture, type of soil required; drainage; flooding and leaching; soil pasteurization; organic matter; ph control; pre-crop(base)

fertilizer application and cultivation in peat moss; mixture rock wool and other inert media; nutrient film technique (nft)/ hydroponics; production and postharvest technology of vegetables and cut flowers; major diseases and insect pests and their management in greenhouse crops.

ENV 512 BIODIVERSITY/WILDLIFE CONSERVATION AND HIMALAYAN ECOSYSTEM 2+0

Unit I: Biodiversity and overview, biodiversity, change in time and space.
Unit II: Biogeography and major biomass systematic, systematic and biodiversity, taxonomic nomenclature, centres of origin, species concept and diversity, origin, evolution and classification of biological diversity, lower and higher plants diversity, genetic resources, exploitation and collection,
Unit III: Plant introduction, migration and utilization, threatened and endangered species.
Unit IV: Principles of preservation and conservation of biological diversity *in situ* and *ex situ.*
Unit V: National and global biodiversity conservation measures, National and International Institutions associated with conservation.
Unit VI: Biodiversity conservation legislations, biodiversity and economics, biodiversity in Indian centre of origin, crops and wild relatives.
Unit VII: Global environmental changes and biodiversity.

ENV 591	**MASTER'S SEMINAR**	**1+0**
ENV 592	**SPECIAL PROBLEM IN M.Sc.**	**0+1**
ENV 600	**MASTER'S RESEARCH**	**0+20**

C. PLANT PHYSIOLOGY

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
PP 501	CELLULAR PHYSIOLOGY AND PLANT WATER RELATIONS	2+1	II
PP 502	PLANT DEVELOPMENTAL BIOLOGY – PHYSIOLOGICAL AND MOLECULAR BASIS	2+0	I
PP 503	PHYSIOLOGICAL AND MOLECULAR RESPONSES OF PLANTS TO ABIOTIC STRESSES	2+1	I
PP 504	HORMONAL REGULATION OF PLANT GROWTH AND DEVELOPMENT	2+1	II
PP 505	PHYSIOLOGY OF GROWTH AND YIELD AND MODELING	1+1	I
PP 506	PHYSIOLOGY OF CROP PLANTS – SPECIFIC CASE STUDIES	2+0	II
PP 507	PHOTOSYNTHESIS AND RESPIRATION	2+1	I
PP 508	MINERAL NUTRITION	2+1	II
PP 591	MASTER'S SEMINAR	1+0	I&II

PLANT PHYSIOLOGY

Course contents

PP 501 CELLULAR PHYSIOLOGY AND PLANT WATER RELATIONS 2+1

Theory:

Unit I: Cell organelles and their physiological functions, structure and physiological functions of cell wall, cell inclusions, cell membrane structure and functions.

Unit II: Soil and plant water relations, water and its role in plants, properties and functions of water in the cell water relations-cell water terminology, water potential of plant cells, its components and significance in agriculture, mechanism of water uptake by roots-transport in roots, aquaporins, movement of water in plants – mycorhizal association on water uptake,water loss from plants.

Unit III: Energy balance-solar energy input-energy dissipation at crop canopy level- evapotranspiration transpiration–driving force for transpiration, plant factors influencing transpiration rate. stomata-classification, structure and function – mechanism of stomatal movement, antitranspirants.

Unit IV: Physiology of water stress in plants, influence of water stress at cell, organ, plant and canopy levels, indices for assessment of drought resistance.

Practical: Demonstration of physical phenomena; plasmolysis; imbibitions; osmosis-osmotic pressure; wall pressure and turgor pressure; measurement of plant water status; relative water content; water saturation deficits chardakov's test; Theory and principle of pressure bomb; psychrometer and osmometer; measurement of transpiration rate; measurement of vapour pressure deficits; Theory andprinciple of porometry; diffusion porometer and steady state porometer; stomatal physiology; influence of aba on stomatal closing.

PP 502 PLANT DEVELOPMENTAL BIOLOGY – PHYSIOLOGICAL AND MOLECULAR BASIS 2+0

Theory

Unit I: General aspects–novel features of plant growth and development, concept of plasticity in plant development, analyzing plant growth, seed germination and seedling growth–mobilization of food reserves during seed germination, tropisms, hormonal control of seed germination and seedling growth.

Unit II: Shoot, leaf and root development–organization of shoot apical, meristem (sam),cell to cell communication, leaf development and differentiation, organization of root apical meristem (ram), root hair and trichome development, cell fate and lineages.

Unit III: Floral induction and development–photoperiodism and its significance, vernalization and hormonal control, inflorescence and floral determination, molecular genetics of floral development and floral organ differentiation, sex determination.

Unit IV: Seed development and dormancy–embryo and endosperm development, cell lineages during late embryo development, molecular and genetic determinants, seed maturation and dormancy.

Unit V: Senescence and programmed cell death (pcd)–senescence and its regulation, hormonal and environmental control of senescence, pcd in the life cycle of plants.

Unit VI: Light control of plant development– discovery of phytochromes and cryptochromes, their structure, biochemical properties and cellular distribution, molecular mechanisms of light perception, signal transduction and gene regulation, biological clocks and their genetic and molecular determinants.

Unit VII: Regeneration and totipotency,organ differentiation and development,cell lineages and developmental control genes in maize.

PP 503 PHYSIOLOGICAL AND MOLECULAR RESPONSES OF PLANTS TO ABIOTIC STRESSES 2+1

Theory

Unit I: Response of plants to abiotic stresses, abiotic stresses affecting plant productivity, basic principles of a crop improvement programme under stress, interactions between biotic and abiotic stresses.

Unit II: Drought-characteristic features, water potential in the soil-plant air continuum,development of water deficits, energy balance concept, transpiration and its regulation–stomatal functions.
physiological processes affected by drought,drought resistance mechanisms,escape dehydration postponement (drought avoidance), dehydration tolerance and characteristics of resurrection plants, osmotic adjustment, osmoprotectants, stress proteins, water use efficiency as a drought resistant trait, molecular responses to water deficit, stress perception, expression of regulatory and functional genes.
Unit III: Stress and hormones, aba as a signaling molecule- cytokinin as a negative signal, oxidative stress, reactive oxygen species (ros), role of scavenging systems (sod, catalase etc.).
Unit IV: High temperature stress, tolerance mechanisms-role of membrane lipids in high temperature tolerance, functions of HSP's.
Unit V: Chilling stress, effects on physiological processes, crucial role of membrane lipids.
Unit VI: Salinity, species variation in salt tolerance, salinity effects at–cellular and whole plant level, tolerance mechanisms, salt tolerance in–glycophytes and halophytes, breeding for salt resistance.
Unit VII: Heavy metal stress, aluminium and cadmium toxicity in acid soils, role of phytochelatins (heavy metal binding proteins).
Practical: Measurement of water status of plants; determination of osmotic potential by vapour pressure and freezing point depression; determination of soil water potential and content by psychrometry and other systems; stress imposition and quantification; stress–stomatal conductance; canopy temperature as a reflection of transpiration and root activity; water use efficiency; cytokinin effect on stomatal behavior.

PP 504 HORMONAL REGULATION OF PLANT GROWTH AND DEVELOPMENT 2+1

Theory
Unit I: Definition and classifiacation of palnt growth regulators- hormones, endogenous growth substances and synthetic chemicals, endogenous growth regulating substances other than hormones, tricontanol, phenols – polyamines, jasmonates, concept of death hormone, site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth development of individual group of hormones-auxins,gibberlins, cytokinins, abscisic acid and ethylene brassinosteroids.
Unit II: Hormone mutants and transgenic plants in understanding role of hormones,signal perception,transduction, and effect at functional gene level of different hormones- auxins- cell elongation, gibberellins, germination of dormant seeds, cytokinins- cell division, retardation of senescence of plant parts, abscisic acid-stomatal closure and induction of drought resistance,ethylene- fruit ripening. allelochemicals and agriculture.
Unit III: Interaction of hormones in regulation of plant growth and developmental processes, rooting of cuttings-flowering, apical dominance, molecular aspects of control of reproductive growth and development.
Unit IV: Synthetic growth regulators- classification, their effect on plant growth and development, practical utility in agriculture and horticulture.
Practical: Quantification of hormones-principles of bioassays; physico chemical techniques and assays; extraction of hormones from plant tissue; auxins-bioassays-auxins effect on rooting of cuttings; abscission; apical dominance; gibberellins-bioassays-ga effect on germination of dormant seeds; cytokinin-bioassays; cytokinin effect on apical dormancy and senescence; ethylene bioassays; effect on breaking dormancy in some seeds.

PP 505 PHYSIOLOGY OF GROWTH AND YIELD AND MODELING 1+1

Theory
Unit I: Plant growth analysis techniques, yield structure analysis, theoretical and actual yields, key growth parameters, analysis of factors limiting crop growth and productivity-the concept of rate limitation.

Unit II: Phenology-growth stages, internal and external factors influencing flowering,plant ideotypes, photoperiodic and thermo-periodic responses and the concept of degree days and crop growth duration, canopy architecture, light interception, energy use efficiency of different canopies, lai, lad, concept of optimum lai, source-sink relationships.
Unit III: Translocation of photosynthates and factors influencing transport of sucrose,physiological and molecular control of sink activity – partitioning efficiency and harvest index.
Unit IV: Apical dominanace, senescence, fruit growth, abscission, photo morphogenesis, photo receptors, phytochrome, cryptochrome.
Unit V: Physiology of flowering-photoperiodism and vernalisation.
Unit VI: Crop growth models-empirical models testing and yield prediction, simple physiological yield models-duncan's, monteith's, and passioura's.
Practical: Plant sampling for leaf area and biomass estimation; analysis of growth and yield parameters – LAD; NAR; CGR; LAI; LAR; SLA portioning efficiency HI; measurement of light interception; light extinction coefficient; energy utilization efficiency based energy intercepted; and realized; computer applications in plant physiology; crop productivity and modeling.

PP 506 PHYSIOLOGY OF CROP PLANTS – SPECIFIC CASE STUDIES 2+0
Theory
Unit I: Crop physiological aspects of rice, wheat, maize, pulses, oil seeds, apple and potato crops.
Unit II: Seed dormancy, photoperiodic and thermoperiodic responses, source-sink relationship.
Unit III: Yield structure and factors influencing yield.
Unit IV: Nutrients and other resource requirements and crop specific features.

PP 507 PHOTOSYNTHESIS AND RESPIRATION 2+1
Theory
Unit I: Photosynthesis-its significance in plant growth, development and bioproductivity, gaseous fluxes in atmosphere,physiological and biochemical aspects, chloroplast structure development and replication, ultra structure of thylakoids, photo systems, mechanism of light absorption, chloroplast electron transport chain, coupling factors and mechanisms of ATP synthesis, and concept of quantum yield, photosynthetic carbon reduction cycle and its regulation, CO_2 concentration mechanism (CCM) as a complementary strategy for carbon fixation, CCM in photosynthetic bacteria, micro algae, submerged aquatic macrophages (SAM), C_4, CAM and single celled C_4 organisms, C_3-C_4 intermediates, photorespiration and its significance, starch and sucrose synthesis and export, concept of canopy photosynthesis, influence of environmental factors such as water stress, high light stress VPD etc.
Unit II: Photosynthesis and crop productivity, energy utilization efficiency by crops, photo inhibition, photo oxidation, excitation energy dissipation mechanisms, photochemical and no-photochemical quenching of chlorophyll fluorescence, photosynthesis and transpiration interaction, significance of WUE, carbon isotope discrimination concept, prospects of improving photo synthetic rate and productivity– potential traits of photosynthesis-biotechnological approaches, molecular aspects, chloroplast genome organization, conceptual approaches of expressing C_4 photosynthesis genes in C_3 species.
Unit III: Mitochondrial respiration, growth and maintenance respiration, cyanide resistant respiration, lipid metabolism.
Practical: Extraction and separation of plant pigments, Isolation of chloroplasts ETC reactions-O_2 evolution; enzymatic determination of starch and sucrose; determination of photosynthetic rates–gas exchange; light; CO_2; VPD response curves; determination of photorespiration by gas exchange-(TPSAPS); genotypic/species differences in photosynthetic rates; measurement of radiation; Eu% light interception; determination of NH_4^+, reduction of inorganic nitrogen species; measurement of rates of respiration.

PP 508 MINERAL NUTRITION 2+1

Theory

Unit I: Overview of essential mineral elements, kinetics of nutrient uptake by plants,biological actions influencing nutrient availability near the root system, nutrient uptake by root cells, long distance transport in plants and movement into developing grains, nutrient transport from vegetative to reproductive organs during reproductive stage of growth and maturity.

Unit II: Molecular mechanism of ion uptake, ion transporters, specific examples of transporters for nitrate, phosphate, potassium and other nutrients, multiple transporters for a single ion and their functional regulation, examples of genes encoding mineral ion transporters, strategies plants adopt to acquire and transport minerals under deficient levels.

Unit III: Molecular physiology of micronutrient acquisition, nitrogen assimilation in photosynthesizing cells – NO_3^-, NO_2^- reduction, GS-GOGAT pathway, photorespiration loss of ammonia and its reassimilation and NUE.

Unit IV: Physiological and molecular mechanisms underlying differential nutrient efficiency in crop genotypes, examples of phosphorous, iron and zinc efficient crop varieties, plant responses to mineral toxicity.

Practical: Mineral nutrients; deficiency symptoms of nutrients; estimation of NO_3; physiological and biochemical changes in plants under nutrient sufficiency and deficiency levels; quantification of pigment levels.

PP 591 MASTER'S SEMINAR 1+0

CHEMISTRY AND BIOCHEMISTRY

http://hillagric.ac.in/edu/cobs/chebio.html

A. CHEMISTRY

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
CHEM 501	ESSENTIAL OF ORGANIC CHEMISTRY	3+0	I
CHEM 502	CHEMISTRY OF NATURAL PRODUCTS	2+1	I
CHEM 503	CHEMISTRY OF PESTICIDES	2+1	I
CHEM 511	MODERN ASPECT OF INORGANIC CHEMISTRY	2+0	II
CHEM 512	ANALYTICAL CHEMISTRY	2+1	II
CHEM 521	ELECTRONIC SPECTROSCOPY	1+1	II

A. CHEMISTRY

Course contents

CHEM 501 ESSENTIALS OF ORGANIC CHEMISTRY 3+0

Unit I: An elementary treatment of physical concepts in organic chemistry, bond length, bond angle, bond energy, hybridization, electro negativity.

Unit II: Dipole moment, inductive effect, electromeric effect, mesomeric effect and hyperconjugative effects, aromaticity and aromatic substitution,Stereochemistry, free radical substitution, nucleophilic and electrophilic substitution, elimination and addition reactions, Eenergy of activation and transition state, role of solvent in reaction mechanisms.

Unit III: Orbital symmetry and the chemical reactions, pericyclic reaction.

Unit IV: chemistry of natural products with special reference to carbohydrates, terpenes, steroids and alkaloids.

CHEM 502 CHEMISTRY OF NATURAL PRODUCTS 2+1

Unit I: Methods of isolation and purification of natural products, classification and configuration of sugars, ring structure of glucose, di, oligo and polysaccharides, conformation of carbohydrates.

Unit II: Isolation, determination of structure, stereochemistry and synthesis of typical members of steroids – cholesterol, bile acids, testosterone, estrone and cortisone.

Unit III: Alkaloids – nicotine, papaverine, morphine, strychnine, acticine, terpenoids – mono, sesqui and diterpenoids.

Unit IV: Structure, synthesis and properties of amino acids, peptides and nucleic acids.

Practical: Qualitative Organic compound analysis involving following steps; physical characteristics; detection of elements; detection of functional groups; identification of unknown organic compound using M.P/B.P; preparation of derivatives.

CHEM 503 CHEMISTRY OF PESTICIDES 2+1

Unit I: Introduction, classification of pesticides, chemistry of organochlorinated hydrocarbons, organophosphorus insecticides, mode of action of important insecticides and their metabolism.

Unit II: Carbamate insecticides, synthetic pyrethroides, different fungicides and herbicides, mode of action and metabolism of important insecticides.

Unit III: Pesticide residues, formulations and their characterization.

Practical: Preparation of WDP, DWT and EC formulations of different insecticides and analysis for active ingredients; residue analysis of different insecticides and gas liquid chromatography.

CHEM 511 MODERN ASPECTS OF INORGANIC CHEMISTRY 2+0

Unit I: Wave mechanical model of atom, atomic and molecular orbitals, molecular orbital Theory of simple diatomic molecules – linear combination of atomic orbitals.

Unit II: Properties of elements (Na, K, Ca, Mg, N, O, S, transition elements), their importance and uses in relation to agriculture and biochemistry.

Unit III: Crystal field Theory, complexes of transition elements and their uses.

Unit IV: Complexes of Group I and II elements and their functions in bio-system.

CHEM 512 ANALYTICAL CHEMISTRY 2+1

Unit I: Role of analytical chemistry, classification and basic principles of analytical methods.

Unit II: Introduction and applications of volumetric analysis, gravimetric estimation.

Unit III: Introduction and uses of colorimetric, spectrophotometric and flame photometric method.

Unit IV: Potentiometric, conductometric titrations and solvent extraction techniques.

Practical: Advantage of the use of equivalent system; preparation of standard solution; sources of errors and precautions in quantitative estimations; spectroscopic estimations in solutions.

CHEM 521 ELECTRONIC SPECTROSCOPY 1+1

Unit I: Electromagnetic radiation, interaction of electromagnetic radiations with matter – absorption and emission.

Unit II: Basic principles of spectrophotometry, electronic transitions, solvent effect, empirical rules of electronic transitions.

Unit III: Ultra violet spectra of dienes, conjugated polyenes, carbonyl and aromatic compounds.

Practical: Use of colorimeters and UV-visible spectrophotometer; verification of Beer;s law; qualitative and quantitative estimations.

B. BIOCHEMISTRY

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
BIOCHEM 501*****	BASIC BIOCHEMISTRY	3+1	I
BIOCHEM 502	PLANT BIOCHEMISTRY	3+0	II
BIOCHEM 503	HUMAN BIOCHEMISTRY	3+0	I
BIOCHEM 504*	ENZYMOLOGY	2+1	II
BIOCHEM 505*	INTERMEDIARY METABOLISM	3+0	II
BIOCHEM 511	CARBON AND NITROGEN METABOLISM	2+1	I
BIOCHEM 521	FOOD AND NUTRITIONAL BIOCHEMISTRY	2+1	II
BIOCHEM 531	MOLECULAR BIOLOGY	2+1	II
BIOCHEM 541	IMMUNOCHEMISTRY	2+0	I
BIOCHEM 551*	TECHNIQUES IN BIOCHEMISTRY	1+3	I
BIOCHEM 591	MASTER'S SEMINAR	1+0	I&II
BIOCHEM 592	SPECIAL PROBLEM IN M.Sc.	0+1	I&II
BIOCHEM 600	MASTER'S RESEARCH	1-18	I&II
BIOCHEM601	BIOCHEMISTRY OF BIOTIC AND ABIOTIC STRESSES	3+0	II
BIOCHEM 602**	ADVANCED MOLECULAR BIOLOGY	3+0	II
BIOCHEM 603	BIOMEMBRANES	2+0	I
BIOCHEM 604	ANVANCED ENZYMOLOGY	2+0	I
BIOCHEM 621	GENOMICS, PROTEOMICS AND METABOLOMICS	2+0	I
BIOCHEM 611**	ADVANCED TECHNIQUES IN BIOCHEMISTRY	0+2	II
BIOCHEM 691	DOCTORAL SEMINAR	1+0	I&II
BIOCHEM 692	SPECIAL PROBLEM IN Ph.D.	1+0	I&II
BIOCHEM 693	DOCTORAL RESEARCH	1-18	I&II

*Compulsory for Master's Programme.

*Compulsory course work for PG students for other disciplines as one of the minor courses.

**Compulsory for Doctoral Programme.

B. BIOCHEMISTRY

Course contents

BIOCHEM 501 BASIC BIOCHEMISTRY 3+1

UNIT I: Scope and importance of biochemistry in agriculture, fundamental principles governing life, structure of water, acid base concept and buffers, pH, hydrogen bonding, hydrophobic, electrostatic and Vander Wals forces.

UNIT II: General introduction to physical techniques for determination of structure of biopolymers, classification, structure and functions of carbohydrates, lipids and biomembranes, amino acids, proteins, and nucleic acids.

UNIT III: Structure and biological functions of vitamins, enzymes classification and mechanism of action, regulation, factors affecting enzyme action, hormones-animals and plants.

UNIT IV: Fundamentals of thermodynamic principles applicable to biological processes, bioenergetics, metabolism of carbohydrates, photosynthesis and respiration, oxidative phosphorylation, lipids, proteins and nucleic acids.

UNIT V: DNA replication, transcription and translation, recombinant DNA technology.

Practicals: Preparation of standard and buffer solutions, extraction and estimation of sugars, amino acids, estimation of proteins by Lowry's method, estimation of DNA and RNA by diphenylamine and orcinol methods, estimation of ascorbic acid, carotenoids and total phenols, separation of biomolecules by TLC and paper chromatography.

BIOCHEM 502 PLANT BIOCHEMISTRY 3+0

UNIT I: Scope and importance of biochemistry in agriculture, plant cell organelles and their separation, structure and functions of cell organelle, photosynthetic pigments in relation to their functions, photosynthesis, C3, C4 and CAM pathways, photorespiration.

UNIT II: Sucrose-starch interconversion, biosynthesis of structural carbohydrates, storage proteins and lipids, biochemistry of nitrogen fixation and nitrate assimilation, sulphate reduction and incorporation of sulphur into amino acids.

UNIT III: Biochemistry of seed germination and development, biochemistry of fruit ripening, phytohormones and their mode of action.

UNIT IV: Signal transduction, biochemistry and significance of secondary metabolites-cyanogenic glycosides, glucosinolates, phenolic compounds, terpenoids, alkaloids, plant defense system.

BIOCHEM 503 HUMAN BIOCHEMISTRY 3+0

UNIT I: Biochemistry of digestion and absorption, detoxification, respiration, biochemistry of specialized tissues – connective tissue, skin, muscle, nervous tissue.

UNIT II: Blood and other body fluids, water-electrolyte and acid-base balance, nutritional and metabolic aspects of major nutrients including vitamins and major trace elements.

UNIT III: Endocrine glands, structure and functions of hormones, immune systems, and their role in defense mechanism.

UNIT IV: Comparative nutrition of man, monogastric animals and ruminants, biochemistry of reproduction.

BIOCHEM 504 ENZYMOLOGY 2+1

UNIT I: Introduction and historic perspective, enzyme nomenclature and classification, enzyme compartmentalization in cell organelles.

UNIT II: Isolation and purification of enzymes, measurement of enzyme activity, ribozymes, isozymes, enzyme structure, enzyme specificity, active site, active site mapping, mechanism of enzyme catalysis.

UNIT III: Cofactors, coenzymes-their structure and role, enzyme kinetics, enzyme inhibition and activation, multi enzyme complexes, allosteric enzymes and their kinetics, regulation of enzyme activity, isolation and purification of enzymes.

UNIT IV: Applications of enzymes in chemical and food industry, enzyme immobilization and clinical applications of enzymes.

Practical: Isolation of soluble proteins and their characterization; enzyme assay by taking any model enzyme like ά-amylase/acid phosphatase/polyphenol oxidatse/nitrate reductase; isolation and purification of any model enzyme like ά-amylase/acid phosphatase; study of the effect of substrate concentrations; pH and inhibitors on enzyme activity; temperature stability of enzyme.

BIOCHEM 505 INTERMEDIARY METABOLISM 3+0

UNIT I: The living cell a unique chemical system, introduction to metabolism, methods of studying metabolism, transport mechanism.

UNIT II: Bioenergetics, biological oxidation, signal transduction, catabolic and anabolic pathways of carbohydrates, lipids, regulation and their metabolic disorders, energy transduction and oxidative phosphorylation.

UNIT IIII: General reactions of amino acid metabolism, degradative and biosynthetic pathways of amino acids and their metabolic disorders, sulphur metabolism, metabolism of nucleotides, nucleic acids and proteins.

UNIT IV: Metabolic engineering concepts, compartmentation of metabolic pathways, metabolic profiles of major organs and regulation of metabolic pathways.

BIOCHEM 511 CARBON AND NITROGEN METABOLISM 2+1

UNIT I: Carbon metabolism, synthesis of sucrose, regulation of sucrose phosphate synthesis, transport of sucrose, phloem loading and unloading, synthesis of starch in leaves and seeds, concept of transitory starch.

UNIT II: Synthesis of fructose, galactomannans raffinose series oligosaccharides and trehalose, nitrogen cycle-biochemistry of nitrate assimilation and its regulation, GS/GOGAT and GDH pathway,

UNIT III: Ureides and amides as nitrogen transport compounds, chemoautotrophy in denitrifying bacteria, biological nitrogen fixation, structure function and regulation of nitrogenase, *nif* genes and their regulation, biochemical basis of legume-Rhizobium symbiosis, genes involved in synthesis.

Practical: Estimation of nitrite content; estimation of protein by Lowry's method; estimation of starch; estimation of nitrate content by hydrazine sulphate reduction method, i*n vivo* assay of nitrate reductase activity; assay of nitrite reductase/glutamine synthetase/ glutamate dehydrogenase activity.

BIOCHEM 521 FOOD AND NUTRITIONAL BIOCHEMISTRY 2+1

UNIT I: Fundamentals of human nutrition, concept of balanced diet, biochemical composition, energy and food value of various food grains (including cereals, pulses, oilseeds).

UNIT II: Fruits and vegetables, physico-chemical, functional and nutritional characteristics of carbohydrates, proteins and fats and their interactions (emulsions, gelation, browning etc.), biochemical and nutritional aspects of vitamins, minerals nutraceuticals.

UNIT III: Antinutritional factors, biochemistry of post harvest storage, effect of cooking, processing and preservation of different food products on nutrients, biochemical aspects of food spoilage, role of lipase and lipoxygenase, oxidative rancidity and antioxidants.

UNIT IV: Enzymes in food industry, food additives (coloring agents, preservatives etc.), concepts of food flavours and aroma, nutritional quality of plant, dairy, poultry and marine products.

Practical: Estimation of starch; lipid/oil; phenols in plant tissue/sample; estimation of carotenoids; estimation of trypsin inhibitor/polyphenol oxidase activities in seeds/leaves; estimation of vitamin C in fruits; reducing & non reducing sugar in fruits; estimation of protein content; estimation of dietary fibre; determination of limiting amino acids; estimation of phytate/oxalate and tannins; estimation of minerals using spectrophotometer and flame photometer.

BIOCHEM 531 MOLECULAR BIOLOGY 2+1

UNIT I: Historical development of molecular biology, nucleic acids as genetic material, chemistry and structure of DNA and RNA, genome organization in prokaryotes and eukaryotes, chromatin structure and function.

UNIT II: DNA replication, DNA polymerases, topoisomerases, DNA ligase, reverse transcriptase, repetitive and non-repetitive DNA, satellite DNA, transcription process, RNA editing, RNA processing, ribosomes structure and function, organization of ribosomal proteins and RNA genes, genetic code, aminoacyl tRNA synthases.

UNIT III: Inhibitors of replication, transcription and translation, translation and post translational modification, nucleases and restriction enzymes, regulation of gene expression in prokaryotes and eukaryotes, DNA sequencing, recombinant DNA technology.

UNIT IV: Vectors, isolation of genes, recombinants vector, selection of recombinants, principle and applications of PCR, Southern and Northern blotting.

Practical: Isolation and purification of DNA and RNA from different sources; check of purity of isolated DNA and RNA; separation of DNA and proteins by PAGE; RAPD, PCR and isozyme analysis experiments.

BIOCHEM 541 IMMUNOCHEMISTRY 2+0

UNIT I: History and scope of immunology, antigens, adjuvants, immune system, organs, tissues and cells, immunoglobulins, molecular organization of immunoglobulin.

UNIT II: Classes of antibodies, antibody diversity, theories of generation of antibody diversity, vaccine, monoclonal antibodies, polyclonal antibodies, hybridoma, recombinant antibodies, complement system-classical and alternate.

UNIT III: Cellular interactions in the immune response, major histocompatibility complex, cell mediated immune response, cytokines. immunoregulation, immunological tolerance, hypersensitivity, mechanisms of immunity.

UNIT IV: Innate resistance and specific immunity, current immunological techniques-ELISA, RIA.

BIOCHEM 551 TECHNIQUES IN BIOCHEMISTRY 1+3

UNIT I: Chromatographic and electrophoretic methods of separation, principles and applications of paper, thin layer, gas, gas-liquid, liquid chromatography and HPLC.

UNIT II: Paper and gel electrophoresis, different variants of polyacrylamide gel electrophoresis (PAGE) like native and SDS-PAGE, 2D-PAGE, capillary electrophoresis, gel filtration, affinity chromatography.

UNIT III: Centrifugation, principles and applications of spectrophotometry (UV-Visible, IR, NMR).

UNIT IV: Tracer techniques in biology, concept of radioactivity, radioactivity counting methods with principles of different types of counters.

UNIT V: Concept of scintillation counters, autoradiography, applications of radioactive tracers in biology.

Practical: Determination of absorption maxima of some important chemicals from their absorption spectra, pH, and preparation of buffers; estimation of biomolecule using spectrophotometer, flame photometer and atomic absorption spectrophotometer, separation of carbohydrates and amino acids by paper chromatography, separation of lipids by thin layer and column chromatography; estimation of iodine and peroxide value; separation of proteins by ion exchange and gel filtration chromatography; electrophoretic techniques to separate proteins and nucleic acids; centrifugation- cell fractionation; application of GLC and HPLC in separation of biomolecules.

BIOCHEM 601 BIOCHEMISTRY OF BIOTIC AND ABIOTIC STRESSES 3+0

UNIT I: Plant-pathogen interaction and disease development, molecular mechanisms of fungal and bacterial infection in plants, changes in metabolism.

UNIT II: Cell wall composition and vascular transport in diseased plants, plant defense response, antimicrobial molecules, genes for resistance, hypersensitive response and cell death, systemic and acquired resistance.
UNIT III: Plant viruses, host-virus interactions, disease induction, virus movement, and host range determination, viroids, pathogen-derived resistance, biochemical basis of abiotic stresses namely osmotic (drought, salinity), temperature.
UNIT IV: Heavy metals, air and water pollutants; interaction between biotic and abiotic stresses, stress adaptation, reactive oxygen species and biotic and abiotic stress, antioxidants, pathogenesis related proteins, phytoalexins.
UNIT V: Enzymes defense system, role of calcium and salicylic acid in plant development, molecular strategies for imparting tolerance against biotic and abiotic stress.

BIOCHEM 602 ADVANCED MOLECULAR BIOLOGY 3+0

UNIT I: Organization of prokaryotic genome, nuclear and organelle genes, concept of genome mapping, molecular evolution, cell development and differentiation.
UNIT II: Prokaryotic and eukaryotic gene regulation, RNA editing, molecular biology of viruses, methods of gene isolation and transfer in plants and animals, molecular basis of male sterility.
UNIT III: Application of genetic engineering in different fields, site directed mutagenesis, gene targeting and gene therapy, bioethics and biosafety guidelines and IPR in recombinant DNA research.

BIOCHEM 603 BIOMEMBRANES 2+0

UNIT I: Concept of biomembranes and their classification based on cellular organelles, physico-chemical properties of different biological and artificial membranes, cell surface receptors and antigen.
UNIT II: Membrane biogenesis and differentiation, membrane components-lipids, their distribution and organization, proteins, intrinsic and extrinsic, their arrangement, carbohydrates in membranes and their function.
UNIT III: Various membrane movements, transport across membrane and energy transduction, role of membrane in cellular metabolism, cell recognition and cell to cell interaction, signal transduction, recent trends and tools in membrane research.

BIOCHEM 604 ADVANCED ENZYMOLOGY 2+0

UNIT I: Theory of enzymatic catalysis, specificity, concept of active site and enzyme substrate complex, active site mapping, factors associated with catalytic efficiency.
UNIT II: Induced fit hypothesis, mechanism of enzyme reactions, effect of different factors affecting enzyme activity, transition state Theory, Arrhenius equation, determination of energy of activation.
UNIT III: Kinetics of pH and temperature and determination of pKa and ΔH of active site amino acids, enzyme kinetics, kinetics of mixed inhibitions, substrate and product inhibition.
UNIT IV: Role of enzymes in regulation of metabolism, allosteric enzymes and their kinetics, bifunctional enzymes, enzyme engineering.

BIOCHEM 611 ADVANCED TECHNIQUES IN BIOCHEMISTRY 0+2

UNIT I: Isolation and purification of protein from microbial/plant/animal source.
UNIT II: Electrophoretic separation of protein, determination of molecular weight of protein using PAGE/ gel filtration method.
UNIT III: Experiments on DNA and RNA, isolation, agarose gel electrophoresis of DNA, isolation of chloroplast and mitochondria by differential centrifugation and their purification by density gradient centrifugation, isolation and purification of enzymes, PCR, RAPD analysis of DNA (isozymic analysis).
UNIT IV: Enzyme immobilization, experiments on application of UV-VIS spectrophotometer, flame photometer, atomic absorption spectrophotometer, GLC and HPLC in separation of biomolecules determination.

BIOCHEM 621 GENOMICS, PROTEOMICS AND METABOLOMICS 2+0

UNIT I: Protein and nucleic acid sequencing, various methods of sequencing including automated sequencing and microarrays, whole genome sequence analysis.

UNIT II: Comparative genomics, functional genomics, transcriptomics, gene identification, gene annotation, pair wise and multiple alignments, application of genomics, quantitative PCR, SAGE, MPSS, microarray.

UNIT III**:** Proteome technology-2D-PAGE, MSMS, MALDI-TOF, protein micro array, comparative proteomics and structural proteomics,metabolic pathway engineering,vitamin A engineering in cereals, microarray analysis, role of bioinformatics in functional genomics.

BIOCHEM 591	**MASTER'S SEMINAR**	**1+0**
BIOCHEM 592	**SPECIAL PROBLEM IN M.Sc.**	**0+1**
BIOCHEM 600	**MASTER'S RESEARCH** (VARIABLE CREDIT HOURS)	**1-18**
BIOCHEM 691**	**DOCTORAL SEMINAR**	**1+0**
BIOCHEM 692	**SPECIAL PROBLEM IN Ph.D.**	**1+0**
BIOCHEM 700	**DOCTORAL RESEARCH** (VARIABLE CREDIT HOURS)	**1-18**

GEO-INFORMATICS

http://14.139.224.135/myapp/cgrt/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
GIS 501	GEOGRAPHIC INFORMATION SYSTEM AND ITS APPLICATION	2+1	I&II
GIS 502	REMOTE SENSING AND ITS APPLICATION	2+1	I&II
GIS 503	ADVANCED TECHNIQUES IN GEO-INFORMATICS	1+1	I&II
GIS 591	MASTER'S SEMINAR	1+0	I&II

Course contents

GIS 501 GEOGRAPHIC INFORMATION SYSTEM AND ITS APPLICATION 2+1

Theory: From real world to GIS, history and concepts of geographic information system, map concepts - map elements, map scales, map legends and map reading, contours, land forms, map projection – coordinate system, datum and projection systems, geo-referencing and digitization, database development and management, data structures, data acquisition, data manipulation, data acquisition through global positioning system, analysis, spatial and non-spatial data integration and thematic mapping, applications of geographic information system.

Practical: GIS Softwares' introduction: ILWIS and ArcGIS (ArcMap, ArcView, ArcInfo); hands-on exercises on map reading, GPS based/ hard copies data acquisition, geo-referencing, digitization, relational data base management (RDBMS), thematic mapping, applications to resources' inventorying, application project in the field of specialization using GIS technologies.

GIS 502 REMOTE SENSING AND ITS APPLICATION 2+1

Theory: Overview of earth, definition of remote sensing, present status of remote sensing in india and abroad, remote sensing satellites, sensors, satellite imageries (definition and procurement), spectral signatures, geo-referencing and geometric correction, image interpretation, analysis and classification (supervised and unsupervised), applications of remote sensing (natural resource management using remote sensing data)

Practical: Remote sensing software's introduction-ERDAS IMAGINE 9.1 and ENVI 4.2, hands-on exercises on procurement procedure of remote sensing data through internet, importing remote sensing data to remote sensing software, geo-processing, image analysis, color visualization, classifications, land-use/land-cover monitoring, application project in the field of specialization using remote sensing technologies.

GIS 503 ADVANCED TECHNIQUES IN GEO-INFORMATICS 1+1

Theory: Data quality and data mining, spatial topology, map algebra techniques for spatial analysis, DEM/DTM, normalised difference vegetation index (NDVI), crop acreage/monitoring through RS data and verification through field survey.

Practical: Spatial statistical analysis, proximity analysis (markets, public distribution system, service prodders etc), spatial impact of various development schemes, contour line feature extraction, DEM generation, slope, aspect, area calculation and interpretation; drainage network for watershed programmes; classification of multi spectral images, change detection through NDVI, resource monitoring

GIS 591 MASTER'S SEMINAR 1+0

MICROBIOLOGY

www.hillagric.ac.in/edu/cobs/microbiology/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
MICRO 501*	PRINCIPLES OF MICROBIOLOGY	2+1	I
MICRO 502*	MICROBIAL TAXONOMY	2+1	II
MICRO 503*	MICROBIAL PHYSIOLOGY AND METABOLISMS	2+1	II
MICRO 504*	MICROBIAL GENETICS	2+1	II
MICRO 505*	TECHNIQUES IN MICROBIOLOGY	0+2	I
MICRO 511	SOIL MICROBIOLOGY	2+1	I
MICRO 512	MICROBIAL MANAGEMENT OF ORGANIC WASTES	2+1	I
MICRO 513	BIOFERTILIZER TECHNOLOGY	2+1	I
MICRO 514	MICROBIAL CONTROL OF CROP PESTS AND DISEASES	1+1	I
MICRO 521	PLANT-MICROBE INTERACTIONS	2+1	II
MICRO 522	ENVIRONMENTAL MICROBIOLOGY	2+1	II
MICRO 531	FOOD MICROBIOLOGY	2+1	I
MIRO 532	DAIRY MICROBIOLOGY	2+1	II
MICRO 541	INDUSTRIAL MICROBIOLOGY	2+1	II
MICRO 542	MICROBIAL BIOTECHNOLOGY	2+1	I
MICRO 551	INTRODUCTION TO HUMAN MICROBIAL PATHOGENS	2+1	I
MICRO 591	MASTER'S SEMINAR	1+0	I &II
MICRO 592	SPECIAL PROBLEM IN M.Sc.	0+1	I&II
MICRO 599	MASTER'S RESEARCH	20	I&II
MICRO 601**	CURRENT TOPICS IN MICROBIOLOGY	2+1	I
MICRO 602**	ADVANCES IN MICROBIAL PHYSIOLOGY	2+0	II
MICRO 603**	ADVANCES IN MOLECULAR MICROBIOLOGY	2+0	I
MICRO 611	ADVANCES IN AGRICULTURAL MICROBIOLOGY	2+1	II
MICRO 612	ADVANCES IN ENVIRONMENTAL MICROBIOLOGY	2+1	I
MICRO 621	ADVANCES IN FERMENTATION TECHNOLOGY	2+1	II
MICRO 622	ADVANCES IN FOOD MICROBIOLOGY	2+1	I
MICRO 691	DOCTORAL SEMINAR	1+0	I&II
MICRO 692	DOCTORAL SEMINAR	1+0	I&II
MICRO 693	SPEICAL PROBLEM IN Ph.D.	0+1	I&II
MICRO 699	DOCTORAL RESEARCH	0+45	I&II

* Compulsory for Master's Programme **Compulsory for Doctoral Programme

MICROBIOLOGY

Course contents

MICRO 501 PRINCIPLES OF MICROBIOLOGY 2+1

UNIT I: Historical developments in microbiology, scope and importance, classification of microorganisms, structure and function of prokaryotic and eukaryotic cells.

UNIT II: Nutrition & metabolism; microbial growth, cultivation of microorganisms, pure culture techniques, genetic recombination in microorganisms.

UNIT III: Microorganisms and geochemical changes, application of microorganisms in industry and agriculture.

Unit IV: Interactions among microorganisms and host, immunology, antigens, antibodies and their reactions.

Practical: Microscopy; staining; sterilization; media preparation; methods of isolation, purification and maintenance of microorganisms; enumeration of microorganisms; morphological, biochemical and serological tests for identification of microbial cultures; antibiotic resistance and sensitivity assay; tests for coliforms.

