SYLLABUS & CURRICULUM

of

B.Tech.

BIOTECHNOLGY

(3rd to 8th semesters)

UNIVERSITY OF CALICUT

(2014 admission)

SCHEME OF III SEMESTER B. Tech. COURSE

Code	Subject	Hours/ Week			Marks		Duration of End Semester examination	*Credits*
		L	T	P/D	Internal	End Semester		
EN14 301	Engineering Mathematics III	3	1	0	50	100	3	4
EN14 302	Computer Programming in C	3	0	1	50	100	3	4
BT14 303	Fluid Flow Operations	3	1	0	50	100	3	4
BT14 304	Microbiology	3	1	0	50	100	3	4
BT14 305	Biochemistry I	3	1	0	50	100	3	4
BT14 306	Bioprocess Calculations	3	1	0	50	100	3	4
BT14 307 (P)	Microbiology Lab	0	0	3	50	100	3	2
BT14 308 (P)	Biochemistry Lab	0	0	3	50	100	3	2
	TOTAL	18	5	7				28

Note: For EN 14 302 Computer Programming in C, the end semester examination will be held by the University as a theory paper.

SCHEME OF IV SEMESTER B. Tech. COURSE

Code	Subject	Hours/ Week			Marks		Duration of End Semester examination	*Credits*
		L	T	P/D	Internal	End Semester		
EN14 401A	Engineering Mathematics IV	3	1	0	50	100	3	4
EN14 402	Environment Science	3	1	0	50	100	3	4
BT14 403	Cell Biology	3	1	0	50	100	3	4
BT14 404	Biochemistry II	3	1	0	50	100	3	4
BT14 405	Analytical Techniques in Biotechnology	3	1	0	50	100	3	4
BT14 406	Mechanical Operations	3	1	0	50	100	3	4
BT14 407 (P)	Fluid Mechanics and Mechanical Operations Lab	0	0	3	50	100	3	2
BT14 408 (P)	Bioanalytical Techniques Lab	0	0	3	50	100	3	2
	TOTAL	18	6	6				28

SCHEME OF V SEMESTER B. Tech. COURSE

Code	Subject	Hours/ Week			Marks		Duration of End Semester examination	*Credits*
		L	T	P/ D	Internal	End Semester		
BT14 501	Mass Transfer Operations	3	1	0	50	100	3	4
BT14 502	Chemical Reaction Engineering	3	1	0	50	100	3	4
BT14 503	Enzyme Science and Engineering	3	1	0	50	100	3	4
BT14 504	Thermodynamics and Heat Transfer	3	1	0	50	100	3	4
BT14 505	Bioinformatics	3	1	0	50	100	3	4
BT14 506	Molecular Biology	3	1	0	50	100	3	4
BT14 507 (P)	Molecular Biology Lab	0	0	3	50	100	3	2
BT14 508 (P)	Bioinformatics Lab	0	0	3	50	100	3	2
	TOTAL	18	6	6				28

SCHEME OF VI SEMESTER B. Tech. COURSE

Code	Subject	Hours/ Week			Marks		Duration of End Semester examination	*Credits*
		L	T	P/ D	Internal	End Semester		
BT14 601	Bioprocess Engineering	3	1	0	50	100	3	4
BT14 602	Food Biotechnology and Engineering	3	1	0	50	100	3	4
BT14 603	Financial Management and Cost Estimation of Process Industries	3	1	0	50	100	3	4
BT14 604	Process Dynamics and Control	3	1	0	50	100	3	4
BT14 605	Genetic Engineering	3	1	0	50	100	3	4
BT14 606	Metabolic Engineering	3	1	0	50	100	3	4
BT14 607 (P)	Heat and Mass Transfer Lab	0	0	3	50	100	3	2
BT14 608 (P)	Bioprocess Engg Lab	0	0	3	50	100	3	2
	TOTAL	18	6	6				28

SCHEME OF VII SEMESTER B. Tech. COURSE

Code	Subject	Hours/ Week			Marks		Duration of End Semester examination	*Credits*
		L	T	P/ D	Internal	End Semester		
BT14 701	Bioprocess Equipment Design	2	1	1	50	100	3	4
BT14 702	Downstream Processing	3	1	0	50	100	3	4
BT14 703	Environmental Engineering	3	1	0	50	100	3	4
BT14 704	Elective I	3	1	0	50	100	3	4
BT14 705	Elective II	3	1	0	50	100	3	4
BT14 706 (P)	Downstream Processing Lab	0	0	3	50	100	3	2
BT14 707 (P)	Reaction Engineering & Process Control Lab	0	0	3	50	100	3	2
BT14 708 (P)	Project	0	0	4	100	-	-	4
	TOTAL	14	5	11				28

SCHEME OF VIII SEMESTER B. Tech. COURSE

Code	Subject	Hours/ Week			Marks		Duration of End Semester examination	*Credits*
		L	T	P/ D	Internal	End Semester		
BT14 801	Bioprocess Instrumentation	3	1	0	50	100	3	4
BT14 802	Safety and Biosafety in Process Plants	3	1	0	50	100	3	4
BT14 803	Industrial Biotechnology and Biopharmaceuticals	3	1	0	50	100	3	4
BT14 804	Elective III	3	1	0	50	100	3	4
BT14 805	Elective IV	3	1	0	50	100	3	4
BT14 806 (P)	Seminar	0	0	3	100	-	-	2
BT14 807 (P)	Project	0	0	7	100	-	-	7
BT14 808 (P)	Viva Voce	0	0	0	-	100	-	3
	TOTAL	15	5	10				32

Total Credits =210

Elective I

BT14 704 (A) Transport Phenomena in Bioprocess Systems
BT14 704 (B) Computer Based Numerical Methods
BT14 704 (C) Biopolymers
BT14 704 (D) Hazardous Waste Management
BT14 704 (E) Process Modeling and Simulation (G)
BT14 704 (F) Cancer Biology

Elective II

BT14 705 (A) Developmental Biology
BT14 705 (B) Molecular Medicine
BT14 705 (C) Gene and Stem Cell Therapy
BT14 705 (D) Modeling and Scale up of Bioreactors
BT14 705 (E) Molecular Modeling and Drug Design (G)
BT14 705 (F) Genomics and Proteomics

Elective III

BT14 804 (A) Bioethics and Intellectual Property Rights (G)
BT14 804 (B) Biomaterials
BT14 804 (C) Nanobiotechnology
BT14 804(D) Immunology and Immunotechnology
BT14 804 (E) Recombinant DNA Technology
BT14 804 (F) Basics of Plant and Animal Biotechnology