MICRO 502 MICROBIAL TAXONOMY 2+1

Unit I: General introduction, microbial evolution & diversity, taxonomic ranks, classification systems-phenetic classification, numerical taxonomy and phylogenetic classification, classical and molecular characteristics used in classification.

Unit II: classification of bacteria-proteobacteria, Deinococcus & nonproteobacteria, low & high G+C Gram positives and Archaea.

Unit III: fungi-classification, structure, characteristics of fungi, slime molds and water molds.

Unit IV: algae-classification, structure and characteristics of algae, protozoa-morphology, encystment and excystment and various representative types, methods of classification of viruses.

Practical: Examination of various types of microorganisms and their cell structures; cultural characteristics; identification of bacteria by biochemical & molecular techniques; exposure for submission of cultures & sequences.

MICRO 503 MICROBIAL PHYSIOLOGY AND METABOLISMS 2+1

Unit I: Structure and function of various cellular components of microorganisms, cell membrane permeability and transport of nutrients.

Unit II: Microbial growth, effect of physical and chemical agents on growth, death in term of mathematical models, batch, continuous and synchronous growth.

Unit III: Sporulation, energy yielding metabolic pathways, biosynthesis and polymerization.

Unit IV: Enzymes and regulation of their activity and synthesis.

Practical: Growth of microorganisms utilizing various carbon and nitrogen sources, measurement of growth and cell size; factors affecting growth; aerobic and anaerobic respiration; cellular composition; sporulation and spore germination; measurement of macromolecules; induction and repression of enzyme synthesis.

MICRO 504 MICROBIAL GENETICS 2+1

Unit I: Nature and function of genetic material in microorganisms, adaptation and mutation, types of mutations and mutation induction, molecular basis of mutation.

Unit II: Exchange of genetic material in microorganisms - transformation, conjugation and transduction, cell fusion.

Unit III: Extra chromosomal genetic elements - plasmids, transposons and insertion elements, genetic organization and fine structure analysis of phage genome.

Unit IV: Genetic mapping, recombinant DNA technology, genetic improvement of industrially important microorganisms.

Practical: Induction of mutation in bacteria through physical; chemical and biological agents; and studying the mutation rate; replica plating techniques; isolation of auxotrophic mutants; demonstration of extra chromosomal genetic elements; experiments on transformation; transduction and conjugation; observation of genetic variation in yeasts.

MICRO 505 TECHNIQUES IN MICROBIOLOGY 0+2

Unit I: Microscopy and its applications, preparation and sterilization of culture media and glassware, isolation and characterization of microorganisms.

Unit II: Maintenance and preservation of microbial cultures, growth parameters, fluctuation test and replica plating techniques.

Unit III: Application of spectrophotometry, centrifugation, GLC, HPLC, chromatography, electrophoresis, sonication, etc.

Unit IV: Antibiotic sensitivity test, precipitation, agglutination and immunodiffusion tests.

MICRO 511 SOIL MICROBIOLOGY 2+1

Unit I: Introduction to soil microbiology, nature and classification of soil microorganisms, growth, nutrition and physiology.

Unit II: Methods of studying soil microorganisms, unculturable soil biota, organic matter decomposition-humus formation, mineralization and transformation of nutrients, biological nitrogen fixation.

Unit III: Pesticide degradation, ecological interrelationships, soil enzymes.

Unit IV: Production & use of bio-fertilizers and their associated problems.

Practical: Isolation; characterization and enumeration of soil microorganisms; microbial biomass determination; degradation of organic matter; nitrogen mineralization; nitrogen fixation; nitrogenase assay; phosphate solubilization and sulphur oxidation; soil enzymes; study of rhizosphere.

MICRO 512 MICROBIAL MANAGEMENT OF ORGANIC WASTES 2+1

Unit I: Organic wastes in the biosphere-tropical, temperate and forest ecosystems, composition, source and quantum of wastes.

Unit II: Decomposition of the organic wastes-aerobic and anaerobic degradation; different composting systems.

Unit III: Disposal of solid & liquid wastes; microbial degradation of pesticides.

Unit IV: Microbial conversion to useful products, bioremediation.

Practical: Quantitative and qualitative enumeration of microorganisms in organic wastes; preparation of different composts; determination of C:N ratio; BOD and COD analysis; degradation of industrial wastes; visit to a sewage treatment plant.

MICRO 513 BIOFERTILIZER TECHNOLOGY 2+1

Unit I:Introduction, microorganisms as biofertilizers, nitrogen fixers, phosphate solubilizing and mobilizing microorganisms.

Unit II: Organic matter decomposers and biocontrol microbial inoculants.

Unit III: Principles of mass production of bio-fertilizers; preparation and use of inoculants.

Unit IV: Quality control and BIS standards; problems and prospects.

Practical: Isolation; characterization and mass production of Rhizobium; Azotobacter; Azospirillum; organic matter decomposer; phosphate solubilizers; Nitrogen fixing activity; indole acetic acid and siderophore production; bioinoculant production and quality control.

MICRO 514 MICROBIAL CONTROL OF CROP PESTS AND DISEASES 1+1

Unit I: Microflora associated with the healthy and diseased insects, parasitism and symbiosis.

Unit II: Symptom logy and diagnosis of microbial diseases of insects, endo- and ecto-toxins production by Bacillus thuringiensis, B. popillae and their mode of action.

Unit III: Fungal pathogens of insects; control of plant root pathogens, control of aerial plant pathogens, prophylaxis, preinoculation, and immunization, microorganisms as healing agents in plants.
Unit IV: Mass production techniques of microbial biocontrol agents.
Practical: Isolation and identification of the external and internal microflora of insects; microbiological examination of diseased insects and isolation of the insect pathogens; assessing the lethal dose of the pathogens; demonstration of Koch's postulates; mass multiplication of insect pathogens; mass production and application methods of bio-control agents.

MICRO 521 PLANT-MICROBE INTERACTIONS 2+1
Unit I: Introduction to plant-microbes interactions, soil-plant-microbe interactions leading to symbiotic, associative, endophytic and pathogenic interactions.
Unit II: Molecular aspects of interactions, methodologies involved in studying plant-microbe interactions.
Unit III: Concept and dynamics of ecosystem, food chain and energy flow.
Unit IV: Transgenic microbes-plants interactions.
Practical: Microbial studies of rhizosphere & phyllosphase, isolation & characterization of mycorhizae; endophytic bacteria and fungi; soil enzymes.

MICRO 522 ENVIRONMENTAL MICROBIOLOGY 2+1
Unit I: Distribution of microorganisms in different eco-systems and their involvement in environmental quality.
Unit II: Life under environmental stresses, role of microorganisms in environmental pollution and its control, microbes as tools in environmental quality.
Unit III: Microbiology of soil, air, water, sludge, sewage, rumen, etc., treatment of solid and liquid wastes.
Unit IV: Microbiological control of insects, pests and pathogens, microorganisms and geochemical changes, biotransformation and biodegradation, xenobiotic compounds, resource recovery.
Practical: Isolation and characterization of microflora from polluted environments; studies of thermophiles; psychrophiles; halophiles, etc.; microbiological analysis of water; waste water;sludge; rumen; biogas plant slurry; composting systems; measurement of BOD; COD; visit to potable water and sewage treatment plants.

MICRO 531 FOOD MICROBIOLOGY 2+1
Unit I: Introduction to food microbiology, microbes in raw and processed foods, food spoilage and preservation, factors affecting microbial activity in foods.
Unit II: Antimicrobial substances in foods, food poisoning and food infections, microbial toxins.
Unit III: Bioassay methods, methods of food preservation, fermented food products, microbes as food, recycling and waste disposal from food industries.
Unit IV: Legislation and bacteriological standards for different foods.
Practical: Procedures for food sampling; microbiological examination of different foods; effect of physical and chemical methods of food preservation on microbial growth; testing of antimicrobial agents for food preservation; enumeration and characterization of various food poisoning microorganisms; microbiological bioassay; bacteriological examination of water; BOD and COD of effluents.

MICRO 532 DAIRY MICROBIOLOGY 2+1
Unit I: Introduction to dairy microbiology, microbiology of milk,characterization and classification of microorganisms present in milk and milk products.
Unit II: Diseases transmitted through milk and dairy products, starter cultures in dairy products, maintenance, propagation and use.

Unit III: Fermented milk products, microbial and technological processes, dairy plant sanitization, recycling and waste disposal.
Unit IV: Utilization of by-products, legislation and bacteriological standards for milk and milk products.
Practical: Isolation and characterization of milk microorganisms; microbiological successions in milk and dairy products; effect of physical and chemical agents on the shelf life of milk and milk products; preservation action of salt; sugar and acids; bacteriological examination of milk and milk products; dye reduction tests; preparation of lactic starter cultures and their use; microbiological examination of water.

MICRO-541 INDUSTRIAL MICROBIOLOGY 2+1
Unit I: Historical development of industrial microbiology, isolation, characterization, maintenance and improvement of industrially important microorganisms, substrates for industrial fermentation.
Unit II: Concepts of industrial fermentation-batch and continuous, single cell protein.
Unit III: Microbial production and recovery of vinegar, alcohol, undistilled and distilled liquors, organic acids, enzymes, vitamins, biofertilizers, bio-insecticides etc.
Unit IV: Biosynthesis of antibiotics, immobilized biocatalysts–propagation and industrial use, biosensor, microbial assay, effluent treatment.
Practical: Isolation and screening of industrially useful microorganisms and their growth characteristics; preparation of inoculum and fermentation media; production of alcohol; organic acids; enzymes and antibiotics; immobilization techniques and their use; bio assay techniques; BOD and COD of effluents.

MICRO-542 MICROBIAL BIOTECHNOLOGY 2+1
Unit I: Recent concepts and developments in microbial biotechnology, microbial assay, bioreactors, biosensors.
Unit II: Microorganisms used in biotechnology, genetic improvement of microorganisms, use of microorganisms in various technological processes-alcohols, organic acids, organic solvents, antibiotics, vitamins, malting, brewing, yeast production, enzyme production, steroids transformation, microbial insecticides, pro-biotics, etc..
Unit III: Immobilized biocatalysts - enzyme, whole cell, batch and continuous cultures.
Unit IV: Microbial cultures of economic importance-production, use, technical and economic feasibility, retting of flax.
Practical: Isolation of industrially important microorganisms; their maintenance and improvement; production of industrial compounds; study of bioreactor and immobilized biocatalysts microbial retting of flax.

MICRO 551 INTRODUCTION TO HUMAN MICROBIAL PATHOGENS 2+1
Unit I: Introduction, morphology, physiology and identification of microorganisms of clinical significance.
Unit II: Sterilization and disinfection.
Unit III: Infection, immunity and immunological techniques, normal flora of human body.
Unit IV: Common diseases in human beings caused by bacteria, viruses and fungi.
Practical: Microbiological processing of clinical samples; identification and characterization of causative microorganisms; antibiotics sensitivity tests; techniques involved in antigen antibody reaction.

MICRO 591 MASTER'S SEMINAR 1+0
MICRO 592 SPECIAL PROBLEM IN M. Sc. 0+1
MICRO 599 MASTER'S RESEARCH 0+20

MICRO 601 CURRENT TOPICS IN MICROBIOLOGY 2+1
Unit I: Microbial systematic-recent concepts used in microbial classification.
Unit II: Current concepts on microbial structures and functions.

Unit III: Microbiological assay methods.
Unit IV: Current topics on diverse groups of microorganisms including viruses.
Practical: Examination and cultivation of diverse groups of microorganisms, application of serological & molecular techniques in microbial taxonomy.

MICRO 602 ADVANCES IN MICROBIAL PHYSIOLOGY 2+0
Unit I: Current topics in microbial physiology.
Unit II: Biomolecules, regulatory control mechanisms, catabolic repression.
Unit III: Kinetics of microbial growth, membrane fluidity, transport of nutrients.
Unit IV: Physiology of thermophilic, halophilic, and other extremophilic microorganisms.

MICRO 603 ADVANCES IN MOLECULAR MICROBIOLOGY 2+0
Unit I: Current topics on molecular aspects of microbial structure and functions.
Unit II: Genetic organization; gene expression, genetic recombination.
Unit III: Bacterial plasmids, insertion sequences, transposons.
Unit IV: Recombinant DNA technology and viriods & prions.

MICRO 611 ADVANCES IN AGRICULTURAL MICROBIOLOGY 2+1
Unit I: Latest concept in taxonomy of nitrogen fixing microorganisms, mechanism of nitrogen fixation.
Unit II: Molecular basis of legume-microbes interaction, genetics and regulation of nitrogen fixation,
Unit III: Interaction between agricultural chemicals, pollutants and soil microorganisms.
Unit IV: Bio-inoculants, plant growth promoting rhizobacteria, nutrient cycles of biosphere, and recent aspects on microbial decomposition.
Practical: Isolation; screening and mass multiplication of microorganisms used as bio-inoculants; BIS standards for bio-inoculants; field evaluation studies with bio-inoculants; studies on plant growth promoting rhizobacteria under field conditions.

MICRO 612 ADVANCES IN ENVIRONMENTAL MICROBIOLOGY 2+1
Unit I: Microbiological aspects of different ecological systems and their management.
Unit II: Microbiological management of solid and liquid wastes.
Unit III: Bioreactors, bioremediation, eutrofication, biomagnifications, disposal of medical wastes.
Unit IV: Legislation on waste disposal systems.
Practical: Studies of microorganisms from different ecological niches including polluted environment; microbiological and chemical analysis of waste waters; industrial effluents and sewage etc.; microorganisms as index of environ mental quality.

MICRO 621 ADVANCES IN FERMENTATION TECHNOLOGY 2+1
Unit I: Perspectives of fermentation technology, fermentor designs and process development,
Unit II: Mother cultures and their mass cultivation.
Unit III: Fermentation kinetics and control, recovery of microbial products, enzyme immobilization, energy and liquid fuel from renewable energy resources.
Unit IV: Genetic engineering and its applications in fermentation technology.
Practical: Studies on selected microbial fermentation processes in batch; semi-continuous and continuous types of reactors; field visits to fermentation industries.

MICRO 622 ADVANCES IN FOOD MICROBIOLOGY 2+1
Unit I: Significance of microorganisms and their enzymes in food and diary industry.
Unit II: Current concepts of food and diary industry, current concepts of food spoilage & preservation, food poisoning and infection.
Unit III: Microbiological standards, regulations and legislation in food and diary industry.

Unit IV: Genetic improvement of microorganisms used in food and dairy industry.

Practical: Isolation; screening and mass multiplication of microorganisms used in the preparation of various fermented food products; studies on food spoilage; microorganisms; microbiological investigations on important food infections and poisoning cases; field visit(s) to food processing industries.

MICRO 691	**DOCTORAL SEMINAR I**	**1+0**
MICRO 692	**DOCTORAL SEMINAR II**	**1+0**
MICRO 693	**SPECIAL PROBLEM IN Ph.D.**	**0+1**
MICRO 699	**DOCTORAL RESEARCH**	**0+45**

PHYSICAL SCIENCES AND LANGUAGES

http://hillagric.ac.in/edu/cobs/physcilan.html

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
STAT 500#	INTRODUCTION TO STATISTICS	1+1	I
STAT 501	MATHEMATICAL METHODS FOR APPLIED SCIENCES	2+0	I
STAT 511*	STATISTICAL METHODS FOR APPLIED SCIENCES	3+1	I&II
STAT 512	EXPERIMENTAL DESIGNS	2+1	II
STAT 513	SAMPLING TECHNIQUES	2+1	II
STAT 521	APPLIED REGRESSION ANALYSIS	2+1	II
STAT 531	DATA ANALYSIS USING STATISTICAL PACKAGES	2+1	I
STAT 591	MASTER'S SEMINAR	1+0	I&II
STAT 541+	MATHEMATICAL STATISTICS	3+0	II
STAT 542+	STATISTICAL INFERENCE	2+0	I
STAT 543+	LINEAR MODEL AND REGRESSION ANALYSIS	2+0	II
COMP 501*	COMPUTER FUNDAMENTALS AND PROGRAMMING	2+1	I&II
COMP 502	INTRODUCTION TO NETWORKING AND INTERNET APPLICATIONS	1+1	I&II

For those who have not studied any course in Statistics at UG level
* Compulsory for all Master's programme
+ For Ph. D. Students only

PHYSICAL SCIENCES AND LANGUAGES

Course contents

STAT 500 INTRODUCTION TO STATISTICS 1+1

Theory

UNIT I: Introduction to Statistics and summarization of data, frequency distribution and its graphical representation, characteristics of frequency distribution and their measures.

UNIT II: Elements of probability.

UNIT III: Simple correlation and regression.

UNIT IV: Sampling and tests of significance, analysis of variance and its application.

UNIT V: Vital statistics methods.

Practical: Construction and graphical representation of frequency distribution; calculations of measures of central tendency; dispersion; skewness and kurtosis; correlation and regression analysis; one sample and two samples tests for mean; analysis of variance–one way and two way classified data; calculations of vital statistics.

STAT 501 MATHEMATICAL METHODS FOR APPLIED SCIENCES 2+0

Theory

UNIT I: Variables and functions, limit and continuity, specific functions, differentiation, theorems of differentiation, differentiation of logarithmic, trigonometric, exponential and inverse functions, function of a function, derivative of higher order, partial derivatives, application of derivatives in agricultural research, determination of points of inflexion, maxima and minima in optimization etc.

UNIT II: Integration as a reverse process of differentiation, methods of integration, reduction formulae, definite integral, applications of integration in agricultural research with special reference to economics and genetics, engineering, etc.

UNIT III: Vectors and vector spaces, matrices, notations and operations, laws of matrix algebra, transpose and inverse of matrix, eigen values and eigen vectors, determinants-evaluation and properties of determinants, application of determinants and matrices in solution of equation for economic analysis.

UNIT IV: Set Theory- set operations, finite and infinite sets, operations of set, function defined in terms of sets.

STAT 511 STATISTICAL METHODS FOR APPLIED SCIENCES 3+1

Theory

UNIT I: Theory of probability, random variable and mathematical expectation, discrete and continuous probability distributions: binomial, Poisson, negative binomial, normal distribution and their applications.

UNIT II: Introduction to Theory of estimation and confidence intervals, concept of sampling distribution and test of significance, chi-square, t and F distributions, and their applications in tests of significance.

UNIT III: Non-parametric tests - sign, Wilcoxon, Mann-Whitney U-test, run test and, median test.

UNIT IV: Correlation and regression, simple and multiple linear regression model, least squares technique, estimation of parameters, predicted values and residuals, correlation coefficient, rank correlation, partial and multiple correlation coefficients, coefficient of determination, test of significance of correlation and regression coefficients, non-linear regression- polynomial, exponential and logarithmic.

Practical: Fitting of distributions-binomial; Poisson; negative binomial and normal; large sample tests; testing of hypothesis based on exact sampling distributions-chi-square; t and F; nonparametric tests; estimators for population parameters and their properties; correlation and regression analysis; fitting of non-linear regression.

STAT 512 EXPERIMENTAL DESIGNS 2+1

Theory

UNIT I: Need for designing of experiments, characteristics of a good design, basic principles of designs - randomization, replication and local control.

UNIT II: Uniformity trials, analysis of variance and interpretation of data, transformations, orthogonality and partitioning of degrees of freedom.

UNIT III: Completely randomized design, randomized block design and Latin square design, repeated Latin square design, analysis of covariance and missing plot techniques in randomized block and Latin square designs.

UNIT IV: Factorial experiments (symmetrical as well as asymmetrical), confounding in symmetrical factorial experiments, factorial experiments with control treatment.

UNIT V: Split plot and strip plot designs, crossover designs, balanced incomplete block design, lattice design-concepts, randomization procedure, analysis and interpretation of results, experiments with mixtures.

Practical: Analysis of data obtained from CRD, RBD, LSD; analysis of factorial experiments with and without confounding; analysis with missing data; balanced incomplete block design; split plot and strip plot designs; transformation of data; analysis of lattice design.

STAT 513 SAMPLING TECHNIQUES 2+1

Theory

UNIT-I: Concept of sampling, sampling from a finite population, sample survey and complete enumeration, sampling and non-sampling errors, planning of sample survey, preparation of questionnaire.

UNIT II: Simple random sampling, sampling for proportion, determination of sample size, inverse sampling; stratified sampling, systematic sampling.

UNIT III: Cluster sampling, multi-stage sampling, double sampling, PPS sampling, use of auxiliary information at estimation as well as selection stages.

UNIT IV: Ratio and regression methods of estimation.

Practical: Simple random sampling-use of random number tables; concepts of unbiasedness; variance; etc.; determination of sample size; inverse sampling; stratified sampling; systematic sampling; cluster sampling; estimation using multistage design; double sampling; PPS sampling; estimation using ratio and regression estimators.

STAT 521 APPLIED REGRESSION ANALYSIS 2+1

Theory

UNIT I: Introduction to correlation analysis and its measures, correlation from grouped data, biserial correlation, rank correlation, testing of population correlation coefficients, multiple and partial correlation coefficients and their testing.

UNIT II: Problem of correlated errors, auto correlation, Durbin Watson statistics, removal of auto correlation by transformation, analysis of collinear data, detection and correction of multicollinearity, regression analysis, method of least squares for curve fitting, testing of regression coefficients, multiple and partial regressions.

UNIT III: Examining the multiple regression equation, concept of weighted least squares, regression equation on grouped data, various methods of selecting the best regression equation, regression approach applied to analysis of variance in one way classification.

UNIT IV: Heteroscedastic models, concept of nonlinear regression and fitting of quadratic, exponential and power curves, economic and optimal dose, orthogonal polynomial.

Practical: Correlation coefficient; various types of correlation coefficients; partial and multiple; testing of hypotheses; multiple linear regression analysis; partial regression coefficients; testing of hypotheses; residuals and their applications in outlier detection; handling of correlated errors; multicollinearity; fitting of quadratic; exponential and power curves; fitting of orthogonal polynomials.

STAT 531 DATA ANALYSIS USING STATISTICAL PACKAGES 2+1

Theory

UNIT I: Use of software packages for summarization and tabulation of data, descriptive statistics, graphical representation of data, exploratory data analysis.

UNIT II: Fitting and testing the goodness of fit of discrete and continuous probability distributions, testing of hypothesis based on large sample test statistics, testing of hypothesis using chi-square, t and F statistics.

UNIT III: Concept of analysis of variance and covariance of data for single factor, multi-factor, one-way and multi-classified experiments, contrast analysis, multiple comparisons, analyzing crossed and nested classified designs.

UNIT IV: Analysis of mixed models, estimation of variance components, testing the significance of contrasts, correlation and regression including multiple regressions.

UNIT V: Discriminant function, factor analysis, principal component analysis, analysis of time series data, fitting of non-linear models, spatial analysis, neural networks.

Practical: Use of software packages for summarization and tabulation of data; obtaining descriptive statistics; graphical representation of data; robust estimation; testing linearity and normality assumption; estimation of trimmed means etc.; cross tabulation of data including its statistics, cell display; table format and means for different sub-classifications; fitting and testing the goodness of fit of probability distributions; testing the hypothesis for one sample t-test, two sample t-test; paired t-test, test for large samples; chi-squares test; F test; one way analysis of variance; contrast and its testing; pair-wise comparisons; multi-way classified analysis of variance- cross classification, nested classification; factorial set up; fixed effect models; random effect models; mixed effect models, estimation of variance components; generalized linear models-analysis of unbalanced data sets; testing and significance of contrasts; estimation of variance components in unbalanced data sets; maximum likelihood; ANOVA; REML; MINQUE; bivariate and partial correlation; distances-to obtain a distance matrix; dissimilarity measures; similarity measures; linear regression; multiple regression; regression plots; variable selection; regression statistics; fitting of growth models-curve estimation models; examination of residuals; discriminant analysis-fitting of discriminant functions; identification of important variables; factor analysis; principal component analysis-obtaining principal components; spectral composition; analysis of time series data-fitting of ARIMA models; working out moving averages; spatial analysis; neural networks.

STAT 591 MASTER'S SEMINAR 1+0

STAT 541 MATHEMATICAL STATISTICS 3+0

Theory

UNIT I: Random variables and their distributions, mathematical expectation and its laws, characteristics and moment generating functions.

UNIT II: Chebychov's and Kolmogrov's inequalities, stochastic convergence, central limit theorems.

UNIT III: Important probability distributions, exact sampling distributions, bivariate probability distributions, sampling distribution of correlation and regression coefficients.

STAT 542 STATISTICAL INFERENCE 2+0

Theory

UNIT I: Two kinds of error in testing hypothesis, uniformly most powerful tests, Neyman Pearson's lemma, derivation of t and F tests for normal populations, likelihood ratio test, tests of hypothesis in the case of monotonic likelihood ratios, unbiased and similar tests.

UNIT II: Consistent and efficient estimates, confidence interval, sufficient statistics, unbiased estimates, Crammer-Rao's theorem.

UNIT III: Maximum likelihood estimates, sequential probability ratio test, O.C. and ASN functions, Stein's two sample procedure – admissibility of tests and estimates, minimum estimates, loss function and risk functions.

STAT 543 LINEAR MODEL AND REGRESSION ANALYSIS 2+0

Theory

UNIT I: Generalized inverse of matrices, theorems on distribution of quadratic forms, Gauss-Markoff theorem - method of least square, concept of estimability, criterion of estimability, special cases - one and two-way classifications (including disproportionate cell frequencies and interaction), Aitken's model.

UNIT II: Estimation of parameters under restrictions, interval estimation and tests of hypothesis in linear models, analysis of co-variance, variance components models - estimation of variance components, mixed models.

UNIT III: Study of linear regression model- statistical inference in linear regression, maximum likelihood and least square estimation, bias and precision of the regression estimates, two and three stage least square method of estimation.

COMP 501 COMPUTER FUNDAMENTALS AND PROGRAMMING 2+1

Theory

UNIT I: Computer fundamentals-number systems, decimal, octal, binary and hexadecimal, representation of integers, fixed and floating point numbers, character representation, ASCII, EBCDIC.

UNIT II: Functional units of computer, I/O devices, primary and secondary memories.

UNIT III: Programming fundamentals with C - algorithm, techniques of problem solving, flowcharting, stepwise refinement, representation of integer, character, real, data types, constants and variables, arithmetic expressions, assignment statement, logical expression.

UNIT IV: Sequencing, alteration and iteration, arrays, string processing.

UNIT V: Sub-programs, recursion, pointers and files.

UNIT VIL: Program correctness, debugging and testing of programs.

Practical: Conversion of different number types;creation of flow chart;conversion of algorithm/flowchart to program;mathematical operators; operator precedence; sequence, control and iteration; arrays and string processing; pointers and file processing.

COMP 502 INTRODUCTION TO NETWORKING AND INTERNET APPLICATIONS 1+1

Theory

UNIT I: Networking fundamentals, types of networking, network topology, introduction to file transfer protocol (FTP), telnet, simple mail transfer protocol (SMTP).

UNIT II: World wide web (WWW), working with internet, web pages, web sites, web servers, web applications.

UNIT III: Hyper Text Markup Language (HTML), DHTML, web based application development.

Practical: Network and mail configuration; using network services; browsing of internet; creation of web pages; creation of websites using HTML and creation of websites using DHTML.

HOME SCIENCE

FAMILY RESOURCE MANAGEMENT

www.hillagric.ac.in/edu/cohs/frm/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
FRM 501*	APPROACHES TO RESOURCE MANAGEMENT	3+0	I
FRM 502*	CONSUMER ERGONOMICS	2+1	II
FRM 503*	ADVANCED INTERIOR SPACE MANAGEMENT	2+1	II
FRM 504*	ADVANCED HOUSING	2+1	I
FRM 505	CONSUMER ISSUES AND CHALLENGES	2+1	II
FRM 506*	CONSUMER GUIDANCE AND COUNSELING	1+2	I
FRM 507	CONSUMER COMMUNICATION MEDIA	1+2	II
FRM 508	PRODUCT DESIGN, TESTING AND EVALUATION	1+2	II
FRM 509	RETAIL MANAGEMENT	2+1	I
FRM 510	WORK AND WORK STATION DESIGN	1+2	II
FRM 511	ADVANCED CAD FOR PRODUCT DESIGN	0+4	II
FRM 512	ENERGY CONSERVATION IN BUILDING DESIGN	2+1	I
FRM 513	CONSUMER ECONOMICS	2+1	I
FRM 514	INTERIOR DESIGN BUSINESS MANAGEMENT	2+1	II
FRM 515	FURNITURE DESIGN AND FABRICATION	2+1	II
FRM 516	COLOUR AND LIGHTING IN INTERIORS	2+1	I
FRM 591	MASTER'S SEMINAR	1+0	I&II
FRM 592	SPECIAL PROBLEM IN M.SC.	0+1	I&II
FRM 599	MASTER'S RESEARCH	0+20	I&II

*****Compulsory for Master's programme

FAMILY RESOURCE MANAGEMENT

Course contents

FRM 501 APPROACHES TO RESOURCE MANAGEMENT 3+0

Theory

UNIT I: Significance and scope of resource management, the evolving discipline of management: classical approach, behavioral approach, systems approach and scientific management.

UNIT II: Managerial decision making-techniques, creativity; rationality and risk and certainty theories and concepts in resource management.

UNIT III: Management process: planning- types and dimensions, planning in a systems perspective, factors affecting planning, implementation-controlling, checking and adjusting, evaluation-evaluation of resource-use and feedback.

UNIT IV: Leadership: importance and characteristics motivation- importance, theories, approaches, elements of sound motivation, organization, supervision and communication.

FRM 502 CONSUMER ERGONOMICS 2+1

Theory

UNIT I: Significance and scope of ergonomics - man, machine and environment system interactions – anthropometry, principles, measurements: application of anthropometry in ergonomics and design - human body in relation to ergonomic study.

UNIT II: Fundamentals of work physiology, muscular efforts, energy consumption, body size and movements, physical fitness: measurement using different techniques.

UNIT III: Mechanical parameters, work postures postural variations and discomfort, measurement - physical work capacity and factors affecting energy requirements and costs for various activities, fatigue.

UNIT IV: Environmental parameters, measurement, evaluation and effect on worker and work performance- visual ergonomics - illusions and accidents - ergonomic investigations: Techniques and problems – ergonomic requirements for people with special needs.

Practical: Anthropometry and its statistical treatment for design applications; methodologies for assessment of ergonomic cost of work in terms of physiological indices; measurement of physical workload; determination of physical fitness using various techniques - measurement of posture and postural discomfort using ergo software - measurement of various environmental parameters; evaluation and effect on worker and work performance.

FRM 503 ADVANCED INTERIOR SPACE MANAGEMENT 2+1

Theory

UNIT I: Effect of interior design and decoration on family well being with particular reference to special needs - Functional and aesthetic considerations in use of elements and principles of design.

UNIT II: Advances in design process of residential and commercial interiors.

UNIT III: Trends in decoration treatments for interiors and interior backgrounds from past to present: furniture, furnishings, lighting, fittings and fixtures, surface materials, finishes.

UNIT IV: Changing trends in thermal, acoustics and safety mechanisms, solutions for problem areas in residential and commercial building interiors.

Practical: Critical analysis of interiors of a selected residential and non-residential buildings and suggested improvements-visits to building design institutes; hotels; furniture and furnishing

show rooms and residential buildings to identify new trends - market survey of surface materials, finishes, fittings and fixtures - detailed cost estimation of interior design and decoration elements.

FRM 504 ADVANCED HOUSING 2+1

Theory

UNIT I: Historical perspective of the architectural features of buildings - structural features of residential buildings in different geo-climatic conditions, social-cultural and economic issues in housing.

UNIT II: Housing stock quality, demand and supply in urban and rural areas of India, role of government and non-government organizations in providing and regulating housing needs.

UNIT III: Ancient science of house design - emerging techniques in the house construction - low-cost building materials and fabrication techniques – eco and ergo-friendly house design - house wiring, sanitary fittings, acoustics - rain water harvesting structures for houses.

UNIT IV: Estimation of cost and housing finance - recent developments in building bye-laws - housing research- landscaping planning.

Practical: Analysis of building forms in different geo-climatic region-visit to housing development organization and building design centers - evolving eco, ergo and space saving house plan for selected geo-climatic region for different socio-economic categories through CAD estimation of cost of construction - assessment of existing house plans and suggesting cost effective renovations - landscape planning.

FRM 505 CONSUMER ISSUES AND CHALLENGES 2+1

Theory

UNIT I: Consumer in changing trends, consumer movement, profile of consumers in India and abroad, public and private sector goods and service providers.

UNIT II: Consumer markets: types and features, market distribution channels.

UNIT III: Consumer behavior, consumer problems and challenges, gender issues in consumerism.

UNIT IV: Multinational trade and consumer welfare in India, consumer empowerment; citizens' charter and right to information act.

Practical: Identification of problems of rural /urban consumers, project work; in depth study of any one identified problem-finding measures to overcome the problem-developing consumer education material on selected issue.

FRM 506 CONSUMER GUIDANCE AND COUNSELING 2+1

Theory

UNIT I: Consumer education, rights and responsibilities of consumer, consumer cooperatives, consumer organizations.

UNIT II: Significance of consumer guidance and counseling, consumer protection measures, legal and non-legal.

UNIT III: Consumer Protection Act, 1986, consumer legislations.

UNIT IV: Consumer redressal mechanism, consumer protection councils.

Practical: Visit to local consumer redressal forum; study the structure and functioning of consumer redressal forum; understanding the procedures for filing a consumer complaint; study of the proceedings of consumer court; visit to local consumer organizations; study of the

procedures in consumer counseling and guidance centre; mock sessions in handling consumer complaints.

FRM 507 CONSUMER COMMUNICATION MEDIA 1+2

Theory

UNIT I: Significance of consumer communication, media and social change, media and consumer demand.

UNIT II: Trends in communication media, credibility in communication.

UNIT III: Media and gender, types of media.

UNIT IV: Advertising as a mode of communication: advertising management and legislation, trends and impact of advertising on consumers.

Practical : Exploring the different consumer communication media; study the impact of print media and electronic media on consumer behavior; report writing and presentation; identifying and developing a communication package on a specific consumer issue; study the role of advertising as a mode of communication; Report writing and presentation; developing a consumer friendly advertisement for a specific product.

FRM 508 PRODUCT DESIGN, TESTING AND EVALUATION 1+2

Theory

UNIT I: Significance and essentials of product design and consumer demand, anthropometry in design.

UNIT II: Product services available to consumers, product safety: hazards and liabilities.

UNIT III: Quality control and standardization for food, textiles, consumer durables and materials, product certification.

UNIT IV: Need for product testing, product testing techniques and devices, product evaluation, product recall.

Practical: Analyzing the user's option on the design of a specific consumer product; understanding the selected consumer products through guidelines given by manufacturers; collecting the standardization norms as per health and safety of workers - conceptualization and development of consumer products with functional alternatives; designing the prototype of the developed product by using CAD software; appraisal on the product testing procedures, processed foods, textiles, electrical & non-electrical detecting adulterants in food items electrical equipment - estimating the device efficiency in electrical and non- electrical equipment; visit to quality control laboratories; detecting adulterants in food items - computerizing testing data – establishing a consumer product testing cell.

FRM 509 RETAIL MANAGEMENT 2+1

Theory

UNIT I: The retail field: development of retailing, retailers, methods of retailing, geographic distribution of retail sales, expenses of retail establishments, price decisions, retail failures.

UNIT II: Small scale retailing: nature and significance of the small scale retailers, independent general store, independent limited line store, miscellaneous types of small scale retailers, measures to overcome competition from big retailers.

UNIT III: Large scale retailing: the chain store- definition, characteristics, growth, factors limiting growth, super market, the departmental store, the discount house, the retail mail-order house.

UNIT IV: The small scale retailers' efforts to preserve and improve his position, major group activities of small scale retailers, advantages, limitations and future of small scale independent store, trends in retailing and e-tailing- mall concepts in metros.

Practical : Study the functioning of different types of retail stores: small scale retailers, mobile retailers, convenience store, general store, specialty store, consumer cooperatives; large scale retailers- super market, departmental stores, chain stores, manufacturer's showrooms, shopping malls, multiplex; direct marketing: telemarketing, mail order, vending machines; personal selling- e-shopping.

FRM 510 WORK AND WORKSTATION DESIGN 1+2

Theory

UNIT I: Work, worker workplace interrelationship – meaning and components of work, work analysis using different techniques - components of worker input – body mechanics.

UNIT II: Functional design: concept, design and arrangement of different work centers

UNIT III: Procedures for studying workplace design: formal and informal techniques – workplace design for different postures.

UNIT IV: Ergonomic factors in design and selection of household goods–displays and controls– functional designing of workplace and equipment- hazards of ill designed workstations.

Practical : Determining the space relationships as per workers' anthropometry, posture and movement at selected workstations - measuring and recording the Anthropometric measurements of worker and dimensions of equipment /furniture used in the unit workspace; measurement of work costs in terms of physiological indices - preparing floor and perspective plans of a unit work space - selecting and analyzing a work station in relation to design features, space relationships, dimensions of equipment and furniture, environment control methods and developing 2D and 3D workplace design – evaluation of existing workstation in a residential and commercial setup and suggesting an ergonomic design layout.

FRM 511 ADVANCED CAD FOR PRODUCT DESIGN 0+4

Practical: Introduction to modeling software - REVIT and 3DS Max – understanding the utility of software to design interiors and exteriors of building and consumer products – evolving conceptual designs and working out the details for residential and commercial buildings; creation of surface elements and built-in decorative features - customized designs for special effects - designing, assembling and modeling consumer products: furniture, lighting fixtures, artifacts - Massing - Rendering and camera animation – Interior and exterior walkthroughs and generating movie file.

FRM 512 ENERGY CONSERVATION IN BUILDING DESIGN 2+1

Theory

UNIT I: Building as a system for residential and commercial needs - energy use and crisis - building design, need and scope for energy use and conservation - environmental and architectural characteristics and energy consumption.

UNIT II: Factors influencing building design - human behavior in relation to interior and built in design.

UNIT III: Climate and thermal comfort - design parameters for climate and energy control - design parameters for visual comfort: day lighting and artificial lighting.

UNIT IV: Energy flow audit and economy - energy models: ENEHOPE model, BREDEM Model, econometric models - green strategies - energy efficient housing options.
Practical: Visits to energy intensive and green buildings - case studies on selected buildings and design assessment in terms of energy use and conservation - energy audit - estimation of energy requirements in buildings using energy models - developing conceptual designs for residential and commercial buildings using green strategies - calculation of energy costs.

FRM 513 CONSUMER ECONOMICS 2+1
Theory
UNIT I: Concept of consumption economics: definition of basic concepts, micro and macro analysis - importance and limitation, theories of consumer behaviour: utility analysis, indifference curve analysis, opportunity cost analysis, elasticity of demand: concept and types.
UNIT II: National income (n.i.): basic terms in accounting national income and its relation to personal disposable income of consumers, the circular flow model, Marginal propensity to consume, concept of multiplier.
UNIT III: Consumption and economic instability: introduction to business cycle, inflation and economic cycle, deflation and economic stability, full employment and inflation.
UNIT IV: Consumer credit and stability, role of government counter cyclical policies and consumers, measurement of cost of living: the index method, changes in economy / policies and its impact on family consumption.
Practical: Study of marketing system of a commodity or service- a project work; analysis of national budgets through panel discussion; analyze the impact of changes in economic policies on family consumption; learn to calculate the cost of living.

FRM 514 INTERIOR DESIGN BUSINESS MANAGEMENT 2+1
Theory
UNIT I: Definition of a profession - principles of interior design business management - establishing interior design practice - ethics and professional conduct.
UNIT II: Business law – business management applications: financial concepts - strategic plans for design presentation- visual graphics, models, and electronic walkthroughs.
UNIT III: Marketing: conditions and strategies –procedures for contract design.
UNIT IV: Professional portfolios, resumes and business cards, Web page, e-service – professional associations and support systems.
Practical: Cost estimation for projects ensuing from project conceptualization to completion medium project - contracting and sub-contracting procedure for the estimated projects - strategic plan for presentation of project for a tender call - portfolio for job in professional firm and resume design.

FRM 515 FURNITURE DESIGN AND FABRICATION 2+1
Theory
UNIT I: Furniture design in different styles – furniture for different functions – furniture decisions.
UNIT II: Human factors in furniture design.
UNIT III: Latest trends in material, furniture construction, assembling and joinery techniques-craftsmanship.

UNIT IV: Decorative finishes-marketing strategies

Practical : Exploring the different types of furniture, material used and fixation methods through literature search and market exposure- developing concept designs and schematic drawing of selected furniture-working out detailed drawings of components and joineries-building small scale model and sample board-estimating quantity of materials required and cost of construction-workshop experience in furniture designing and construction exposure to furniture care and maintenance.

FRM 516 COLOUR AND LIGHTING IN INTERIORS 2+1

Theory

UNIT I: Fundamentals of colour and light in interior environments – theory of colour and light as perceived by the human eye.

UNIT II: Colour: properties, systems, mixing, symbolism, cultural effects and psychology - physical and perceptual aspects of colour and lighting - need for colour and lighting to provide comfort and adequate safety – need for quality in the selection of colours and lighting in the built environment.

UNIT III: Concepts of lighting - safety and emergency lighting.

UNIT IV: Effects of colour on people, use of colour and light in interior in relation to function, materials, surface finish and colour scheme integration, visual tricks to play – space making, space shrinking, camouflage and disguise

Practical Evolving Munsell and Ostwald colour wheels - colour schemes for problem areas in residential and non-residential interiors - studying the psychological and emotional effects of colours in interiors - influence of light on colour in simulated conditions.

FRM 591 MASTER'S SEMINAR 1+0
FRM 592 SPECIAL PROBLEM IN M.Sc. 0+1
FRM 599 MASTER'S RESEARCH 0+20

FOOD SCIENCE AND NUTRITION

www.hillagric.ac.in/edu/cohs/fsn/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
FN 501*	ADVANCED FOOD SCIENCE	2+1	I
FN 502*	ADVANCED NUTRITION	3+0	II
FN 503*	FOOD ANALYSIS	1+3	I
FN 504*	ADVANCES IN COMMUNITY NUTRITION	1+2	I
FN 505	FOOD PROCESSING TECHNOLOGY	3+0	I
FN 506	CLINICAL NUTRITION	2+2	I
FN 507	NUTRITION DURING LIFE CYCLE	3+0	I
FN 508	NUTRITION AND PHYSICAL FITNESS	2+1	II
FN 509	ADVANCED DIET THERAPY	2+1	II
FN 510	FOOD TOXICOLOGY	2+1	I
FN 511	ADVANCED HUMAN PHYSIOLOGY	2+1	II
FN 512	FOOD SERVICE MANAGEMENT	1+2	I
FN 513	FOOD PRODUCT DEVELOPMENT	1+1	I
FN 514	NUTRITION & IMMUNITY	2+0	I&II
FN 591	MASTER'S SEMINAR	1+0	I&II
FN 592	SPECIAL PROBLEM IN M.Sc	0+1	I
FN 599	MASTER'S RESEARCH	0+20	I&II
FN 601**	ADVANCES IN MACRONUTRIENTS	3+0	I
FN 602	ADVANCES IN VITAMINS AND HORMONES	2+0	I
FN 603**	MINERALS IN HUMAN NUTRITION	2+0	I
FN 604**	ADVANCES IN FOOD SCIENCES AND TECHNOLOGY	2+1	I
FN 605	ADVANCES IN ENERGY METABOLISM	2+0	II
FN 606	NUTRITION AND AGRICULTURAL INTERFACE	3+0	I
FN 607	NUTRITION IN EMERGENCIES	2+0	II
FN 608	APPLICATION OF BIOTECHNOLOGY IN FOOD SCIENCE AND NUTRITION	2+0	I
FN 609	GLOBAL NUTRITIONAL PROBLEMS	2+0	II
FN 610	MATERNAL AND CHILD NUTRITION	3+0	I
FN 611	ADVANCES IN POST HARVEST FOOD CONSERVATION	2+0	I
FN 612	RESEARCH METHODS IN FOOD SCIENCE AND HUMAN NUTRITION	2+0	II
FN 613	ADVANCES IN FOOD ENGINEERING AND POST HARVEST TECHNOLOGY	2+0	I
FN 691	DOCTORAL SEMINAR I	1+0	I&II
FN 692	DOCTORAL SEMINAR II	1+0	I&II
FN 693	SPECIAL PROBLEM IN Ph.D	0+1	II
FN 699	DOCTORAL RESEARCH	0+45	I&II

* Compulsory for Master's Programme ** Compulsory for Doctoral programme

FOOD SCIENCE AND NUTRITION

Course contents

FN 501 ADVANCED FOOD SCIENCE 2+1

Theory

UNIT I: Colloidal chemistry as related to foods, evaluation of food by subjective and objective methods, carbohydrates in foods- sources and characteristics of sugar, starch, cellulose, pectin and gums in foods, unavailable carbohydrates and their functions in foods, effect of cooking and processing techniques on nutrients.

UNIT II: Protein in foods: plant and animal proteins, non-conventional proteins, functions, chemical and physical properties related to foods, effect of cooking and processing techniques, fats and oils- functions, properties, uses, processing techniques, changes during heating, processing and storage.

UNIT III: Classification, importance and composition of different food groups, effect of cooking and other processing techniques on their nutritive value.

UNIT IV: Classification and importance of beverages, food pigments, Browning reaction, definition, classification, uses and legal aspects of food additives, classification, nature and uses of leavening agents, food adulteration, food labeling

Practical: Microscopic structure of different starch granules; evaluation of food by subjective and objective methods; changes in colour, texture and flavour of foods due to processing; effect of cooking on protein, fat and carbohydrates; product preparation using different foods; project work related to text.

FN 502 ADVANCED NUTRITION 3+0

Theory

UNIT I: Functions, sources, requirements, digestion, absorption and metabolism of carbohydrates, definition, composition, classification, functions and role of dietary fibre in various physiological disorders.

UNIT II: Basis of requirement, functions, sources, digestion, absorption and metabolism of protein, methods of assessing protein quality, basis of requirement, functions, sources, digestion, absorption and deficiency disorders of lipids, essential fatty acids and eicosanoids in human nutrition.

UNIT III: Requirements, functions, sources, deficiencies, metabolism and toxicities of fat and water soluble vitamins.

UNIT IV: Requirement, functions, sources, deficiency, toxicity, metabolism and factors affecting absorption and utilization of macro and micro minerals: water balance, acid and base balance.

UNIT V: Energy, RDA, methods of estimation, formulation of requirement, basal metabolic rate (BMR) respiratory quotient (RQ)

FN 503 FOOD ANALYSIS 1+3

Theory

UNIT I: Familiarization to terms and calculations used in preparation of various standard solutions, sample and sampling techniques, quality control and assurance.

UNIT II: Principles, techniques and applications of colorimetric, spectrophotometer and atomic absorption spectrophotometer.

UNIT III: Principles, techniques and applications of spectrophotometer fluorimetry, flame photometry and electrophoresis.

UNIT IV: Principles, techniques and application of chromatography (paper chromatography, TLC, GLC, HPLC), introduction to animal assay.

Practical: Handling of equipment and instruments; Preparation of samples, solutions and buffers; estimation of quality parameters; quantitative estimation of proximate principles, minerals and vitamins by use of colorimetry, flame photometry, UV spectrophotometer, chromatography, atomic absorption spectrophotometer and photofluorometry, Analysis of antinutritional factors; estimation of protein and starch digestibility, fractionation of protein, food adulteration, estimation of sugars and dietary fibre

FN 504 ADVANCES IN COMMUNITY NUTRITION 1+2

Theory

UNIT I: Assessment of the nutritional status at individual, household and institutional level, direct and indirect methods.

UNIT II: Ecological, socio-cultural, economic and demographic correlations of malnutrition, prevalence, etiology, biochemical and metabolic changes in vitamin A deficiency, PEM, iron deficiency anemia, IDD, obesity, diabetes and gall stones, role of national and international agencies to combat malnutrition.

UNIT III: Major nutritional problems of the state, nation and world, nutrition intervention- definition, importance, methods of nutrition intervention and their impact evaluation, nutrition education methods and its execution, food habits, food fads and fallacies

UNIT IV: National nutritional programmes and policies, nutritional surveillance, national programmes and policies regarding food production and distribution.

Practical: Market survey for food availability and their cost, development of low cost nutritious recipes suitable for various vulnerable groups, visit to the ongoing public health nutrition programme and report writing, techniques of assessment of nutritional status.

Project Work: Studying existing diet and nutrition practices, planning and conducting survey, analyzing data and writing report, development, implementation and evaluation of community nutrition and health programmes.

FN 505 FOOD PROCESSING TECHNOLOGY 2+1

Theory

UNIT I: Principles underlying food processing operations including thermal, radiation, refrigeration, freezing and dehydration, effect of processing on physicochemical characteristics.

UNIT II: History and methods of food preservation, processing technology for preservation and production of variety and indigenous food products, losses during storage, handling and processing of cereals and legumes, oilseeds, fruits and vegetables, food spoilage and its causes

UNIT III: Processing technology for milk and milk products, egg, meat, poultry and fish, convenience foods, processed foods, technologies underlying in mutual supplementation, enrichment and fortification, fermentation, malting, germination, food additives commonly used in food industries for color, flavor, and as preservatives.

UNIT IV: Quality control in food industry: raw material, finished products, waste management and sanitation in food industries, packaging of foods, storage and marketing of processed foods.

Practical: Familiarization with equipment used in food preservation, exercise with different food preservation methods by using different food groups, organoleptic evaluation: visit to food processing units.

FN 506 CLINICAL NUTRITION 2+2

Theory

UNIT I: Methods for estimating requirements and recommended allowances of energy, protein, minerals and vitamins for different age groups and physiological states.

UNIT II: Nutrient interrelationship, historical background, epidemiology, preventive and therapeutic measures of protein energy malnutrition.

UNIT III: Interrelationship, etiology and preventive measures of vitamin and mineral deficiencies toxicities.
UNIT IV: Principles and interpretation of clinical laboratory methods with particular emphasis on their interpretation relative to nutritional status and disease, Interaction between nutrients, infections and drugs.
Practical: Biochemical analysis of blood under normal and diseased conditions for glucose, calcium, iron, creatinine, urea, uric acid, albumin, globulin, cholesterol, phosphate, glutamate oxaloacetate transaminase, glutamate pyruvate transaminase, phospholipids, analysis of urine for specific metabolites under normal and diseased conditions.

FN 507 NUTRITON DURING LIFE CYCLE 3+0

Theory

UNIT I: adulthood: sex, occupation, income, pregnancy: physiological changes in pregnancy, weight gain during pregnancy, food and nutrient requirements, storage of nutrients during pregnancy and impact of good nutrition on the outcome of pregnancy, complications of pregnancy and their nutritional management, lactation: physiology of lactation, impact of nutrition on efficiency and milk production, food and nutrient requirements during lactation.
UNIT II: Infancy: role of nutrition on physical and mental development, rate of growth - weight as an indicator, assessment of growth, nutrient requirement during infancy, feeding of infants - value of breast feeding, breast milk composition, breast feeding vs. artificial feeding, types of milk and their use in infant feeding, methods of formula preparation, weaning and supplementary foods, weaning practices in the community, special nutritional concern in infant feeding, feeding the premature and low birth weight infants, nutritional disorders and common ailments in infancy, feeding the sick child, immunization schedule and growth charts.
UNIT III: Preschool age: growth and development - physical and mental, prevalence of malnutrition in preschool years and food habits, nutritional requirements during preschool year and supplementary foods, school age: growth and development, nutritional requirements of school age children, specific problems in feeding school children.
UNIT IV: Adolescence: physical and physiological changes, nutritional requirements of adolescents, food preferences and nutritional problems, elderly: physical and physiological changes, nutritional requirement, problems of old age, nutrients influencing aging process.

FN 508 NUTRITION AND PHYSICAL FITNESS 2+1

Theory

UNIT I: Overview of nutritional management vis-à-vis physical fitness, body composition and physical fitness.
UNIT II: Methods of measuring body composition: direct and indirect, body composition in different physiological conditions and factors affecting it.
UNIT III: Energy metabolism and physical fitness: concept, importance, influencing factors.
UNIT IV: Techniques to measure energy expenditure and energy intake, techniques to assess physical fitness, aging theories, physiology, mechanism and role of nutrients in arresting aging process.
Practical: Project relevant to text: selection of topic, planning of project, development and standardization of tool, collection of data, analysis of data, report writing.

FN 509 ADVANCED DIET THERAPY 2+1

Theory

UNIT I: Role of dietician in a health care team in hospital and community, newer concepts in dietary management of various nutritional disorders and disease conditions: fevers, infections.
UNIT II: Dietary management during burns, allergy, gastrointestinal and liver diseases.
UNIT III: Dietary management of cardiovascular diseases, renal disorders and obesity.
UNIT IV: Dietary management of diabetes, cancer and HIV, Nutrition in critical care.

UNIT V: Dietary management of neurological disorders, inborn errors of metabolism

Practical: Formulation of food exchanges; therapeutic modifications of diet in terms of nutrients; consistency and composition for various disorders and diseases; preparation of SOAP notes and case studies, visits to hospitals.

FN 510 FOOD TOXICOLOGY 2+0

Theory

UNIT I: Introduction and significance of food toxicology, food poisoning: types, causative factors, preventive symptoms, natural food toxins, anti-nutritional factors, other food toxins, harmful effects, methods of removal.

UNIT II: Microbial toxins and food intoxications: source of contamination, effect on health, preventive measures, methods of inactivation/destruction.

UNIT III: Chemical toxins: pesticides, insecticides, metallic and others, residual effects, preventive measures, methods of removal.

UNIT IV: Food packaging material, potential contaminants from food packaging material, food laws and standards: FPO, ISI, AgMark, Codex Alimentarius, ISO, HACCP, mark for vegetarian and non vegetarian foods, eco-friendly products and others in operation.

FN 511 ADVANCED HUMAN PHYSIOLOGY 2+1

Theory

UNIT I: Reticulo-endothelial system: functions, classification, lymphatic system: functions, circulation, circulatory system: blood – composition, blood cells - development and function of blood cells, blood clotting, blood grouping and hemoglobin, heart: anatomy, cardiac cycle, blood pressure and factors affecting blood pressure.

UNIT II: Respiratory system: anatomy, physiology and mechanism of respiration, regulation of respiration, digestive system: anatomy of gastrointestinal tract and accessory organs, digestion and absorption of food, regulation of appetite.

UNIT III: Excretory system: anatomy and functions of kidney, formation, composition and excretion of urine, endocrine glands, mode of action of hormones.

UNIT IV: Reproductive system: structure and functions of male and female reproductive organs, nervous system: anatomy and functions, Musculo-skeletal system: anatomy and functions.

Practical: Estimation of hemoglobin, identification of blood groups, preparation of blood slide, identification and counting of blood cells, haematocrit and sedimeentientientientientientientiod pressure, examination of abnormal constituents of urine, estimation of glucose and cholesterol in blood.

FN 512 FOOD SERVICE MANAGEMENT 1+2

Theory

UNIT I: Types of food services, organization: definition, types, management: tools of management.

UNIT II: Personnel management, books, records and record keeping, cost control in food services, Menu planning.

UNIT III: Meal services management: types of services, quantity food production: principles involved in development of recipes in large scale cooking, standardization of recipes, utilization of left over foods.

UNIT IV: Planning of layout and equipment for foods services, sanitation and hygiene in handling foods, personnel hygiene and its importance.

Practical: standardization of recipes: planning and preparation, modification in basic recipe, preparation of standard recipe, use of left over foods, visit to different types of food service institutions and study the following: organization, physical plan and layout, food service equipment, sanitation and hygiene, practical experience in organization and management of a college cafeteria/ hotels.

FN 513 FOOD PRODUCT DEVELOPMENT 1+1

Theory

UNIT I: Basic principles of food product development, sensory properties of food and their role in product development, formulation and evaluation of recipes at laboratory level, bulk food preparation for food institutions and enterprises: servings, nutritive value and costing.

UNIT II: Evaluation of food-objective and subjective methods, selection and training of judges, development of score cards and analysis of data.

UNIT III: Consumer evaluation-development of schedule and data analysis, packaging material, types for different products, food labeling.

UNIT IV: Food safety issues in product development, food quality regulations and standards, quality control and HACCP, product formulation and development for general and therapeutic use.

Practical: Sensory evaluation: methods, training of judges, score card preparation; selection and modification of food product to be developed; formulation and standardization of products; objective and subjective evaluation of the products; evaluation of consumer acceptability; packaging and sale of products, preparation of video film for media.

FN 514 NUTRITION AND IMMUNITY 2+0

Theory

UNIT I: Immunity: definition and history, classification, immunological responses, cell types involved, mechanism of phagocytosis and antigen-antibody reactions, regulation of immunity, mucosal defence system- effect of nutrients.

UNIT II: Effect of malnutrition on immunity, carbohydrates and immune system, fat and immune system-factors affecting acquired immunity, protein and immune functions- effect of arginine, glutamine and sulphur amino acids, Glutathione and immune system.

UNIT III: Role of vitamins in immune functions-effect of deficiency, role of minerals-effect of deficiency and excess on immune cell functions.

UNIT IV: Probiotics and antioxidants - their effect on immune function, immunity against infection - role of immunization.

FN 591	**MASTER'S SEMINAR**	**1+0**
FN 592	**SPECIAL PROBLEM IN M.Sc**	**0+1**
FN 599	**MASTER'S RESEARCH**	**0+20**

FN 601 ADVANCES IN MACRONUTRIENTS 3+0

Theory

UNIT I: Carbohydrates, proteins and lipids-their digestion, absorption, metabolism, inborn errors of metabolism.

UNIT II: Metabolic disorders-diabetes, dental caries, obesity, atherosclerosis, hyperlipidemias and hypertension, glucose homeostasis determined by insulin/glycogen ratio, carbohydrates free diet and its metabolic consequences, glycemic index, dietary fiber- definition, composition, classification, functions and role in various physiological disorders.

UNIT III: Classification of protein, new discoveries in protein and their functions such as protein in Immune system, as lubricants, biological buffers and carriers, evaluation of protein quality: in vitro and in vivo methods, animal and human bioassays: amino acid pool, protein turnover in man with special reference to body size, age and various nutrition and pathological conditions, regulation of proteins, requirements, novel food sources of protein, effect of insulin, corticosteroids, thyroids, androgen and growth hormone on protein metabolism, inheritable disorders of amino acid metabolism of protein, effect of dietary protein on cardiovascular disease and cholesterol metabolism, adaptation of body to low intake of energy and protein.

UNIT IV: Estimation of body fat, lipoproteins and hyper lipoproteinemia, hypolipidemic action of PUFA omega-3 fatty acids and oxidation products of cholesterol, lipids and cancer, fish oils in health and disease, oxidation products of cholesterol, disturbance in lipid metabolism, role of reversal diet in cardiovascular disorders, high blood cholesterol - causes, prevention and treatment, hypolipidemic action of rice bran, oat, barley and legumes.

FN 602 ADVANCES IN VITAMINS AND HORMONES 2+0

Theory

UNIT I: General definition and history of vitamins and hormones, causes of vitamin deficiencies in India, chronology, chemistry, distribution, functions, absorption, transport, metabolism, deficiency manifestations

UNIT II: Nutritional requirements, methods of assay, interaction with other nutrients, antagonists and analogues of vitamins

UNIT III: Hypervitaminosis of water and fat soluble vitamins, vitamin fortification and supplementation, endocrine and exocrine secretion of hormones-organs of secretion, metabolism, mechanism of action, regulation and sites of action, biological effects and interaction.

UNIT IV: Assessment of vitamin status of population, antioxidants and their relationship with aging, cancer and other metabolic disorders.

FN 603 MINERALS IN HUMAN NUTRITION 2+0

Theory

UNIT I: general definition and history of minerals, causes of macro and micro mineral deficiencies in India, chronology, chemistry, distribution, functions, absorption, transport, metabolism, deficiency manifestations.

UNIT II: Nutritional requirements, methods of assay of all the minerals, interactions of minerals with other nutrients, antagonists and analogues of minerals.

UNIT III: Assessment of mineral status of population, mineral fortification and supplementation, major mineral pollutants- their harmful effect to health, mutagenicity, carcinogenicity, teratogencity, heavy metal toxicity, use of mineral isotopes/ tracers in nutritional studies.

UNIT IV: Metaloenzymes, antioxidants and their relationship with aging, cancer and other metabolic disorders, heavy metal toxicity, trace minerals: their chronology, chemistry, distribution, functions, absorption, metabolism, requirements, deficiency manifestation and interaction.

FN 604 ADVANCES IN FOOD SCIENCE AND TECHNOLOGY 2+1

Theory

UNIT I: Recent advances in the field of carbohydrates, lipids, proteins, vitamins and minerals in relation to human nutrition, nutritional changes during processing

UNIT II: Nutrogenomics, incorporating genetics into dietary guidance, recent advances in the field of food analysis, food fortification, food fabrication, food additives and safety evaluation

UNIT III: Foods of future, special nutrients, food processing and product development, regulating food processing and preservation through TQM and HACCP.

UNIT IV: GM foods and their health implications, functional foods and organic foods, specialty foods, impact of WTO in food regulation.

Practical: Product development and shelf life of nutritionally fortified foods using advanced technologies, field study of food processing and preservation in relation to TQM and HACCP in an industry.

FN 605 ADVANCES IN ENERGY METABOLISM 2+0

Theory

UNIT I: Scope and application of bioenergetics for human nutrition, energy types, energy store in man, its components and measurements.

UNIT II: Methods of estimation of energy requirement, factors affecting energy requirements and expenditure.

UNIT III: Thermogenesis, interrelationship between metabolic regulations, mechanism of hunger and its energy cost of macromolecules.

UNIT IV: Weight control and obesity-role of adipose tissues, effect of hormones on energy metabolism.

FN 606 NUTRITION AND AGRICULTURAL INTERFACE 3+0

Theory

UNIT I: Food situation in India and in the world, food production and consumption trends, food balance sheets, role of nutrition in agricultural planning and national development.

UNIT II: Linkages between agricultural practices, food production, food distribution and nutritional status, food crop failure and malnutrition, poverty and vicious cycle of low food production, consumption indicators, nutritional status indicators and their role in agricultural planning.

UNIT III: Agricultural development and its effect on food availability, effect of food production and economic policies on food availability, impact of physical resources, farming systems, cropping system, inputs and manipulation, agricultural marketing system, post harvest processing of foods on food and nutrition situation, food distribution systems.

UNIT IV: Food and nutrition security at national and household level, nutrition policy implementation, nutritional impact of agricultural programmes, food price control and consumer subsidy, contribution of national and international organization for agricultural development.

FN 607 NUTRITION IN EMERGENCIES 2+0

Theory

UNIT I: Starvation in emergencies arising out of drought, floods, earth quakes, locust, war, wrong policies and poverty, historical perspectives.

UNIT II: Effect of inanition, short, medium and long term emergencies on food and nutrients intake, precautions against food shortage, food needs at national level during normal emergencies

UNIT III: Major nutritional deficiency diseases in emergencies, Mobilization of local resources, General fund distribution, social funds, Mass and supplementary feeding, therapeutic feeding.

UNIT IV: Control of communicable diseases, public health and hygiene problems during emergencies.

FN 608 APPLICATION OF BIOTECHNOLOGY IN FOODS AND NUTRITION 2+0

Theory

UNIT I: History, processes and products of biotechnology, application of biotechnology in production of nutritious foods.

UNIT II: Role of biotechnology in enzymology, product development, fermentation process, fruit juice extraction, genetic improvement of food grade microorganisms.

UNIT III: Nutritional significance of food products developed by biotechnological techniques.

UNIT IV: Scientific, technological and resource constraints on biotechnology, important factors affecting development in biotechnology.

FN 609 GLOBAL NUTRITIONAL PROBLEMS 2+0

Theory

UNIT I: Food production and consumption pattern of developed and developing countries.

UNIT II: An overview of world nutrition situation and assessment of problems of developing countries in light of prevalence, etiology, indicators and preventive measures.

UNIT III: Nutrition and health programmes to alleviate malnutrition, role of national and international organizations.

UNIT IV: Historical background, role of food and nutrition policies in socio-economic development and as determinants of productivity, achievement and aberrations of food and nutrition policies, cost and benefits of special programmes.

FN 610 MATERNAL AND CHILD NUTRITION 3+0

Theory

UNIT I: Current scenario of maternal and child nutrition, nutritional aspect of embryogenesis, factors affecting outcome of pregnancy, physiological changes in body composition and mental development in relation to prenatal and postnatal nutrition.

UNIT II: Effect of nutritional status of mother on quantity and quality of breast milk, recent guidelines in infant feeding and complementary feeding, feeding of premature babies, HIV and breast feeding, drug abuse and breast feeding.

UNIT III: Nutritional problems and requirements of preschool and school going children, growth and development of children, growth monitoring using growth charts.

UNIT IV: Strategies to improve maternal and child health in India, role of BPNI in promotion of breast feeding in India, importance of world breast feeding week.

FN 611 ADVANCES IN POST HARVEST FOOD CONSERVATION 2+0

Theory

UNIT I : Population growth and food production and food needs,post harvest food losses,factors affecting post harvest losses and their control,pre and post treatments in relation to improving shelf-life.

UNIT II : Methods for reducing post harvest losses ,need for pre-processing and processing of foods in relation to conservation, evaluation of food preservation and preparation ,methods. Importance and need for cleaning, grading, transportation and storage of foods;

UNIT III: Traditional and modern food storage structures; community storage structures; refrigerated, hypo boric, controlled atmospheric storage of foods; use of radiation in food conservation; role of packaging and packaging materials in food conservation.

UNIT IV: Present status of storage and processing; role of research institutions and warehouses corporations in food conservation; marketing standards and food laws.

FN 612 RESEARCH METHODS IN FOOD SCIENCE& HUMAN NUTRITION 2+0

Theory

UNIT I: Review of advanved techniques in food analysis and quality control; rheological techniques and instrumentation applicable to dpugh systems, milk, fruit and vegetable products, juices, syrups, meats, malt extract and confectionery foods, including fermented foods

UNIT II: Determination of browning and associated reaction in the foods and their implications, integration of science and engineering, principles of fluid concentrates, frozen and dehydrated products and their unit operations.

UNIT III: Quantitative and qualitative methods of food analysis, food contaminants, residual and deleterious effects in foods, purification and bioassay techniques

UNIT IV: Objective and subjective methods of evaluation of foods, food fortification, supplementation, complementation for the development of new products

FN 613 ADVANCES IN FOOD ENGINEERING& POST HARVEST TECHNOLOGY 2+0

Theory

UNIT : Advances in thermal processing of foods, equipments and machines involved in thermal processing

UNIT II: Heat transfer- theory and application, fluid flow- theory and applications; fruit and vegetable processing equipments; cleaning, washing, grading, size reduction.

UNIT III: Conveyers and elevators; milling and mixing; applications in food processing; grain cleaning and grading equipments; grain drying and storages

UNIT IV: Unit operations and basic equipments involved in milling, baking, parboiling and malting; equipments and machines involved in oil extraction; theory and applications of refrigeration , freezing, evaporation, concentration and processing equipments and their applications in food processing ; milk processing equipments.

FN 691	**DOCTORAL SEMINAR I**	**1+0**
FN 692	**DOCTORAL SEMINAR II**	**1+0**
FN 693	**SPECIAL PROBLEM IN Ph.D**	**0+1**
FN 699	**DOCTORAL RESEARCH**	**0+45**

HOME SCIENCE EXTENSION & COMMUNICATION MANAGEMENT

http://hillagric.ac.in/edu/cohs/hsee/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
HECM 501	GLOBAL EXTENSION SYSTEMS	3+0	I
HECM 502	EXTENSION MANAGEMENT	2+0	II
HECM 503	RESEARCH METHODS IN HOME SCIENCE	3+0	I
HECM 504	GENDER SENSITIZATION FOR EMPLOYMENT	2+0	II
HECM 591	MASTER'S SEMINAR	1+0	I&II

HOME SCIENCE EXTENSION & COMMUNICATION MANAGEMENT

Course contents

HECM 501 GLOBAL EXTENSION SYSTEMS 3+0

Theory

UNIT I: Extension systems in India, extension efforts after independence-community development programme-genesis and critical appraisal, panchayati raj institutions, area and target oriented programme -IAAP, T&V, special programmes for poor, women and children - IRDP, TRYSEM, DWCRA, JRY, IAY, SGSY.

UNIT II: Extension approaches to rural development, adult literacy programme-need, importance and objective, national literacy mission, post literacy activities, support structures and their functions – DRDA, NREGP, central social welfare board, state social welfare board, NABARD.

UNIT III: National level voluntary agencies – CAPART and KVIC, ICAR extension systems- KVK, NATP, IVLP, ATIC, NAIP, AICRP, role of SAUs in rural development, role of international organizations in rural development.

UNIT IV: Review of five year plans in India, privatization of extension services-scope and limitations, comparative extension system of selected developed and developing countries: USA, UK, Israel, China, Pakistan, Japan and Brazil with brief history, approaches, organizational structure, linkage with research and extension methods used, its comparative analysis with Indian extension system.

HECM 502 EXTENSION MANAGEMENT 2+0

Theory

UNIT I: Concept of administration and management, principles and theories of administration and management, schools of management thoughts, meaning, nature and scope of extension management, scientific management movement.

UNIT II: Process of management, planning, organizing, staffing- meaning, definition of staffing, directing, communicating, co-ordination, controlling, monitoring and evaluation.

UNIT III: Organizational climate, behavior, development, management by objective (MBO).

UNIT IV: Qualities and functions of extension personnel, extension system of ICAR, SAUs and state departments, problems and issues of extension management in India, critical appraisal of management of various extension organizations, community conflicts and its resolution.

HECM 503 RESEARCH METHODS IN HOME SCIENCE 3+0

Theory

UNIT I: Research – Meaning and importance, types of research, qualities of researcher, steps of research-selection and delineating of research problem, statement of general and specific objective, formulation of assumptions and hypothesis, planning research design, selection and development of data collection tools, collection of data, analysis and interpretation of data, drawing conclusion, writing research report.

UNIT II: Understanding some concepts in research, assumption, delimitations, operational definition, measurement and its levels, variable and their types, hypothesis - meaning, importance, characteristics and ways of stating hypothesis.

UNIT III: Review of literature – importance, sources of literature, organizing review, collection and presentation.

UNIT IV: Research design, historical or documentary, experimental, ex-post-facto, eurvey, case study, field studies.

UNIT V: Sampling - meaning and importance, sampling techniques, determine size of sample.

UNIT VI: Techniques of data collection, observation, interview and questionnaire, projective technique. Scale and tests - meaning and construction, validity and reliability of tools.
UNIT VII: Data analysis - tools and methods, interpretations of data, documentation and presentation, summary, conclusion and recommendations, writing abstract.
UNIT VIII: The research report, formal style of writing, chapterisation, heading, pagination, tables and figures, appendices and bibliography, acknowledgement, writing for publications.

HECM 504 GENDER SENSITIZATION FOR EMPLOYMENT 2+0

Theory

UNIT I: Gender and empowerment: meaning, gender related definitions and importance for empowering women, need and focus on gender sensitization - gender in community diversity and its implication for empowerment.
UNIT II: Gender perspectives in development of women, social characteristics, roles, responsibilities, resources, constraints, legal issues and opportunities, economical, educational and other parameters.
UNIT III: Gender tools and methodologies: dimensions and methodologies for empowerment, gender budgeting, gender analysis framework – context, activities, resources and programme action profile.
UNIT IV: Technologies and empowerment - gender specific technologies, household technology interface, socio-cultural interface and women as consumer of technologies. Gender issues and development: health and nutrition, violence, governance, education and media.

HECM 591 MASTER'S SEMINAR 1+0

HUMAN DEVELOPMENT

http://hillagric.ac.in/edu/cohs/hd/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
HDFS 501*	THEORIES OF HUMAN DEVELOPMENT AND BEHAVIOR	3+0	I
HDFS 502*	ADVANCES IN LIFE SPAN DEVELOPMENT	2+1	II
HDFS 503*	GENDER ISSUES IN HUMAN DEVELOPMENT AND FAMILY RELATIONS	2+1	I
HDFS 504*	CHILDREN WITH DEVELOPMENTAL CHALLENGES	2+1	II
HDFS 505	INNOVATIVE PROGRAMMES IN EARLY CHILDHOOD CARE EDUCATION	2+1	II
HDFS 506	METHODS AND TECHNIQUES OF ASSESSMENT IN DEVELOPMENT	1+2	II
HDFS 507	GUIDANCE AND COUNSELING	2+1	I
HDFS 508	GERONTOLOGY	2+1	II
HDFS 509	ADOLESCENT DEVELOPMENT AND CHALLENGES	2+1	II
HDFS 510	PARENT AND COMMUNITY EDUCATION	1+2	II
HDFS 511	APPRAISAL OF CHILD AND FAMILY WELFARE INSTITUTIONS	1+1	I
HDFS 512	DEVELOPMENT OF LEARNING MATERIAL AND CHILDREN'S LITERATURE	1+2	II
HDFS 513	FAMILY THERAPY	2+1	I
HDFS 591	MASTER'S SEMINAR	1+0	I&II
HDFS 592	SPECIAL PROBLEM IN M.SC.	0+1	I&II
HDFS 599	MASTER'S RESEARCH	0+20	I&II

*****Compulsory for Master's programme

HUMAN DEVELOPMENT

Course contents

HDFS 501 THEORIES OF HUMAN DEVELOPMENT AND BEHAVIOR 3+0

Theory

UNIT I**:** Meaning, types and functions of Theory, theoretical perspectives- biological, environmental, interactional, cultural context, concepts and implications of psychoanalytic Theory of sigmund freud and Neo-freudians.

UNIT II: Psychosocial Theory of Erikson, field Theory of Kurt Lewin, stimulus –response Theory and social learning theories, cognitive Theory of Jean Piaget.

UNIT III: Moral development Theory of Kohlberg, attachment Theory of Bowlby, language Theory of Chomsky, need Theory of Abraham Maslow, ecological Theory of Bronfrenbrenner.

UNIT IV: Cultural historical Theory of development of Vygotsky, self theories-comparative analysis of theories and their application, integrated approach to Theory building.

HDFS 502 ADVANCES IN LIFE SPAN DEVELOPMENT 2+1

Theory

UNIT I: Life span development; physical development, psycho-motor development; role of heredity and environment, recent trends in assessing pre-natal and neo-natal status.

UNIT II: Genetic research and its influence on child's development, current trends in physical, motor, intellectual, socio-emotional, moral development of children from birth to adolescence, socialization practices and influencing factors and impact of social-emotional deprivation on different stages of development.

UNIT III: Culture and its impact, emotional maturity, stability and catharsis, personality changes in self perceptions and gender role development through different developmental stages, influence of cultural factors.

UNIT IV: Integrated view of development from a life span perspective- recent research trends in human development issues.

Practical: Study of physical motor, social; emotional, intellectual, language and moral development; personality development at different ages; using standard measurement tools/instruments; writing interpretative reports for parents, teachers and referral services.

HDFS 503 GENDER ISSUES IN HUMAN DEVELOPMENT AND FAMILY RELATIONS 2+1

Theory

UNIT I: Concept of gender- its biological and socio-cultural connotations, importance of gender differences in human development, gender theories - gender orientation Theory of Sandra Bem, gender schema Theory, Theory of ego development and gender.

UNIT II: Demographic challenges to family ecology, gender issues in family involvement and cohesiveness (socialization, family roles, responsibilities and family adjustment), impact of gender roles, responsibilities and socialization practices.

UNIT III: Working towards family solidarity and social well being (values and ethics in the promotion of happy family life).

UNIT IV: Changing trends in gender role orientation, its socio- economic and cultural impact on the family and society.

Practical: Gender analysis of mass media content, books, television and films interviewing children; parents to study gender socialization practices; administering gender role orientation scale to adolescents / women interpreting the results; case study of three generation families to identify the differences in the gender orientation roles and responsibilities; case studies for gender role performance.

HDFS 504 CHILDREN WITH DEVELOPMENTAL CHALLENGES 2+1

Theory

UNIT I: Classification of developmentally challenged children, current statistics, its implications on the quality of life, multi disciplinary view of children with special needs.

UNIT II: Remedial programmes for different types of special needs- mental deficiency, sensory disabilities, neurological disorders, physically challenged.

UNIT III: Special programmes for the gifted, characteristics, assessment, educational and vocational interventions.

UNIT IV: Policies, government provisions, concessions, facilities and legislations for challenged children.

Practical: Study of etiology; characteristics, diagnosis of children with different disabilities; conducting individual home based intervention by collaborating with other professionals and also with institutions for center-based intervention- schools, clinics, also with pediatric wards, special schools; collaborative work with professionals in development of Intervention packages for children with special needs.

HDFS 505 INNOVATIVE PROGRAMMES IN EARLY CHILDHOOD CARE AND EDUCATION 2+1

Theory

UNIT I: Need and scope for innovative pogrammes in early childhood, innovative programmes for child care and education development.

UNIT II: Support services networking, innovative programmes for intellectual and motor development.

UNIT III: Support services for communication, social and emotional development of young children.

UNIT IV: Programmes for foundations for lifelong learning, preventing and arresting developmental delays / disabilities.

Practical: Planning, execution and evaluation of innovative programmes for intellectual and social growth of young children; planning, execution and evaluation of innovative programmes for emotional and motor growth of young children.

HDFS 506 METHODS AND TECHNIQUES OF ASSESSMENT IN HUMAN DEVELOPMENT 1+2

Theory

UNIT I: Assessment - definition, function, concept of measurement, techniques and their relative efficacy in measuring different aspect of human development.

UNIT II: Trends and challenges in assessment of human behavior, ethical issue in the assessment of human development.

UNIT III: Scientific methods and their criteria-reliability, validity control, item analysis, assessment methods, processing operations, use of objective measures and methods.

UNIT IV: Development of test / scale and standardization procedure types of scales – nominal ordinal, interval and ratio scale

Practical: Screening and diagnostic assessment for various development through different tools and techniques; physical – anthropometric measurement, psychomotor and mental development (bayley's scale etc.); cognitive and language -Wechsler's scale of intelligence; achievement interest and aptitude scale, personality and behavior - emotional maturity and temperament; parent child relations, child - rearing practices, parenting styles achievement and aptitude ; interpretation of assessment and report to parent and teachers.

HDFS 507 GUIDANCE AND COUNSELING 2+1

Theory

UNIT I: Introduction to guidance and counseling, concept, aims, need, nature and scope of guidance and counseling -basic principles of guidance and counseling.

UNIT II: Types of guidance and counseling services - educational, vocational, personal, marriage and family, leisure time, research trends in guidance and counseling in India and abroad.
UNIT III: Competencies and role of a guidance and counseling professionals, modes and methods of counseling; essential of conducting guidance and counseling session, understanding the process of guidance and counseling.
UNIT IV: Knowledge and skills to handle assessment tools, effective communication and documentation skills, networking with allied professionals and institutions.
Practical: Compile research reviews on various aspect of guidance and counseling; prepare a observation checklist to analyze guidance and counseling centers -organizational structure, Objective, types of services provided, facilities available etc.; competencies of the personnel, feed back of the clients towards the services, financial management / budget, support of other professionals / agencies to centre etc.; successful case studies of the centre; simulation exercises of guidance and counseling children and parents; reports of films / video shows related to the course.

HDFS 508 GERONTOLOGY 2+1

Theory

UNIT I: Definition - socio demographic profile of the aged in Indian context, theoretical perspective on aging, impact of aging on physical, psychological, socio-emotional aspects, abuse.
UNIT II: Aging and health, aging and financial status, stress among the aged and coping strategies.
UNIT III: The aged in the family context- problems and prospects, support systems, contemporary socio-cultural changes and their effects on the aged- international scenario.
UNIT IV: Research trends in gerontology and methodological issues, welfare of the aged –policies and programmes.
Practical: Review of study methods in gerontology; identification of focus areas on aging ; developing a tool on selected topics on aging, field testing and appraisal; visit to institutions for aged and critical evaluation; project proposal for developmental programmes for aged.

HDFS 509 ADOLESCENT DEVELOPMENT AND CHALLENGES 2+1

Theory

UNIT I: Adolescence – definition, importance of the stage, traditional theories of adolescence, modern theories, biological development, maturation, environmental learning, interactional and cultural context, perspectives of adolescent development, interpersonal relationships, socio- cultural attitudes of adolescents.
UNIT II: Consequences of puberty changes, sexual development, early and late maturation and psychological implications.
UNIT III: Intellectual development- formal operations, complexities of adolescent thoughts, moral development - integration of self and psycho-sexual resolution and resolving identity crisis - reorganization of social life-relationship with peers and parents, heterosexual relationships.
UNIT IV: Vocational preferences, training and work, transition to adulthood - conflicts with special reference to contemporary socio - cultural changes.
Practical: Case studies; interviewing early and late adolescents on issues – problems, pubertal changes, friendships and career; case studies, interviewing early and late adolescents on issues – aspirations, self and social awareness, political awareness, mass media preferences; depiction of adolescents in mass media - content analysis of media- films, television, literature.