Elective IV

BT14 805 (A) Project Engineering
BT14 805 (B) Entrepreneurship Development (G)
BT14 805 (C) Energy Engineering
BT14 805 (D) Total Quality Management
BT14 805 (E) Membrane Separation Technology
BT14 805 (F) Protein Engineering

THIRD SEMESTER

EN14 301: ENGINEERING MATHEMATICS III

(Common for all branches)

Teaching scheme **Credits: 4**

3 Hrs lecture and 1 hour tutorial per week

Objective

- *To provide a quick overview of the concepts and results in complex analysis that may be useful in engineering.*
- *To introduce the concepts of linear algebra and Fourier transform which results with wide area of application.*

Module I: Functions of a Complex Variable (15 hours)

Functions of a Complex Variable – Limit – Continuity – Derivative of a Complex function – Analytic functions – Cauchy-Riemann Equations – Laplace equation – Harmonic Functions – Conformal Mapping – Examples: e^{Z}, sinz, coshz, $(z+{}^{1}/_{Z})$– Mobius Transformation.

Module II: Functions of a Complex Variable (15 hours)

Definition of Line integral in the complex plane – Cauchy's integral theorem (Proof of existence of indefinite integral to be omitted) – Independence of path – Cauchy's integral formula – Derivatives of analytic functions (Proof not required) – Taylor series (No proof) – Laurent series (No proof) – Singularities - Zeros – Poles - Residues – Evaluation of residues – Cauchy's residue theorem – Evaluation of real definite integrals.

Module III: Linear Algebra (15 hours) – (Proofs not required**)**

Vector spaces – Definition, Examples – Subspaces – Linear Span – Linear Independence – Linear Dependence – Basis – Dimension– Orthogonal and Orthonormal Sets – Orthogonal Basis – Orthonormal Basis – Gram-Schmidt orthogonalisation process – Inner product spaces – Definition – Examples – Inequalities ; Schwartz, Triangle (No proof).

Module IV: Fourier Transforms (15 hours)

Fourier Integral theorem (Proof not required) – Fourier Sine and Cosine integral representations – Fourier transforms – transforms of some elementary functions – Elementary properties of Fourier transforms – Convolution theorem (No proof) – Fourier Sine and Cosine transforms – transforms of some elementary functions –Properties of Fourier Sine and Cosine transforms.

Text Books

Module I:

Erwin Kreysig, *Advanced Engineering Mathematics, 8e,* John Wiley and Sons, Inc. Sections: 12.3, 12.4, 12.5, 12.6, 12.7, 12.9

Module II:

Erwin Kreysig, *Advanced Engineering Mathematics, 8e,* John Wiley and Sons, Inc. Sections: 14.1, 14.2, 14.3, 14.4, 14.4, 15.1, 15.2, 15.3, 15.4

Module III:

Bernaed Kolman, David R Hill, *Introductory Linear Algebra, An Applied First Course,* Pearson Education.

Sections: 6.1, 6.2, 6.3, 6.4, 6.8, Appendix.B.1

Module IV:

Wylie C.R and L.C. Barrett, *Advanced Engineering Mathematics*, McGraw Hill. Sections: 9.1, 9.3, 9.5

Reference

1. H S Kasana, *Complex Variables, Theory and Applications,* 2e, Prentice Hall of India.
2. John M Howie, *Complex Analysis,* Springer International Edition.
3. Anuradha Gupta, *Complex Analysis*, Ane Books India.
4. Shahnaz bathul, *Text book of Engineering Mathematics, Special functions and Complex Variables,* Prentice Hall of India.
5. Gerald Dennis Mahan, *Applied mathematics*, Springer International Edition.
6. David Towers, *Guide to Linear Algebra*, MacMillan Mathematical Guides.
7. Inder K Rana, *An Introduction to Linear Algebra*, Ane Books India.
8. Surjeet Singh, *Linear Algebra,* Vikas Publishing House.
9. Howard Anton, Chris Rorres, *Elementary Linear Algebra, Applications Version*, John Wiley and Sons.
10. Anthony Croft, Robert Davison, Martin Hargreaves, *Engineering Mathematics*, Pearson Education.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions 8x 5 marks=40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

EN14 302 COMPUTER PROGRAMMING IN C

(Common for all branches)

Teaching scheme **Credits: 4**

2 Hrs lectures and 2hour lab per week

Objectives

- *To impart the basic concepts of computer and information technology*
- *To develop skill in problem solving concepts through learning C programming in practical approach.*

Module I (15 hours)

Introduction to Computers: CPU, Memory, input-output devices, secondary storage devices, Processor Concepts - Evolution and comparative study of processors. Machine language, assembly language, and high level language. Inside a PC, Latest trends and technologies of storage, memory, processor, printing etc. Concept of Program and data, System software - BIOS, Operating System- Definition-Functions-Windows, and Linux. Compilers and assemblers, Computer networks, LAN, WiFi.

Module II (15 hours)

Basic elements of C: Flow chart and algorithm – Development of algorithms for simple problems. Structure of C program – Operators and expressions – Procedure and order of evaluation – **Input and Output functions.** *while*, *do-while* and *for* statements, *if*, *if-else*, *switch*, *break, continue*, *goto,* and *labels*. Programming examples.

Module III (15 hours)

Functions and Program structures: Functions – declaring, defining, and accessing functions – parameter passing methods – **Recursion** – Storage classes – *extern*, *auto*, *register* and *static*. Library functions. Header files – C pre-processor. Example programs. **Arrays**: Defining and processing arrays – passing arrays to functions – two dimensional and multidimensional arrays – application of arrays. Example programs.

Module IV (15 hours)

Structures – declaration, definition and initialization of structures, unions, **Pointers**: Concepts, declaration, initialization of pointer variables simple examples **Concept of a file** – File operations File pointer.