HDFS 510 PARENT AND COMMUNITY EDUCATION 1+2

Theory

UNIT I: Concept and history of parent education; with special reference to India, objective and theoretical approaches to parent education programmes.

UNIT II: Basic approaches to communication, group, mini group approach, large group and individual approaches, single and multi- media approach, distance home education, parent education in school and community, teachers as a parent educator.
UNIT III: Communication techniques, written media/ printed matter and visual media, increasing competency of a parent educator, knowledge of the subject matter, training of personnel, special projects - open house parent training centres; parent involvement in community programmes.
UNIT IV: Special target groups for parent education, parents of young children, economically and socially backward, adopted, divorced, single and other needy parents living in urban, slum and rural areas, developmental problems and disability during childhood and adolescence.
Practical: Conducting parent teacher meetings in urban, rural, slum areas and schools; assessing knowledge of youth and parents regarding various aspects of family and community life; starting short-term action oriented / rehabilitative programmes using various techniques of parent education; preparing educational material for community participation.

HDFS 511 APPRAISAL OF CHILD AND FAMILY WELFARE INSTITUTIONS 1+1

Theory
UNIT I: Concept of monitoring and evaluation- need appraisal – orientation to the supportive and substitutive services related to the welfare and families, type of evaluation techniques for different types of institutions for children, impact analysis- type and methods of monitoring, enhancing functional quality of institutions and evaluation.
UNIT II: Family welfare – concept, scope and need, historical perspectives, roles and responsibilities of family and community, constitutional provisions- act, amendments related to family, laws and policies governing mainstreaming of vulnerable children (i.e. street children, child laborers) and families (adoptive families, reorganized families).
UNIT III: Orientation to welfare institutions and programmes, developmental programmes related to health, nutrition, and education, provision of basic resources - family care and counseling, agencies.
UNIT IV: Organizations and programmes for family welfare- local, national and international- aims, objective and services.
Practical: Visits to study child welfare institutions and evaluation of strategies for enhancing managerial skills of personnel and generation of resources; implementing developed plan of action and its evaluation, report writing; observational visits and evaluation of family welfare institutions and organizations; proposals for developing welfare project for health, nutrition, education and rehabilitation of the disabled families; implementation strategies of project, to test its efficacy; monitoring and evaluation of services for family welfare; criteria and impact assessment.

HDFS 512 DEVELOPMENT OF LEARNING MATERIAL AND CHILDREN'S LITERATURE 1+2

Theory
UNIT I: Significance of teaching materials for early childhood education programs, principles of developing materials for children, concept, importance and characteristics of creativity, promoting creative environments.
UNIT II: Planning and developing learning material for - physical, motor, social, language, creativity, mental and personality development, care and maintenance of materials.
UNIT III: Literature for Children: need and scope of children's literature, children's literature through the ages, contributors to children's literature, and characteristic features of literature for children: sources, features and significance of folk tales, folk songs, folk arts, mythology, historical events, science concept, biographies, fantasy and fairy tales.

UNIT IV: Types and importance of poetry, picture book, short stories and fables in educational programmes, role of puzzles, cartoons, comics, comic strips, skits, role plays, dance in educating children, creating literary environment in school, role of children's library.

Practical: Visit to play centers, toy manufacturing units, shops, fairs etc.; observing practical utility of different toys and teaching materials; preparation of teaching materials for different developmental domains; field testing and critical analysis of developed materials; survey of existing children's literature, observational visit to book exhibition, book fair, libraries and mobile vans; group discussion on elements of writing for children-poem, stories, puppet shows, cartoon strips, picture books; developing items of literature for different domains using pictures, audio video materials and computer aided designs.

HDFS 513 FAMILY THERAPY 2+1

Theory

UNIT I: Theoretical developments in marital and family therapy, schools for family therapy, structured, strategic, experimental family and integrated family therapy.

UNIT II: Social learning approach: Cotemporary marital therapies, psychoanalytic, behavioral, system theory approaches, areas and scope of marriage and family therapy.

UNIT III: Psychosomatic symptoms, psychiatric disorders, marital distress, alcoholism, drug dependence, juvenile offences, problems of adolescence, conduct problems, work and school phobias.

UNIT IV: Qualities of marriage and family therapist, advanced techniques of marriage and family therapy, future direction for marriage and family therapy- bridging research, theory and practices, advances in clinical assessment, preventive and enrichment programmes.

Practical: Observational visits and screening families in need of therapy; case studies of different areas of marriage and family therapy; case studies of different methods; techniques of marriage and family therapy.

HDFS 591 MASTR'S SEMINAR 1+0
HDFS 592 SPECIAL PROBLEM IN M.Sc. 0+1
HDFS 599 MASTER'S RESEARCH 0+20

VETERINARY & ANIMAL SCIENCES

ANIMAL GENETICS AND BREEDING

http://hillagric.ac.in/edu/covas/abgb/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
AGB 601	ANIMAL CYTOGENETICS AND IMMUNOGENETICS	2+1	I
AGB 602 *	MOLECULAR GENETICS IN ANIMAL BREEDING	2+1	II
AGB 603 *	POPULATION AND QUANTITATIVE GENETICS IN ANIMAL BREEDDING	2+1	I
AGB 604 *	SELECTION METHODS AND BREEDING SYSTEMS	3+1	I
AGB 605	BIOMETRICAL TECHNIQUES IN ANIMAL BREEDING	3+1	I
AGB 606 *	CONSERVATION OF ANIMAL GENETIC RESOURCES	2+0	II
AGB 607	CATTLE AND BUFFALO BREEDING	2+1	II
AGB 608	SMALL FARM ANIMAL BREEDING (SHEEP, GOAT, SWINE AND RABBIT)	2+0	II
AGB 609	POULTRY BREEDING	2+1	II
AGB 610	LABORATORY ANIMAL BREEDING	1+0	II
AGB 691*	MASTER'S SEMINAR	1+0	III
AGB 699 *	MASTER'S RESEARCH	0+20	III & IV
AGB 701 **	RECENT ADVANCES IN ANIMAL GENETICS	2+0	I
AGB 702 **	RECENT TRENDS IN ANIMAL BREEDING	2+0	I
AGB 703	ADVANCES IN BIOMETRICAL GENETICS	2+1	I
AGB 704 **	ADVANCES IN SELECTION METHODOLOGY	2+1	II
AGB 705	BIOINFORMATICS IN ANIMAL GENETICS AND BREEDING	2+0	II
AGB 706	ADVANCES IN MOLECULAR CYTOGENETICS	2+0	I
AGB 707	UTILISATION OF NON-ADDITIVE GENETIC VARIANCE IN FARM ANIMALS	2+1	II
AGB 791**	DOCTORAL SEMINAR I	1+0	I
AGB 792**	DOCTORAL SEMINAR II	1+0	II
AGB 799**	DOCTORAL RESEARCH	0+45	I&II

* Compulsory for Master's Programme ** Compulsory for Doctoral Programme

ANIMAL GENETICS AND BREEDING

Course contents

AGB 601 ANIMAL CYTOGENETICS AND IMMUNOGENETICS 2+1

Theory

UNIT I: Development in animal cytogenetics and immunogenetics of farm animals, immunoglobulins and their types, antigen-antibody interactions, immune response, ELISA.

UNIT II: Major histocompatibility complex, genetics of biochemical variants and their applications, ir-genes and concepts of disease resistance including major genes, hybridoma and its significance, concept of immuno-fertility, BoLA, BuLA, TLRs, Interleukins.

UNIT III: Chromatin structure of eukaryotes, chromosome number and morphology in farm animals banding and karyotyping, chromosomal and genetic syndromes, DNA packing in chromosomes, Z+B DNA, FISH chromosome painting and PRINS, RH Panel Mapping.

UNIT IV: Mutation and assays of mutagenesis, sister chromatid exchanges, recombinant DNA technique and its application in animal improvement programme.

Practical: Polymorphism of haemoglobulins; transferrins; enzymes/proteins; preparation of monovalent blood reagent-isoimmunization; titre testing and absorption of polyvalent serum; identification of bar bodies; in vitro and in vivo preparation of somatic metaphase chromosomes; screening of chromosomal abnormalities; microphotography and karyotyping; banding procedures for comparing the chromosomal complement, FISH and PRINS.

AGB 602 MOLECULAR GENETICS IN ANIMAL BREEDING 2+1

Theory

UNIT I: Basic concept, Genesis and importance of molecular techniques, Genome organization – physical and genetic map, current status of genome maps of livestock.

UNIT II: Molecular markers and their application, RFLP, RAPD, Microsatellite/Minisatellite markers, SNP marker, DNA fingerprinting.

UNIT III: DNA sequencing, Genome sequencing, Genomic Library, Polymerase Chain Reaction (PCR), its types (PCR-RFLP, AS-PCR etc.) and applications, Transgenesis and methods of gene transfer.

Unit IV: Statistical techniques for analyzing molecular genetic data, Quantitative Trait Loci (QTL) mapping and its application in animal breeding, Genome scan, Candidate gene approach, Genomic selection, Marker Assisted Selection- basic concept.

Practical: Extraction and purification of genomic DNA; Gel electrophoresis; Restriction enzyme digestion of DNA and analysis; PCR; PCR-RFLP; PCR-SSCP; Bioinformatics tool for DNA sequence analysis; Design of primer; Isolation of RNA; cDNA synthesis; Statistical methods for analyzing molecular genetic data.

AGB 603 POPULATION AND QUANTITATIVE GENETICS IN ANIMAL BREEDING 2+1

Theory

UNIT I: Individual verses population, genetic structure of population, factors affecting changes in gene and genotypic frequencies and their effect on genetic structure of animal populations, approach to equilibrium under different situations, viz: single autosomal locus with two alleles, single sex-linked locus, two pairs of autosomal linked and unlinked loci.

UNIT II: Small population, random genetic drift, effective population size, pedigreed populations, regular and irregular inbreeding systems.

UNIT III: Quantitative genetics-gene effects, population mean and variance and its partitioning, biometric relations between relatives.

UNIT IV: Genetic and phenotypic parameters-their methods of estimation, uses, possible biases and precision, scale effects and threshold traits.

Practical: Problems relating to gene and genotypic frequencies under different conditions; estimation of inbreeding in regular and irregular systems; estimation of effective population size; computation of quantitative genetic effects; estimation of variance components; computation of heritability; repeatability; genetic; environmental and phenotypic correlations and their standard errors.

AGB 604 SELECTION METHODS AND BREEDING SYSTEMS 3+1

Theory

UNIT I: Type of selection and their genetic consequences, response to selection and its prediction and improvement of response to selection.

UNIT II: Theoretical aspects of accuracy and efficiency of different base of selection, prediction of breeding value using different criteria, combined selection, correlated response to selection and efficiency of indirect selection.

UNIT III: Selection of several traits, evaluation of short term and long term selection experiments viz: bidirectional selection and asymmetry of response, selection plateux and limit.

UNIT IV: Genetic aspects and consequences of various mating systems, effects of mating systems on mean and variance.application of various mating system in animal improvement, selection for general and specific combining ability, genetic polymorphysim and its application in genetic improvement.

Practical: Estimation of breeding values from different sources of information;prediction of direct and correlated response to different bases of selection;computation of breeding values using different sources of information for female and male selection;computation of realized heritability and genetic correlation, selection index; computation; accuracy and response in component traits; estimation of heterosis for different types of crosses; estimation of GCA and SCA.

AGB 605 BIOMETRICAL TECHNIQUES IN ANIMAL BREEDING 3+1

Theory

UNIT I: Review of basic concepts in statistical inference and balanced experimental designs, nature of structure of animal breeding data and sources of variation.

UNIT II: Introduction to matrix algebra, types of matrices and matrix operations, determinants and their properties, methods of finding inverse of a matrix and their application.

UNIT III: ANOVA, regression and correlations, Henderson's methods for estimation of variance components, basic concepts of linear models,least-squares analysis, maximum likelihood, method of estimation, generalized LS and weighted LS, Fisher's discriminant function and its application, D2 - statistics in divergent analysis.

UNIT IV: Linear models in animal breeding, methods of analysis of unbalanced animal breeding data, adjustment of data, data base management and use of software packages in animal breeding.

Practical: Matrix applications;determinant and inverse of matrices; building of models for various types of data; estimation of variance components; least squares method for analysis of research data; collection,compilation, coding, transformation and analysis of animal breeding data by using above bio metrical techniques with computer application.

AGB 606 CONSERVATION OF ANIMAL GENETIC RESOURCES 2+0

Theory

UNIT I: Domestic animal diversity in india, its origin, history and utilization, present status and flow of animal genetic resources and its contribution to livelihood security, methodology for genotypic characterization of livestock and poultry breeds through systematic surveys, fodder availability,management of breed, physical, biochemical and performance traits and uniqueness of

animals of a breed,social,cultural and economic aspects of their owners/communities rearing the breed.
UNIT II: Methodology for molecular genetic characterization, diversity analysis and relationship among the breeds,concept of conservation, *In-situ* and *ex-situ* (*invivo* and *in-vitro*), models of conservation,prioritization of breeds for conservation, national and international strategies for conservation of animal genetic resources.
UNIT III: Status, opportunities and challenges in conservation of AnGR,IPR issues pertaining to animal genetic resources/animal products or by-products, registration of livestock breeds and protection of livestock owner's rights in India.

AGB 607 CATTLE AND BUFFALO BREEDING 2+1

Theory

UNIT I: History of dairy cattle and buffalo breeding,breeds of cattle and buffallo and their characterization, inheritance of important economic traits, recording and handeling of breeding data, standardization of records, computation of correction factors for the adjustment of the data, estimation of breeding values of the cows and bulls.
UNIT II: Sire evaluation methods using single trait and multiple traits, construction of sire indices, sire evaluation under animal model, sire mode, and maternal grand sire model,open nucleus breeding systems with MOET.
UNIT III: Methods of cross breeding, breeding of type, milk quality and production efficiency, plans for developing new breeds of dairy cattle, history of development of important breeds of dairy cattle.
UNIT IV: Considerations in the import of exotic germplasm for breeding cattle in the tropics, appraisal of buffalo and cattle breeding programme, role of breed associations in dairy improvement.
Practical: Performance recording; milk recording;estimation of economic traits;standardization of records;index cards;sire evaluation;comparison of latest methods;computation of genetic parameters;genetic gain;estimation of heterosis;culling and replacement.

AGB 608 SMALL FARM ANIMAL BREEDING (SHEEP, GOAT, SWINE AND RABBIT) 2+0

Theory

UNIT I: Breeds, economic traits, prolificacy, breeding records and standardization.
UNIT II: Genetic parameters, selection of males and females, breeding systems, development of new breeds.
UNIT III: Breeding policy, breeding research, conservation of breeds.
UNIT IV: Culling and replacement – EADR.

AGB 609 POULTRY BREEDING 2+1

Theory:

UNIT I: Origin and history of poultry species,chicken, turkey, duck and quail,important qualitative traits in poultry including lethal,economic traits of egg type chicken and their standardization,selection criteria,aids to selection,index selection and osborne index,restricted selection index,economic traits of meat,type chicken and their standardization.
UNIT II: Selection criteria and selection indices,response to selection,genetic controls,genotype and environment interaction,inbreeding, and its effects on production traits in egg and meat-type chickens,inbred lines,strain development,crossing,strain and line crosses,introduction to diallel cross,utilisation of heterosis and reciprocal effect,reciprocal recurrent selection and recurrent selection.
UNIT III: Industrial breeding,artificial insemination in chicken,autosexing,random sample test.

UNIT IV: Biochemical variants and immunogenetics of poultry,use of molecular genetics in poultry breeding,quantitative trait loci and marker,assisted selection,conservation of poultry genetic resources.

Practical: Inheritance of qualitative traits;economic traits of egg-type and meat-type chicken; procedures of standardization;estimations of heritability; correlation between various production traits; inbreeding co-efficient and heterosis;selection of sires and dams;osborne index;restricted selection index;collection and evaluation of semen and insemination;diallel cross.

AGB 610 LABORATORY ANIMAL BREEDING 1+0

Theory

UNIT I: Introduction to laboratory animal genetics,breeding colonies of mice, rats, hamsters, guinea pigs and rabbits.

UNIT II: Selection and mating methods/systems,monogamous, polygamous and others.

UNIT III: Development of genetically controlled laboratory animals,rules for nomenclature, inbred strains, outbred stocks, mutant stocks, recombinant inbred strains, transgenic strains, gene targeting and production of 'gene knock-out' animals.

UNIT IV: Genetic control and monitoring, record keeping,ethics of laboratory animal use.

AGB 691 MASTER'S SEMINAR 1+0

AGB 699 MASTER'S RESEARCH 0+20

AGB 701 RECENT ADVANCES IN ANIMAL GENETICS 2+0

Theory

UNIT I: Eukaryotic genome, gene families, pseudogenes SnRNPs, gene conversion, tandemly repeated genes, nuclear organiser region, mRNA splicing, minisatellites, microsatellites and its usage.

UNIT II: Transprosons, RNA processing transcuplion regulation of gene expression, selective gene amplification, post transceptional regulation, the proteasome and longevity of proteins.

UNIT III: Transgenic animals their benefits in livestock production, somatic cell nuclear transfer, transgenic animals in biomedical research, ethical consideration of transgenic animals,gene therapy and transgenic animal production, pharming of Pharmaceutical.

UNIT IV:Radiation hybrid panels and their usage in livestock, microdissection of chromosomes, *In-situ* hybridization, chromosome painting, meiotic crossing over, genome selection,structure and functions of major histocompatibility complex, T Cell receptor, CD4, Toll Like Receptors and their functions.

AGB 702 RECENT TRENDS IN ANIMAL BREEDING 2+0

Theory

UNIT I: Biometrical models and their analytical techniques on simulated and actual animal breeding data using computer application and use of programme in the field of animal breeding.

UNIT II: Formulation of detailed breeding plans ongoing breed improvement programmes and their impact analysis in various species of livestock under different situations.

UNIT III: Advanced techniques in genetic manipulation for multiplication and improvement of livestock species.

AGB 703 ADVANCES IN BIOMETRICAL GENETICS 2+1

Theory

UNIT I: Mating designs, genetic basis of tripple test cross analysis (TTC), triallele analysis, partial diallel crosses and mating design for studying reciprocal an maternal differences.

UNIT II: Models for studying the inheritance of endosperm characters, classificatory problems, discriminant function, D2 analysis, principal component analysis.

UNIT III: Use of genetic parameters for prediction of recombinant inbred lines, advances in studies of genotype environment interaction and selection indices.
UNIT IV: Generation matrix and its use in population genetics,gene mapping of QTL (quantitative trait loci).
Practical: Estimation of genetic parameters, diallel analysis, triallel analysis, D2 analysis, problems in matrix**.**

AGB 704 ADVANCES IN SELECTION METHODOLOGY 2+1

Theory

UNIT I: Fundamental theorem of natural selection,selection in finite populations effect on genetic structure and variance,optimum designs for the estimation of genetic parameters,design of selection experiments for testing selection theory.
UNIT II: Methods of measurement of genetic and environmental trends, advances in selection indices multistage, restricted and retrospective selection indices.
UNIT III: Multi-information, empirical evaluation of selection theory, genetic slippage, limits to selection, asymmetry of response, selection experiments, effect of selection on variance.
UNIT IV: Selection for threshold traits,single and multiple trait best linear unbiased estimation (BLUE) and prediction (BLUP), selection under single and multiple trait animal models, direct and correlated response through various selection indices, relationship between BLUP and selection index, fundamentals of marker assisted selections.
Practical: Estimation of relative economic values; determination of culling levels and selection intensity;construction of various indices; estimation of direct and correlated response; QTL analysis using LDMAS & LEMAS.

AGB 705 BIOINFORMATICS IN ANIMAL GENETICS AND BREEDING 2+0

Theory

UNIT I: Overview of bioinformatics, database concepts, algorithms, information resources for protein and genome databases, Gene Bank, EMBL, SWISSPROT, PROSITE.
UNIT II: Nucleotide and protein sequence analysis, pair-wise and multiple sequence alignments, Phylogeny, micro-array processing, clustering, analysis software, secondary database search.
UNIT III: Genetic characterisation, use of bioinformatics tools for identifying QTL and selection of elite germplasm.

AGB 706 ADVANCES IN MOLECULAR CYTOGENETICS 2+0

Theory

UNIT I: Structure of eukaryotic chromosomes, evolution of karyotype, various in vitro cell culture techniques, cell lines and utility,genotoxicity.
UNIT II: Somatic cell genetics,stem cell genetics,molecular cytogenetics and gene mapping, ISH, FISH, radiation hybrid mapping, fibre-FISH, PRINS.
UNIT III: Positional cloning, spectral karyotyping.
UNIT IV: Image analysis, chromosome walking, chromosome painting.

AGB 707 UTILISATION OF NON-ADDITIVE GENETIC VARIANCE IN FARM ANIMALS 2+1

Theory

UNIT I: Heterosis, forms and genetic basis, detection and estimation of non-additive genetic variance, average dominance, overdominance.
UNIT II: Partitioning of between cross variance, general combining ability, specific combining ability and reciprocal effects, methods of analyzing diallel crosses, utilization of non-additive genetic variance.

UNIT III: Crossbreeding systems,crossbreeding effects,recurrent and reciprocal recurrent selection and their forms.
UNIT IV: Development of specialized sire and dam lines, inbred lines and their maintenance, inbreeding and hybridization.
Practical: Computation of degree of dominance using NC Plans; analysis of partial and complete diallel cross data; estimation of crossbreeding effects; estimation of genetic correlation among paternal purebred and crossbred half sibs; computation of response through RS and RRS.

AGB 791	**DOCTORAL SEMINAR I**	**1+0**
AGB 792	**DOCTORAL SEMINAR II**	**1+0**
AGB 799	**DOCTORAL RESEARCH**	**0+45**

ANIMAL NUTRITION

www.hillagric.ac.in/ed/covas/an/index.html

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
ANN 601	ANIMAL NUTRITION – ENERGY AND PROTEIN	3+0	I
ANN 602	ANIMAL NUTRITION – MINERALS, VITAMINS AND FEED ADDITIVES	3+1	II
ANN 603	FEED TECHNOLOGY	1+1	I
ANN 604	FEED CONSERVATION, STORAGE AND QUALITY CONTROL	2+2	I
ANN 605	RUMINANT NUTRITION	2+1	II
ANN 606	NON-RUMINANT NUTRITION	1+1	I
ANN 607	NUTRITION OF COMPANION/ LABORATORY, WILD AND ZOO ANIMALS	2+1	II
ANN608	RESEARCH TECHNIQUES IN ANIMAL NUTRITION	1+3	I&II
ANN 609	NON CONVENTIONAL FEED STUFF AND TOXIC CONSTITUENTS/ANTIMETABOLITES IN ANIMAL FEEDSTUFF	2+1	I
ANN 691	MASTER'S SEMINAR	1+0	I&II
ANN 692	SPECIAL PROBLEM IN M. V. Sc.	0+1	I&II
ANN 699	MASTER'S RESEARCH	20	I&II
ANN 701	MODERN CONCEPTS OF FEEDING RUMINANTS AND FORAGE UTILIZATION	3+0	I
ANN 702	MODERN CONCEPTS OF FEEDING MONOGASTRIC ANIMALS	2+0	I
ANN 703	NUTRITION AND RUMEN FERMENTATION	1+1	I
ANN 704	ADVANCES IN MICRONUTRIENTS	1+0	II
ANN 705	ADVANCED TECHNIQUES IN NUTRITION AND RESEARCH	1+2	II
ANN 706	ADVANCES IN FEED TECHNOLOGY	1+1	II
ANN 707	CLINICAL NUTRITION	1+1	I
ANN 708	NUTRIENT AND DRUG INTERACTION	2+0	II
ANN 709	NEW FEED RESOURCES AND TOXICANTS IN ANIMAL FEEDING	2+0	I
ANN 791	DOCTORAL SEMINAR I	1+0	I&II
ANN 792	DOCTORAL SEMINAR II	1+0	I&II
ANN 793	SPECIAL PROBLEM IN Ph. D.	0+1	I&II
ANN 799	DOCTORAL RESEARCH	45	I&II

ANIMAL NUTRITION

Course contents

ANN 601 ANIMAL NUTRITION – ENERGY AND PROTEIN 3+0

Theory

UNIT I: Basic terminology and classification of carbohydrates, fats and proteins,fundamental concepts of digestion and metabolism of carbohydrate fat and protein in different species of animals, gluconeogenesis, recent advances in glucogenic precursors on acetate utilization,NPN metabolism, urea fermentation potential and metabolizable protein, amino acids imbalance, antagonism and toxicity.

UNIT II: Measures of feed energy, partitioning of feed energy, efficiency of energy and protein utilization, feeding standards-comparative appraisal and limitations.

UNIT III: Rumen degradable protein (RDP), and rumen undegradable protein (UDN) and kinetics, energetics of protein synthesis and turnover, quantification of microbial protein synthesis, protein quality determination in monogastrics and utility.

UNIT IV: Energy balance, fasting metabolism, direct and indirect calorimetry, determination of energy and protein requirements, energy and protein requirement for maintenance,growth, pregnancy and lactation in ruminants, companion animals and poultry.

ANN 602 ANIMAL NUTRITION – MINERALS, VITAMINS AND FEED ADDITIVES 3+1

Theory

UNIT 1: Essential minerals, general role of minerals, soil-plant-animal-human relationship, requirement of minerals, factors affecting requirements, macro elements and micro elements, their distribution, metabolism, physiological functions, deficiencies and excesses, requirements and sources, probable essential minerals, toxic minerals, definition, history, classification, chemistry, functions, deficiencies and excesses, requirements and sources of water soluble and fat-soluble vitamins.

UNIT II: Critical minerals for ruminants and non-ruminants, chelates and chelated minerals, inter-relationship of minerals with other nutrients, impact of minerals arising from industrial affluent on animal health and production,critical limits of minerals in edible herbages, bioavailability studies in minerals,impact of minerals on reproduction, concept of area specific minerals.

UNIT III: Relationship of vitamins with other nutrients,critical vitamins for ruminants and non-ruminants,feed additives including probiotics prebiotics, synbiotics and feed enzymes,research techniques in nutrition.

Practical: General principles of mineral estimation; sampling and processing techniques; estimation of macro- and micro-minerals;determination of bioavailability ofminerals; formulation of mineral mixture for various species; identification of adulterants and quality control; atomic absorption spectrometry in mineral estimation; preparation of diets for mineral studies; principles of vitamin estimation; estimation of some important vitamins (vitamin A,E,C); formulation of vitamin mixture for various species.

ANN 603 FEED TECHNOLOGY 1+1

Theory

UNIT I: Importance of feed technology in relation to animal productivity, the integrated biological, chemical and physical basis for evaluating the inherent nutritional quality of feed ingredients and feeds, familiarization of various feed mill equipments, layout and operations, problems of feed manufacturing units and control measures, quarantine measures.

UNIT II: Introduction to the formula feed manufacturing including principles of material handling, grinding, mixing, pelleting and other major processing operations, crumbling,flaking, popping,

extrusion, principles of instrumentation and analysis, with emphasis on application to quality control and research in the feed industry.
UNIT III: The formulation of concentrate mixtures, premixes and rations using computer, automated feed mill, personal management in feed plants, laws and regulation of feed manufacturing industry, codex alimentarius, HACCP, organizational charts for small, medium and large feed plants, labour standard, planning and production programme, handling of plant equipment, merits and demerits of automated feed plant.
Practical: Identification of feed ingredients and their specifications; as well as compound feed for different categories of livestock and poultry; feed microscopy; formulating premixes; introduction to pulverisers; pelletisers; complete feed blocks equipments; plant layout and design of different capacity of feed mills; problems related to feasibility; record keeping in different sections of feed mill; experiential learning at the feed plant for preparing feed; urea molasses mineral blocks; mineral mixture.

ANN 604 FEED CONSERVATION, STORAGE AND QUALITY CONTROL 2+2
Theory
UNIT I: Principles of feed and fodder processing and preservation techniques, their merits and demerits,procurement, planning and purchase procedures, traditional and modern farm level storage structures, feed storage and godown management, estimation of storage capacity and stack plan.
UNIT II: Evaluation of processed and preserved feeds and forages, effect of moisture, temperature and relative humidity on storage of feedstuffs and their effect on biotic factors, handling and storage of liquid feed ingredients, physical and chemical changes in feeds during storage, storage losses, insect pests and rodents in feed stores and their control, role of fungi, tolerance limits and measures to check them in stored products.
UNIT III: Factors affecting the quality of feed and feedstuffs on preservation, microbiological evaluation of processed and preserved feeds, effect of preservation on nutritional value of feed, properties and mode of action of pesticides and fumigants, principles of good sanitation and hygiene of godowns.
UNIT IV: Proximate composition, limitations of various systems of analysis, partitioning of forage fibre by van soest method, quality control of feed ingredients, specifications of feed ingredients and finished feeds, BIS standard, pesticide and insecticide residues in feeds.
Practical: Laboratory evaluation of preserved and processed feed and forages; physical properties of feeds and feedstuffs; identification of insect-pests and fungi in stored products; techniques for detection of hidden infestation in grains; quality control and inspection of stored feed materials; moisture equilibrium determination and estimation of chemical changes including alcoholic acidity; rancidity and uric acid in feeds during storage; weende proximate analysis; van soest fibre fractionation; enzymatic evaluation; pro rata deduction (Feed laws); urea; FFA; peroxide value; adulterants; and heavy metals.

ANN605 RUMINANT NUTRITION 2+1
Theory
UNIT I: Nutrients and their metabolism with special reference to milk, meat and wool production.
UNIT II: Feeding standards, their history, comparative appraisal and limitations, classification of feedstuffs, nutrient requirements for calves, heifers, dry, pregnant and lactating cows,buffaloes, sheep and goat.
UNIT III: Introduction to rumen microflora and fauna, development of rumen, role of milk replacers and calf starters, maximising microbial protein synthesis.
UNIT IV: Feed formulation of large and small ruminants for different physiological stages, concept of complete feed, limiting nutrients and strategic feeding of high yielding ruminants, concept of by-pass nutrients and their impact on production, reproduction and immune status, importance of CLA,

omega fatty acids, scope for value addition in milk, different systems of feeding buffalo for beef production, feeding during natural calamities, feeding in various agro-climatic zones of India.

Practical: Design and planning of feeding experiments; identification of feed and fodder on the basis of its composition; artificial rumen technique; methods for evaluation of feedstuffs- in vitro gas; in sacco digestion kinetics; determination of nutritive value of feeds and fodders by metabolism trial in dairy cattle; determination of nutritive value of pastures by the use of range techniques; study of rumen metabolic profile; preparation of bypass nutrients identification of rumen microbes and rumen studies.

ANN 606 NON-RUMINANT NUTRITION 1+1

Theory

UNIT I: Nutrients, their metabolism and requirements for poultry and swine during different stages of growth and production, limiting amino acids-lysine and methionine.

UNIT II: Feeding systems and feed additives, feed formulations for different purposes including least cost rations.

UNIT III: Quality control of poultry and swine rations for efficient egg and meat production, nutrition in relation to disease and stress.

UNIT IV: Nutritional factors affecting quality of the products, hind gut fermentation and its importance,nutrient requirements of rabbits and equines, nutritional manipulation for producing value added egg, meat / pork.

Practical: Design and planning for poultry and swine feeding experiments; formulation and compounding of general and least cost rations; determination of nutritive value of poultry and swine feeds by balance experiments; evaluation of protein quality; visit to poultry and piggery units; feed and fodder stores; use of software in least cost feed formulations; basic principles governing the least cost formulation software.

ANN 607 NUTRITION OF COMPANION, LABORATORY, WILD AND ZOO ANIMALS 2+1

Theory

UNIT I: Feed habits, food patterns, digestive structure and functions of companion, laboratory, wild and zoo animals, natural dietary habits,nutritional requirements of various species of animals.

UNIT II: Feeding standards and feeding habits of companion/laboratory animals, importance of colostrum and feeding of neonates and growing animals, feeding and care of nursing mothers, feeding of sick and old animals,post surgical nutrition.

UNIT III: Ration formulation for captive animals, artificial feeding and feeding during emergency, nutritive characteristics of forages for wild animals, adequacy of forage plants for wild and zoo animals, diets used in captivity, raising orphans, nutritional melodies, nutrition of semi wild and semi domestic animals like mithun and yak under special topography.

UNIT IV: Composition, presentation, sterilization, palatability, assessment and storage of companion/laboratory animal diets, companion food tables and their nutritional assessment, mistakes and misleading information on companion food labels and labeling.

UNIT V: Nutraceuticals in companion/laboratory animal foods, nutritional deficiency diseases, geriatric nutrition, corrective measures.

Practical: Formulation and preparation of hygienic; balanced diets and feeding for companion / laboratory animals; characteristics of ration formulation and feeding schedules of wild and zoo animals; feeding schedules for sick and orphan wild/zoo animals; artificial and emeergency feeding;general feeding habits and different feed constituents of wild and captive animals;research methodology of companion/laboratory animals;processing and storage of companion/laboratory diets; visit to zoological parks and wildlife sanctuary.

ANN 608 RESEARCH TECHNIQUES IN ANIMAL NUTRITION 1+3

Theory

UNIT I: Principles of animal experimentation, specialized feed compounding, introduction and principle of GLC, HPLC, AAS, tracer technique, flame photometer, NIR, SF6, amino acid analyzer.

UNIT II: Importance and principle of various techniques in estimating chemical and biochemical constituents and toxic principles in feeds, fodders, importance, principles and procedures for estimating chemical and biochemical constituents in blood, milk, rumen liquor, meat, wool etc.

Practical: Cell wall partitioning; lignin as internal marker in feedstuffs; mineral estimation by atomic absorption spectrophotometer; in-vitro/in-sacco determination of digestibility and digestion kinetics; determination of energy content of feed; faeces and urine using bomb calorimeter;methodology for quality improvement of animal feeds;interpretation and presentation of results;tracer techniques in animal nutrition;quality evaluation of silage and hay; feed energy estimation; nitrate; urea; aflatoxin; salmonella; glycosides andsedimentation tests; blood profile; meat quality.

ANN 609 NON CONVENTIONAL FEEDSTUFFS AND TOXIC CONSTITUENTS / ANTIMETABOLITES IN ANIMAL FEEDSTUFF 2+1

Theory

UNIT I: Present and future feed requirements and current availability for livestock and poultry, use of non-traditional feeds, by-products of agricultural, industrial, food processing units and forest by-products, evaluation by chemical and biological methods, formulation of economical rations, level of inclusion of various non conventional feeds in livestock ration.

UNIT II: Classification of toxic principles in animal feedstuffs, chemico-physical properties of various toxins, effect of toxins on biological system and nutrients utilization in different species of livestock, detoxification of toxin principles by various physical, chemical and biological techniques, insecticide and pesticide residue detection.

Practical: Estimation of various protease inhibitors; tannins; and mycotoxins in various feeds and feedstuffs; nitrates; HCN; oxalates; insecticide and pesticide residues; saponins; Gossypol; mimosine and heavy metals.

ANN 691 MASTER'S SEMINAR 1+0

ANN 692 SPECIAL PROBLEM IN M.V.Sc. 0+1

ANN 699 MASTER'S RESEARCH 0+20

ANN 701 MODERN CONCEPTS OF FEEDING RUMINANTS AND FORAGE UTILAZIATION 3+0

Theory

UNIT I: Developments in ruminant digestive physiology,energy protein requirement and measurement, requirements of other nutrients, importance of energy and protein quantity and quality,feed input and milk output relationship.

UNIT II: Concept of limiting amino acids for high yielders, strategic feeding of high yielding dairy cows and meat producing ruminants, concept of phase feeding, bypass nutrient technology, feeding during stress, nutrition-immunity interaction, designer milk and meat, rumen manipulation to reduce methanogenesis, nitrogen oxide emission and heavy metal residues, metabolic profile tests.

UNIT III: Use of conserved forages in ruminant feeding, chemical composition of common and newer forage,factors affecting nutritive value of commonly available grasses, pastures, silage, hay and crop residues, voluntary intake of fodder at different stages of growth, newer methods of forage

evaluation, calculated in vitro ME and DOMD by using prediction equations, merits and demerits of using leaf protein, top feeds and their effective utilization, pasture consumption and evaluation studies.
UNIT IV: Seminars on current topics of special interest.

ANN 702 MODERN CONCEPTS OF FEEDING MONOGASTRIC ANIMALS 2+0

Theory:
UNIT I: Nutritional factors affecting egg quality and hatchability in poultry, feeding for designer eggs, role of essential fatty acids, amino acids imbalance, toxicity and interactions in monogastrics.
UNIT II: Developments in digestive physiology of swine,equines,measurement of protein and energy requirements,influence of processing of feeds and fodders in mono-gastric animal nutrition.
UNIT III: Modern concepts of amino acid nutrition at various physiological stages, role of vitamins and minerals in health and disease, advances in new generation feeds and feed additives,

ANN 703 NUTRITION AND RUMEN FERMENTATION 1+1

Theory:
UNIT I: Nutrient requirements for fertility and gestation, prenatal growth and foetal nutrition, post-natal feeding, growth and developments, body composition at prenatal and postnatal stages, abnormalities due to malnutrition.
UNIT II: Rumen microflora and microfauna, considerations and limitations in relation to ruminant feeding practices, manipulation of rumen fermentation, physical, chemical and biological means, role of sulphur and phosphorus in rumen fermentation, modeling ruminant digestion and metabolism, principles.
Practical: Microbial and protozoal count; determination TVFA by chromatography; estimation of ammonia in rumen liquor;study on protection of protein in relation to degradability; rumen fermentation products; artificial rumen techniques; rumen enzyme assay.

ANN 704 ADVANCES IN MICRONUTRIENTS 1+0

Theory:
UNIT I: Developments in the study of major, minor and toxic minerals in animals,animal, soil- plant interrelationship,concepts in absorption and transport of micronutrients,kinetics and metabolism physiological and biochemical interactions among nutrients,interrelationship of minerals and vitamins in relation to metabolism and requirements, mineral toxicities in relation to livestock feeding.
UNIT II: Developments in vitamin and mineral requirements for growth, reproduction and lactation, identification and correction of deficiencies and toxicities of minerals in farm animals.
UNIT III: Bio-availability of macro and micro nutrients,factors affecting the bio-availability of minerals,bio-marker concept for mineral requirement for correction of deficiencies and toxicity of minerals.

ANN 705 ADVANCED TECHNIQUES IN NUTRITION AND RESEARCH 1+2

Theory:
UNIT I: Developments in analysis of nutrients in feeds, estimation of toxins and mycotoxins, application of atomic absorption spectrophotometer, HPLC, Enzymatic methods of feed analysis, Isotopes in nutrition research, feed microscopy, analytical aspect of feeds and fodders using N,I,R.
UNIT II: Faecal innoculum as alternative to rumen liquor in *in vitro* studies, degradability of feeds by various techniques, rates of VFA and microbial production.
Practical: Estimation of major; minor and toxic minerals by atomic absorption spectrophotometer; estimation of mycotoxin by HPLC; estimation of oxalate; nitrates; tannin and mimosine; VFA

fractionation by GC; SF6 Technique; amino acid analyzer; NIR; HPLC; purine derivatives; milk fat and FA estimation.

ANN 706 ADVANCES IN FEED TECHNOLOGY 1+1

Theory

UNIT I: Feed and fodder processing,particle size reduction,bulk density,processing of grains and oil seeds,processing of roughages,feed plant layout and design,feed plant management, storage of feeds.

UNIT II: Non conventional feed resources,formulation of concentrates, premixes and rations, improvement of nutritive value of poor quality roughages, liquid feed supplements, solid state fermentation (SSF) technology.

Practical: Feed microscopy tests for certain adulterants and anti nutritional factors;feed plant design;processing of roughages; feed plant sanitation;wild seed identification; qualitative tests for rancidity;minerals and adulterants;visit to commercial feed plant.

ANN 707 CLINICAL NUTRITION 1+1

Theory:

UNIT I: Nutritional factors responsible for disorders, metabolic disorders and production diseases in farm animals,prevention of metabolic disorders,recommended dietary regimens.

UNIT II: Effect of coccidiostats and dietary antigens in early weaned livestock, nutrition in relation to emerging diseases, effect of nutrition on fertility, reproduction and lactation, toxic minerals and counter action (Selenium and fluorine).

UNIT III: Stress nutrition and post surgical nutrition, nutritional manipulation and feeding of sick animals,pesticides residues in feeds and fodders and their impact on animal health, reproduction and production.