Text Books

1. P. Norton, *Peter Norton's Introduction to Computers*, Tata McGraw Hill, New Delhi.

2. E. Balaguruswamy, *Programming in ANSI C*, 3rd ed., Tata McGraw Hill, New Delhi, 2004 **Reference Books**

1. B. Gottfried, *Programming with C*, 2nd ed, Tata McGraw Hill, New Delhi, 2006
2. B. W. Kernighan, and D. M. Ritchie, *The C Programming Language*, Prentice Hall of India, New Delhi, 1988
3. K. N. King. *C Programming: A Modern Approach*, 2nd ed., W. W. Norton & Company, 2008
4. P. Norton, *Peter Norton's Computing Fundamentals*, 6th ed., Tata McGraw Hill, New Delhi, 2004.
5. S. Kochan, *Programming in C*, CBS publishers & distributors
6. M. Meyer, R. Baber, B. Pfaffenberger, *Computers in Your Future*, 3rd ed., Pearson Education India

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Lab Practical Tests

20% - Assignments

20% - Main Record

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 303 FLUID FLOW OPERATIONS

Teaching Scheme:

3 hrs lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To impart the basic concepts of fluid statics and dynamics*
- *To study the basic equations of flow*
- *To study about the metering and pumping of fluids*

- *To study about the flow of fluids through packed beds and fluidized beds*

Module 1 [15 hrs]

Introduction to fluid mechanics. Definition of fluid, physical properties of fluids – density,specific weight, specific gravity, compressibility, surface tension, vapour pressure and viscosity, absolute and kinematic viscosity. Units and dimensions of the properties. Variation of properties with temperature and pressure. Rheology of fluids. Classification of fluids. Fluid statics and applications – Pascal's law. Hydrostatic equilibrium in gravity and centrifugal fields. Barometric equation. Principle of manometers. Different types of manometers. Principles of continuous gravity and centrifugal decanters. Introduction to fluid flow phenomenon. Reynolds experiment. Reynolds number, classification of flow.

Module II [15 hrs]

Basic equation of fluid flow. Equation of continuity, equation of motion, Euler equation,Bernoulli equation, momentum equation. Kinetic energy and fluid friction correction factors.Laminar flow of incompressible fluids in pipes and conduits. Shear stress and velocitydistribution in circular channels. The friction factor, Hagen-Poiseuille equation. Darcy and Weisbach equation. Concept of equivalent diameter. Friction factor chart, Friction losses from change in velocity and direction and loss due to pipe fittings. Turbulent flow, universal velocity distribution equations, friction factor- Reynolds number relationship, Nikuradse- Carman Equation, average velocity, Blassius equation (derivation not required), Prandtl's law.

Module III [15 hrs]

Transportation and metering of fluids. Pipes and pipe standards, tubings, pipe joints, flange, expansion joints, valves, automatic control valves. Different types of pumps. Description and comparison of rotary pumps, reciprocating pumps, jet pumps, air lift, and diaphragm pumps. Detailed study of centrifugal pumps - velocity diagrams, developed head, volumetric flow rate relation, various losses, characteristic curves, NPSH, cavitation, pump priming. Flow measuring devices - venturimeter, orifice meter, pitot tube, rotameter, weirs and notches.

Module IV [15 hrs]

Flow past immersed bodies: Drag coefficient, flow through packed bed. Ergun equation.Kozney- Carman equation. Blake Plummer equation. Design of packed beds. Motion ofparticles through fluids. Motion from gravitational and centrifugal fields. Terminal settlingvelocity. Stokes' law. Intermediate law-Newton law. Free and hindered settling Fluidization. The phenomenon of Fluidization, Minimum fluidizing velocity, Advantages and disadvantages of fluidized beds. Industrial applications.

BT14 304 MICROBIOLOGY

Teaching Scheme:

3 Hrs lecture and 1 hr tutorial per week **Credits: 4**

Objectives:

- *To develop knowledge of the nature and characteristics of microorganisms*
- *To evaluate the role of microbes in public health and various industries*

Module 1 [15 hrs]

History and development of microbiology. Microbial diversity. Principles of microbial taxonomy.

Morphology ultra – structure and reproduction of bacteria, actinomycetes, blue – green algae, yeasts, fungi, algae and viruses. Microscopy-Bright field microscopy – fluorescence microscopy, phase contrast microscopy. Electron microscopy. Theory of staining microorganisms. Simple staining. Differential staining- Gram staining, Acid fast staining, spore staining. Special staining techniques- Flagella staining. negative staining. Sterilization-Control of microorganisms by physical and chemical agents.

Module II [15 hrs]

Nutritional requirements of microorganisms, Nutritional types of bacteria – Formulation of growth medium and different types of media- Synthetic media, complex media Selective media, differential media, enrichment media, enriched media. Pure culture techniques- Spread plate, Pour plate and streak plate, preservation and maintenance of cultures.

Module III [15 hrs]

Microbial growth – growth curve, generation time. Batch culture, Fed batch culture and continuous culture, Synchronous culture- techniques adopted to generate synchronous culture, Measurement of microbial growth, Enumeration techniques- cell numbers and cell mass. Influence of environmental factors on growth

Module IV [15 hrs]

Microbiological analysis of water- Test for coliforms, Microbial flora of soil. Interactions among soil microorganisms - Mutualism, commensalisms, predation, parasitism, amensalism, competition, symbiosis, Use of micro organisms as biofertilizer and bioinsecticide. Microbial spoilage of foods and preservation of foods-Physical and chemical methods, Food borne diseases and intoxications.

Text books:

1. M.J.Pelczar Et Al, Microbiology, Tata Mcgraw Hill
2. Prescott Et Al:Microbiology, Mcgraw Hill, USA
3. Dubey and Maheswari, A textbook of Microbiology , S Chand Publications
4. Tauro, Kapoor &Yadav; *An introduction to microbiology*,Wiley Eastern Ltd.

Reference Books:

1. Microbiology: An Introduction: Tortora, Funke & Case. 7th edition, 2001
2. Microbiology: Davis, Dulbecco, Eisen and Ginsburg.
3. Introduction to Microbiology: Ross
4. General Microbiology: Stainier, Adelberq and Ingraham.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of systems using any technical

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 305 BIOCHEMISTRY – I

Teaching Scheme:
3 Hrs lecture and 1 hr tutorial **Credits: 4**

Objectives :

- *To understand the fundamental aspects of life*
- *To impart the knowledge of the elemental composition of biomolecules*

Module 1 [15 hrs]

Introduction to biochemistry. A historical perspective. General features of biomolecules. Carbohydrates: structure and properties of monosaccharides, oligosaccharides and polysaccharides, Ring structure and mutarotation. Homo and heteropolysaccharides. Mucopolysaccharides. Sialic acids. Bacterial cell wall polysaccharides. Glycoproteins, membrane glycoproteins and their biological functions. Blood group substances.

Module II [15 hrs]

Aminoacids and proteins: structure, nomenclature and properties of aminoacids. General reactions of aminoacids. Peptide bond. Classification of proteins, Basic understanding of primary, secondary, tertiary and quaternary structure of proteins. Denaturation and renaturation. Enzymes: Nomenclature and classification of enzymes. Activation energy and transition state enzyme activity, active sites, theories of enzyme specificity. Role of effectors and cofactors.

Module III [15 hrs]

Lipids - classification and structure, essential fatty acids- glycerides, hydrolysis of fats, structure and properties of phospholipids and glycolipids. Prostaglandins- structure, biological properties. Cholesterol- structure and biological importance.

Module IV [15 hrs]

Nucleic acids: structure and properties of Purine and pyrimidine bases. Nucleosides and nucleotides. Structure of nucleic acids. Base pairing role. Structure and functions of DNA and RNA Double helical model of DNA structure. A, B and Z DNA.Vitamins: Chemistry and biological functions of fat soluble Vitamin A, Vitamin D, Vitamin K and Vitamin E. Water soluble Vitamins: B complex and Vitamin C. Biological functions.

Text books:

1. Vasudevan and Sreekumar – A Text book of Biochemistry for Medical Students , Jaypee Publications
2. A.L. Lehninger: *Principles of Biochemistry* CBS publications.

3. Jain and Jain , Fundamentals of Biochemistry, S Chand Publications

References:

1. E.L.Smith, R.L.Hill et al: *Principles of Biochemistry*, Vol I, MC Graw Hill Book Company.
2. Lubert Stryer: *Biochemistry*,W.H.Frceman co
3. Donald Voet, Judith.G.Voet: *Biochemistry*,Wiley and sons.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of continuous systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 306: BIO PROCESS CALCULATIONS

Teaching Scheme:
3 Hrs lecture and 1 hr tutorial **Credits: 4**

Objectives

- *To study the laws regarding gas ,liquid and vapour*
- *To develop understanding about material balance and energy balances*
- *To study the stoichiometry and thermodynamics of microbial growth and product formation*

Module 1 [15 hrs]

Introduction to bioprocesses: Historical development of bioprocess technology, an overview of traditional and modern applications of biotechnological processes, role of bioprocess engineer in the biotechnology industry, outline of an integrated bioprocess and the various (upstream and downstream)

unit operations involved in bioprocesses, generalized process flow sheets.

Fermentation processes: General requirements of fermentation processes, Basic design and construction of fermentor and ancillaries, Main parameters to be monitored and controlled in fermentation processes, An overview of aerobic and anaerobic fermentation processes and their application in the biotechnology industry, solid-substrate fermentation and its applications.

Module II [15 hrs]

Overview of process industry and bioprocess industry. Definition of unit operations and unit processes. Units and dimensions. SI Units. Fundamental concepts of stoichiometry like mole concept, mass fraction, mole fraction, volume – fraction, average molecular weight. Concentration of liquids and solutions. Fundamental laws for gas, vapour, and liquid , vapour pressure of pure liquids, effect of temperature on vapour pressure, Clausius Claperon equation, Antoine equation. Ideal gas law, Dalton's law, Amagat‘s law. Real gas properties, Van der Waals equation, critical state, reduced variables, compressibility factor, vapour liquid equilibria, Raoult‘s law, and Henry‘s law. Humidity and saturation, wet bulb and dry bulb temperature, humidity charts.

Module III [15 hrs]

Material balances. Law of conservation of mass. Material balance without chemical reactions. Total and component balances, concept of steady state, batch and continuous process. Tie element basis for calculations. Recycling and bypassing operations. Material balance with chemical reactions. Concept of excess reactant, limiting reactant, conversion, yield, degree of completion. Energy balance. Law of conservation of energy. Components of energy balance equation. Heat and work. Internal energy. Concept of Enthalpy and heat capacity. Enthalpy changes. Heat effects accompanying chemical reactions. Standard heats of reaction, combustion and formation. Hess‘s law. Effect of temperature on standard heats of reaction. Steady state energy balance calculations. Steam tables.

Module IV [15 hrs]

Stoichiometry of microbial growth and product formation. Stoichiometric calculations – elemental balances, degree of reduction. Yield coefficients. Biomass yield. Product stoichiometry. Theoretical oxygen demand. Maximum possible yield. Thermodynamics of microbial growth. Heat of reaction with oxygen as electron acceptor and with oxygen not the electron acceptor. Energy balance equation for cell culture. Fermentation energy balance equation.

TEXT BOOKS

1. Bailey and Ollis, ―Biochemical Engineering Fundamentals‖, McGraw-Hill (2nd Ed.),1986.
2. Shule and Kargi, ―Bioprocess Engineering‖, Prentice Hall, 1992.
3. Narayanan & Lakshmikutty, Stoichiometry and Process Calculations, Prentice Hall of India

REFERENCES

1. Pauline Doran, ―Bioprocess Engineering Calculation‖, Blackwell Scientific Publications.
2. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, ―Principles of Fermentation Technology‖, Science & Technology Books.
3. Harvey W. Blanch, Douglas S. Clark, ―Biochemical Engineering‖, Marcel Dekker, Inc.
4. Hougen A Watson K M, Ragatz R A. Chemical Process Principles, John Wiley
5. Gavhane K. A., Introduction to Process Calculations Stoichiometry, Nirali Prakashan
6. David M Himmelblau– *Basic principles and calculations in Chemical Engg* – Prentice Hall
7. V. Venkatarmani and N. N.Ananthraman – *Process calculation* – Prentice Hall India.
8. B. I. Bhatt and S. M. Vora – *Stoichiometry* – Tata McGraw Hill.
9. Williams E T, Johnson R C, Stoichiometry for chemical engineers, McGraw Hill.
10. Rao D P, Murthy D V S, Stoichiometry for chemical engineers, McMillan

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be solution using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 307 (P) MICROBIOLOGY LABORATORY

Teaching Scheme:
3 hours practical per week **Credit: 2**

Objectives

- *To attain knowledge about the morphology and in vitro cultivation of microorganisms*
- *To study about the microbial analysis of food water and soil*

Experiments:

1. Sterilization techniques; Wet heat, dry heat, filtration, disinfection
2. Preparation of culture media, cotton plugging and sterilization
3. Culturing of microorganisms: broth, agar, pure culture, streak Plate, pour plate, Spread plate isolation and preservation of bacterial culture.
4. Identification of microorganisms: Staining techniques, Simple staining, Gram staining, spore, capsule, fungal staining, and biochemical test- Carbohydrate Fermentation, IMViC, TSI, Urease Test.
5. Quantification of microorganisms: counting microscopy, nephelometry /turbidometry, total N or dry weight.
6. Growth curve of bacteria
7. Microbiological analysis of water,

8. Food microbiology: milk, fermented food. Salmonella in poultry
9. Factors affecting the bacterial growth: effect of temperature and pH
10. Clinical microbiology: Normal mouth flora, Antibiotic Assay
11. Microbial population in soil
12. Isolation of nitrogen fixing organisms.