Practical: Determination of blood glucose; blood urea nitrogen; SGOT SGPT; total protein; cholesterol and ketone bodies; metabolic profile tests.

ANN 708 NUTRIENT AND DRUG INTERACTION 2+0

Theory:

UNIT I: Effects of drugs on digestion and absorption of nutrients, drugs and intestinal microbial interaction, effect of drugs and antibiotics as feed additives, physiological effects, use and abuse,

UNIT II: Nutrients in drug detoxification, antagonists, hormones and their effect on growth and carcass qualities, drug residues in animal products - milk and meat, effect on food change, legal aspects of drugs in animal products.

ANN 709 NEW FEED RESOURCES AND TOXICANTS IN ANIMAL FEEDING 2+0

Theory:

UNIT I: Demand and availability of feed, formulation of database in computer, strategy in food animal production, agricultural by-products, agroindustrial by-products, farm waste, crop residues, organic wastes of animal origin, slaughter house waste, industrial waste and their feeding value in animals.

UNIT II: Processing to enhance feed utilization and availability, possible health hazards due to waste utilization-chemical and nutritional changes in waste product due to processing, quality standard and their acceptance.

UNIT III: Naturally occurring toxicants, toxicants of plants and non-microbial origin, naturally occurring alkaloids, mycotoxins and their toxicity, acquired toxicants, pesticides, weedicides and heavy metals.

UNIT IV: Effect of toxins on rumen fermentation and nutrient utilization, methods of detoxification, food and feed contaminants, their impact on animal performance.

ANN 791	**DOCTORAL SEMINAR I**	**1+0**
ANN 792	**DOCTORAL SEMINAR II**	**1+0**
ANN 793	**SPECIAL PROBLEM IN Ph. D.**	**0+1**
ANN 799	**DOCTORAL RESEARCH**	**0+45**

ANIMAL REPRODUCTION, GYNAECOLOGY & OBSTETRICS

http://hillagric.ac.in/edu/covas/argo/index.html

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
VOG 601	GENERAL GYNAECOLOGY	3+1	I
VOG 602	FEMALE INFERTILITY	3+1	II
VOG 603	VETERINARY OBSTETRICS	2+2	II
VOG 604	ANDROLOGY AND MALE INFERTILITY	3+1	I
VOG 605	SEMEN PRESERVATION AND ARTIFICIAL INSEMINATION	2+1	I
VOG 606	REPRODUCTIVE BIOTECHNOLOGY	2+1	II
VOG 607	CLINICAL PRACTICE I	0+3	I
VOG 608	CLINICAL PRACTICE II	0+3	II
VOG 691	MASTER'S SEMINAR	1+0	I&II
VOG 699	MASTER'S RESEARCH	0+20	I&II
VOG 701	ADVANCES IN GYNAECOLOGY	2+1	I
VOG 702	ADVANCES IN OBSTETRICS	2+1	II
VOG 703	ADVANCES IN ANDROLOGY	2+1	I
VOG 704	ADVANCES IN REPRODUCTIVE BIOTECHNOLOGY	1+1	II
VOG 705	ADVANCES IN SEMEN PRESERVATION	1+1	I
VOG 706	CLINICAL PRACTICE I	0+3	I
VOG 707	CLINICAL PRACTICE II	0+3	II
VOG 790	SPECIAL PROBLEM IN Ph.D.	0+2	II
VOG 791	DOCTORAL SEMINAR I	1+0	I
VOG 792	DOCTORAL SEMINAR II	1+0	II
VOG 799	DOCTORAL RESEARCH	0+45	I&II

ANIMAL REPRODUCTION, GYNAECOLOGY & OBSTETRICS

Course contents

VOG 601 GENERAL GYNAECOLOGY 3+1

Theory

UNIT I: Puberty and sexual maturity, role of hypothalamic, pituitary, gonadal axis in attainment of puberty and sexual maturity, onset of postpartum ovarian activity, endocrine regulation of estrous cycle.

UNIT II: Folliculogenesis, oogenesis and ovulation and associated endocrine pattern, manipulation of follicular waves, synchronization of estrus and ovulation and induction of ovarian activity.

UNIT III: Gamete transport, fertilization, implantation and maternal recognition of pregnancy.

UNIT IV: Embryonic and fetal development, placentation, fetal circulation and gestation, position of fetus in the uterus, age characteristics of fetus.

UNIT V: Pregnancy diagnosis, clinical, ultrasonographic, endocrinological and other diagnostic laboratory tests, pseudo-pregnancy and its treatment.

UNIT VI: Factors affecting reproduction, seasonality, nutrition, stress, environment, management, suckling and diseases.

UNIT VII: Lactation and artificial induction of lactation.

Practical: Clinical examination of female genitalia; biometry of female genital organs; rectal and vaginal examination to diagnose cyclic phases of estrous cycle; fern pattern of cervical mucus and exfoliated vaginal cytology; pregnancy diagnosis in large and small animals by various methods; estimation of age of the fetus; use of ultrasound / RIA / ELISA in gynaecology; synchronization of estrus and ovulation in farm animals.

VOG 602 FEMALE INFERTILITY 3+1

Theory

UNIT I: Introduction to infertility, classification, economic impact, anatomical causes of infertility, congenital and hereditary causes and acquired defects.

UNIT II: Nutritional causes of infertility, importance of body condition score.

UNIT III: Managemental and environmental causes of infertility, out of season breeding.

UNIT IV: Infectious causes of female infertility, specific and non-specific infections.

UNIT V: Ovarian dysfunction, anoestrus, cystic ovarian degeneration, anovulation, delayed ovulation and luteal insufficiency.

UNIT VI: Repeat breeding, its causes, diagnosis and treatment.

UNIT VII: Early embryonic death (EED), causes, diagnosis and therapeutic management.

UNIT VIII: Abortion, infectious and non-infectious causes, diagnosis and prevention of abortion.

UNIT IX: Interactions in Immunological mechanisms and infertility.

Practical: Record keeping; herd fertility assessment and management; diagnosis and treatment of infertility in female animals; use of uterine swabs for bacterial and fungal culture; histo-pathological evaluation of uterine biopsy; exfoliated vaginal cytology and hormone assay; use of ultrasonography in diagnosis of infertility; immunodiagnostic techniques.

VOG 603 VETERINARY OBSTETRICS 2+2

Theory

UNIT I: Parturition, stages of parturition, mechanism of initiation of parturition, hormonal profiles associated with parturition.

UNIT II: Principles of handling of dystocia, obstetrical procedures, mutations, fetotomy, caesarean section, obstetrical anesthesia and analgesia, epidural anesthesia.

UNIT III: Fetal and maternal dystocia, causes, diagnosis and management.

UNIT IV: Uterine torsion, causes, diagnosis and its correction.

UNIT V: Diseases and accidents during gestation and around parturition.
UNIT VI: Etiology, diagnosis and treatment of ante-partum and post-partum uterine and vaginal prolapsed.
UNIT VII: Induction of parturition and elective termination of pregnancy.
UNIT VIII: Involution of uterus following normal and abnormal parturition.
UNIT IX: Care of dam and the newborn.

Practical: Pelvimetry of different species of farm animals; diagnosis and correction of abnormal fetal presentation; position and posture in phantom box; epidural anesthesia; ovariohysterectomy and caesarean operation; fetotomy exercises; detorsion of uterus; management of prolapse; handling of clinical cases of dystocia.

VOG 604 ANDROLOGY AND MALE INFERTILITY 3+1

Theory

UNIT I: Structure and function of reproductive tract of male.
UNIT II: Sexual behavior and examination of bulls for breeding soundness.
UNIT III: Spermatogenesis, (formation, migration, maturation and ejaculation of semen), fine structure of spermatozoa, semen and its composition.
UNIT IV: Diseases transmitted through semen.
UNIT V: Factors affecting semen quality, semen culture, tests for assessment of sperm motility, sperm survival and fertilizing capacity of spermatozoa.
UNIT VI: Causes of infertility, hereditary, congenital, infectious, nutritional and hormonal, pathological and functional disturbances of epididymis, vas deferens and accessory sex glands.
UNIT VII: Impotentia coeundi and impotentia generandi, testicular hypoplasia and degeneration, causes and effect on semen and fertility.
UNIT VIII: Coital injuries and vices of male animals.

Practical: General and rectal examination for biometrics of male genitalia and accessory sex glands; breeding soundness evaluation of male animals; semen evaluation for sperm abnormalities; fertility and determination of other biochemical constituents of seminal plasma; computer assisted semen analysis (CASA); microbiological load of semen; examination; diagnosis and treatment of infertile male animals.

VOG 605 SEMEN PRESERVATION AND ARTIFICIAL INSEMINATION 2+1

Theory

UNIT I: History of artificial insemination.
UNIT II: Methods of semen collection.
UNIT III: Semen evaluation: macroscopic, microscopic, biochemical and microbiological tests, computer assisted semen analysis (CASA).
UNIT IV: Semen preservation, extenders for preservation of semen at different temperatures, semen additives for enhancement of motility and fertilizing capacity of spermatozoa.
UNIT V: Cryopreservation of semen, effects of cryopreservation on spermatozoa, semen quality and fertility.
UNIT VI: Thawing protocols of frozen semen, factors affecting post-thaw semen quality.
UNIT VII: Ideal protocol for AI in different species of animals, factors affecting success of AI.

Practical: computer assisted semen analysis (CASA); collection and evaluation of semen; preparation of extenders; preservation of semen: room temperature; refrigeration and cryopreservation; handling and evaluation of processed semen; practice of AI techniques.

VOG 606 REPRODUCTIVE BIOTECHNOLOGY 2+1

Theory

UNIT I: Embryo transfer technology, selection of donors and recipients.

UNIT II: Synchronization, super-ovulation, surgical and non-surgical collection of embryos and evaluation of embryos.
UNIT III: Cryopreservation of embryos, transfer of embryos to donors.
UNIT IV: *In vitro* fertilization, *in vitro* maturation, micromanipulation of embryos.
UNIT V: Sexing of sperm and embryos.
UNIT VI: Transgenic animals, chimeras.
UNIT VII: Stem cell biotechnology.
UNIT VIII: Immuno-neutralization of hormones, immuno-modulation of fertility.
Practical: Synchronization of estrus in donors and recipients; super-ovulation; surgical and non-surgical collection and transfer of embryos; collection of oocytes from slaughter house genitalia; *in vitro* fertilization; *in vitro* maturation and cryopreservation of embryos; sexing of embryos.

VOG 607 CLINICAL PRACTICE I 0+3
Practical: Clinical examination of animals affected with reproductive disorders; use of diagnostic techniques for diagnosis and institution of required therapy; maintenance of case records; presentation on selected /assigned cases.

VOG 608 CLINICAL PRACTICE II 0+3
Practical: clinical examination of animals affected with reproductive disorders; use of diagnostic techniques for diagnosis and institution of required therapy; maintenance of case records; presentation on selected /assigned cases.

VOG 691 MASTER'S SEMINAR 1+0
VOG 699 MASTER'S RESEARCH 0+20

VOG 701 ADVANCES IN GYNAECOLOGY 2+1
Theory
UNIT I: Neuro-endocrine control of reproduction, follicular development, ovulation, fertilization and implantation, embryonic and fetal development.
UNIT II: Maternal recognition of pregnancy, advances in early diagnosis of pregnancy.
UNIT III: Embryonic losses, abortion and their prevention.
UNIT IV: Seasonal breeders, synchronization and induction of estrus and ovulation in seasonal breeders, assisted reproductive technology (ART) to increase reproductive efficiency in farm animals.
UNIT V: Effect of stress, nutrition and immunological factors on fertility.
UNIT VI: Onset of postpartum ovarian activity and factors affecting it.
UNIT VI: Diagnostic & therapeutic approaches in infertility, principles of hormone therapy in reproductive disorders, laparoscopic and ultrasonographic diagnosis of ovarian/uterine dysfunction, RIA/ELISA techniques for hormones assay in reproductive disorders, vaginal and uterine cytology.
Practical: Clinical examination of female animals; use of ultrasonography in ovarian function (follicular image pattern; follicular dynamics) and in early pregnancy diagnosis and infertility; utility of uterine culture; uterine cytology and uterine biopsy (histopathological examination) in infertility investigation; laparoscopy in diagnosis of ovarian and uterine dysfunction; ELISA/RIA of hormones and interpretation of results; use of assisted reproductive technology (ART) to enhance reproductive efficiency in farm animals.

VOG 702 ADVANCES IN OBSTETRICS 2+1
Theory
UNIT I: Conceptus and its development, factors influencing gestation period and birth weight.
UNIT II: Anomalies of conceptus, teratogens and effect of stress on conceptus development.

UNIT III: Mechanism of initiation of parturition, use of tocolytic drugs in management of uterine inertia.
UNIT IV: Induction of parturition and termination of abnormal pregnancies, obstetrical analgesia and anaesthesia.
UNIT V: Pre-treatment evaluation of the dam suffering from dystocia, management of maternal and fetal dystocia, hydrallantois, hydramnion, fetal mummification, fetal maceration, uterine inertia and uterine torsion.
UNIT VI: Fetotomy, caesarean section and ovario-hysterectomy.
UNIT VII: Neo-natal physiology and post-natal adaptations.
UNIT VIII: Involution of uterus, post-partum ovarian dysfunction and their manipulation.

Practical: Obstetrical operations in fetal dystocia; mutations; fetotomy; caesarean section; ovario-hysterectomy; induction of parturition; use of tocolytic drugs in dystocia; obstetrical analgesia and anaesthesia.

VOG 703 ADVANCES IN ANDROLOGY 2+1

Theory

UNIT I: Spermatogenesis, spermatogenic waves, sperm passage in male genitalia, biochemical milieu of male genitalia, correlation between motility and fertilizing capacity of spermatozoa.
UNIT II: Separation of motile and immotile spermatozoa, sexing and separation of male and female determining spermatozoa.
UNIT III: Sperm plasma membrane and its permeability and binding properties, acrosome and lysosomal enzymes, sperm nucleus and nuclear proteins, mitochondria and their role in sperm metabolism, flagellum and the mechano-chemical basis of motility and cyclic nucleotides.
UNIT IV: Biochemistry of seminal plasma and accessory sex gland secretions, electrolytes, proteins, enzymes and amino acids in seminal plasma, fructose and other sugars, lipids, cholesterol, steroid hormones and prostaglandins in seminal plasma.
UNIT V: Fructolysis index, aerobic and anaerobic metabolism of spermatozoa.
UNIT VI: Biochemical markers of fertility in males, sperm chromatin structure assay, anti-sperm antibodies.

Practical: Breeding soundness evaluation of bulls; biochemical tests of semen for evaluation of fertility; semen culture for diagnosis of venereal diseases; diagnosis and treatment of genital pathological condition; computer assisted semen analysis (CASA); semen evaluation for assessment of fertilizing capacity of spermatozoa: cervical mucus penetration test; sperm capacitation test; hypo osmotic swelling test and zona free hamster egg penetration test; anti-sperm antibody assay.

VOG 704 ADVANCES IN REPRODUCTIVE BIOTECHNOLOGY 1+1

Theory

UNIT I: Embryo transfer technology and its application in farm animals.
UNIT II: Selection and management of donor and recipient animals, super-ovulation, surgical and non-surgical collection, evaluation of embryos and transfer of embryos.
UNIT III: *In vitro* fertilization and maturation of oocytes.
UNIT I: Micromanipulation, sexing and cryopreservation of embryos.
UNIT V: Sexing of sperm and embryos.
UNIT VI:Transgenic animals, chimeras.
UNIT VII: Stem cell biotechnology.
UNIT VIII: Immuno-neutralization of hormones, immune-modulation of fertility.

Practical: Evaluation of superovulatory hormonal regimens in donors and synchronization of estrus in recipients; surgical and non-surgical collection and transfer of embryos; collection of oocytes from slaughter house genitalia; *In vitro* fertilization; *in vitro* maturation and cryopreservation of embryos; sexing of embryos.

VOG 705 ADVANCES IN SEMEN PRESERVATION 1+1

Theory

UNIT I: Transmission of venereal diseases through semen and their prevention.

UNIT II: Factors affecting motility and fertilizing capacity of spermatozoa, semen collection, extension and cryopreservation of semen, damages to spermatozoa caused by cryopreservation.

UNIT III: Use of semen additives for promotion of sperm motility and fertilizing capacity.

UNIT IV: Thawing protocols for frozen semen, post-thaw evaluation of motility and fertilizing capacity of spermatozoa.

Practical: Collection of preputial washings and semen for bacterial load and venereal pathogens; preparation of semen extenders with different additives; use of different freezing protocols for preservation of semen; evaluation of fertility with frozen semen; enzymatic changes in semen following cryopreservation.

VOG 706 CLINICAL PRACTICE I 0+3

Practical: Clinical examination of animals affected with reproductive disorders; use of diagnostic techniques for diagnosis and institution of required therapy; maintenance of case records; presentation on selected/ assigned cases.

VOG 707 CLINICAL PRACTICE II 0+3

Practical: Clinical examination of animals affected with reproductive disorders; use of diagnostic techniques for diagnosis and institution of required therapy.

VOG 790 SPECIAL PROBLEM IN Ph.D. +2

Practical: Student will carry out research on allotted project and submit the project along with research papers for publication in scientific journals.

VOG 791	**DOCTORAL SEMINAR I**	**1+0**
VOG 792	**DOCTORAL SEMINAR II**	**1+0**
VOG 799	**DOCTORAL RESEARCH**	**0+45**

VETERINARY ANATOMY AND HISTOLOGY

http://hillagric.ac.in/edu/covas/vah/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
VAN 601	COMPARATIVE OSTEOLOGY AND ARTHROLOGY	1+2	I
VAN 602	COMPARATIVE SPLANCHNOLOGY	2+2	II
VAN 603	MYOLOGY, ANGIOLOGY, NEUROLOGY AND AESTHESIOLOGY OF OX	1+3	I
VAN 604	GROSS ANATOMICAL TECHNIQUES	0+2	II
VAN 605	THEORY AND PRACTICE OF HISTOLOGICAL AND HISTOCHEMICAL TECHNIQUES	1+2	I
VAN 606	GENERAL HISTOLOGY AND ULTRASTRUCTURE	3+1	I
VAN 607	SYSTEMIC HISTOLOGY AND ULTRASTRUCTURE	3+1	II
VAN 608	DEVELOPMENTAL ANATOMY	3+1	II
VAN 691*	MASTER'S SEMINAR	1+0	I
VAN 699*	MASTER'S RESEARCH	20	I&II
VAN 701	MYOLOGY, ANGIOLOGY, NEUROLOGY AND AESTHESIOLOGY OF EQUINE, CANINE &PORCINE	0+3	I
VAN 702	PRINCIPLES & APPLICATIONS OF BIOMECHANICS	2+0	II
VAN 703	AVIAN ANATOMY	1+2	I
VAN 704	NEUROANATOMY	3+1	II
VAN 705	ENDOCRINE ANATOMY	2+1	I
VAN 706	THEORY AND APPLICATIONS OF ELECTRON MICROSCOPE	2+1	II
VAN 707	HISTOENZYMOLOGY &IMMUNOCYTOCHEMISTRY	2+1	II
VAN 708	APPLIED EMBRYOLOGY AND TERATOLOGY	1+2	I
VAN 709	FUNCTIONAL VETERINARY ANATOMY	2+0	II
VAN 710	GROSS ANATOMY OF LABORATORY ANIMALS	1+1	I
VAN 790	SPECIAL PROBLEM IN Ph.D.	0+2	II
VAN 791**	DOCTORAL SEMINAR I	1+0	I
VAN 792**	DOCTORAL SEMINAR II	1+0	I
VAN 799**	DOCTORAL RESEARCH	45	I&II

* Compulsory for Master's Programme ** Compulsory for Master Ph.D Programme

VETERINARY ANATOMY AND HISTOLOGY

Course contents

VAN 601 COMPARATIVE OSTEOLOGY AND ARTHROLOGY 1+2

Theory

UNIT I: Technical terms, structure, chemical composition and classification of bones.

UNIT II: Bones of appendicular skeleton of ox as a type and their comparison withthose of horse, dog, pig and poultry.

UNIT II: Bones of axial skeleton of ox as a type and their comparison with those ofhorse, dog, pig and poultry.

UNIT IV: Classification and detailed study of different joints of the body.

UNIT V: Study the various indices for estimating race, sex and age of differentanimals, basics of biomechanics of the locomotor system, radiography ofnormal and developing bones.

Practical: Demonstration of all bones and dissection of joints of buffalo/Cattle.

VAN 602 COMPARATIVE SPLANCHNOLOGY 2+2

Theory

UNIT I: Descriptive anatomy of various organs of digestive system and associatedglands of ox and their comparison with those of horse, dog, pig and poultry, study of formation of thoracic, abdominal and pelvic cavities, reflection ofthese cavities.

UNIT II: Study of various organs/structures and associated glands constituting therespiratory system of ox and their comparison with those of horse, dog, pigand poultry.

UNIT III: Detailed study of organs and associated glands comprising the urinarysystem of ox as a type and their comparison with those of horse, dog, pigand poultry.

UNIT IV: Complete study of various organs and associated glands of male and femalegenital systems.

UNIT V: Surgical sites for various operations and clinically significant areas forperforming auscultation, percussion and for carrying out surgicalprocedures such as laryngotomy, oesophagotomy, gastrotomy, rumenotomy, cystotomy, urethrotomy, caesarian section, exploratorylaparotomy, mammectomy, thoracotomy, thoracocentesis etc.

Practical: Demonstration of structure and placement of organs in body cavities of allthe animals.

VAN 603 MYOLOGY, ANGIOLOGY, NEUROLOGY AND AESTHESIOLOGY OF OX 1+3

Theory

UNIT I: Classification of muscle fibres, origin, insertion and relations of muscles of different body parts.

UNIT II: Topographic anatomy of the vascular system comprising of heart, arteries, veins and lymphatics.

UNIT III: Study of various components of central nervous system, peripheral nervous system and autonomic nervous system.

UNIT IV: Complete study of the gross anatomy of various sense organs.

UNIT V: Study of different nerve blocks, intravenous sites and enucleation of eyeball.

Practical: Dissection of heart; different vessels; brain; cranial nerves; brachial plexuses and lumbo-sacral plexus; Dissection of eye; ear; hoof and horn of buffalo/cattle.

VAN 604 GROSS ANATOMICAL TECHNIQUES 0+2

Practical: Embalming fluids; embalming of animals; maceration and preparation of skeletons; gross staining of brain sections; demonstration of sites of ossifications; preparation of transparent specimens; preparation of casts of various organs; blood vessels and ducts etc.

VAN 605 THEORY AND PRACTICE OF HISTOLOGICAL AND HISTOCHEMICAL TECHNIQUES 1+2

Theory

UNIT I: Preparation of tissues for light microscopy using different fixatives.

UNIT II: Different staining methods for routine light microscopy.

UNIT III: Frozen sectioning techniques and staining methods for enzymes, carbohydrates, lipids, proteins, pigments etc.

UNIT IV: Silver staining techniques for nervous tissue.

Practical: Study of different techniques for collection; fixation and processing of animal tissues; preparation of paraffin and frozen sections; handling and care of microtomes; demonstration of staining of carbohydrates, lipids, proteins, nucleic acids and enzymes.

VAN 606 GENERAL HISTOLOGY AND ULTRASTRUCTURE 3+1

Theory

UNIT I: Light and ultrastructural details of animal cell.

UNIT II: Light and ultrastructural details of epithelial tissue.

UNIT III: Light and ultrastructural details of muscular tissue.

UNIT IV: Light and ultrastructural details of connective tissue.

UNIT V: Light and ultrastructural details of nervous tissue.

Practical: Demonstration of different components of cells and intercellular substances of the above referred tissues by special staining through the use of light; phase contrast; dark field; fluorescent and electron microscopes.

VAN 607 SYSTEMIC HISTOLOGY AND ULTRASTRUCTURE 3+1

Theory

UNIT I: Light and ultrastructure of different organs of digestive system of ruminants with differential features among domestic animals.

UNIT II: Light and ultrastructure of different organs of respiratory, lymphoid and cardiovascular systems.

UNIT III: Light and ultrastructure of different organs of urino-genital systems.

UNIT IV: Light and ultrastructure of different sense organs and nervous system.

Practical: Study of histological structure of organs of digestive; respiratory; urinary; genital and cardiovascular systems of buffalo; horse and dog/cat.

VAN 608 DEVELOPMENTAL ANATOMY 3+1

Theory

UNIT I: Gametogenesis, fertilization, cleavage and gastrulation.

UNIT II: Development of foetal membranes and placenta in domestic animals.

UNIT III: Histogenesis of nervous system, sense organs, endocrine organs and cardiovascular system.

UNIT IV: Embryonic development of digestive, respiratory, uro-genital and musculoskeletal system.

Practical: Study of serial sections of the chick and pig embryos at different stages ofdevelopment.

VAN-691 MASTER SEMINAR 1+0

VAN-699 MASTER RESEARCH 0+20

VAN 701 MYOLOGY, ANGIOLOGY, NEUROLOGY AND

Practical: Dissection of different body regions with respect to muscles, blood vessels and nerves, and see the topographic positioning of different organs indifferent body cavities in equine, canine and porcine.

VAN 702 PRINCIPLES AND APPLICATIONS OF BIOMECHANICS 2+0

Theory

UNIT I: Biomechanics, its definition and scope with reference to anatomy and physiology of domestic animals and musculo-skeletal dynamics.

UNIT II: Locomotion and clinical applications, biomechanics of cortical and trabecular bones.

UNIT III: Biomechanics of fracture fixation, instrumentation and techniques in locomotion and their applications in lameness.

VAN 703 AVIAN ANATOMY 1+2

Theory

UNIT I: The study of the gross features of different body systems of domestic fowl.

UNIT II: The study of microscopic features of different body systems of domestic, fowl.

Practical: Dissection and demonstration of various body systems of fowl and turkey; microscopic examination of slides of various organ systems of fowl.

VAN 704 NEUROANATOMY 3+1

Theory

UNIT I: The gross and microscopic anatomy of the brain and spinal cord.

UNIT II: Study of various cranial and spinal nerves along with their associated nuclei.

UNIT III: Motor and sensory pathways, different ascending and descending tracts of brain and spinal cord and autonomic nervous system.

Practical: Gross dissection and microscopic examination of the brain and spinal cord; demonstration of the nerves, nerve plexuses; ganglia of cranial importance; study of the serial sections of the brain and spinal cord in domestic animals.

VAN 705 ENDOCRINE ANATOMY 2+1

Theory

UNIT I: Advanced gross and microscopic anatomy of the hypothalamus and pituitary gland.

UNIT II: Advanced gross and microscopic anatomy of the thyroid, parathyroid and thymus.

UNIT III: Advanced gross and microscopic anatomy of the adrenal glands, islets of langerhans, pineal body and other tissues associated with endocrine secretions.

Practical: Demonstration of the topographic anatomy in the embalmed specimens and microscopic examination of the endocrine glands of ruminants.

VAN 706 THEORY AND APPLICATIONS OF ELECTRON MICROSCOPE 2+0

Theory

UNIT I: Introduction and principles of electron microscopy.

UNIT II: Methods for transmission electron microscopy.

UNIT III: Methods for scanning electron microscopy.

Practical: Preparation of blocks and demonstration of various techniques used for carrying out TEM and SEM.

VAN 707 HISTOENZYMOLOGY AND IMMUNOCYTOCHEMISTRY 2+1

Theory

UNIT I: Classification of enzymes, principles of enzymes histochemistry methods.

UNIT II: Substrates, combination, coupling azo-dye methods, capture reagents.

UNIT III: Localization of enzymes and controls in enzyme histochemistry.

UNIT IV: Fluorescence microscopy in enzyme histochemistry, immunohistochemistry-principles and techniques.

Practical: Preparation of fixatives and buffers used in histochemistry; methods of preparations and microscopical examination of routine and special preparations showing different cell organelles and inclusions; methods fortryptophan-ss; sh groups; glycogen-glycoproteins; mucopolysaccharides and lipids;methods and identification of alkaline and acid phosphatases – succinic dehydrogenase; cytochrome-oxidase; choline-esterase; catecholamines by fluorescence microscopy; immunohistochemistry–principles and techniques.

VAN 708 APPLIED EMBRYOLOGY AND TERATOLOGY 1+2

Theory

UNIT I: Principles of experimental embryology and teratology.

UNIT II: Factors affecting the developmental mechanisms of embryo.

UNIT III: Use of organizers implants, chemical and hormonal preparations in the developmental models and available literature on teratogenicexperimentation.

Practical: Collection and study of various teratological specimens from domesticanimals;class iscussions on experimental models and available literatureon teratogenic experimentation.

VAN 709 FUNCTIONAL VETERINARY ANATOMY 2+0

Theory

UNIT I: The relationship of structure to form and function.

UNIT II: The relationship of structure for adaptation and behavior.

UNIT III: Relationship of structure in relation to clinical conditions/applications.

VAN 710 GROSS ANATOMY OF LABORATORY ANIMALS 1+1

Theory

UNIT I: Study of different organs of digestive system of different laboratory animals.

UNIT II: Detailed study of urinary, male and female reproductive systems of different laboratory animals.

UNIT III: Complete study of respiratory system of different laboratory animals.

UNIT IV: Study of organs of circulation and nervous system of different laboratory animals.

UNIT V: Descriptive anatomy of endocrine glands of different laboratory animals.

Practical: Demonstration of placement and relations of different organs in the body cavities of different laboratory animals.

VAN 790 SPECIAL PROBLEM IN Ph.D. 0+2

Practical: Short research problem(s) involving contemporary issues and research techniques.

VAN 791 DOCTORAL SEMINAR I 1+0

VAN 792 DOCTORAL SEMINAR II 1+0

VAN 799 DOCTORAL RESEARCH 0+45

VETERINARY MEDICINE

http://hillagric.ac.in/edu/covas/vcm/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
VCM 601	RUMINANT CLINICAL MEDICINE I	2+0	I
VCM 602	RUMINANT CLINICAL MEDICINE II	2+0	II
VCM 603	EQUINE CLINICAL MEDICINE	2+0	I
VCM 604	CANINE AND FELINE CLINICAL MEDICINE	2+0	II
VCM 605	SWINE CLINICAL MEDICINE	1+0	I
VCM 606	AVIAN MEDICINE	1+0	II
VCM 607	ZOO, WILD AND LABORATORY ANIMAL MEDICINE	2+0	II
VCM 608	DISEASES OF RABBIT AND FISH	1+0	II
VCM 609	PRODUCTION DISEASES	2+0	I
VCM 610	DISEASES OF ANIMALS CAUSED BY TOXICANTS	1+0	II
VCM 611	VETERINARY FORENSIC MEDICINE	1+1	I
VCM 612	CLINICAL DIAGNOSTIC TECHNQUES	0+2	II
VCM 613	VETERINARY EMERGENCY MEDICINE	0+2	II
VCM 614	CLINICAL PRACTICE I	0+3	I
VCM 615	CLINICAL PRACTICE II	0+3	II
VCM 691	MASTER'S SEMINAR	1+0	I&II
VCM 699	MASTER'S RESEARCH	0+20	I&II
VCM 701	ADVANCES IN GASTROENTEROLOGY	2+1	I
VCM 702	ADVANCES IN CARDIOPULMONARY MEDICINE	2+0	II
VCM 703	ADVANCES IN NEUROLOGICAL AND UROLOGICAL DISORDERS	2+0	II
VCM 704	ADVANCES IN ENDOCRINE AND DERMATOLOGICAL DISORDERS	2+0	I
VCM 705	ADVANCES IN PRODUCTION DISEASES	2+0	I
VCM 706	ADVANCES IN PAEDIATRICS AND GERIATRICS	1+0	II
VCM 707	ADVANCES IN VETERINARY DIAGNOSTICS	1+2	II
VCM 708	ADVANCES IN VETERINARY THERAPEUTICS	1+2	I
VCM 709	ADVANCED CLINICAL PRACTICE I	0+2	I
VCM 710	ADVANCED CLINICAL PRACTICE II	0+2	II
VCM 711	ADVANCED CLINICAL PRACTICE III	0+2	I
VCM 790	SPECIAL PROBLEM IN Ph.D.	0+2	II
VCM 791	DOCTORAL SEMINAR I	1+0	I
VCM 792	DOCTORAL SEMINAR II	1+0	II
VCM 799	DOCTORAL RESEARCH	0+45	I&II

VETERINARY MEDICINE

Course contents

VCM 601 RUMINANT CLINICAL MEDICINE I 2+0

Theory

UNIT I: General systemic states.
UNIT II: Diseases of alimentary system, liver and urinary system.
UNIT III: Diseases of respiratory and nervous system.

VCM 602 RUMINANT CLINICAL MEDICINE II 2+0

Theory

UNIT I : Diseases of cardiovascular system, blood and blood forming organs.
UNIT II: Diseases of musculoskeletal system and skin.
UNIT III: Diseases of eyes, ears, nose.

VCM 603 EQUINE CLINICAL MEDICINES 2+0

Theory

UNIT I : General systemic states and diseases of alimentary system and liver.
UNIT II: Diseases of respiratory, cardiovascular sytem, blood and blood forming organs.
UNIT III: Diseases of urinary and nervous systems, Diseases of musculoskeletal system and skin.

VCM 604 CANINE AND FELINE CLINICAL MEDICINE 2+0

Theory

UNIT I: Specific needs of canine and felines, pet psychology, pet behavior and adaptation needs, General systemic states.
UNIT II: Diseases of digestive system, liver and pancreas, cardiovascular system, blood and blood-forming organs.
UNIT III: Diseases of respiratory system, urogenital and nervous systems.
UNIT IV: Diseases of musculoskeletal system and skin.
UNIT V: Diseases of endocrine system, diseases of new borne animals.

VCM 605 SWINE CLINICAL MEDICINE 1+0

Theory

UNIT I: General systemic states and diseases of digestive system.
UNIT II: Diseases of cardiovascular and respiratory system.
UNIT III: Diseases of urogenital, nervous system and skin.
UNIT IV: Diseases of endocrine system and of newborn animals.

VCM 606 AVIAN MEDICINE 1+0

Theory

UNIT I: Diseases due to deficiency of vitamins (vitamins A, B complex, C, D, K); minerals (calcium, phosphorus, manganese, zinc, sodium and chloride).
UNIT II: Miscellaneous diseases/conditions/ vices (cage layer fatigue, blue comb disease, beak necrosis, round heart disease, kerato-conjunctivitis, ascites, urolithiasis, fatty liver, kidney hemorrhagic syndrome, heat stroke, cannibalism, vent picking).

VCM 607 ZOO, WILD AND LABORATORY ANIMAL MEDICINE 2+0

Theory

UNIT I: Etiology, symptoms, diagnosis and management of various diseases of zoo, wild and laboratory animals, diseases of urinary system.

UNIT II: Diseases, restraint, feeding and health management of exotic animals kept as pets.

VCM 608 DISEASES OF RABBIT AND FISH 1+0

Theory

UNIT I: Infectious diseases of rabbit and Fish.

UNIT II: Non-infectious diseases of rabbits and fish.

UNIT III: Diagnostic tests related to rabbit and fish diseases.

VCM 609 PRODUCTION DISEASES 2+0

Theory

UNIT I: General aspects, production diseases (parturient paresis, downer cow syndrome, ketosis, post-parturient haemoglobinuria, hypomagnesemic tetany, pregnancy toxaemia).

UNIT II: Lactation tetany of mares, eclampsia of bitches, osteodystrophia fibrosa, azoturia of equines, rheumatism-like syndrome in buffaloes, hypothyroidism, diabetes mellitus and diabetes insipidus in dogs.

UNIT III: Deficiency diseases (calcium, phosphorus, vitamin-D3, vit-A, vit B-complex, vit-C and vit-K).

UNIT IV: Deficiency diseases (iron, copper, cobalt, zinc, manganese, iodine, vitamin E and selenium).

VCM 610 DISEASES OF ANIMALS CAUSED BY TOXICANTS 1+0

Theory

UNIT I: Diseases caused by physical agents and poisoning of organic and inorganic compounds.

UNIT II: Diseases caused by farm chemicals and phytotoxins.

UNIT III: Diseases caused by mycotoxins and zootoxins.

UNIT IV: Diseases caused by poisonous plants, snake and insect bites.

VCM 611 VETERINARY FORENSIC MEDICINE 1+1

Theory

UNIT I: Veterolegal aspects of ante mortem and post mortem examination.

UNIT II: Examination of wounds, blood, offenses, frauds in animals and their products, animal cruelty and welfare, DNA analysis of clinical samples.

UNIT III: Study of common laws related to veterolegal aspects.

Practical: Ante mortem and post mortem examination; examination of wounds, blood, offenses, frauds in animals and their products; collection, dispatch and examination of veterolegal samples.

VCM 612 CLINICAL DIAGNOSTIC TECHNQUES 0+2

Practical

UNIT I: Clinical tests and their interpretation related to diseases of alimentary tract; liver; cardiovascular system; blood and blood-forming organs of various species of animals.

UNIT II: Clinical tests and their interpretation related to respiratory, urinary, nervous, endocrine, musculoskeletal and integumentary systems of various species of animals.

VCM 613 VETERINARY EMERGENCY MEDICINE 0+2

Practical

UNIT I: Diagnosis and therapeutic management of various emergencies of cardiovascular; respiratory; gastrointestinal; urinary and nervous systems.

UNIT II: Diagnosis and therapeutic management of various emergencies of toxicities; sting bites and burns of farm and companion animals.

UNIT III: Monitoring critical ill patient; application of emergency care procedures for resuscitation of critically ill patient.

VCM 614 CLINICAL PRACTICE I 0+3

Practical: Diagnostic and therapeutic protocol application; specimen collection; examination and management of sick farm and companion animals.

VCM 615 CLINICAL PRACTICE II 0+3

Practical: Diagnostic and therapeutic protocol application; specimen collection; examination and management of sick farm and companion animals.

VCM 691 MASTER' S SEMINAR 1+0

VCM 699 MASTER' S RESEARCH 0+20

VCM 701 ADVANCES IN GASTROENTEROLOGY 2+1

Theory

UNIT I: Advances in diagnosis, therapy and control of diseases of gastrointestinal system and associated organs of farm animals,

UNIT II: Advances in diagnosis, therapy and control of diseases of gastrointestinal system and associated organs of companion animals.

Practical: Advanced clinical procedures for the diagnosis of diseases of gastrointestinal system and associated organs of farm and companion animals.

VCM 702 ADVANCES IN CARDIOPULMONARY MEDICINE 2+0

Theory

UNIT I: Advances in diagnosis and therapeutic management of diseases of circulatory system.

UNIT II: Advances in diagnosis and therapeutic management of diseases of respiratory system.

UNIT III: Advances in diagnosis and therapeutic management of diseases of blood and blood forming organs in animals.

VCM 703 ADVANCES IN NEUROLOGICAL AND UROLOGICAL DISORDERS 2+0

Theory

UNIT I: Advances in diagnosis, therapy and control of diseases of nervous system.

UNIT II: Advances in diagnosis, therapy and control of diseases of urogenital system.

UNIT III: Advances in diagnosis, therapy and control of diseases of locomotor system.

VCM 704 ADVANCES IN ENDOCRINE AND DERMATOLOGICAL DISORDERS 2+0

Theory

UNIT I: Advances in diagnosis, therapy and control of diseases of skin and integumentary system.

UNIT II: Advances in diagnosis, therapy and control of diseases of endocrine system.

VCM 705 ADVANCES IN PRODUCTION DISEASES 2+0

Theory

UNIT I: Latest advances in diagnosis, therapy and prophylaxis of metabolic diseases of farm and companion animals.

UNIT II: Latest advances in diagnosis, therapy and prophylaxis of nutritional diseases of farm and companion animals.

UNIT III: Latest advances in diagnosis and treatment of various poisonings and toxicities.

VCM 706 ADVANCES IN PAEDIATRICS AND GERIATRICS 1+0

Theory

UNIT I: Recent advances in diagnosis, therapy and control of diseases and management of emergencies of neonates.

UNIT II: Recent advances in diagnosis, therapy and control of diseases and management of emergencies of geriatric animals.

VCM 707 ADVANCES IN VETERINARY DIAGNOSTICS 1+2

Theory

UNIT I: Blood and serum biochemical and hematological analyses.

UNIT II: Imaging techniques for the diagnosis of animal diseases (x-ray, contrast radiography, CT, MRI, Scintigraphy, Echocardiogram etc).

UNIT III: Electrocardiography, ophthalmoscopy, ultrasonography, EEG, CVP, GFR assessment, pulse-oxymetry etc.