REFERENCE

1. Micro Biology: Laboratory Theory and applications, M.J. Heboffee aw BE Pierce Morten Publishing House, 2006.

Sessional work assessments

Lab Practical and Record = 60%
Two tests (2 x 10) = 30%
Regularity = 10%
Total marks = 50

Semester end examination

Fair record = 10%
Viva voce = 20%
Procedure and tabulation form, Conducting experiments and results = 70
% Total marks = 100

BT14 308 (P) BIOCHEMISTRY LABORATORY

Teaching Scheme:
3 hours practical per week **Credits: 2**

Objective:

- *To study about the qualitative and quantitative analysis of biomolecules*
- *To analyze the biomolecules in a living tissue*

Experiments:

1. Units, Volume and weight measurements, concentration units, pH measurement,
2. Preparation of buffers.
3. Qualitative tests for (a) carbohydrates and (b) amino acids
4. Estimation of reducing sugars by the Benedicts‘ method.
5. Quantitative estimation for amino acids-Ninhydrin method.
6. Protein estimation by Biuret/Folins‘/Bradford method.
7. Extraction, Identification and quantification of biomolecules from living tissues (Plant & Animal).
8. Extraction of lipids
9. Saponification of fats
10. Estimation of cholesterol
11. Estimation of nucleic acids: (a) Estimation of DNA (b) Estimation of RNA
12. Trypsin digestion of proteins

REFERENCES

1. Wilson and Walker ―Principles and Techniques of Practical Biochemistry‖ 4 Edn. Cambridge Knew pros 1997.
2. Plummer DT ―An Introduction to Practical Biochemistry‖ III Edn., Tata Mc Grawhill.

Sessional work assessments

Lab Practical and Record = 60%
Tests = 30%
Regularity = 10%
Total marks = 50

Semester End examination

Fair record = 10%
Viva voce = 20%
Procedure and tabulation form,
Conducting experiments and results = 70 %
Total marks = 100

FOURTH SEMESTER

EN14 401A: Engineering Mathematics IV

(Common for ME, CE, PE, CH, BT, PT, AM, and AN)

Teaching scheme **Credits:** 4

3 hour lecture and 1 hour tutorial

Objective

- *To provide a comprehensive introduction to those models and methods most likely to be encountered and used by students in their careers in engineering.*
- *To provide an introduction to some important partial differential equations*

Module I: Probability Distributions (15 hours)

Random variables – Mean and Variance of probability distributions – Binomial Distribution – Poisson Distribution – Poisson approximation to Binomial distribution – Hyper Geometric Distribution – Geometric Distribution – Probability densities – Normal Distribution – Uniform Distribution – Gamma Distribution.

Module II: Theory of Inference (15 hours)

Population and Samples – Sampling Distribution – Sampling distribution of Mean (σ known) – Sampling distribution of Mean (σ unknown) – Sampling distribution of Variance – Interval Estimation – Confidence interval for Mean – Null Hypothesis and Tests of Hypotheses – Hypotheses concerning one mean – Hypotheses concerning two means – Estimation of Variances – Hypotheses concerning one variance – Hypotheses concerning two variances – Test of Goodness of fit.

Module III: Series Solutions of Differential Equations (15 hours)

Power series method for solving ordinary differential equations – Frobenius method for solving ordinary differential equations – Bessel's equation – Bessel functions – Generating functions (No proof) – Relation between Bessel functions – Orthogonality property of Bessel functions (Proof not required).

Module IV: Partial Differential Equations (15hours)

Introduction – Formation of PDE – Complete Solution – Equations solvable by direct integration – Linear

PDE of First order, Legrange's Equation: $Pp + Qq = R$ – Non-Linear PDE of First Order, $F(p,q) = 0$, Clairaut's Form: $z = px + qv + F(p,q)$, $F(z,p,q) = 0$, $F_1(x,q) = F_2(y,q)$ – Classification of Linear PDE's –

Derivation of one dimensional wave equation and one dimensional heat equation – Solution of these equation by the method of separation of variables.

Text Books

Module I:

Richard A Johnson, CB Gupta, *Miller and Freund's Probability and statistics for Engineers, 7e*, Pearson Education- Sections: 4.1, 4.2, 4.3, 4.4, 4.6, 4.8, 5.1, 5.2, 5.5, 5.7

Module II:

Richard A Johnson, CB Gupta, *Miller and Freund's Probability and statistics for Engineers, 7e*, Pearson Education- Sections: 6.1, 6.2, 6.3, 6.4, 7.2, 7.4, 7.5, 7.8, 8.1, 8.2, 8.3, 9.5

Module III:

Erwin Kreysig, *Advanced Engineering Mathematics, 8e,* John Wiley and Sons, Inc.-Sections: 4.1, 4.4, 4.5

Module IV:

N Bali, M Goyal, C Watkins, *Advanced Engineering Mathematics, A Computer Approach, 7e,*

Infinity Science Press, Fire Wall Media- Sections: 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.9

Erwin Kreysig, *Advanced Engineering Mathematics, 8e,* John Wiley and Sons, Inc. Sections: 11.2, 11.3, 9.8 Ex.3, 11.5

Reference books

1. J.S.Chandan, *Statistics for Business and Economics*, Vikas Publishing House.
2. Anthony Croft, Robert Davison, Martin Hargreaves, *Engineering Mathematics*, Pearson Education.
3. H Parthasarathy, *Engineering Mathematics, A Project & Problem based approach,* Ane Books India.

4. B V Ramana, *Higher Engineering Mathematics*, McGrawHill.
5. J K Sharma, *Business Mathematics, Theory and Applications*, Ane Books India.
6. John bird, *Higher Engineering Mathematics*, Elsevier, Newnes.
7. Wylie C.R and L.C. Barret, *Advanced Engineering Mathematics*, McGraw Hill.
8. V R Lakshmy Gorty, *Advanced Engineering Mathematics-Vol. I, II.*, Ane Books India.
9. Sastry S.S., *Advanced Engineering Mathematics-Vol. I and II*., Prentice Hall of India.
10. Michael D Greenberg, *Advanced Engineering Mathematics*, Pearson Education.
11. Babu Ram, *Engineering Mathematics Vol.I & II*, Pearson Education.
12. S.Palaniammal, *Probability and Random Processes*, Prentice Hall of India.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions 8x 5 marks=40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

EN14 402: ENVIRONMENTAL SCIENCE

(Common for all branches)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To understand the problems of pollution, loss of forest, solid waste disposal, degradation of environment, loss of biodiversity and other environmental issues*
- *To create awareness among the students to address these issues and conserve the environment in a better way.*