Practical: Assignments on advanced diagnostic techniques for various diseases of domestic animals; use of above mentioned advanced diagnostic techniques where ever possible; collection of CSF; gastric / rumen /intestinal fluid; absorption and digestion tests; water withheld; low and high dose dexamithasone test; ACTH stimulation; hormone profile; enzyme profile.

VCM 708 ADVANCES IN VETERINARY THERAPEUTICS 1+2

Theory

UNIT I: Fluid and electrolyte imbalance and therapy.

UNIT II: Antimicrobial, antineoplastic and hormonal therapy.

UNIT III: Blood transfusion and Emergency critical care, peritoneal dialysis / hemodialysis, gastric lavage, fluid therapy, parenteral total nutrition, nebulization, oxygen therapy, paracentesis, thoracocentesis.

Practical: Assignments on advanced therapeutic approaches in various diseases of domestic animals.

VCM 709 ADVANCED CLINICAL PRACTICE I 0+2

Practical: Diagnostic and therapeutic protocol application; specimen collection; examination and management of sick farm and companion animals.

VCM 710 ADVANCED CLINICAL PRACTICE II 0+2

Practical: Diagnostic and therapeutic protocol application; specimen collection; examination and management of sick farm and companion animals.

VCM 711 ADVANCED CLINICAL PRACTICE III 0+2

Practical: Diagnostic and therapeutic protocol application; specimen collection; examination and management of sick farm and companion animals.

VCM 790 SPECIAL PROBLEM IN Ph.D. 0+2

A short-term project work on some aspect of etio-pathogensis; diagnosis and therapy of diseases of domestic animals.

VCM 791 DOCTORAL SEMINAR I 1+0

VCM 792 DOCTORAL SEMINAR II 1+0

VCM 799 DOCTORAL RESEARCH 0+45

VETERINARY MICROBIOLOGY

http://hillagric.ac.in/edu/covas/vmicro/index.html

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
VMC 601	BACTERIOLOGY I	3+1	I
VMC 602	BACTERIOLOGY II	3+1	II
VMC 603	VETERINARY MYCOLOGY	1+1	I&II
VMC 604	GENERAL VIROLOGY	2+1	I
VMC 605	SYSTEMATIC ANIMAL VIROLOGY	3+1	II
VMC 606	PRINCIPLES OF IMMUNOLOGY	2+1	I
VMC 607	VACCINOLOGY	2+0	I&II
VMC 608	DIAGNOSTICS OF INFECTIOUS DISEASES	1+2	I&II
VMC 609	TECHNIQUES IN MICROBIOLOGY AND IMMUNOLOGY	0+3	I&II
VMC 691*	MASTER'S SEMINAR	1+0	I&II
VMC 699*	MASTER'S RESEARCH	0+20	I&II
VMC 701**	ADVANCES IN BACTERIOLOGY	2+1	I
VMC 702**	ADVANCES IN MYCOLOGY	2+1	I
VMC 703	BACTERIAL GENETICS	2+1	I
VMC 704	MICROBIAL TOXINS	2+1	II
VMC 705	MOLECULAR DETERMINANTS OF BACTERIAL PATHOGENESIS	2+1	II
VMC 706**	ADVANCES IN VIROLOGY	2+1	I
VMC 707	MOLECULAR AND GENETIC ASPECTS OF VIRAL PATHOGENESIS	2+1	II
VMC 708	STRUCTURE FUNCTION RELATIONSHIP OF DNA AND RNA VIRUSES	3+0	I
VMC 709	ONCOGENIC VIRUSES	2+0	II
VMC 710	SLOW VIRAL INFECTIONS AND PRIONS	2+0	II
VMC 711**	MOLECULAR IMMUNOLOGY	2+1	I&II
VMC 712**	ADVANCES IN CELLULAR IMMUNOLOGY	2+1	I&II
VMC 713	CYTOKINES AND IMMUNOMODULATORS	2+0	II
VMC 714	ADVANCES IN VACCINOLOGY	2+0	I
VMC 715	ADVANCES IN IMMUNODIAGNOSTICS	1+1	II
VMC 716	MODERN IMMUNOTECHNOLOGY	1+2	II
VMC 717	CURRENT TOPICS IN INFECTION AND IMMUNITY	3+0	I
VMC 718	VETERINARY MICROBIAL BIOTECHNOLOGY	2+1	I
VMC 790	SPECIAL PROBLEM IN Ph.D.	0+2	II
VMC 791**	DOCTORAL SEMINAR I	1+0	I
VMC 792**	DOCTORAL SEMINAR II	1+0	II
VMC 799**	DOCTORAL RESEARCH	0+45	I&II

* Compulsory for Master's Programme **Compulsory for Doctoral Programme

VETERINARY MICROBIOLOGY

Course contents

VMC 601 BACTERIOLOGY I 3+1

Theory

UNIT I: Introduction to historical development of cellular organization, genetic & chemical characteristics of eukaryotic and prokaryotic cells, classification, nomenclature and identification, genetic characterization and numerical taxonomy,bacterial cell structure, physiology and antigenic structure.

UNIT II: Determinants of pathogenicity and its molecular basis, bacteriophages, temperate and virulent phages, lysogeny and lysogenic conversion, bacterial genetics, bacterial variation, genetic transfer mechanisms (transformation, transduction and conjugation), plasmids, transposons and drug resistance, recombinant DNA technology.

UNIT-III: Systemic study of following bacteria: Gram negative,aerobic rods and cocci, family *Pseudomonadaceae, Legionellaceae, Neisseriaceae,* and genus *Brucella,* Facultative anaerobic gram-negative rods, family-*Vibrionaceae, Pasteurellaceae, Enterobacteriaceae*and other genera,

Practical: Morphological characterization; cell fractionation; enrichment & isolation technology; various methods used in growth measurement and bacterial preservation; gene transfer experiment; detailed characterization (biochemical; serological; pathogenicity) of bacteria.

VMC 602 BACTERIOLOGY II 3+1

Theory

UNIT I: Systematic study of following pathogenic bacteria, gram positive cocci, family *Micrococaceae*, endospore forming Gram positive rods and cocci, family *Bacillaceae* genus *Bacillus, Sporolactobacillus* and *Clostridium,* Spirochetes, Family *Spirochetaceae* and other families like *Spirillaceae,* coryneform bacteria, *Dermatophillaceae, Streptomycetaceae.*

UNIT II: *Mycobacteria* and *Nocardia,* family *Actinomycetaceae* Atypical prokaryotes such as *Chlamydia, Rickettsiae, Mycoplasma, Acholeplasma, Spiroplasma, Anaeroplasma* and *Thermoplasma.*

UNIT III: Regular non-sporing Gram-positive Gram positive rods such as *Listeria* and *Erysipelas,* Anaerobic Gram-negative straight, curved and helical rods, family *Bacteriodaceae* and genus *Bacteroides* and *Fusobacterium.*

Practical: Detailed and comparative study of morphology, biochemical reactions, physiology, serology and pathogenicity of various bacteria studied in **Theory**; isolation of bacteria from field materials leading to their characterization and identification.

VMC 603 VETERINARY MYCOLOGY 1+1

Theory

UNIT I: Morphology, physiology, reproduction, cultural characters, classification of fungi, and immunology of pathogenic fungi.

UNIT II: Systematic study of animal mycoses such as aspergillosis, candidiasis, cryptococcosis, epizootic lymphangitis, mycetomas, sporotrichosis, histoplasmosis, blastomycosis, coccidioidomycosis, haplomycosis, rhinosporidiosis, zygomycosis, mycotic abortion, mycotic mastitis, mycotic dermatitis, dermatophytoses, mycotoxicosis etc.

Practical: Collection and processing of clinical material for isolation of fungi; Study of gross and microscopic characters of pathogenic fungi.

VMC 604 GENERAL VIROLOGY 2+1

Theory

UNIT I: History of virology, origin and nature of viruses, biochemical and morphological structure of viruses, nomenclature and classification of viruses.

UNIT II: Replication of DNA and RNA viruses, viral genetics and evolution.

UNIT III: Genetic and non-genetic interactions between viruses, virus-cell interactions, viral pathogenesis, viral persistence, oncogenic viruses epidemiology of viral infections.

UNIT IV: Immune response to viruses, viral vaccines, viral chemotherapy.

Practical: Orientation to a virology laboratory; preparation of equipment for sterilization; collection; preservation; transportation of samples and their processing; isolation and cultivation of viruses in animals/birds; embryonated chicken eggs; media and reagents for cell culture; trypsinization and maintenance of monolayer cell cultures; isolation of virus in cell cultures; titration of viruses by 50% end-point cytopathogenicity; and haemagglutination; detection of viral antibodies by serum neutralisation test; agar gel precipitation test; haemagglutination inhibition and ELISA.

VMC 605 SYSTEMATIC ANIMAL VIROLOGY 3+1

Theory

UNIT I: Studies on animal viruses belonging to various families, and prion agents given below with reference to antigens, cultivation, pathogenesis, epidemiology, disease status in india, diagnosis, immunity and control, capripoxvirus, avipoxvirus, cowpoxvirus; bovine herpes viruses, equine herpes viruses, infectious lyrangeotracheitis virus, marek's disease virus, pseudorabies virus, malignant catarrh fever virus, infectious canine hepatitis virus, egg drop syndrome virus, inclusion body hepatitis hydropericardium virus, papiollomatosis, canine parvoviruses, feline panleucopenia virus.

UNIT II: Newcastle disease virus, canine distemper virus, rinderpest virus, PPR virus, infectious bursal disease virus, rotavirus, blue tongue virus, African horse sickness virus, rabies virus, ephemeral fever virus, borna virus.

UNIT III: Infectious bronchitis virus, transmissible gastroenteritis virus, equine arteritis virus, equine encephalomyelitis viruses, swine fever virus, BVDV-mucosal disease virus,foot and mouth disease virus, duck hepatitis virus, visna/maedi virus, equine infectious anemia virus, avian leucosis complex virus, bovine leukemia virus, chicken anemia virus, prions, scrapie, bovine spongiform encephalopathy.

Practical: Isolation of viruses in embryonated eggs and cell cultures; cytopathogenicity of representative animal viruses *viz*., cell death, syncytia formation, inclusion body etc; diagnosis of animal viruses employing various serological tests *viz.*, haemagglutination and haemagglutination inhibition for Newcastle disease virus; agar gel diffusion and virus neutralization test for infectious bursal disease viruses: diagnosis of IBD virus and rotavirus by latex agglutination test; serotyping of FMD virus by ELISA; electropherotyping of rotavirus; PCR for diagnosis of viral infections.

VMC 606 PRINCIPLES OF IMMUNOLOGY 2+1

Theory

UNIT I: History of immunology, immunity types, cardinal features, and phylogeny, vertebrate immune system, lymphoid organs and tissues, development of B and T lymphocyte repertoires and other leukocytes, differentiation markers and other distinguishing characters of leukocytes, lymphoid cells trafficking.

UNIT II: Antigens, fundamental features, types, factors affecting immunogenicity, adjuvants, antibodies, structure, functions and classification, theories of antibody production, immunoglobulin genes and genetic basis of antibody diversity, complement system, activation pathways and biological activities.

UNIT III: Major histocompatibility complex, structure, functions and gene organization, T lymphocyte subsets, antigen-specific T cell receptors: structure, gene organization and

genetic basis of diversity, immune response development, phase of humoral and cell-mediated immune response development, cellular interactions, properties and classification of various cytokines, immunoregulation.

UNIT IV: Immunity against veterinary infectious agents, immunologicals surveillance and cancer immunity, immunological tolerance, its breakdown and autoimmunity, immune-deficiencies: types and examples, hypersensitivity: classification, mechanisms of induction and examples.

Practical: Preparation of antigens for laboratory animals immunization; production; collection and preservation of antisera; quantitation of immunoglobulins in antisera by zinc sulphate turbidity and single radial immunodiffusion; examination of lymphoid organs of animals; tests for *in-vivo* and *in-vitro* phagocytosis; separation and counting of peripheral blood lymphocytes; separation and concentration of immunoglobulin by ammonium sulphate precipitation and dialysis; demonstration of antigen-antibody interactions in serological tests such as agar gel precipitation; immunoelectrophoresis; bacterial agglutination; direct and passive hemagglutination; latex agglutination; complement fixation; enzyme-linked immunosorbent assay; immunoblotting.

VMC 607 VACCINOLOGY 2+0

Theory

UNIT I: History of veterinary vaccinology, Vaccines, classification, comparison of major types, components of various types of vaccines, immunogens adjuvants, stabilizers, preservatives, vehicles, vaccine qualities, definitions and methods of testing, vaccine development, cost-effectiveness of preventive immunization programmes, stages of development, clinical trials and regulatory requirements.

UNIT II: Traditional vaccines, inactivated, attenuated and toxoid vaccines, methods of construction of traditional vaccines, microbial cultures, embryonated eggs, cell culture, seed-lots of vaccine organisms, methods of inactivation and attenuation of pathogens.

UNIT III: Modern vaccines, nucleic acids, vectored vaccines, recombinant expressed immunogens, synthetic peptides, marker vaccines, etc, combination/multivalent vaccines, novel immunomodulators and delivery systems, modern methods of vaccine construction, methods based on synthetic chemistry and DNA technology.

UNIT IV: Vaccine formulation, pharmacopeal requirements, vaccine stability and preservation, cold chain, immunization schedules of veterinary vaccines logistic problems and vaccination failure, strategies of disease control and eradication by vaccination.

VMC 608 DIAGNOSTICS OF INFECTIOUS DISEASES 1+2

Theory

UNIT I: Diagnosis of infectious diseases: an overview, principles of serodiagnostic, agglutination-reaction based tests, precipitation-reaction based tests, complement fixation test and enzyme immunoassays.

UNIT II: Principles of molecular diagnostic tests, PCR, RT-PCR, Southern blotting, northern blotting, western blotting, and dot-blot, DNA diagnostics versus serodiagnostics, development and validation of diagnostic tests.

Practical: Serodiagnostic tests for infectious diseases; bacterial slide and microtitre plate agglutination; agar gel immunodiffusion test; passive hemagglutination; hemagglutination inhibition and latex agglutination tests; complement fixation test; enzyme linked immunosorbent immunoassays; dot-ELISA; fluorescent antibody technique; immune-electron microscopy virus neutralization test etc; molecular diagnostic techniques: protein profiling of infectious agents by SDS-polyacrylamide gel electrophoresis; antigen profiling of infectious agents by immunoblotting; nucleic acids by various formats of polymerase chain reaction and reverse transcription-PCR; dot-blot technique etc.

VMC 609 TECHNIQUES IN MICROBIOLOGY AND IMMUNOLOGY 0+3

Practical : Preparation of different media used in bacteriology and mycology; isolation and identification of bacteria and fungi; antibiotic sensitivity of microorganisms from clinical specimens; plasmid profiling; pathogenicity test in cell culture or laboratory animals; maintenance and preservation of bacteria and fungi; cryopreservation and reconstitution of preserved cell lines; concentration and purification of animal viruses by chemical agents; differential centrifugation; density gradient centrifugation; and ultra filtration etc; Storage of animal viruses by freeze drying and ultra freezing; biophysical and biochemical characterization of animals viruses; molecular characterization of viral protein and nucleic acid; immunoglobulin purification by salt precipitation and chromatographic techniques; antispecies antibody production; enzyme-linked immunosorbent assays for antigen and antibody detection; neutrophils and peritoneal macrophage isolation and demonstration of phagocytic activity; lymphocyte separation; lymphocyte proliferation assay; tuberculin-type delayed type hypersensitivity reaction.

VMC 701 ADVANCES IN BACTERIOLOGY 2+1

Theory

UNIT I: Advanced studies on cytology, biochemical activities, antigenic structure and molecular biology of bacteria.

UNIT II: Advanced studies on pathogenicity, immunology and serology of bacteria.

Practical: Biochemical, physiological and pathogenesis studies of various bacterial diseases.

VMC 702 ADVANCES IN MYCOLOGY 2+1

Theory

UNIT I: Advanced studies on taxonomic genetics, physiology and antigenic characterization of pathogenic fungi.

UNIT II: Advanced studies on molecular approaches for identification of fungi and immunology and serology of mycoses.

Practical: Biochemical, physiological and pathogenesis studies of various fungal diseases.

VMC 703 BACTERIAL GENETICS 2+1

Theory

UNIT I: Procaryotic and eucaryotic genome, replication of eukaryotic and prokaryotic DNA, structure, classification and replication of plasmids, molecular basis of mutations.

UNIT II: Biochemical genetic and gene mapping by recombination, fine gene structure analysis, gene transfer in bacteria through transduction, transformation and conjugation and gene mapping by these processes.

UNIT III: Transposable elements, gene cloning and gene sequencing, regulation of gene expression.

Practical: Mutagenesis of microorganisms by different methods; production, isolation and characterization of mutants; determination of mutation rate; isolation, characterization and curing of plasmids; transfer of plasmid by conjugation; electroporation; tetrad and random spore analysis.

VMC 704 MICROBIAL TOXINS 2+1

Theory

UNIT I: The role of microbial toxins in the pathogenesis of diseases, biochemical and biological characteristics of toxins produced by various bacteria, toxin producing gram positive and negative bacteria, properties and clinical conditions produced by different bacterial toxins.

UNIT II: Production, characterization, and study of pathogenicity of various fungal toxins.

Practical: Isolation of toxigenic strains of bacteria from suspected material; production of toxins in suitable media; purification and characterization of toxins; biological characterization in animal and in tissue culture; immunobiological studies of toxins.

VMC 705 MOLECULAR DETERMINANTS OF BACTERIAL PATHOGENESIS 2+1

Theory

UNIT I: Molecular structure, production and mode of action of bacterial adhesions, invasions, impedins, agressins, modulins, capsule, flagella, enzymes, components of cell wall and siderophores.

UNIT II: The production, structure and molecular mechanism of actions of various exotoxins and endotoxins, siderophores and cytotoxins, and plasmids in causation of disease.

Practical: To study the production and effects of exotoxins and endotoxins; LPS and various enzymes produced by the bacteria on various cell culture and live animals.

VMC 706 ADVANCES IN VIROLOGY 2+1

Theory

UNIT I: Biology of RNA and DNA virus replication.

UNIT II: Current concepts in animal virus research with respect to viral structure and architecture, viral virulence, viral pathogenesis, persistence and on cogenesis.

UNIT III: Latest trends in the development of antivirals.

UNIT IV: Cloning and expression in viral vectors.

Practical: Separation and characterization of viral proteins and nucleic acid by polyacrylamide gel electrophoresis; column chromatography; blotting techniques; problem oriented practical assignments aimed at development of bioreagents and relevant diagnostic tests; screening and evaluation of antiviral agents for efficacy and toxicity.

VMC 707 MOLECULAR AND GENETIC ASPECTS OF VIRAL PATHOGENESIS 2+1

Theory

UNIT I: Mechanisms of viral infection and spread through the body, detailed study of virus host interactions.

UNIT II: Host immune responses to viral infections, viral strategies to evade host immune responses.

UNIT III: Pathogenesis of viral diseases of various systems, animal models for studying viral pathogenesis, molecular and genetic determinants of viral virulence, mechanisms of viral virulence.

UNIT IV: Molecular and genetic determinants of viral persistence, viral oncogenesis, viralimmunosuppression, and immunopathology, animal models for studying viral pathogenesis.

Practical: Pathotyping of animal viruses using Newcastle disease virus as model; determination of immunosuppressive potential of animal viruses using infectious bursal disease virus/marek's disease virus/chicken anemia virus; characterization of molecular determinants of viral virulence using variants; recombinants and reassortants; isolation and molecular characterization of viruses with varying virulence.

VMC 708 STRUCTURE FUNCTION RELATIONSHIP OF DNA AND RNA VIRUSES 3+0

Theory

UNIT I: Methods of studying virus structure and architecture, methods of amplification of viral nucleic acids, molecular characterization of viral protein and nucleic acid, nucleotide sequencing, and its analysis by software programmes.

UNIT II: Detailed study of virus replication in various groups of animal viruses.

UNIT III: Understanding the relationship between structure and function of animal DNA and RNA viruses, development of modern vaccines and anti virals using the relationship between structure and function of animal DNA and RNA viruses.

VMC 709 ONCOGENIC VIRUSES 2+0

Theory

UNIT I: General features of cell transformation and characterization of transformed cells, Oncogenic RNA and DNA viruses, expression of viral and cellular oncogenes.

UNIT II: Mechanisms of viral oncogenesis, diagnosis of viral oncogenesis.

VMC 710 SLOW VIRAL INFECTIONS AND PRIONS 2+0

Theory

UNIT I: Epidemiology, pathogenesis, diagnosis and control of slow viral infections.

UNIT II: Properties, replication and epidemiology of prions, pathogenesis, immunity, diagnosis and control of various diseases caused by prions, recent trends in prion research.

VMC 711 MOLECULAR IMMUNOLOGY 2+1

Theory

UNIT I: Pathogen associated molecular patterns and pattern recognition receptors in immunity, advances in characterization of antigens and superantigens, epitope mapping, novel functions of immunoglobulins and their fragments produced by rDNA technology.

UNIT II: Cytokines and cytokine receptors, structure and function, complement components genes and polymorphism, MHC genes, evolutionary aspects of recombination activating genes-mediated immunity in vertebrates.

UNIT III: Immunoinformatics as applied to MHC molecules-peptide complexes and other molecules, immunomics.

Practical: Purification of immunoglobulin classes and IgG subclasses; IgG fragments production by pepsin and papain digestion; cytokine quantitation and detection by ELISPOT assay; IgV gene amplification and sequencing; use of immunoinformatics tools to Ig genes.

VMC 712 ADVANCES IN CELLULAR IMMUNOLOGY 2+1

Theory

UNIT I: Hematopioetic stem cells and differentiation pathways of various leukocytes, B and T lymphocyte repertories, lymphocyte-endothelial cell interactions during lymphocyte emigration and recirculation, antigen presenting cells, T cell subsets, regulatory T cells, memory B and T cells, NK cell biology.

UNIT II: Cellular interactions during immune response development, microenvironments, antigen processing and presentation, activation of B and T cells, co-stimulatory molecules, cytokines in intercellular communication, signal transduction pathways in B and T cell activation.

UNIT III: Immunoregulation of B and T cell response, mucosal immune system, oral tolerance and its breakdown, advances in transplantation immunology, SCID, gene-knockout and transgenic animals in immunobiology research.

Practical: Fluorescence activated and magnetic cell sorting of lymphocyte subsets; lymphocyte proliferation assays using non-radioisotope methods; adoptive transfer of lymphocyte subsets; cytotoxic T cell assays; and ELISPOT assays for enumeration of lymphocyte subsets secreting cytokines.

VMC 713 CYTOKINES AND IMMUNOMODULATORS 2+0

Theory

UNIT I: Cytokines and immunomodulators, definitions and classification, cytokines structure and functions, cytokine receptors, structural types and presence on different cells, roles in activation, division and differentiation of immune cells, and immunoregulation.

UNIT II: Cytokine networks, cytokines in reproductive processes and neuroendocrino-immunological interactions, immunomodulators in control of diseases, cytokines as adjuvants and imunomodulators, colony stimulating factors and other cytokines in stem cell research.

VMC 714 ADVANCES IN VACCINOLOGY 2+0

Theory

UNIT I: Advances in vaccine development research, antigen identification and characterization employing newer molecular technologies such as microarrays, *in-vivo* expression technology, signature-tagged mutagenesis and phage display technology etc.

UNIT II: Immunoinformatics as applied to epitope mapping, T cell epitopes, identification of pathogenic epitopes etc, novel vaccines, nucleic acids, marker vaccines, mucosal vaccines, bacterial ghosts as vaccines, virus-like particles, futuristic vaccines, anti-allergic, anti-autoimmune diseases, de-addition vaccines, transplant survival/prolonging vaccines etc.

VMC 715 ADVANCES IN IMMUNODIAGNOSTICS 1+1

Theory

Newer methods of immunodiagnosis: simple, rapid, penside immunodiagnostic tests
such as immunochromatofocussing, immunofiltration tests etc, development of highly sensitive enzyme immunoassays such as immune-PCR, use of luminescent substrate etc, discriminant immunoassays for differentiating cross-reactive antigens, antibodies in biosensors.

Practical: Development of immunofiltration test using monoclonal antibody for diagnosis of any veterinary infectious disease, blocking ELISA to differentiate cross-reactive antigens.

VMC 716 MODERN IMMUNOTECHNOLOGY 1+2

Theory

UNIT I: Historical developments in modern immunotechnology, hybridoma technology, advances in monoclonal antibody production, chimeric and humanized monoclonal antibodies.

UNIT II: Recombinant DNA technology for expression of antibody fragments, fab, scFv, bispecific antibody, nanobody and various other antibody formats, modern uses of antibody fragments, biosensors, catalysis, therapeutics, *in-vivo* imaging, microarrays, proteomics, etc.

Practical: Production of murine monoclonal antibody against antigens of infectious agents by hydridoma technique; production of phage display library of scFv or camel nanobody; selection of antigen-specific phage displayed antibody fragment by panning or other techniques.

VMC 717 CURRENT TOPICS IN INFECTION AND IMMUNITY 3+0

Theory

UNIT I: Introduction and historical developments, host-pathogen relationship.

UNIT II: Effector mechanisms of specific and non-specific immunity to different groups of Microbes.

UNIT III: Immunobiology of major viral, bacterial and fungal diseases of animals, types of

vaccines in infectious diseases and current trends in vaccine development.

VMC 718 VETERINARY MICROBIAL BIOTECHNOLOGY 2+1

Theory

UNIT I: History of microbial biotechnology, microbes in nature, microbes as infectious agents of human and animals, host-microbe relationships, microbial metabolism and growth characteristics, microbial genetics.

UNIT II: Introduction to molecular biology of microorganisms, DNA, RNA and proteins structure and functions, DNA replication, RNA transcription reverse transcription, protein translation, regulatory mechanisms, bacterial extrachromosomal DNA elements.

UNIT III: Genetic engineering: restriction enzymes, DNA ligases, DNA polymerases, RNases and DNases, other enzymes, DNA sequencing, plasmids and phage-derived vectors, bacterial hosts for cloning and expression of transgenes, genomic libraries and sequencing, blotting of DNA, RNA and proteins, polymerase chain reaction, microarrays, metagenomics.

UNIT IV: Expression of antigens and antibody fragments useful as diagnostic reagents and vaccines, PCR and blotting techniques in infectious disease diagnosis, nucleic acid vaccines, vectored viral and bacterial vaccines, construction of defined mutants and marker vaccines using genetic manipulation techniques, display technologies for production of immunobiologicals, manipulation of microbial processes for production of industrially useful substances.

Practical: Extraction of nucleic acids from viruses and bacteria; restriction endonuclease digestion of DNA and resolution in agarose gel electrophoresis; PCR amplification of DNA; RT-PCR of RNA; insertion of DNA fragments into plasmid/phagemid/phage vectors; construction of competent *E.coli* host cells; transformation and transfection of competent *E; coli* cells; screening of transformants and isolation of clones; DNA sequencing of clones/PCR amplicons; expression of genes of bacterial/viral antigens; Use of PCR for infectious disease diagnosis.

VMC 790 SPECIAL PROBLEM IN Ph.D. 0+2

Practical: Short research problem(s) involving contemporary issues and research techniques.

VMC 791	**DOCTORAL SEMINAR I**	**1+0**
VMC 792	**DOCTORAL SEMINAR II**	**1+0**
VMC 799	**DOCTORAL RESEARCH**	**0+45**

VETERINARY PARASITOLOGY

http://hillagric.ac.in/edu/covas/vpara/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
VPA 601	VETERINARY HELMINTHOLOGY I	2+1	I
VPA 602	VETERINARY HELMINTHOLOGY II	2+1	II
VPA 603	VETERINARY ENTOMOLOGY AND ACAROLOGY	2+1	I
VPA 604	VETERINARY PROTOZOOLOGY	2+1	II
VPA 605	PARASITOLOGICAL TECHNIQUES	0+2	I
VPA 606	CLINICAL PARASITOLOGY	1+1	I
VPA 607	TRENDS IN CONTROL OF LIVESTOCK AND POULTRY PARASITES	1+1	I
VPA 608	IMMUNOPARASITOLOGY	2+1	II
VPA 609	PARASITIC ZOONOSES	2+0	II
VPA 610	PARASITES OF ZOO AND WILD ANIMALS	2+1	II
VPA 611	MALACOLOGY	1+1	II
VPA 691*	MASTER'S SEMINAR	1+0	II
VPA 699*	MASTER'S RESEARCH	0+20	I&II

*Compulsory for Master's Programme

VETERINARY PARASITOLOGY

Course contents

VPA 601 VETERINARY HELMINTHOLOGY I 2+1

Theory

UNIT I: Introduction, history, classification, general account and economic importance of Platyhelminths.

UNIT II: Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families Dicrocoeliidae, Opisthorchiidae, Strigeidae And Fasciolidae.

UNIT III: Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families Echinostomatidae, Heterophyidae, Plagiorchiidae, Troglotrematidae, Prosthogonimidae, Nanophyetidae and Paragonimidae.

UNIT IV: Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families Notocotylidae, Brachylemidae, Cyclocoelidae, Paramphistomatidae and Schistosomatidae.

UNIT V: Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to families Mesocestoididae, Anoplocephalidae, Thysanosomidae, Dipylidiidae and Dilepididae.

UNIT VI: Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to families Davaineidae, Hymenolepididae, Taeniidae and Diphyllobothriidae.

Practical: Identification of trematode and cestode parasites, their eggs and intermediate hosts; observation on parasitic stages in host tissues and associated pathological lesions.

VPA 602 VETERINARY HELMINTHOLOGY II 2+1

Theory

UNIT I: Introduction, history, classification, general account and economic importance of nematodes and thorny-headed worms.

UNIT II: Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families Ascarididae, Anisakidae, Oxyuridae, Heterakidae and Subuluridae.

UNIT III: Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families Rhabditidae, Strongyloididae and Strongylidae.

UNIT IV: Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families Trichonematidae, Amidostomidae, Stephanuridae, Syngamidae and Ancylostomatidae.

UNIT V: Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families Metastrongylidae, Protostrongylidae, Filaroididae, Trichostrongylidae, Ollulanidae, Crenosomatidae and Dictyocaulidae.

UNIT VI: Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families Spiruridae, Thelaziidae, Acuariidae, Tetrameridae, Physalopteridae, Gnathostomatidae, Filariidae, Setariidae, Onchocercidae and Dracunculidae.

UNIT VII: Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families Trichinellidae, Trichuridae, Capillariidae, Dioctophymatidae, Polymorphidae, Oligacanthorhynchidae and Gnathobdellidae.

Practical: Identification of nematode parasites, their eggs and intermediate hosts; differentiation study of their stages in the tissues and associated pathological lesions.

VPA 603 VETERINARY ENTOMOLOGY AND ACAROLOGY 2+1

Theory

UNIT I: Introduction, history, classification and economic importance.

UNIT II: Distribution, life cycle, seasonal pattern, pathogenesis, economic significance and control of arthropods belonging to the families Culicidae, Ceratopogonidae, Simuliidae and Psychodidae.

UNIT III: Distribution, life cycle, seasonal pattern, pathogenesis, diagnosis, economic significance and control of arthropods belonging to the families Tabanidae, Gasterophilidae, Muscidae, and Glossinidae.

UNIT IV: Distribution, life cycle, seasonal pattern, pathogenesis, diagnosis, economic significance and control of arthropods belonging to the families Oestridae, Sarcophagidae, Calliphoridae and Hippoboscidae.

UNIT V: Distribution, life cycle, seasonal pattern, pathogenesis, diagnosis, economic significance and control of arthropods belonging to the families Pediculidae, Haematopinidae, Linognathidae, Menoponidae, Philopteridae and Trichodectidae.

UNIT VI: Distribution, life cycle, seasonal pattern, pathogenesis, diagnosis, economic significance and control of arthropods belonging to the families Siphonapteridae, Cimicidae and Reduviidae.

UNIT VII: Distribution, life cycle, seasonal pattern, pathogenesis, diagnosis, economic significance and control of arthropods belonging to the families Dermanyssidae, Argasidae and Ixodidae.

UNIT VIII: Distribution, life cycle, seasonal pattern, pathogenesis, diagnosis, economic significance and control of arthropods belonging to the families Sarcoptidae, Psoroptidae, Demodicidae, Trombiculidae, Cytoditidae and Linguatulidae.

UNIT IX: Strategic control measures of arthropods with special emphasis on improved versions of chemical, biological and immunological control and integrated pest management.

Practical: Collection, preservation, identification and differentiation of various arthropods and their developmental stages; associated pathological changes and lesions; skin scraping examination.

VPA 604 VETERINARY PROTOZOOLOGY 2+1

Theory

UNIT I: Introduction, history, classification, general account, economic importance of protozoan parasites.

UNIT II: Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the families Trypanosomatidae, Monocercomonadidae, Trichomonadidae, Hexamitidae and Endamoebidae.

UNIT III: Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the families Eimeriidae, Cryptosporidiidae and Sarcocystidae,

UNIT IV: Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the families Plasmodiidae, Babesiidae, Theileriidae, Haemogregarinidae and Balantidiidae.

UNIT V: Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of Rickettsiales like *Anaplasma, Ehrlichia* and *Haemobartonell.*

Practical: Identification of protozoan parasites and observation on parasite stages in host tissues and the attendant pathological lesions; diagnosis of protozoan parasites of veterinary importance.

VPA 605 PARASITOLOGICAL TECHNIQUES 0+2

Practical: Microscopy; micrometry; camera lucida drawings; micro- and digitalphotography; collection, processing and examination of faecal and blood samples; lymphnode biopsies; skin scrapings and nasal washings from animals forparasitological findings; quantitative faecal examination; evaluation of the efficacy and resistance of drugs against parasites; maintenance of tick and fly colonies in laboratory for experimental purposes and testing of drugs; tick dissection for vector potential; collection of aquatic snails from field and their examination for the presence of

different parasitic stages; collection, fixation, staining, whole mounts and identification of parasites; cryopreservation of parasites; culturing techniques for important parasites and pasture larval count; worm count and assessment of worm burden; remote sensing (RS) and geographic information system (GIS) as tools for mapping parasitic diseases.

VPA 606 CLINICAL PARASITOLOGY 1+1

Theory

UNIT I: History, clinical signs, gross and microscopic examination of secretions and Excretions of clinical cases.

UNIT II: Collection and dispatch of material to laboratory for diagnosis.

UNIT III: Animal sub-inoculation tests, blood and biopsy smear examination, histopathology of affected organs.

Practical: Identification, observation of parasitic stages in host tissues, excretions, secretions and associated pathological lesions.

VPA 607 TRENDS IN CONTROL OF LIVESTOCK AND POULTRY PARASITES 1+1

Theory

UNIT I: Conventional and novel methods of control of helminth, anthelmintics, their mode of action, characteristic of an ideal anthelmintic, anthelmintic resistance, spectrum of activity, delivery devices, integrated control method and immunological control Formulation of deworming schedule, snail and other intermediate host control.

UNIT II: Conventional and novel methods of control of protozoan parasites, antiprotozoan drugs, their mode of action, integrated control method andimmunological control.

UNIT III: Conventional and novel methods of control of insects, insecticides/acaricides - methods of application, their mode of action, insecticide resistance, integrated control method and immunological control.

Practical: *In vivo* and *in vitro* detection of efficacy of and resistance to parasiticidal agents.

VPA 608 IMMUNOPARASITOLOGY 2+1

Theory

UNIT I: Introduction, types of parasitic antigens and their characterization.

UNIT II: Types of immunity in parasitic infections, cellular and humoral immunity to parasites, hypersensitivity, regulation of the immune response.

UNIT III: Evasion of immunity, immumomodulations and their uses.

UNIT IV: Immune responses in helminths, arthropods and protozoa of veterinary importance.

UNIT V: Immunodiagnostic tests and their techniques, application of biotechnological tools in the diagnosis and control of parasitic diseases.

UNIT VI: Vaccines and vaccination against parasitic infections.

UNIT VII: Genetic control of parasites.

Practical: Preparation of various antigens (somatic, secretory and excretory) and their fractionation and characterization; raising of antisera and demonstration of various immunodiagnostic methods for the diagnosis of parasitic infections.

VPA 609 PARASITIC ZOONOSES 2+0

Theory

UNIT I: Introduction to the concept of zoonotic infections, definitions, various classifications of zoonoses, host-parasite relationships, modes of infections, factors influencing prevalence of zoonoses.

UNIT II: A detailed study of transmission, epidemiology, diagnosis and control of major protozoa of zoonotic importance.

UNIT III: A detailed study of transmission, epidemiology, diagnosis and control of major helminths of zoonotic importance.
UNIT IV: A detailed study of transmission, epidemiology, diagnosis and control of major arthropods of zoonotic importance.

VPA 610 PARASITES OF ZOO AND WILD ANIMALS 2+1

Theory

UNIT I: A detailed study of major protozoa of zoo and wild animals with particular emphasis on morphological features, geographical distribution, epidemiology, diagnosis and management.
UNIT II: A detailed study of major arthropod parasites of zoo and wild animals with particular emphasis on morphological features, geographical distribution, epidemiology, diagnosis and management.
UNIT III: A detailed study of major helminth parasites of zoo and wild animals with particular emphasis on morphological features, geographical distribution, epidemiology, diagnosis and management.
Practical: Methods for investigating parasitic diseases in wild animals; collection of parasites at post-mortem; identification and quantification of parasites; visit to zoo and wild life parks / sanctuaries.

VPA 611 MALACOLOGY 1+1

Theory

UNIT I: Characters and classification of Mollusca.
UNIT II: Occurrence, distribution, ecology, life history, morphology and control of vector snails belonging to families, Planorbidae, Lymnaeiidae, Thiridae, Amnicolidae, Helicidae, Succineidae and Zonitidae.
Unit III: Examination of vector molluscs for parasitic infections.
Unit IV: Haematology, internal defense mechanisms, parasite-induced pathology and molluscan tissue culture.
Practical: Collection and identification of vector molluscs, study of their shells and internal organs, Breeding, rearing and maintenance of vector molluscs in the laboratory, Examination of molluscs for various developmental stages of parasites.

VPA-691 MASTER'S SEMINAR 1+0
VPA-699 MASTER'S RESEARCH 0+20

VETERINARY PATHOLOGY

http://hillagric.ac.in/edu/covas/vpath/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
VPP 601*	GENERAL PATHOLOGY	2+1	I
VPP 602*	TECHNIQUES IN PATHOLOGY	1+1	II
VPP 603 *	ANIMAL ONCOLOGY	1+1	I
VPP 604*	CLINICAL PATHOLOGY	1+2	II
VPP 605*	NECROPSY PROCEDURES AND INTERPRETATIONS-I	0+1	I
VPP 606	NECROPSY PROCEDURES AND INTERPRETATIONS-II	0+1	II
VPP 607 *	SYSTEMIC PATHOLOGY	2+1	II
VPP 608*	PATHOLOGY OF INFECTIOUS DISEASES OF DOMESTIC ANIMALS	2+1	I
VPP 609	TOXICOPATHOLOGY	2+1	I&II
VPP 610*	AVIAN PATHOLOGY	2+1	II
VPP 611	PATHOLOGY OF LABORATORY ANIMALS, FISH AND WILD ANIMALS	2+1	I&II
VPP 612*	VETEROLEGAL PATHOLOGY	1+0	I&II
VPP 690	SPECIAL PROBLEM IN M.V.Sc.	0+1	I&II
VPP 691*	MASTER'S SEMINAR	1+0	I&II
VPP 699 *	MASTER'S RESEARCH	0+20	I&II

*Compulsory for Master's Program

VETERINARY PATHOLOGY

Course contents

VPP 601 GENERAL PATHOLOGY 2+1

Theory

UNIT I: Introduction and history of pathology, principles of pathology including etiology, course and termination of disease.

UNIT II: Advanced study of various degenerations, infiltrations, necrosis, endogenous and exogenous pigmentations.

UNIT III: Circulatory and growth disturbances, reversible and irreversible cell injury.

UNIT IV: Inflammation including vascular and cellular alterations with emphasis on chemical mediators, hypersensitivity and immune mediated mechanisms, mechanism of healing and fever.

Practical: To study the gross and microscopic changes in degenerations, infiltrations, pigmentations; circulatory and growth disturbances and different types of necrosis in different tissues of domestic animals; study of gross and histopathological features of different types of inflammation.

VPP 602 TECHNIQUES IN PATHOLOGY 1+1

Theory

UNIT I: Basic histopathological techniques, collection of tissues, fixation, processing and section cutting, staining by routine and special methods.

UNIT II: Principles of dark ground, phase contrast and fluorescent microscopy and micrometry.

UNIT III: Histochemical techniques for demonstration of fat, glycogen and fibrous connective tissue, mucopolysaccharides and common enzymes.

Practical: Collection of tissues for histopathological, histochemical, toxic, bacterial and viral examination; use of different fixatives for preservation of museum specimens; application of different techniques- histopathological, cryosectioning, micrometry, routine and special staining; demonstration of different inclusions, bacteria and fungi in tissues; histochemical techniques to demonstrate different tissue constituents.

VPP 603 ANIMAL ONCOLOGY 1+1

Theory

UNIT I: Study of different neoplasms of animals including their identification and epidemiology.

UNIT II: Etiology, histogenesis and experimental production.

UNIT III: Tumour immunology, cell cultures, transplantation and biological behavior.

Practical: To study the gross and microscopic changes in different types of neoplasms.

VPP 604 CLINICAL PATHOLOGY 1+2

Theory

UNIT I: Study of changes in blood, urine, faeces, cerebrospinal fluid and biopsy specimens and their interpretation.

UNIT II: Exfoliative cytology, organ function tests and their interpretation.

UNIT III: Biochemical profile of blood/plasma/serum and its correlation with disease conditions in domestic animals.

Practical: Evaluation of laboratory investigations on blood, urine, faeces and biopsy specimens from natural and experimentally produced disease conditions.

VPP 605 NECROPSY PROCEDURES AND INTERPRETATIONS I 0+1

Practical: Detailed necropsy examination of various species of farm animals; laboratory animals and wildlife; necropsy case presentation and report writing/protocol preparation; collection of specimens

for diagnosis of viral; bacterial; protozoan; parasitic diseases; toxic/poisoning and for histochemistry/histopathology; systemic examination of brain; lungs; heart; endocrine glands; lymph nodes; liver; gastro-intestinal tract; urinary and genital systems for gross pathological and histopathological studies and correlation of the observations to diagnose the disease conditions.

VPP 606 NECROPSY PROCEDURES AND INTERPRETATIONS II 0+1

Practical: Detailed necropsy examination of various species of small animals, poultry, laboratory animals and wildlife; necropsy case presentation and report writing / protocol preparation; collection of specimens for diagnosis of viral, bacterial, protozoan, parasitic diseases, toxic/ poisoning and for histochemistry / histopathology; systemic examination of brain, lungs, heart, endocrine glands, lymph nodes, liver, gastro-intestinal tract, urinary and genital systems for gross pathological and histopathological studies and correlation of the observations to diagnose the disease conditions.

VPP 607 SYSTEMIC PATHOLOGY 2+1

Theory

UNIT I: An advanced study of pathological conditions affecting different organs of haemopoietic (bone marrow, blood, spleen, lymph node), circulatory (heart, blood vessels and lymph vessels) and respiratory (nasal cavity, larynx, trachea, bronchi, lung and pleura) systems, study of etiology, pathology and pathogenesis of specific infectious and non-infectious diseases of domestic animals related to the above mentioned systems.

UNIT II: Advanced study of pathological conditions affecting different organs of digestive (buccal cavity, pharynx, oesophagus, stomach and intestines), urinary (kidneys, ureter, urinary bladder and urethra) and genital (male and female organs including mammary gland) systems, Study of etiology, pathology and pathogenesis of specific infectious and non-infectious diseases of domestic animals related to the above mentioned systems.

UNIT III: Advanced study of pathological conditions affecting different organs of nervous (brain and spinal cord), endocrine (pituitary, thyroid, parathyroid, pancreas), musculo-skeletal systems (muscles and bones), and organs of special senses (eye, ear), skin and its appendages (hoof, tail), study of etiology, pathology and pathogenesis of specific infectious and non-infectious diseases of domestic animals related to the above mentioned systems/organs.

Practical: To study the gross and histopathological changes in important conditions affecting various systems; study of gross and microscopic lesions in specific diseases pertaining to above said systems.

VPP 608 PATHOLOGY OF INFECTIOUS DISEASES OF DOMESTIC ANIMALS 2+1

Theory

UNIT I: Pathology of various viral diseases of domestic animals.

UNIT II: Pathology of various bacterial and fungal diseases of domestic animals.

UNIT III: Pathology of various rickettsial and parasitic diseases of domestic animals.

Practical: To study the slides, museum specimens including autopsy specimens concerned with specific diseases.

VPP 609 TOXICOPATHOLOGY 2+1

Theory

UNIT I: Introduction, mode of action, diagnosis and treatment of different poisons and their classification.

UNIT II: Pathogenesis, gross and microscopic pathology of diseases caused by toxic plants, organic and inorganic poisons commonly taken or administered maliciously to different species of domestic animals.

Practical: To study gross and histopathological alterations as a result of ingestion of toxic plants and extraneous poisons in domestic animals.

VPP 610 AVIAN PATHOLOGY 2+1

Theory:

UNIT I: Pathology of infectious diseases of chickens, turkeys, ducks and other birds.

UNIT II: Pathology of non-infectious diseases of chickens, turkeys, ducks and other birds.

Practical: Necropsy examination of the different species of poultry; study of gross and histopathological lesions in naturally occurring and artificially produced diseases of birds.

VPP 611 PATHOLOGY OF LABORATORY ANIMALS, FISH AND WILD ANIMALS 2+1

Theory

UNIT I: Introduction, disease transmission and inter-phase.

UNIT II: Pathology of important infectious diseases (viz, bacterial, viral, fungal and parasitic) of fish, laboratory and wild/zoo animals.

UNIT III: Pathology of non-infectious diseases of fish, lab/ wild/zoo animals.

Practical: Post-mortem examination of wild animals including wild birds; study of gross and microscopic lesions of important infectious and non-infectious diseases of fish and laboratory animals.

VPP 612 VETEROLEGAL PATHOLOGY 1+0

Theory

UNIT I: General knowledge about the laws relating to veterinary practice, professional discipline and professional etiquettes.

UNIT II: Regulations dealing with diseases of animals in India regarding epidemiology, quarantine certificate, issue of soundness certificate etc.

UNIT III: Common causes of violent death, criminal assault, cruelty to animals, malicious poisoning, snake bite, electrocution, gunshot wounds, automobile accidents, doping etc.

VPP 690 SPECIAL PROBLEM IN M.V.Sc. 0+1

VPP 691 MASTER'S SEMINAR 1+0

VPP 699 MASTER'S RESEARCH 0+20

VETERINARY PHARMACOLOGY AND TOXICOLOGY

http://hillagric.ac.in/edu/covas/vpharma/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
VPT 601	GENERAL PHARMACOLOGY	2+0	I
VPT 602	AUTONOMIC AND AUTOCOID PHARMACOLOGY	2+1	II
VPT 603	CNS PHARMACOLOGY	2+1	II
VPT 604	DIGESTIVE AND RESPIRATORY PHARMACOLOGY	2+0	I
VPT 605	CARDIOVASCULAR AND RENAL PHARMACOLOGY	2+0	I
VPT 606	ENDOCRINE AND REPRODUCTIVE PHARMACOLOGY	2+0	I
VPT 607	CHEMOTHERAPY	2+1	I
VPT 608	TOXICOLOGY OF XENOBIOTICS	2+1	II
VPT 609	TOXICOLOGY OF PLANT AND TOXINS	2+0	II
VPT 610	PHARMACOLOGICAL TECHNIQUES	1+1	I
VPT 611	TECHNIQUES IN TOXICOLOGY	1+1	II
VPT 612	ETHNOPHARMACOLOGY	2+0	II
VPT 691	MASTERS' SEMINAR	1+0	I&II
VPT 699	MASTERS' RESEARCH	0+20	I&II

VETERINARY PHARMACOLOGY AND TOXICOLOGY

Course contents

VPT 601 GENERAL PHARMACOLOGY 2+0

Theory

UNIT I: History and scope of pharmacology, principles of drug absorption, distribution, metabolism and elimination, drug bioavailability and routes of administration.

UNIT II: Important pharmacokinetic parameters and their clinical significance.

UNIT III: Pharmacodynamics, mechanism of action and the relationship between drug concentration and effect, signal transduction mechanism and drug receptors for physiological regulatory molecules.

UNIT IV: Quantitation of drug-receptor interactions and elicited effects, competitive and non-competitive antagonism, factors affecting drug response, adverse drug reactions.

VPT 602 AUTONOMIC AND AUTACOID PHARMACOLOGY 2+1

Theory

UNIT I: Anatomical and physiological considerations of autonomic nervous system (ANS).

UNIT II: Neurohumoral transmission in ANS.

UNIT III: Pharmacology of cholinergic agonists and antagonists.

UNIT IV: Pharmacology of adrenergic agonists and antagonists.

UNIT V: Ganglionic stimulants and blockers.

UNIT VI: Autacoids, histamine, serotonin, kinins, eicosanoids and platelet activating factor.

Practical: Pharmacological experiments on intact and isolated preparations for studying the effects of various prototype drugs on vascular; intestinal; respiratory; urinary and reproductive smooth muscles; autonomic ganglia; skeletal muscles; blood pressure; ECG; heart etc.

VPT 603 CNS PHARMACOLOGY 2+1

Theory

UNIT I: Anatomical and physiological considerations of central nervous system (CNS), neurohumoral transmission in CNS.

UNIT II: Historical development, theories, principles and stages of general anaesthesia.

UNIT III: Pharmacology of anaesthetics, sedatives, hypnotics, neuroleptics, antiepileptics.

UNIT IV: CNS stimulants, analeptics, opioid agonists and antagonists, non-steroidal anti-inflammatory agents, central and peripheral muscle relaxants, local anaesthetics, therapeutic gases, euthanizing agents, Doping.

Practical: Study of pharmacodynamics of prototype drugs of each group in experimental animals.

VPT 604 DIGESTIVE AND RESPIRATORY PHARMACOLOGY 2+0

Theory

UNIT I: Pharmacology of drugs acting on gastrointestinal tract, appetite stimulants, emetics and anti-emetics.

UNIT II: Anti-ulcer drugs, modulators of gastric and intestinal motility and secretions.

UNIT III: Gastrointestinal protectants and adsorbents, laxatives and cathartics.

UNIT IV: Agents promoting digestive functions; bile acids and pancreatic enzymes, drugs affecting liver, rumen pharmacology.

UNIT V: Pharmacology of drugs acting on respiratory system, pathogenesis of inflammatory respiratory diseases.

UNIT VI: Bronchodilators, antitussives, mucolytics, expectorants, decongestants.

UNIT VII: Drugs used in treatment of asthma.

VPT 605 CARDIOVASCULAR AND RENAL PHARMACOLOGY 2+0

Theory

UNIT I: Pharmacology of cardiac glycosides.

UNIT II: Antiarrhythmic, antihypertensive and antihyperlipidaemic drugs.

UNIT III: Drugs affecting vasomotor and cardiorespiratory reflex mechanisms and haemopoietic system.

UNIT IV: Coagulants and anticoagulants, thrombolytic agents.

UNIT V: Pharmacology of drugs affecting renal functions and fluid-electrolyte balance.

UNIT VI: Fluid and electrolyte therapy, diuretics, antidiuretics, uricosuric drugs.

VPT 606 ENDOCRINE AND REPRODUCTIVE PHARMACOLOGY 2+0

Theory

UNIT I: Pharmacology of drugs affecting endocrine functions of pituitary, thyroid, adrenals and pancreas.

UNIT II: Hormonal regulation of calcium and phosphorus homeostasis.

UNIT III: Pharmacology of drugs affecting male reproductive organs, spermatogenesis.

UNIT IV: Pharmacology of drugs affecting female reproductive organs, ovulation, oestrus, conception, gestation and lactation.

UNIT V: Oxytocic and tocolytic drugs.

VPT 607 CHEMOTHERAPY 2+1

Theory

UNIT I: General consideration and principles of chemotherapy, classification of chemotherapeutic agents, development of microbial resistance to antimicrobials, combination therapy.

UNIT II: Systemic and gut acting sulfonamides, diaminopyrimidines, quinolones sulfones, nitrofurans.

UNIT III: Penicillins, cephalosporins, beta-lactam antibiotics.

UNIT IV: Chloramphenicol, tetracyclines, macrolides, polymixins, polypeptides.

UNIT V: Aminoglycosides and other antibiotics.

UNIT VI: Anti-protozoans, anthelmintics, ectoparasiticides.

UNIT VII: Antituberculosis, antifungal, antiviral and antineoplastic drugs.

Practical: General methods for assay of chemotherapeutic agents; antibiotic sensitivity tests; estimation of sulfonamides, penicillins, oxytetracyclines, trimethoprim and nitrofurans in biological fluids to study their kinetics and bioavailability.

VPT 608 TOXICOLOGY OF XENOBIOTICS 2+1

Theory:

UNIT I: Principles and scope of toxicology, sources of poisoning.

UNIT II: General modes of action of poisons, detoxification, factors affecting toxicity, general principles of diagnosis and treatment of poisonings.

UNIT III: Toxicology of metals, agrochemicals, solvents and vapors, feed additives.

UNIT IV: Toxic effects of radiations and radioactive chemicals, genetic and developmental toxicology, forensic and regulatory aspects of toxicology.

Practical: Extraction, separation and detection of common poisons in toxicological specimens; study of toxicity and antidotal treatment in animals; designing of animal toxicity experiments and general toxicity tests.

VPT 609 TOXICOLOGY OF PLANTS AND TOXINS 2+0

Theory

UNIT I: Classification, identification and chemical constituents of poisonous plants, plants containing cyanide, nitrate/nitrite, oxalate, lectins and cardiotoxic glycosides.

UNIT II: Plants producing lathyrism, thiamine deficiency and photosensitization.

UNIT III: Toxicology of mycotoxins, aflatoxins, rubratoxins, ochratoxins, trichothecenes, tremorgens and ergot.

UNIT IV: Animal bites and stings, snake venom, scorpion, spider and insect stings and toad poisoning, Bacterial toxins, botulism.

VPT 610 PHARMACOLOGICAL TECHNIQUES 1+1

Theory

UNIT I : Principles of drug action and bioassay, dose response curves and their analysis.

UNIT II: Techniques for setting up isolated and intact preparations.

UNIT III: Organization of screening programme of drugs, multidimensional screening procedures and gross observational methods.

Practical: Setting up of isolated and intact preparations; recording of BP in dog/rat; ecording of ECG in rat; experiments on drug potentiation; antagonism and achyphylaxis; construction of dose-response plots; calculation of EC50; issociation rate constants, potency ratio, pAx, pDx and pD'x values; specific tests for evaluation of tranquillizing, hypnotic, analgesic, anticonvulsant, eneral and local anesthetic, muscle relaxant, anti-inflammatory, antipyretic, antiarrhythmic, antihypertensive, antihyperglycemic and anticholesterimic activities; determination of otency ratio, median effective, toxic or lethal doses; Bioassay techniques.

VPT 611 TECHNIQUES IN TOXICOLOGY 1+1

Theory

UNIT I: Animal models in toxicological studies.

UNIT II: Animal toxicity tests for acute, sub-acute and chronic toxicity.

UNIT III: Specific toxicity tests for neurotoxicity, immunotoxicity, developmental, behavioural, reproductive and inhalation toxicity, mutagencity, carcinogenicity.

UNIT IV: Animal toxicological tests for the study of metabolism, synergism and antagonism,

Practical: Tests for acute, sub-acute and chronic toxicity; protocols and various specific toxicity tests; assay for marker enzymes; analysis of toxicant residues in biological materials.

VPT 612 ETHNOPHARMACOLOGY 2+0

Theory

UNIT I: Historical aspects, traditional Indian remedies and regional folklore in disease cure.

UNIT II: Classification, identification and chemical constituents of medicinal plants, extraction, distillation, evaporation and other processes used in purification and preparation of active constituents from medicinal plants.

UNIT III: Standardization and clinical validation of bioactive molecules from vegetable sources, therapeutic and adverse effects of potential herbal drugs, Indigenous drugs used as carminatives, antiseptics, antimicrobials, analgesics, and anti-inflammatory agents.

UNIT IV: Alternate systems of medicine in animals.

VPT 691 MASTER'S SEMINAR 1+0

VPT 699 MASTER'S RESEARCH 0+20

VETERINARY PHYSIOLOGY AND BIOCHEMSITRY

http://hillagric.ac.in/edu/covas/vpy/index.htm ; http://hillagric.ac.in/edu/covas/vbio/index.html

A. VETERINARY PHYSIOLOGY

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
VPY 601	PHYSIOLOGY OF DIGESTION	2+1	I&II
VPY 602	CARDIOVASCULAR AND RESPIRATORY PHYSIOLOGY	2+1	I&II
VPY 603	RENAL PHYSIOLOGY AND BODY FLUID DYNAMICS	2+1	I&II
VPY 604	HAEMATOLOGY	2+1	I&II
VPY 605	VITAMINS AND MINERALS IN ANIMAL PHYSIOLOGY	2+0	I&II
VPY 606	PHYSIOLOGY OF ANIMAL REPRODUCTION	2+1	I&II
VPY 607	CLINICAL PHYSIOLOGY	2+1	I&II
VPY 608	NEUROMUSCULAR PHYSIOLOGY	2+1	I&II
VPY 609	CHEMICAL BIOREGULATION IN PHYSIOLOGICAL FUNCTIONS	3+0	I&II
VPY 610	RESEARCH TECHNIQUES IN VETERINARY PHYSIOLOGY	0+2	I&II
VPY 691	MASTER'S SEMINAR	1+0	I&II
VPY 699	MASTER'S RESEARCH	0+20	I&II
VPY 701	APPLIED PHYSIOLOGY OF BODY FLUIDS AND ELECTROLYTES	2+1	I&II
VPY 702	PHYSIOLOGY OF ANIMAL BEHAVIOUR	2+0	I&II
VPY 703	COMPARATIVE PHYSIOLOGY OF RMINANT DIGESTION	2+1	I&II
VPY 704	ADVANCES IN NEURO-ENDOCRINOLOGY	2+1	I&II
VPY 705	MYOPHYSIOLOGY AND KINESIOLOGY	2+1	I&II
VPY 706	AVIAN PHYSIOLOGY	2+1	I&II
VPY 707	PHYSIOLGY OF LACATATION	2+1	I&II
VPY 708	ADVANCES IN ENVIRONMENTAL PHYSIOLOGY AND GROWTH	2+1	I&II
VPY 709	ADVANCES IN RUMEN MICROBIOLOGY AND METABOLISM	2+1	I&II
VPY 710	ADVANCES IN IMMUNOPHYSIOLOGY	2+1	I&II
VPY 711	PHYSIOLOGY OF STRESS	2+1	I&II
VPY 790	SPECIAL PROBLEM IN Ph.D.	0+2	I&II
VPY 791	DOCTORAL RESEARCH I	1+0	I&II
VPY 792	DOCTORAL RESEACRH II	1+0	I&II
VPY 799	DOCTORAL RESEARCH	45	I&II

A. VETERINARY PHYSIOLOGY

Course contents

VPY 601 PHYSIOLOGY OF DIGESTION

2+1

Theory

UNIT I: Basic characteristics and comparative physiology of digestive system of domestic animals.

UNIT II: Gastro-intestinal motility, secretory functions of gastro-intestinal tract, their regulation and gastro-intestinal hormones.

UNIT III: Absorption, metabolism and excretion of various nutrients, appetite and control of feed intake.

UNIT IV: Development of ruminant system and rumen environment, ruminant microbial digestion, its advantages and disadvantages, rumino-reticular motility, its significance and control,

UNIT V: Rumen microbiology, digestion in birds.

Practical: Collection of saliva and its enzymatic studies; activity of pepsin and trypsin enzymes; gastric and intestinal motility; estimation of digestive metabolites such as glucose, ketone bodies, triglycerides, cholesterol, ureanitrogen and total proteins; liver function tests; method of collection of rumen liquor-merits and demerits; determination of pH; total volatile fatty acids; ammonia-nitrogen and total-nitrogen in strained rumen liquor; rate of passage of digesta and its estimation; rumino-reticular movements; artificial rumen; counting of protozoa and bacteria.

VPY 602 CARDIOVASCULAR AND RESPIRATORY PHYSIOLOGY 2+1

Theory

UNIT I: Heart muscle, heart as pump, origin and propagation of heart beat, electrophysiology of heart, rhythmic excitation of heart, cardiac cycle, heart sound and dynamics of valvular and congenital heart defect.

UNIT II: Cardiac output and its measurements, factors affecting cardiac output, venous return and its regulation, control of the heart.

UNIT III: Normal electro-cardiogram, electrocardiographic interpretation in cardiac myopathies and cardiac arrhythmias.

UNIT IV: Circulation and hemodynamics, coronary, systemic and pulmonary circulation, their regulation, energetics of circulation, pathophysiology of circulation.

UNIT V: Respiration, mechanism of ventilation, hemoglobin, oxygen and carbondioxide transport, respiratory gas exchange, respiratory adjustment at high altitude and deep swimming, neural and chemical control of respiration, artificial respiration, respiration in birds.

Practical: Determination and recording of cardiac output; blood pressure and electrocardiogram; blood volume; estimation of lung volumes and capacities by spirometery; effect of various levels of exercise on lung functional capacities; estimation of blood gases.

VPY 603 RENAL PHYSIOLOGY AND BODY FLUID DYNAMICS 2+1

Theory

UNIT I: An overview of nephron structure and function, renal homeostatic function and renal excretory function.

UNIT II: Quantitative analysis of renal function, renal haemodynamics, glomerular filtration-its mechanism and measurement, permselectivity of the glomerular capillary wall, structural basis of GFR, tubular reabsorption and transport.

UNIT III: Role of kidney in acid-base balance, physiology of micturition, endocrine control of renal function, non excretory functions of kidney.

UNIT IV: Skin-general anatomy of epidermis, dermis, hypodermis, mechanical protection, permeability, actinic irradiation, sweat glands, sebaceous glands, skin grafting, immune properties of skin.

UNIT V: Composition of body fluids and their regulation, excretory system in birds.

Practical: Collection and preservation of urine; physical and chemical analysis of urine and its interpretation in health and disease condition; demonstration of various kidney function tests: glomerular filtration rate, creatinine clearance rate, urea clearance rate and glucose tolerance test.

VPY 604 HAEMATOLOGY 2+1

Theory

UNIT I: Red blood cells, anaemia, different types of anaemia, polycythemia and their effect on circulation in mammals and birds.

UNIT II: Resistance of the body to infection, leukocytes, tissue macrophage system and inflammation.

UNIT III: Immunity, immunoglobulins, immunogenetics, polymorphism in hemoglobin, transferrin etc., changes in blood during diseases, iatrogenic blood diseases, hemorrhagic diathesis, hemophilias.

UNIT IV: Hemostasis and coagulation factors, role of platelets, fibrinolysis, blood groups, transfusion of blood, tissue and organ transplantation, conditions causing bleeding disorders.

Practical: Haemograms; platelet count; erythrocyte fragility; estimation of serum iron and iron binding capacities of plasma; separation of variants of hemoglobin and transferrin by electrophoresis; examination of bone marrow; isolation of different types of blood cells by sedimentation and column chromatography.

VPY 605 VITAMINS AND MINERALS IN ANIMAL PHYSIOLOGY 2+0

Theory:

UNIT I: Introduction and brief history, definition, general properties and overview of functions.

UNIT II: Fat soluble vitamins, their functions and deficiency diseases.

UNIT III: Water soluble vitamins and vitamin-like compounds, their functions and deficiency diseases.

UNIT IV: Physiological functions of trace elements, their role in metabolism, toxicity, deficiency diseases.

VPY 606 PHYSIOLOGY OF ANIMAL REPRODUCTION 2+1

Theory

UNIT I: Functional histomorphology of male and female reproductive system, development of male and female sex organs, endocrine and neuroendocrine relation in male and female reproductive function in different domestic animals.

UNIT II: Sexual cycles and mating behaviours in females, oogenesis, folliculogenesis and ovulation, secretions of female reproductive tract in different species of animals.

UNIT III: Male mating behaviour, spermatogenesis, spermiogenesis, seminiferous, epithelial cycles, spermatozoa- structure and composition, maturation and transportation, secretions of male reproductive tract.

UNIT IV: Transport of male and female gametes, fertilization, implantation, pregnancy and parturition, post-partum recovery in different species of domestic animals.

Practical: Heat detection in different animals; palpation of reproductive organs; physical and biochemical evaluation of semen; determination of sperm enzyme; leakage during freezing; preservation of semen; RIA of steroid hormones.

VPY 607 CLINICAL PHYSIOLOGIES 2+1

Theory

UNIT I: Cardiovascular, respiratory, hepatic and renal evaluation of body functions in relation to clinical conditions.

UNIT II: Carbohydrate, fat, protein and mineral metabolism in health and disease of various species.

UNIT III: Functions and dysfunctions of liver, kidney and gastro-intestinal tract.
UNIT IV: Clinico-immunological evaluation of immune responses and clinical enzymology.

Practical: Qualitative tests for glucose; ketone bodies, protein and calcium in urine; quantitative determination of glucose in blood and urine; electrophoresis of plasma proteins; determination of sodium and potassium in serum; determination of serum chloride; separation of amino acids; thin-layer chromatography of serum lipids.

VPY 608 NEUROMUSCULAR PHYSIOLOGIES 2+1

Theory

UNIT I: Types and classification of muscles, comparative histopathology of muscles, skeletal muscle fibers, membrane and action potential at myoneuronal junction, molecular characteristics of contractile filaments, molecular mechanism of muscle contraction, relationship between actin andmyosin filaments, overlap and tension developed by the contracting muscles, contractile process of smooth muscles.
UNIT II: Length and tension relationship, force and velocity relationship, skeletal muscle energetics, metabolism and lactate shuttle, exercise, adaptation to training and performance, neuromuscular disorders of domestic animals.
UNIT III: Nervous system, synapse, transmission and processing of information, receptors, brain and spinal reflexes, motor functions of brain stem, limbic system, memory, sleep, learning, autonomic nervous system.
UNIT IV: Special senses and somatic senses.

Practical: Recording of electro-myogram; fatigue; tetanus in muscles; effect of temperature on different types of muscles; demonstration of intestinal movements; effect of drugs on all types of muscles; estimation of muscles specific enzymes.

VPY 609 CHEMICAL BIOREGULATION IN PHYSIOLOGICAL FUNCTIONS 3+0

Theory

UNIT I: Methods of study bioregulation including methods of endocrine analysis, manipulation and disruption of biorhythms in homeostatic and natural ecosystem.
UNIT II: Hormonal relationship in animal production, concepts in hormone function, classification and methods of study, hormonal assay, mechanism of hormone synthesis, release and transport, mechanisms of hormone action, target cell interactions.
UNIT III: Genetic and genomic approaches in endocrinology, animal models and alternate uses of animal model, regulation and metabolism of hypothalamic, hypophyseal, thyroid and adrenal hormones.
UNIT IV: Gonadal and placental hormones, their regulation and mechanism of action, hormonal principles of pineal gland and its role in production.
UNIT V: Endocrine control of carbohydrate and calcium homeostasis, hormones and adaptation to environment, hormonal regulation of gastro-intestinal activity, prostaglandins, hormones in fertility regulation and production augmentation, avian endocrinology.

VPY 610 RESEARCH TECHNIQUES IN VETERINARY PHYSIOLOGY 0+2

Practical: Recording of ECG; EMG; blood pressure; pulse rate; movement of GI tract by physiograph; Gas Liquid Chromatography; electrophoresis;estimation of various electrolytes; estimation of bacterial production rate and VFA production rate; solid and liquid digesta flow rates and body composition using radio-isotopes; *in vitro* and *in sacco* rumen studies; ELISA; RIA; techniques of various hormones.

VPY 701 APPLIED PHYSIOLOGY OF BODY FLUIDS AND ELECTROLYTES 2+1

Theory

UNIT I Volume and composition of body fluids, exchange of water and electrolytes between body compartments, blood and external environment, osmolarity of fluid.

UNIT II Regulation of volume and osmolarity of extra cellular fluid, regulation of pH and acid base balance, formation and composition of cerebrospinal fluid and lymph.

UNIT III Clinical implications of change in electrolytes and body fluids, structural and functional consideration of plasma and its composition, diuresis and endocrine control of renal functions.

UNIT IV Clinical feature in fluid and electrolyte imbalance, clinicopathological indictors of fluid and electrolytes imbalance.

Practical Determination of electrolytes viz. sodium, potassium and chloride in plasma; determination of total body water and plasma volume by various techniques i.e. dye dilution and radioisotope technique; estimation of osmolarity and osmolality of body fluids.

VPY 702 PHYSIOLOGY OF ANIMAL BEHAVIOUR 2+0

Theory

UNIT I Introduction to animal ethology, neurophysiological basis of animal behaviour.

UNIT II Behaviour in relation to changes in the environment, feeding behaviour, grazing, stall feeding and rumination.

UNIT III Sexual behaviour in the female and male, maternal behavior, milk let down.

UNIT IV Social behaviour, communication in animals, animal temperament, response of dogs and horses to training.

VPY 703 COMPARATIVE PHYSIOLOGY OF RUMINANT DIGESTION 2+1

Theory

UNIT I Functional development of ruminant stomach, rumen motility and its control.

UNIT II Salivary secretion and its regulation, intraruminal environment, rumen metabolites and their assimilation, NPN feeding, nitrogen recycling.

UNIT III Synthesis of microbial proteins and vitamins, rumen dysfunctions, comparative efficiency of rumen function in different species, stoichiometry of carbohydrate fermentation.

UNIT IV Manipulation of rumen fermentation, protected nutrients feeding, probiotics supplementation etc., rumen flow rate and rumen volume.

Practical Reticulo-ruminal motility, artificial rumen techniques, total volatile fatty acids and their fractions, bacteria, protozoa and fungi in rumen; low rates of ruminal contents.

VPY 704 ADVANCES IN NEURO-ENDOCRINOLOGY 2+1

Theory

UNIT I Neuroendocrine integrating mechanism, structure of hypothalamus, pituitary gland, limbic and other neural pathways and endocrine functions.

UNIT II Neural control of oxytocin, adrenocorticotropic hormone, aldosterone, thyrotropic hormone, growth hormone, gonadotrophins etc., hypothalamic releasing factors and the neuro-vascular link between brain and anterior pituitary.

UNIT III Role of afferent impulses from genitals and other regions in reproductive system, influence of hormones on brain activity.

UNIT IV Effects of drugs on neuro-endocrine system. Neuro-endocrine mechanisms in birds. Interaction of nervous, endocrine and immune system in animal production and reproduction.

Practical Radio-immuno assay of progesterone, effects of ovariectomy, effects of testosterone treatment, bioassay of estrogens, estimation of T_3 and T_4 in blood.

VPY 705 MYOPHYSIOLOGY AND KINESIOLOGY 2+1

Theory

UNIT I Structure of muscle, chemical composition, muscle contraction and irritability echanical properties of skeletal muscle.

UNIT II Thermal properties of muscles, chemical correlates of contraction.

UNIT III Molecular basis of muscular contraction of skeletal muscle, pathophysiology of muscles and myocardium.

UNIT IV Lever systems of body joints, synovial fluid formation and its physiology, principles of kinesiology and its application in work physiology.

Practical Electromyogram, tetany, electro-cardiogram, intestinal movements, effects of various drugs on all types of muscles.

VPY 706 AVIAN PHYSIOLOGY 2+1

Theory

UNIT I Digestive and urinary system.

UNIT II Blood, cardiovascular and respiratory system.

UNIT III Reproductive and endocrine system.

UNIT IV Nervous system and musculo-skeletal system.

Practical Study of blood cells, haemoglobin, packed cell volume (haematocrit) and erythrocyte sedimentation rate; determination of glucose, calcium, uric acid and urea in blood; electrophoretic separation of plasma proteins and egg proteins.

VPY 707 PHYSIOLOGY OF LACTATION 2+1

Theory

UNIT I Functional anatomy, histology and cytology of mammary gland in domestic animals.

UNIT II Development of mammary gland, hormonal control of mammary gland growth.

UNIT III Process of lactation, initiation of milk secretion, hormonal control of lactation, biochemical and histological changes in mammary gland during lactation, mechanism of galactopoiesis.

UNIT IV Neural control of lactation, milk let down, milk ejection and inhibition of milk ejection, induced lactation, composition of milk in different species of animals.

Practical Examination of normal udder of cow and buffalo; composition of colostrum and milk during different phases of lactation; effect of adrenalin and oxytocin on milk let down, artificial induction of lactation; estimation of lactogenic hormones.

VPY 708 ADVANCES IN ENVIRONMENTAL PHYSIOLOGY AND GROWTH 2+1

Theory

UNIT I Ecology of farm animals, biological rhythms, mammalian circadian rhythms, their regulation, components of physical environment, biometeorology and principles of thermoregulation in mammals and birds.

UNIT II Physiological response of farm animals to heat and cold, effect of various climatic components on health and production (growth and egg production), reproduction and climatic adaptation.
UNIT III Concept and definitions of cellular, prenatal and postnatal growth- patterns in different species of domestic animals.
UNIT IV Factors affecting live weight growth viz. nutrition, hormones, vitamins, antibiotics, environment, ageing and senescence, growth anomalies.
Practical Growth measurement and growth curves, recording of various climatic variables, effect of climatic variables on growth and production.

VPY 709 ADVANCES IN RUMEN MICROBIOLOGY AND METABOLISM 2+1
Theory
UNIT I Introduction to rumen bacteria, protozoa and fungi, development and natural fluctuation in rumen microbial population.
UNIT II Microbial ecology and physiology of feed degradation within the rumen metabolism of nitrogen containing compounds.
UNIT III Degradation of carbohydrate, fat and protein by rumen microbes, NPN utilization, Microbe-microbe interaction, protected nutrients and other feed additives.
UNIT IV Genetics and biotechnology of rumen microbes, rumen anaerobic fungi, their role and interaction with other rumen microbes.
Practical Counting of total and differential protozoa, total and viable bacteria and fungi in rumen liquor; individual VFA by GLC; defaunation and manipulation of rumen fermentation; culture of bacteria and fungi.

VPY 710 ADVANCES IN IMMUNOPHYSIOLOGY 2+1
Theory
UNIT I Introduction, history, body defense, organs of immune system, ontogeny and phylogeny of immune system, vertical transmission of immunity and difference between vertebrates and invertebrates
UNIT II Immunoglobulins-basic structure and functions, hematopoiesis, T-cell and B-cell-evolution, development and their functions, species specific immunity, cytokines-sources and actions, MHC, genetic organization of immunoglobulin, MHC and complement system.
UNIT III Immune-endocrine interactions, immune system in reproduction, ageing, stress and other physiological functions, immunomodulation.
UNIT IV Hypersensitivity, diseases related to immune system, dysfunction, autoimmune disorders and their genesis, immunodeficiency.
Practical Qualitative and quantitative analysis of immunoglobulins in body fluids, RIA, ELISA, electrophoresis techniques in immunophysiology, raising hyperimmune sera and blood group immunophysiology.

VPY 711 PHYSIOLOGY OF STRESS 2+1
Theory
UNIT I Definition of stress, various types of stresses, their effect on animal production and reproduction.
UNIT II Physico-chemical changes of blood composition due to exercise and work, energy utilization and requirement of muscles during work and exercise.

UNIT III Capacity of work under field and controlled laboratory conditions, factors that regulate it.
UNIT IV Effect of various stresses on endocrine status of animals, endurances in animals.
Practical Measurement of various biochemical parameters during stress and /or exercise in animals, measurement of various hormones during different stresses in animals, measurement of cardio-respiratory reactions during stresses.
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VPY 790 SPECIAL PROBLEM IN Ph.D. 0+2
Practical
Short research problem(s) involving contemporary issues and research techniques.

VPY 791 DOCTORAL RESEARCH I 1+0
VPY 792 DOCTORAL RESEACRH II 1+0
VPY 799 DOCTORAL RESEARCH 0+45

B. VETERINARY BIOCHEMISTRY

CODE	COURSE TITLE	CREDITS	SEMESTER
VBC 601	CHEMISTRY OF ANIMAL CELL	2+0	I&II
VBC 602	TECHNIQUES IN BIOCHEMISTRY	0+2	I&II
VBC 603	APPLICATIONS OF GENOMICS AND PROTEOMICS IN MOLECULAR BIOLOGY	2+0	I&II
VBC 604	BIOCHEMISTRY OF BIOMOLECULES: CARBOHYDRATES, LIPIDS AND MEMBRANE'S STRUCTURE	2+0	I&II
VBC 605	ENZYME CATALYSIS, KINETICS, INHIBITION AND REGULATION	2+0	I&II
VBC 606	METABOLISM I: CARBOHYDRATES AND LIPIDS	2+0	I&II
VBC 607	METABOLISM II: NUCLEIC ACIDS AND AMINO ACIDS	2+0	I&II
VBC 608	METABOLISM III: INTEGRATION AND REGULATION	2+0	I&II
VBC 609	CENTRAL DOGMA AND PROTEIN FUNCTION	2+0	I&II
VBC 610	CLINICAL BIOCHEMISTRY OF ANIMALS	2+1	I&II
VBC 611	BIOCHEMICAL BASIS OF DISEASES OF DOMESTIC ANIMALS	2+0	I&II
VBC 612	ENDOCRINOLOGY AND REPRODUCTIVE BIOCHEMISTRY	2+0	I&II
VBC 613	BIOCHEMICAL BASIS OF ANIMAL PRODUCTION	2+1	I&II
VBC 691	MASTER'S SEMINAR	1+0	I&II
VBC 699	MASTER'S RESEARCH	0+20	I&II

B. VETERINARY BIOCHEMISTRY

Course contents

VBC 601 CHEMISTRY OF ANIMAL CELL 2+0

Theory

UNIT I: Pre-biotic world, chemical evolution, cellular architecture, molecular organization and metabolic function.

UNIT II: Thermodynamics, chemical equilibrium, standard state, living cell as steady state, open system obeying laws of thermodynamics, minimum energy conformation, quantum mechanical calculation, ΔG and ATP.

UNIT III: Properties of water, homeostasis, pH, osmosis, viscosity, surface forces adsorption, dialysis, diffusion rate and the sizes of organisms, the blood buffering system, chemical basis of oral and parental fluid/electrolyte therapies, bacterial toxigenic diarrhoeas.

VBC 602 TECHNIQUES IN BIOCHEMISTRY 0+2

Practical: Solving problems using Henderson–Hasselbalch equation; pH; pKa and buffer concentration; normality; application of colorimetry; spectrophotometry and NMR-X ray crystallography; paper; column and thin layer chromatography; partition and adsorption coefficient; quantitative and qualitative chromatography of amino acids; lipids and sugars including elution; gas chromatography; packing of column and choice of detectors and densitometry; application of electrophoresis; electrophoresis of proteins and nucleic acids; use of sodium dodecyl sulfate and molecular weight determination; densitometry procedures and quantitative assays; immunoelectrophoresis; its applications; isoelectrofocussing and isotacophoresis; molecular sieving and its application in biochemistry; general properties of dextran; acrylamide; agar and other media used for gel filtration; ultracentrifugation– its principle and use; preparative analytical and density gradient ultracentrifugation; fractionation of sub-cellular components and molecular weight determination using ultracentrifuge.

VBC 603 APPLICATIONS OF GENOMICS AND PROTEOMIC IN MOLECULAR BIOLOGY 2+0

Theory

UNIT I: Nucleotides, nucleic acids, high order structures, cohesions and condensins in chromosome structure, SMC proteins, sequencing, mutation, evolution, DNA libraries, Bacterial RNA polymerase, RNA interference, DNA replication, RNA synthesis, control of gene expression, DNA microarrays/chips.

UNIT II: PCR, Recombinant DNA technology in improving domestic animals, RELP, gene and gene products, genetic changes in hereditary diseases, cancer and detection ion DNA probes, gene therapy DNA vaccines, antitumor antibodies, telomerases and topoisomerases in treatment of diseases, *Staphylococcus* resistance to erythromycin.

UNIT III: Peptide bonds, acid-base properties, stereochemistry, side chain modifications, biological activities, green fluorescent protein, polypeptide diversity, protein purification and analysis, protein sequencing, reconstructing the sequence, gene duplication and protein families, protein modules, combinatorial peptide libraries folding, structural bio-informatics, protein structure prediction and design, proteomics, drug molecules, myoglobin and haemoglobin, mechanism and co-operativity in Hb, high altitude adaptation in ruminants and equines, use of amino acid analysis in disease diagnosis.