Module I (15 hours)

The Multidisciplinary nature of environmental science. Definition-scope and importance-need for public awareness. Natural resources. Renewable and non-renewable resources: Natural resources and associated problems-forest resources: Use and over exploitation, deforestation, case studies. Timber extraction,

mining, dams and their defects on forests and tribal people- water resources: Use and over utilization of surface and ground water, floods, drought , conflicts over water, dams-benefits and problems.- Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.- Food resources: World food problems, changes caused by agriculture over grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.-Energy resources: Growing energy needs, renewable and non-renewable energy resources, use of alternate energy resources, Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Module II (15 hours)

Ecosystems-Concept of an ecosystem-structure and function of an ecosystem – producers, consumers, decomposers-energy flow in the ecosystem-Ecological succession- Food chains, food webs and Ecological pyramids-Introduction, types, characteristics features, structure and function of the following ecosystem-Forest ecosystem- Grassland ecosystem –Desert ecosystem-Aquatic ecosystem(ponds, streams, lakes, rivers, oceans , estuaries)

Biodiversity and its consideration Introduction- Definition: genetic, species and ecosystem diversity-Bio-geographical; classification of India –value of biodiversity: consumptive use, productive use, social ethical , aesthetic and option values Biodiversity at Global, national , and local level-India at mega – diversity nation- Hot spot of biodiversity-Threats to biodiversity: habitat loss, poaching of wild life, man , wild life conflicts – Endangered and endemic species of India-Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.

Module III (15 hours)

Environmental pollution Definition-Causes, effects and control measures of Air pollution- Water pollution –soil pollution-Marine pollution-Noise pollution-Thermal pollution-Nuclear hazards-Solid waste management: Causes, effects and control measures of urban and industrial wastes-Role of an individual in prevention of pollution. Pollution case studies-Disaster management: floods , earth quake, cyclone and landslides-Environmental impact assessment

Module IV (15 hours)

Environment and sustainable development-Sustainable use of natural resources-Conversion of renewable energy resources into other forms-case studies-Problems related to energy and Energy auditing-Water conservation, rain water harvesting, water shed management-case studies-Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust-Waste land reclamation Consumerism and waste products-Reduce, reuse and recycling of products-Value education.

Text Books:

1. Daniels & Krishnaswamy, Environmental studies, Wiley India pvt ltd, 2009
2. Raman Sivakumar, Introduction to environmental science and engineering, 2nd edn, .Tata McGraw Hill, 2010
3. Anindita Basak, Environmental Studies, Pearson Education, 2009
4. Suresh K.D, Environmental Engineering and Management, Katson Books, 2007
5. Benny Joseph, Environmental studies, 2nd edn, McGraw Hill, 2009

References:

1. Raghavan Nambiar,K Text book of Environmental Studies,Scitech Publishers(India) Pvt. Ltd
2. S.P Misra, S.N Pandey, Essential Environmental studies, Ane books, Pvt Ltd, 2009

3. P N Palanisamy, P Manikandan,A Geetha, Manjula Rani, Environmental Science, Pearson Education, 2012
4. D.L. Manjunath, Environmental Studies, Pearson Education, 2011

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

Note: Field work can be Visit to a local area to document environmental assets-river/forest/grass land/mountain or Visit to local polluted site-urban/rural/industrial/agricultural etc. or Study of common plants, insects, birds etc. or Study of simple ecosystems-pond, river, hill slopes etc. or mini project work on renewable energy and other natural resources , management of wastes etc.

University Examination Pattern

PART A: Analytical/problem solving SHORT questions 8x 5 marks=40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 403 CELL BIOLOGY

Teaching Scheme:
3 Hrs lecture and 1 hr tutorial per week **Credit: 4**

Objectives :

- *To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles*
- *To understand the cellular components underlying mitotic cell division.*

Module I [15 hrs]

Introduction to cell theory - prokaryotic cells - eukaryotic cells - cell number - plant and animal cells - cell as a polyphasic colloidal system – ultra-structure and chemical composition of plasma membrane - membrane asymmetry - fluidity in plasma membrane - pores - glycocalyx - functions of plasma

membrane - permeability and transport - structure of plant cell wall and bacterial cell wall.

Module II [15 hrs]

Cytoplasmic vacuolar system - morphology, ultra-structure and functions of endoplasmic reticulum - microsomes - structure, chemical composition and functions of golgi complex. Microbodies - structure, enzymes, stability, polymorphism, biogenesis and functions of lysosomes. Ribosomes - shape and size - ultrastructure - mitochondrial and chloroplast ribosomes – chemical composition - biogenesis – functions. Mitochondria - ultrastructure - respiratory chain - redox potential - chemical composition - biogenesis - functions.

Module III [15 hrs]

Plastids - functions - chloroplasts - chemical composition - pigments - phycobilins – photochemical reaction systems - mechanism of photosystem.Structure and functions of centriole - extra cellularstructure - interphase nucleus - morphology of eukaryotic chromosomes - molecular organization of chromosomes

Module IV [15 hrs]

Cell division - mitosis - karyokinesis – cytokines is - cytoplasmic events - process and significance of meiosis - spermatogenesis and cogenesis

Cell growth - cellular aging - regulation of cell size - theories of carcinogenesis. Techniques for the propagation of prokaryotic and eukaryotic cells - cell line - generation of cell lines - maintenance of stock-cells - characterization of cells - immuno cytochemistry - morphological analysis techniques - cell culture -cell fractionation - tissue hornogenization - centrifugation - elutriation.

Text Books:

1. *Kimb*all T.W : *Cell Biology,* Wesley Publishers
2. Smith and Wood : *Cell Biology,* Chapman and Hall.

Reference Books

1. Darnell, Lodish and Baltimore : *Molecular Cell Biology,* W.H. Freeman
2. Molecular Biology of Cell by Albert et.al. John Wiley & Sons
3. The Cell by Cooper. ASM Press
4. Cell and Molecular Biology by Karp. John Wiley & Sons

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions 8x 5 marks=40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 404 BIOCHEMISTRY II

Teaching Scheme:
3 Hrs lecture and 1 hr tutorial **Credits: 4**

Objectives

- *To impart complete understanding of biochemical processes associated with the living cell*
- *To enable the students to see how metabolic pathways communicate with each other*

Module I [15 hrs]

Metabolism of carbohydrates – reactions, energetics and regulation of glycolysis – pentose phosphate pathway and its significance – gluconeogenesis pathway and its regulation – biosynthesis of lactose, sucrose and starch – glycogenolysis and glycogenesis – control of glycogen metabolism – maintenance of blood glucose levels – TCA cycle – photosynthesis.

Module II [15 hrs]

Metabolism of proteins - essential and non-essential amino acids - degradation and biosynthesis of amino acids - urea cycle : reactions, regulation and its linkage with the citric acid cycle - metabolism of aromatic amino acids, cystein, histidine and serine.

Module III [15 hrs]

Metabolism of lipids - fatty acid oxidation - ketone bodies - ketosis - biosynthesis of fatty acids and triglycerides - metabolism of phospholipids - cholesterol metabolism. Metabolism of nucleic acids - *Denovo* biosynthesis of purine and pyrimidine nucleotides - regulation of purine and pyramidine nucleotide biosynthesis - salvage pathways of purines and pyrimidines - formation of deoxyribonucleotides - catabolism of purines and pyrimidines.

Module IV [15 hrs]

Bioenergetics - redox potential - biological oxidation - mitochondria and components of electron transport system - respiratory control -oxidative phosphorylation - ATP production – chemi-osmotic theory - uncouplers and inhibition of oxidative phosphorylation.

Text books:

1. Vasudevan and Sreekumar – A Text book of Biochemistry for Medical Students , Jaypee Publications
2. A.L. Lehninger: *Principles of Biochemistry* CBS publications.
3. Jain and Jain , Fundamentals of Biochemistry, S Chand Publications

References:

1. E.L.Smith, R.L.Hill et al: *Principles of Biochemistry*, Vol I, MC Graw Hill Book Company.

2. Lubert Stryer: *Biochemistry*,W.H.Frceman co
3. Donald Voet, Judith.G.Voet: *Biochemistry*,Wiley and sons.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions 8x 5 marks=40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 405 ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY

Teaching Scheme:
3 Hrs lecture and 1 hr tutorial **Credits: 4**

Objectives:

- *Provide an understanding of the principles and practical applications of the major analytical techniques used in Biotechnological Applications*
- *To understand the advantages and disadvantages of different analytical techniques and their use in the identification and characterization of bio-molecules*

Module I [15 hrs]
Photometry and spectro-photometry : The Beer-Lambert Law, percentage transmittance and absorbance; photoelectric colorimeters; spectrophotometers - types, UV visible, IR, atomic absorption, NMR and mass spectro-photometers.

Module II [15 hrs]
Chromatography : Partition chromatography - mobile and stationary phases paper chromatography - solvent systems - development of Rf value- ascending and descending techniques - two dimensional chromatography - thin layer chromatography.

Column chromatography - preparation of columns - gradient elution - analysis of fraction and elution profiles - ion exchange chromatography - preparation and activation of ion exchange materials - affinity chromatography - separation of macromolecules - gas chromatography and high performance liquid

chromatograph (HPLC).

Module III [15 hrs]

Electrophoresis - paper and gel electrophoresis – immune-electrophoresis - enzyme linked immune-absorbant assay (ELISA) – iso-electric focusing - two dimensional electrophoresis – capillary electrophoresis. Dialysis - separating membranes - factors affecting dialysis - gelfiltration - ultrafiltration-application of filtration techniques. ..;

Differential centrifugation - preparation of cellular organelle and other materials ; disintegration of cells , density gradient centrifugation; analytical ultracentrifuge - determination of molecular weight.

Module IV [15 hrs]

Radio isotope techniques - radioactive disintegration - radioactive isotopes used in biology - detection of radioactivity - Geiger counters— strip counters - labeling of biological material with radioactive isotope - scintillation counting - liquid scintillation counters - autoradiography.

Text Books

1. T.G. Cooper : *Tools of Biochemistry,* Wiley Interscience
2. D. Holme and H. Peck : *Analytical Biochemistry*, Longman.

Reference Books

1. Willard Merrit and Deana Settle : *Instrumental Methods of Analysis,* CBS Publishers & Distributors.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of continuous systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions 8x 5 marks=40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 406 MECHANICAL OPERATIONS

Teaching Scheme:
3 Hrs lecture and 1 hr tutorial per week **Credits: 4**

Objectives:

- *To impart the basic concepts of size reduction and the knowledge about the size reduction equipments*
- *To study about the various mechanical separation operations*

Module I [15 hours]

Characterization of solid particles. Sieve analysis, particle size distribution , cumulative and differential methods of analysis, mean diameter, specific surface area, microscopic counting,pipette analysis, hydrometer analysis. Size reduction, equipments used for primary and secondary stage size reduction. jaw crusher, hammer mill, ball mill, rod mill, disk attrition mill, fluid energy mill. Laws of size reduction. Selection of equipments. Industrial screen, effectiveness of screens, capacity of screens. Closed and open circuit grinding. Wet and dry grinding.

Module II [15 hours]

Filtration. Constant rate filtration and constant pressure filtration. Batch and continuous filtration. Sand filter, plate and frame filter press, leaf filter, rotary vacuum filter, incompressible cake, cake porosity, filter aids, methods of application, optimum time cycle. Principle of centrifugal filtration. Suspended batch centrifuge. Automatic batch centrifuges.

Module III [15 hours]

Sedimentation. Settling theory, equipment for sedimentation - thickeners. Clarifier and thickener design. Kynch theory. Determination of thickener area. Sedimentation principles. . Equilibrium sedimentation. Sedimentation coefficient. Equivalent time. Production centrifuges – tubular bowl centrifuges. Ultra centrifugation. Flocculation and sedimentation. Disk – stack bowl centrifuge – centrifugation theory. Agitation and mixing of liquids – Purposes of agitation, types of agitators, flow patterns, circulation rate, velocity patterns and velocity gradients, power consumption. Agitation selection & scalar. Dispersion Operations – Liquid liquid dispersion, Gas liquid dispersion.

Module IV [15 hours]

Cross flow filtration (CFF) Micro filtration and ultra filtration. Applications of CFF. Types of membranes permeate flux for ultra filtration, concentration polarization in ultra filtration, Micro filtration. Filter media in cross flow filtration. Equipments in cross flow filtration. Membrane fouling. Scale up and design of cross flow filtration. Batch and continuous ultra filtration system.