VBC 604 BIOCHEMISTRY OF BIOMOLECULES: CARBOHYDRATES, LIPIDS AND MEMBRANE'S STRUCTURE 2+0

Theory

UNIT I: Carbohydrates, structure, glycoconjugates in cell surface, extra cellular matrix, sugar code functions, peptidoglycan-specific antibiotics, cellular effects of Insulin, glucose supply and removal, ruminal fermentation, role of liver, glucose tolerance, indirect monitoring of blood glucose, ketone bodies.

UNIT II: Lipid classification, metabolism of LCFA, TAG, PL, sphingolipids, cholesterol, lipoproteins, regulation of lipid metabolism in fed and fasted states, regulation of FA oxidation, FAs as regulatory molecules, glucose production and FAs in type II diabetes, ketone bodies as fuel.

UNIT III: Lipid bilayers, lipid motility, integral membrane proteins, lipid linked proteins, peripheral membrane proteins, fluid mosaic model, membrane skeleton, lipid asymmetry, vesicle trafficking, secretory pathway, membrane rafts, caveolae fusion, lung surfactant, structure of bacterial rhodopsin, thermodynamics of membrane transport, ionophores, porins, ion channels, aquaporins, transport proteins, P and F types (Na+ - K+) ATPases, Ca2+, ion–gradient, gap junction, Cl^--HCO_3-exchanger, cardiac glycosides, abnormalities in cell membrane fluidity, haemolytic anaemia.

VBC 605 ENZYME CATALYSIS, KINETICS, INHIBITION AND REGULATION 2+0

Theory

UNIT I: Mechanisms, enzyme activation energy and reaction co-ordination, acid base, covalent, metal ion, proximity and orientation effects, preferential transitional state binding.

UNIT II: Chemical kinetics, enzyme kinetics, kinetic data analysis, bisubstrate reactions, competitive, uncompetitive, mixed inhibitors, allosteric regulation, drug design, drug discovery, bioavailability and toxicity, clinical trials, cytochrome P450 and adverse drug reactions, synthesis of bacterial peptidoglycans, oxygenases, mixed function oxidases, enzyme linked diagnostics.

UNIT III: Lysozyme, serine proteases, physiology and tumor cell metastasis, nerve poisons, blood coagulation cascade, equine immuno-deficiency enzyme inhibitors, suicide activators (DFMO for inhibition of ornithine decarboxylases in trypanosomiasis).

VBC 606 METABOLISM I: CARBOHYDRATES AND LIPIDS 2+0

Theory

UNIT I: Metabolic control, analysis for enzymes limiting the flux through a pathway, trophic strategies, universal mapping of metabolic pathways, thermodynamic relationships, ΔG, ATP and phosphoryl group transfer, coupled reactions, thioesters, NAD+ and FAD.

UNIT II: Overview of carbohydrate and lipid cycles, control of glycolysis, glycolysis in cancer cells, control of pentose phosphate pathways, deficiency of glucose-6-phosphate dehydrogenase, control of glycogen metabolism, control of gluconeogenesis, GSD, Regulation of citric acid cycle, pathways that use citric acid intermediates, sugar interconversions and nucleotide – linked sugar formation, disorders associated with impairment of metabolism.

UNIT III: Electron transport and oxidative phosphorylation, generation of heat by uncoupling in brown adipose tissue.

UNIT IV: Regulation of fatty acid metabolism, inhibitors of fatty acids biosynthesis, sphingolipid degradation and lipid storage disease, regulation of cholesterol synthesis, PGs in NSAID, leukotrienes, HETEs, hypersensitivity, influence of glucose metabolism on lipid metabolism.

VBC 607 METABOLISM II: NUCLEIC ACIDS AND AMINO ACIDS 2+0

Theory:

UNIT I: Overview of pathways of amino acid and nucleic acid metabolism, lysosomal degradation, ubiquitin, proteosome, breakdown of amino acids, heme biosynthesis and degradation, biosynthesis

of physiologically active amines, nitric oxide, homocystein as marker of disease, diseases of amino acid metabolism, porphyrias.
UNIT II: Nucleotide synthesis and degradation, inhibition of thymidylate synthesis in cancer therapy, mutation in coenzyme binding sites and diseases, forces stabilizing NA structure, restriction endonucleases, small inhibitory RNAs, chromatin organization, inhibitors of topoisomerases as antibiotic and anticancer agents, interfering with purine and pyramidine metabolism.
UNIT III: Viral nucleic acids, DNA damage and repair, telomerase, ageing and cancer, topoisomerases as drug targets, chemotherapy can target precursors of DNA synthesis, antibiotics and toxins that target RNA polymerase, lysosomal enzymes, gout, diseases in purine and pyrimidine nucleotide metabolic impairment.

VBC 608 METABOLISM III: INTEGRATION AND REGULATION 2+0
Theory
UNIT I: Regulation and integration of all metabolic pathways.
UNIT II: Organ specialization in fuel metabolism, brain, muscle, adipose tissue, liver, kidney, inter organ metabolic pathways, hormonal control of fuel metabolism, tracing metabolic fates, perturbing the system.
UNIT III: Signal transduction, gated ion channels, G-proteins, adenylate cyclase, receptor tyrosine kinase, protein phosphatases, cGMP, Ca2+, interaction with phosphoserine/tyrosine, integrations, drugs and toxins, cell cycle and CDKs that affect cell signaling.
UNIT IV: Oncogenes and cancers, mitochondrial genes and diseases, reactive oxygen species, cyanide and arsenic poisoning, metabolic interrelationships in obesity, diabetes, cancer, aerobic and anaerobic exercise in horses, pregnancy, lactation and stress injury, mitochondria in apoptosis and oxidative stress, cell suicide, liver diseases, renal diseases, acid-base balance, metabolic/sensory transduction in nervous tissue, vision, blood coagulation.

VBC 609 CENTRAL DOGMA AND PROTEIN FUNCTION 2+0
Theory
UNIT I: Overview of transcription and translation in eukaryotes, collision between DNA polymerase and RNA polymerase, inhibitors of transcription, introns, evolution and expansion of the genetic code.
UNIT II: The effects of antibiotics and toxins on protein synthesis, X – chromosome inactivation, Eukaryotic gene expression, protein targeting.
UNIT III: Actin structure, microfilament dynamics, actin-myosin reacting cycle, tubulin dimmer, microtubules dynamics, kinensins, dyeins.
UNIT IV: Antigen-antibody binding, cytokines, principles of immunochemical methods, agglutination, precipitation, typing of major histo-compatibility antigens, blood group substances in farm animals.
UNIT V: Proteins as infectious agents (prions – BSE), Protein misfolding and aggregation, plasma proteins, synthesis, functions, influences of physiological factors and inflammation on proteins, dysproteinemias, defects in collagen synthesis, transmissible multiple drug resistance, transcription factors and cardiovascular diseases, transferrin, lactoferrin, ferritin and ceruloplasmin.

VBC 610 CLINICAL BIOCHEMISTRY OF ANIMALS 2+1
Theory
UNIT I: Disturbances of gastro-intestinal function, disturbances of rumen function, lactic acidosis, pickled pigs and malignant hyperthermia, diagnosis of neuromuscular disorders.
UNIT II: Myocardial infarction, respiratory distress syndrome, primary renal dysfunctions and test, doping, problems in game horses.

UNIT III: Enzymes of diagnostic importance, toxicity of ammonia in animals, genetic defects in urea cycle, lysosomal storage diseases, ATP synthase inhibitory protein during ischemia, ischaemic – reperfusion injury.
UNIT IV: Molecular oncology and tumor markers, CSF characteristics in diseases, clinical biochemistry in toxicology, glycosylated hemoglobin, HbA1c, fructosamine, deranged glucose metabolism in cancerous tissue, free Radical damage.
Practical: Estimation of constituents (enzymes, metabolites and electrolytes) of body fluids during normal and pathological conditions; estimation of hormones; liver and kidney function tests; total volatile fatty acids and the fractions in ruminants**.**

VBC 611 BIOCHEMICAL BASIS OF DISEASES OF DOMESTIC ANIMALS 2+0
Theory
UNIT I: Diabetes mellitus, hyperinsulemia, galactosemia, hypoglycaemia of baby pigs, gGlycogen Storage Disease, Carbohydrate balance in ruminants, biochemical alterations in body fluids of ruminants in hypoglycaemia, Ruminant ketosis.
UNIT II: Hypercholesterolemia, atherosclerosis, hyperlipidemia in canine, feline, equine, pathophysiology of ketonemia, ketosis associated with fasting, diabetes, pregnancy, lactation and post exercise.
UNIT III: Anemias of the newborn, cytosolic enzyme deficiencies and membrane abnormalities in erythrocytes, porphyrins and porphyrias, disorders of iron metabolism, neutrophil function defects and its testing, equine immunodeficiency.
UNIT IV: Hepatic insufficiencies and its laboratory assessment, pancreatitis and insuffiency, metabolic diseases of Ca, P, Mg metabolism, Iron overload and injection, inorganic polyphosphate metabolism.

VBC 612 ENDOCRINOLOGY AND REPRODUCTIVE BIOCHEMISTRY 2+0
Theory
UNIT I: Mechanism of harmone action, receptor binding, biosynthetic and metabolic aspects in physio-pathology of hormones, factors, and minerals.
UNIT II: Metabolic functions of the hormones of the hypothalamus, pituitary, thyroid, parathyroid, pancreas, adrenal, pineal, ovaries and testes, biochemistry of prostaglandins and related agents, clinical endocrine aspects in production and reproduction status in domestic animals and poultry.

VBC 613 BIOCHEMICAL BASIS OF ANIMAL PRODUCTION 2+1
Theory
UNIT I: Chemistry of milk lipids, proteins, carbohydrates, minerals, vitamins, pigments, and enzymes, structure of milk lipids, fat globular membranes, modification of milk fat, milk proteins – casein, amino acid composition, whey proteins, immunoglobulins, genetic polymorphism, carbohydrates: structure and sweetness.
UNIT II: The biochemistry controlling postmortem energy metabolism mechanisms, application of genomic technologies to the improvement of meat quality of farm animals, identification of meat quality parameters by proteomics, application of proteomics to understand the molecular mechanisms behind meat quality, oxidative stability of post mortem muscles from sheep of various ages.
UNIT III: Metabolic demands of draft animals, and biochemical aspects of work and kinesiology.
Practical: Biochemical tests for proteins of meat, milk and egg and analysis of wool structure.

VBC 691 MASTER'S SEMINAR 1+0
VBC 699 MASTER'S RESEARCH 0+20

VETERINARY PUBLIC HEALTH AND EPIDEMIOLOGY

http://hillagric.ac.in/edu/covas/vph/index.htm

Courses at Glance

CODE	COURSE TITLE	CREDITS	SEMESTER
VPH 601*	ELEMENTS OF VETERINARY PUBLIC HEALTH	1+1	I
VPH 602	BACTERIAL AND RICKETTSIAL AGENTS OF PUBLIC HEALTH SIGNIFICANCE	2+1	II
VPH 603	VIRAL, FUNGAL AND PARASITIC AGENTS OF PUBLIC HEALTH SIGNIFICANCE	2+1	I
VPH 604*	ZOONOSES AND PUBLIC HEALTH	2+1	II
VPH 605	PRINCIPLES OF FOOD HYGIENE AND SAFETY	2+1	I
VPH 606	FOOD-BORNE INFECTIONS AND INTOXICATIONS	2+1	I
VPH 607*	MEAT AND MILK HYGIENE	2+1	I
VPH 608*	ENVIRONMENTAL POLLUTION AND SAFETY	3+1	II
VPH 609	FISH, FISH PRODUCTS AND SEAFOOD HYGIENE	1+1	II
VPH 610	BIOTERRORISM AND DISASTER MANAGEMENT	1+1	I
VPH 691*	MASTER'S SEMINAR	1+0	II
VPH 699*	MASTER'S RESEARCH	0+20	I&II

* Compulsory for Master's programme

VETERINARY PUBLIC HEALTH

Course contents

VPH 601 ELEMENTS OF VETERINARY PUBLIC HEALTH 1+1

Theory

UNIT I: The purposes and scope of veterinary public health, veterinary interests in public health, principal functions and fields of activity of public health veterinarians.

UNIT II: Definition of veterinary public health administration, organisation, administration and implementation of veterinary public health services and programmes.

UNIT III: Public health team, administration and functions, place of veterinarian in the public health team, veterinary public health agencies and institutions in India and abroad.

Practical: Collection of information about set up of veterinary public health in different countries.

VPH 602 BACTERIAL AND RICKETTSIAL AGENTS OF PUBLIC HEALTH SIGNIFICANCE 2+1

Theory

UNIT I: Importance of microbes in relation to veterinary public health, cultural, biochemical and other identification characters, ecology, transmission and survivability of bacteria in nature.

UNIT II: Description of *Bacillus, Listeria, Mycobacterium, Clostridium, Staphylococcus, Enterococcus, Brucella and Leptospira*.

UNIT III: Description of *Vibrio, Salmonella, Escherichia, Campylobacter, Yersinia, Lactobacillus, Pseudomonas and Micrococcus*.

UNIT IV: Description of *Coxiella, Rickettsia and Chlamydia*.

Practical: Isolation and identification methods for important bacterial and rickettsial agents of public health significance from host, vehicle and environment.

VPH 603 VIRAL, FUNGAL AND PARASITIC AGENTS OF PUBLIC HEALTH SIGNIFICANCE 2+1

Theory

UNIT I: Systematic study of viral agents of Japanese encephalitis, encephalomyelitis, rabies, influenza, KFD, Rift valley fever, and enteroviruses, their morphological and other characters, ecology, transmission and survivability in nature.

UNIT II: Description of fungal agents of public health importance belonging to genera, *Aspergillus, Penicillium, Fusarium, Mucor, Histoplasma, Microsporum, Trichophyton and Sporotrichum*.

UNIT III: Description of parasites of public health importance, *Taenia, Echinococcus, Trichinella, Toxoplasma, Diphyllobothrium, Fasciola, and Cryptosporidium.*

Practical: Isolation and identification methods for important fungal, viral and parasitic agents of public health significance from host, vehicle and environment.

VPH 604 ZOONOSES AND PUBLIC HEALTH 2+1

Theory

UNIT I: Concept and classification of zoonoses, comprehensive description of etiology, host range, epidemiology, diagnosis and management of zoonotic diseases.

UNIT II: Bacterial diseases: anthrax, brucellosis, tuberculosis, salmonellosis, yersiniosis, leptospirosis, listeriosis, plague, tularaemia, glanders, malidiosis, staphylococcosis, streptococcosis, tetanus, botulism, infections due to *Clostridium perfringens, E. coli, Aeromonas hydrophilla, Bacillus cereus, Vibrio parahaemolyticus*, cat scratch disease, chlamydiosis, lyme disease, borreliosis (relapsing fever).

UNIT III: Detailed description of viral zoonoses, food-borne viruses viz, rota, tickborne encephalitis, FMD, hepatitis A & E, Norwalk, entero, parvo, adeno, cytomegalo, astro, calci and corona viruses, influenza, rabies, vector-borne viruses viz, Japanese encephalitis, kyasanur forest disease, chickengunya, crimean-Congo haemorrhagic fever, dengue fever, West-Nile viruses, yellow fever, rift-valley fever, equine encephalitis, louping ill, and some rare and potential zoonotic viruses such as Newcastle and pox viruses.
UNIT IV : Q fever and other rickettsiosis, fungal infections viz, dermatophytosis, blastomycosis, coccidioidomycosis, cryptococcosis, histoplasmosis, aspergillosis, candidiasis, rhinosporidiosis and sporotrichosis, Attributes and impact of parasitic zoonoses, description, etiology, host range, epidemiology, diagnosis and disease management of echinococcosis, taeniasis and cysticercosis, toxoplasmosis, trichinellosis, cryptosporidiosis, dracunculosis, fasciolopsiosis, sarcocystosis, liver fluke diseases, cutaneous and visceral larva migrans, schistosomiasis, leishmaniasis, trypanosomosis.
Practical: Isolation and identification of zoonotic agents; diagnostic procedures of zoonotic diseases.

VPH 605 PRINCIPLES OF FOOD HYGIENE AND SAFETY 2+1
Theory
UNIT I: Relation between veterinary public health and food hygiene, concept of food hygiene, impact of environmental sanitation and other factors on food quality.
UNIT II: Food spoilage, safety and preservation methods.
UNIT III: Microbiological standards and quality control (biological and other indicators of hygienic quality and spoilage) of foods to prevent food-borne infections.
UNIT IV: General principles of prevention of food-borne illnesses, GMP, HACCP, risk analysis,
Practical: Procedures of evaluation of hygienic/microbiological quality of raw and processed foods especially of animal origin by detection of biological and other indicators.

VPH 606 FOOD-BORNE INFECTIONS AND INTOXICATIONS 2+1
Theory
UNIT I: Food-borne bacterial infection and intoxications due to *Salmonella*, *Campylobacter*, *Clostridium*, *Staphylococcus*, *Listeria*, *Vibrio*, *E, coli*, *Bacillus cereus*, and bacterial toxins.
UNIT II: Food-borne viral infections: infectious hepatitis, poliomyelitis, gastroenteritis etc., natural toxic substances in foods.
UNIT III: Health problems due to food additives, biocides, bacterial toxins.
UNIT IV: Heavy metals, antibiotics, hormones etc, in food.
Practical: Detection and quantitation of food-borne pathogens, toxins, antibiotics, pesticides and additives in foods.

VPH 607 MEAT AND MILK HYGIENE 2+1
Theory:
UNIT I: Principles of food hygiene with special reference to foods of animal origin, human health and economics, nature and problem of food supply in India.
UNIT II: Meat hygiene and public health, abattoir hygiene.
UNIT III: Milk hygiene and public health, in place cleaning.
UNIT IV: Egg, food legislation, meat and milk adulteration.
Practical: Milk and meat inspection; quality control tests of meat; milk and fish.

VPH 608 ENVIRONMENTAL POLLUTION AND SAFETY 3+1
Theory
UNIT I: Introduction to environmental hygiene, environment and health, microbial aspects of pollution.

UNIT II: Soil pollution, air pollution, water pollution and health.
UNIT III: Genetic risk from environmental agents, health problems from nuclear energy and radiation pollution, environmental estrogens and pesticides pollution.
UNIT IV: Dissemination of excreted pathogens, animal-waste and human risk, principles of safe disposal of waste.
UNIT V: Heavy metals, pesticides, veterinary drug residues and human health.
Practical: Determination of potability of drinking water; estimation and detection of pathogenic microbes in water, air, soil, animal products, sewage and animal waste; inspection of sewage and waste disposal plants/sites.

VPH 609 FISH, FISH PRODUCTS AND SEAFOOD HYGIENE 1+1
Theory
UNIT I: Fisheries and resources, fish preservation, hygienic quality control.
UNIT II: Hygienic disposal and utilization of byproducts of fish, hygienic handling, transportation and marketing of fish.
UNIT III: Fish borne diseases in relation to human health.
Practical: Study of physical and biological indicators of wholesome fish to determine hygienic status of raw and processed fish; residue analysis in fish.

VPH 610 BIOTERRORISM AND DISASTER MANAGEMENT 1+1
Theory
UNIT I: Natural and manmade disaster, impact analysis and classification of disaster scale, essential preparations to manage disaster, role and sequence of emergency medical services by veterinarians.
UNIT II: Effect of natural disasters like floods, prolonged draughts, forest fires, earthquakes, tsunami and tidal damages, storms etc, on animal population both domestic and wild, post-disaster disease susceptibility, emergency control and remedial measures.
UNIT III: Biomedical hazards and biosafety, occupational health risk management, major agents and their characteristics which have been used in the past and those which can be used in future as biological weapons.
UNIT IV: Biological weapons, hazard analysis and combating bioterrorism, bioethics and social ethics, advisory role of veterinarians.
Practical: Detection of biohazards during disaster; detection and characterization of various organisms used as biological agents; use of disinfectants for their destruction.

VPH 691 MASTER'S SEMINAR 1+0
VPH 699 MASTER'S RESEARCH 0+20

VETERINARY SURGERY & RADIOLOGY

http://hillagric.ac.in/edu/covas/vsr/index.htm

Courses at a glance

CODE	COURSE TITLE	CREDITS	SEMESTER
VSR 601	PRINCIPLES OF SURGERY	2+0	I
VSR 602	CLINICAL PRACTICE I	0+3	I
VSR 603	CLINICAL PRACTICE II	0+3	II
VSR 604	SMALL ANIMAL ANAESTHESIA II	2+1	I
VSR 605	LARGE ANIMAL ANAESTHESIA	2+1	II
VSR 606	DIAGNOSTIC IMAGING TECHNIQUES	2+1	II
VSR 607	VETERINARY OPHTHALMOLOGY AND DENTISTRY	1+1	II
VSR 608	SMALL ANIMAL SOFT TISSUE SURGERY	2+1	I
VSR 609	LARGE ANIMAL SOFT TISSUE SURGERY	2+1	I
VSR 610	ORTHOPAEDICS AND LIMB SURGERY	2+1	II
VSR 691	MASTER'S SEMINAR	1+0	I&II
VSR 699	MASTER'S RESEARCH	0+20	I&II
VSR 701	CLINICAL SURGICAL PRACTICE I	0+2	I
VSR 702	CLINICAL SURGICAL PRACTICE II	0+2	II
VSR 703	CLINICAL SURGICAL PRACTICE III	0+2	I
VSR 704	ANAESTHESIA OF WILD AND LABORATORY ANIMALS	1+1	II
VSR 705	ADVANCES IN ANAESTHESIOLOGY	2+1	I
VSR 706	ADVANCES IN DIAGNOSTIC IMAGING TECHNIQUES	2+1	I
VSR 707	NEUROSURGERY	2+1	II
VSR 708	EXPERIMENTAL SURGICAL TECHNIQUES IN ANIMALS	1+1	II
VSR 789	SPECIAL PROBLEM IN Ph.D. ANAESTHESIA	0+2	I
VSR 790	SPECIAL PROBLEM IN Ph.D. SURGERY	0+2	II
VSR 791	DOCTORAL SEMINAR I	1+0	I&II
VSR 792	DOCTORAL SEMINAR II	1+0	I&II
VSR 799	DOCTORAL RESEARCH	45	I&II

VETERINARY SURGERY & RADIOLOGY

Course contents

VSR 601 PRINCIPLES OF SURGERY 2+0

Theory

UNIT I: Wound healing, current concepts of inflammation and management, wound infections, antimicrobial therapy, principles of surgical asepsis, sterilization and disinfection.

UNIT II: Systemic effects of surgical stress, hemorrhage and haemostasis, metabolism of the surgical patient, fluid therapy in surgical patients, acid base balance, shock, hyper alimentation, blood transfusion, Host defense mechanism.

UNIT III: Biomaterials, surgical immunity, pre-operative assessment of the surgical patient, post-operative care of the surgical patient, chemotherapy of tumors.

UNIT IV: Operating room emergencies, cardio-pulmonary embarrassment and resuscitation, monitoring of surgical patient.

UNIT V: Principles of laser surgery, cryosurgery, electro surgery, lithotripsy and endoscopy, physiotherapy, stem cell therapy etc..

VSR 602 CLINICAL PRACTICE I 0+3

Practical: Client management; public relations; code of conduct; management of surgical affections; designing of surgical hospital; hospital management; database management; attending surgical cases; surgical facilities; equipments; disaster management.

VSR 603 CLINICAL PRACTICE II 0+3

Practical: Client management; animal welfare and rehabilitation; public relations; code of conduct; management of surgical affections; designing of surgical hospital; hospital management; database management; attending surgical cases; surgical facilities; equipments and personnel; disaster management.

VSR 604 SMALL ANIMAL ANAESTHESIA II 2+1

Theory

UNIT I: General considerations for anaesthesia, peri-operative and post-operative pain and its management.

UNIT II: Sedation, analgesia and pre-medication, anaesthetic agents (injectable anaesthetics, dissociative anaesthetics, inhalation anaesthetics), muscle relaxants, neuromuscular blocking agents and local analgesia.

UNIT III: Anaesthetic techniques, anaesthetic equipments, artificial ventilation.

UNIT IV: Anaesthesia of small animals, pediatric and geriatric patients, birds.

UNIT V: Monitoring of anaesthesia, anaesthetic emergencies, complications and their management, euthanasia.

Practical: Anaesthetic equipments and instrumentation, artificial ventilation, use of various preanaesthetic and anaesthetic agents in small animals, anaesthetic triad, balanced anaesthesia, total intravenous anaesthesia.

VSR 605 LARGE ANIMAL ANAESTHESIA 2+1

Theory

UNIT I: General considerations for anaesthesia, peri-operative pain, and postoperativepain and its management.

UNIT II: Pre-anaesthetic and anaesthetic adjuncts, injectable anaesthetics, dissociative anaesthetics, inhalation anaesthetics.

UNIT III: Local anaesthetics, neuromuscular blocking agents.

UNIT IV: Anaesthetic techniques, anaesthetic machines, breathing systems, artificial ventilation.
UNIT V: Monitoring of anaesthesia, anaesthetic emergencies and complications, anaesthesia of pediatric and geriatric patients, euthanasia.

Practical: Anaesthetic equipments and instrumentation; artificial ventilation; use of various preanaesthetic and anaesthetic agents in large animals; anaesthetic triad; balanced anaesthesia; total intravenous anaesthesia.

VSR 606 DIAGNOSTIC IMAGING TECHNIQUES 2+1

Theory

UNIT I: Conventional and digital X-ray machine, quality of radiation, formation of radiograph technique chart, artifacts and their prevention, special diagnostic radiographic procedures, radiographic quality, radiographic accessories, differentiation of radiographic densities in relation to clinical diagnosis.
UNIT II: Principles of radiographic interpretation, plain and contrast radiographic techniques of small and large animals, image intensification.
UNIT III: Principles of radiation therapy, medical radioisotope curves, radiation laws and regulations.
UNIT IV: Principles of ultrasound, basic physics, transducers, equipment controls, display models, terminology of echotexture and artifacts, application of ultrasound in small and large animals.
UNIT V: Doppler techniques echocardiography and its application, introduction to MRI, CT scan, nuclear medicine, xeroradiography, positron emission tomography technique and other imaging techniques.
UNIT VI: Electromagnetic radiations, hazards of electromagnetic radiations and protection and bio-safety.

Practical: Acquaintance with imaging equipments; dark room processing techniques and X-ray film handling; formulation of technique chart with fixed kVp and variable mAs; basics of radiographic interpretation of diseases; computer aided image acquisition and retrieval; radiographic positioning of different regions in domestic animals; angiography; cardiac catheterization and other contrast radiographic techniques of different types; interpretation of ultrasonographs, MRI, CTscans etc.

VSR 607 VETERINARY OPHTHALMOLOGY AND DENTISTRY 1+1

Theory

UNIT I: General Anatomical and physiological considerations for ophthalmic surgery.
UNIT II: Ophthalmic examination and diagnosis, local anaesthesia of eye, ocular therapeutics, diagnostic instruments.
UNIT III: General consideration for eye surgery, diseases and surgery of eye lids, lacrimal apparatus, naso-lacrimal duct.
UNIT IV: Diseases of conjuctiva, cornea, sclera, iris, orbit, lens, vitreous and aqueous humor, retina and optic nerve.
UNIT V: Ocular manifestation of systemic diseases.
UNIT VI: Anatomy of teeth, examination of teeth, diseases of teeth-congenital anomalies (retained deciduous teeth, impacted teeth, abnormalities in the shape of teeth), diseases of teeth- acquired diseases (dental caries, fracture of teeth, endodontic disease, dental materials and dental radiography), restorative dentistry, periodontal disease, tooth extraction, gum diseases, current techniques in dentistry.

Practical: Ophthalmic instrumentation; examination of the eye and its adnexa; preparation of patient for eye anaesthesia and surgery; canthotomy; tarsorrhaphy; transplantation of cornea; keratoplasty; anterior chamber paracentasis; flushing of naso-lacrimal duct; iridectomy; lens extraction/implantation; dentistry instrumentation; dental radiography; teeth cleaning; tooth extraction.

VSR 608 SMALL ANIMAL SOFT TISSUE SURGERY 2+1

Theory

UNIT I: Skin and adnexa- the integument, management of skin wounds, principles of plastic and reconstructive surgery, pedicle grafts, skin grafts, burns, electrical chemical and cold injuries.

UNIT II: Surgical approaches/ affections of ear, oral cavity and pharynx, abdomen, thorax, the salivary glands, oesophagus, stomach, intestines, rectum and anus, liver and biliary system, pancreas.

UNIT III: Hernias-abdominal hernia, diaphragmatic hernia, perineal hernia, inguinal, scrotal, and umbilical hernia etc, surgical approaches to thoracic wall and pleura.

UNIT IV: Respiratory system-functional anatomy, diseases of upper respiratory system and lower respiratory system.

UNIT V: Surgical anatomy of the cardiovascular system, cardiovascular physiology, diagnostic methods, cardiac disorders, principles of vascular surgery, basic cardiac procedures, hypothermia, basic peripheral vascular procedures, peripheral vascular disorders, portacaval shunts and anomalies, haemolymphatic system, bone marrow, spleen, tonsils, lymph nodes and lymphatics, thymus.

UNIT VI: Male reproductive system-anatomy of the male genital organs, diagnostic and biopsy techniques, surgical affections of male genital organs; female reproductive system-anatomy, diagnostic techniques, surgical affections of female genital organs.

UNIT VII: Urinary system-anatomy of the urinary tract, principles of urinary tract surgery, kidneys, ureters, surgery of the bladder, surgical diseases of the urethra, medical dissolution and prevention of canine uroliths, feline urologic syndrome.

UNIT VIII: Endocrine system-pituitary, adrenals, thyroid, parathyroid, surgical affections of mammary glands and tail, surgical affections of nervous system, special sense organs.

Practical: Practice of various surgical techniques of skin and adnexa; alimentary system; hernias; respiratory system; cardiovascular system; male and female reproductive systems; urinary system; mammary glands and tail.

VSR 609 LARGE ANIMAL SOFT TISSUE SURGERY 2+1

Theory

UNIT I: Abdominal wall, integumentary system- skin and appendages, mammary gland, tail, affections of oral cavity.

UNIT II: Surgical affections of respiratory system, cardiovascular and lymphatic system.

UNIT III: Surgical affections of digestive system, urinary and genital system.

UNIT IV: Surgical affections of nervous system, special sense organs.

Practical: Practice of various surgical techniques of skin, alimentary system,; hernias, respiratory system, cardiovascular system, male and female reproductive system, urinary system, mammary glands and tail; surgical affections of nervous system; special sense organs.

VSR 610 ORTHOPAEDICS AND LIMB SURGERY 2+1

Theory

UNIT I: Fractures and dislocations, fracture healing, ligaments and tendons – repair techniques.

UNIT II: Treatment of fractures of different bones in domestic animals, bone diseases.

UNIT III: Various affections of the joints, their diagnosis and treatment.

UNIT IV: Conformation of the limb, anatomy of hoof.

UNIT V: Lameness and allied surgical conditions of fore limbs/hind limbs, rehabilitation of orthopaedic patient.

Practical: Internal and external fixation of fractures and dislocation; arthrotomy; tenotomy; examination of limbs for lameness; nerve blocks; injections in joints; operations for arthritis; hoof surgery and corrective shoeing; physiotherapy; Instrumentation; neurological examination; imaging the spine; skull and brain; surgical approach to the cervical spine; thoracolumbar spine and brain.

VSR-691 MASTER'S SEMINAR 1+0
VSR-699 MASTER'S RESEARCH 0+20

VSR 701 CLINICAL SURGICAL PRACTICE I 0+2

Practical: Client management; public relations; code of conduct; management of surgical affections; designing of surgical hospital; hospital management; 58 database management; attending surgical cases; surgical facilities; equipments and personnel.

VSR 702 CLINICAL SURGICAL PRACTICE II 0+2

Practical: Client management; public relations; code of conduct; management of surgical affections; designing of surgical hospital; hospital management; database management; attending surgical cases; surgical facilities; equipments and personnel.

VSR 703 CLINICAL SURGICAL PRACTICE III 0+2

Practical: Client management; public relations; code of conduct; management of surgical affections; designing of surgical hospital; hospital management; database management; attending surgical cases; surgical facilities; equipments and personnel.

VSR 704 ANAESTHESIA OF WILD AND LABORATORY ANIMALS 1+1

Theory

UNIT I: General considerations in chemical restraint of captive and free ranging wild animals.

UNIT II: Methods of administration of anaesthesia in captive, free ranging animals and laboratory animals.

UNIT III: Local and general anaesthesia in exotic species, wild animals, zoo animals and laboratory animals.

UNIT IV: Anaesthetic emergencies and complications.

Practical: Familiarization with capture equipments; local anaesthetic techniques; use of various preanaesthetic and anaesthetic agents in laboratory animals; monitoring of patient during general anaesthesia.

VSR 705 ADVANCES IN ANAESTHESIOLOGY 2+1

Theory

UNIT I: Considerations for general anaesthesia, drug interactions in anaesthesia, perioperative pain and distress, effects of anaesthetics on CNS function.

UNIT II: Pharmacology of preanaesthetics and anaesthetic adjuncts, injectable anaesthetics, dissociative anaesthetics, inhalation anaesthetics, local anaesthetics, muscle relaxants and neuromuscular blocking agents.

UNIT III: Anaesthetic machines and breathing system, airway management and ventilation, acid-base physiology and fluid therapy during anaesthesia, monitoring of anaesthetized patients, anaesthetic emergencies andaccidents.

UNIT IV: Anaesthesia for selected diseases (cardiovascular dysfunction, pulmonary dysfunction, neurologic diseases, renal diseases, hepatic diseases, gastrointestinal diseases, endocrine diseases, airway diseases).

UNIT V: Anaesthesia for special patients (ocular patients, heart patients, caesarian section patients, trauma patients, neonatal and geriatric patients), euthanasia.

Practical: Various procedures for catheterization of heart and great vessels; haemodynamic changes and pulmonary function tests during trials of anaesthetics; electrocardiographic; encephalographic evaluation of central nervous system activity; cybernetics; data acquisition and retrieval.

VSR 706 ADVANCES IN DIAGNOSTIC IMAGING TECHNIQUES 2+1

Theory

UNIT I: Biological effects of radiations (alpha, beta, X-ray and gamma rays) *in vivo* and *in vitro* cellular response following radiation as an immunosuppressive agent.

UNIT II: Isotopes (natural and man-made), cyclotron reactor, half-life, decay pattern, storage and handling of radioactive material, fluoroscopy, magnetic resonance imaging and computerised axial tomography, xeroradiography, doppler techniques, indications for ultrasound diagnosis.

UNIT III: Methods in the detection of isotopes, Geiger-Mullar tubes, photo-multiplier tube, medical use of isotope, dosimetry, nuclear medicine and its use in diagnosis of thyroid, kidney, bone and liver function studies.

UNIT IV: Labelling of isotope and biological uses, detonation and fission products.

UNIT V: Radiation therapy in cancer patients, biological effects of radiation physics, physics of radiation.

UNIT VI: Doppler techniques echocardiography and its application, MRI, CT scan, nuclear medicine, xeroradiography, positron emission tomography technique etc..

UNIT VII: Electromagnetic radiations, hazards of electromagnetic radiations and protection and bio-safety.

Practical: Radiation safety measures; handling radioactive material; measurement of thyroid function and cardiac output; demonstration of advanced radiological techniques.

VSR 707 NEUROSURGERY 2+1

Theory

UNIT I: Nervous system-anatomy and physiology.

UNIT II: Clinical neurology, pathogenesis of disease of the central nervous system.

UNIT III: Diagnostic methods-electrodiagnostic methods, neuroradiology.

UNIT IV: Fundamentals of neurosurgery, surgical approaches to brain, surgical diseases of peripheral nerves, surgical approaches to the spine, diseases of the spinal column, intervertebral disc diseases.

UNIT V: Intracranial surgery.

Practical: Instrumentation; neurological examination; imaging the spine; skull and brain; surgical approach to the cervical spine; thoracolumbar spine and brain.

VSR 708 EXPERIMENTAL SURGICAL TECHNIQUES IN ANIMALS 1+1

Theory

UNIT I: General considerations and protocols for designing experiments.

UNIT II: Surgical models of various systems, Care and feeding of genobiotic experimental animals.

UNIT III: Rumen and intestinal fistulae, production of experimental peritonitis and ascitis, nephrectomy, adrenalectomy.

UNIT IV: Cannulation of various blood vessels and lymphatics, portacaval shunt.

UNIT V: Principles of transplantation of organs and use of prosthetic material.

UNIT VI: Tissue engineering-*in vitro*, *in vivo*, *ex vivo* techniques, regenerative therapy.

Practical: Various experimental surgical techniques and special problems related to veterinary surgery, radiology and anaesthesiology; transplantation of skin, fascia, tendon and blood vessels.

VSR 789 SPECIAL PROBLEM IN Ph.D. ANAESTHESIA 0+2

Practical: Investigative anaesthetic problems in clinical or experimental models; didactic and interpersonnel learning-teaching; problem solving self learning strategies in problems related to anaesthesia.

VSR 790 SPECIAL PROBLEM IN Ph.D. SURGERY 0+2

Practical: Investigative surgical problems in clinical or experimental models; didactic and interpersonnel learning-teaching; problem solving self-learning strategies in problems related to surgery.

VSR 791 DOCTORAL SEMINAR I 1+0
VSR 792 DOCTORAL SEMINAR II 1+0
VSR 799 DOCTORAL RESEARCH 0+45

E. LIBRARY

http://hillagric.ac.in/library/index.htm

LIB 501 LIBRARY AND INFORMATION SERVICES

1+0

Theory : Introduction to library services; Role of libraries in University education, research, extension and technology transfer; Classification systems and organization of Library; Sources of information- Primary Sources, Secondary Sources and Teritiary Sources, with emphasis on reference tools and digital resources; Intricacies of abstracting and indexing, CAS, SDI services, (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts etc.); Tracing information from reference sources, information explosion and language barrier; Literature survey; Citation techniques/Bibliographic control and Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-abbreviations like ibid etc.

ANNEXURE I

LIST OF COURSES EQUATED UNDER Ph.D. STUDENT EXCHANGE PROGRAMME MoU TO BE OFFERED DURING FIRST SEMESTER OF Ph.D. PROGRAMME BETWEEN CSK HPKV PALAMPUR AND PAU LUDHIANA

AGRICULTURE

A. **AGRICULTURAL ECONOMICS**

SR NO.	CODE	COURSE TITLE	CREDITS
	PAU/CSKHPKV	PAU/ CSKHPKV	
1	Econ 601/ AG ECON 601	ADVANCED MICRO-ECONOMIC ANALYSIS	2+0
2	Econ 602/AG ECON 602	ADVANCED MACRO-ECONOMIC ANALYSIS	2+0
3	Econ 603/ AG ECON 603	ADVANCED ECONOMETRICS	2+1
4	Econ 605/ AG ECON 605	QUANTITATIVE DEVELOPMENT POLICY ANALYSIS	2+1
5	Econ 606/ AG ECON 606	ADVANCES IN AGRICULTURAL MARKETING	2+1

B. VEGETABLE SCIENCE

SR NO.	CODE	COURSE TITLE	CREDITS
	PAU/CSKHPKV	PAU/ CSKHPKV	
1	Veg 601/ VSC 601	ADVANCES IN VEGETABLE PRODUCTION	3+0
2	Veg 602/VSC 602	ADVANCES IN VEGETABLE BREEDING / ADVANCES IN BREEDING OF VEGETABLE CROPS	3+0
3	Veg 605/VSC 604	SEED CERTIFICATION, PROCESSING AND STORAGE OF VEG CROPS/ ADVANCES IN VEGETABLE SEED PRODUCTION	3+0
4	Veg 604/VSC 605	ABIOTIC STRESS MANAGEMENT IN VEGETABLE CROPS	3+0

HOME SCIENCE

C. FOOD AND NUTRITION

SR NO.	CODE	COURSE TITLE	CREDITS
	PAU/CSKHPKV	PAU/ CSKHPKV	
1	FN 601/ FN 601	ADVANCES IN MACRONUTRIENTS	3+0
2	FN 602/FN 602	ADVANCES IN VITAMINS AND HORMONES	2+0
3	FN 603/ FN 603	MINERALS IN HUMAN NUTRITION	2+0
4	FN 605/ FN 607	NUTRITION IN EMERGENCIES	2+0

NOTE: THE ABOVE LISTED COURSES AT A, B AND C WILL BE OFFERED IN THE 2ND SEMESTER OF THE ACADEMIC YEAR i.e. THE 1ST SEMESTER OF Ph.D. STUDENTS.

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Printed and Published by : Dr.K.K.Katoch, Dean, Postgarduate Studies,
on behalf of CSKHPKV, Palampur - 176 062 (H.P.) India