Text

1. Mc Cabe &Smith: ―*Unit operations in Chemical Engg*‖ McGraw Hill
2. Christe J Geankoplis ―*Transport Process and Unit Operations*‖. Prentice Hall of India.
3. Badger and Benchero, ―*Introduction to Chemical Engineering* ―, Mc Graw Hill

References

1. Coulson J.M. & Richardson J.F., Chemical Engineering, Vol. II, ELBS, Pergamon Press

2. Foust A.S. et al, Principles of Unit Operations, John Wiley
3. Perry R.H., Chemical Engineers Handbook, McGraw Hill
4. George Granger Brown, Unit Operations, Wiley

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 407 (P) FLUID MECHANICS & MECHANICAL OPERATIONS LAB

Teaching Scheme:
3 hours practical per week **Credits 2**

Objective:

- *To study about various fluid flow operations, particle analysis and mechanical separation*

Experiments

1. Characteristic curves of a centrifugal pump and determination of maximum
2. efficiency.
3. Determination of coefficient of discharge of orifice meter and venturi meter.
4. Drag coefficient of a falling sphere in fluid.
5. Pressure drop of liquid passing through a packed bed.
6. Pressure drop characteristics of a fluidized bed.
7. Losses in pipe fittings, expansion and contraction.
8. Ball mill – verification of the laws of crushing.
9. Sieve analysis-determination of particle size.
10. Effectiveness of a screen
11. Pipette analysis
12. Determination of the mean specific cake resistance and compressibility factor using a

13. batch leaf filter.
14. Batch sedimentation in a slurry
15. Flocculation screening
16. Cross flow filtration.
17. Study of Jaw crusher
18. Study of rotary vacuum filter.

Sessional work assessments

Lab Practical and Record = 60%
Tests = 30%
Regularity = 10%
Total marks = 50

Semester End examination

Fair record = 10%
Viva voce = 20%
Procedure and tabulation form,
Conducting experiments and results = 70 %
Total marks = 100

BT14 408(P) BIOANALYTICAL TECHNIQUES LAB

Teaching Scheme:
3 hours practical per week **Credits 2**

Objective:

- *To provide experience in various bioanalytical techniques in biotechnology*

Experiments

1. Precision, accuracy and validity of an experiment. Analysis and presentation of data.
2. Colorimetry and spectrophotometry
3. Verification of Beer-Lambert's law-using UV-Vis spectrophotometer.
   a. Change in absorbance with concentration of potassium permanganate.
   b. Absorption maxima– change in absorbance in potassium permanganate with wavelength.
   c. Concentration of two components in a binary mixture. Absorption of light by potassium dichromate and potassium permanganate.
   d. Change in absorbance of albumin and DNA solution with wave length.
4. Absorption spectra of nucleotides
5. Separation of amino acids by paper chromatography Determination of Rf value.
6. Extraction of lipids and separation using thin layer chromatography
7. Column chromatography
8. Determination of molecular weight of an enzyme by gel filtration.
9. Separation of protein by SDS page.
10. Separation of nucleic acids by agarose gel electrophoresis
11. Biotin labeling of cellular constituents.

Sessional work assessments

Lab Practical and Record = 60%
Tests = 30%
Regularity = 10%
Total marks = 50

Semester End examination

Fair record = 10%
Viva voce = 20%
Procedure and tabulation form,
Conducting experiments and results = 70 %
Total marks = 100

FIFTH SEMESTER

BT14 501: MASS TRANSFER OPERATIONS

Teaching Scheme:
3 Hrs lecture and 1 hr tutorial per week **Credits: 4**

Objectives:

- *To impart the basic concepts of mass transfer*
- *To develop an understanding of different separation processes like Distillation, extraction, drying and crystallization*

Module I [15 hrs]

Classification of mass transfer operations Diffusional mass transfer Fick‘s law. One component transferring to non-diffusing component and equimolar counter diffusion diffusivity estimation. The mass transfer coefficient. Dimensionless groups in mass transfer. Theories of mass transfer. Film theory, Penetration theory, surface – renewal theory, the boundary layer theory. Momentum, heat and mass transfer analogies. Interphase mass transfer. The two-film theory, the overall mass transfer coefficient. General features of equipment for mass transfer – Tray tower, packed tower, bubble column, ,and spray tower.

Module II [15 hrs]

Basic concepts of distillation – vapor – liquid equilibrium, the Raoult‘s law, Relative volatility, Deviations from ideality. Flash vaporization of a binary mixture, simple distillation, continuous fractionation, McCabe-Thiele method, Ponchon, - Savarit method, minimum reflux ratio. Total reflux, optimum reflux ratio. Design of packed towers.

Module III [15 hrs]

Liquid – liquid extraction applications, Liquid – liquid equilibrium. Solvent selection, Design calculations for stage wise extraction, single stage and multi stage operation, crosscurrent and countercurrent operations, liquid – liquid extraction equipment. Super critical fluid extraction. Leaching-Applications, Heap and insitu leaching, single stage and multistage leaching. Leaching equipments.

Module IV [15 hrs]

Drying of wet solids. Classification of drying equipment. Drying equipment. Drying calculations – cross circulation drying and through circulation drying. Material and energy balance in a continuous dryer. Freeze drying. Drying time in a continuous counter current dryer. Crystallization. Principles of crystallization. Nucleation and crystal growth. Effect of impurities on crystal formation Fractional crystallization, caking of crystals. Crystallization equipment.

Text book:

1. Treybal ―*Mass Transfer operations*‖ McGraw Hill International
2. McCabe-Smith ―*Unit operations of Chemical Engg*‖ McGraw Hill International
3. Binay K Dutta ―*Mass Transfer and Separation processes*‖.
4. Badger and Banchero,‖ *Introduction to Chemical Engineering*‖, Mc- Graw Hill

References:

1. Coulson J.M., J.F. Richardson, J.R. Backhurst and J.M. Harker, ―***Coulson & Richardson's Chemical Engineering***‖, Vol. I, 6th Edn., Butter worth Heinemann, Oxford, 1999.
2. Seader J. D. & Henley E. J., Separation Process Principles
3. Welty J. R., Wilson R. E. & Wicks C. E., Fundamentals of momentum heat and Mass Transfer, John Wiley.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be problem solution using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions 8x 5 marks=40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

Note:- Use of Heat and Mass Tansfer data book, Steam Tables and attested copies of relevant charts are permitted for examination.

BT14 502 CHEMICAL REACTION ENGINEERING

Teaching Scheme:
3 Hrs lecture and 1 hr tutorial **Credits: 4**

Objectives:

- *To impart the basic concepts of reaction kinetics*

- *To develop knowledge for design of ideal reactors*
- *To study about non-isothermal reactor design*
- *To study about the fundamentals of non-ideal reactors and heterogeneous catalytic reactors.*

Module I [15 hrs]

Introduction to chemical reaction engineering. Classification of chemical reactions and reactors. Variables affecting the rate of reaction. Definition of reaction rate. Kinetics of homogeneous reaction. Concentration dependent term and temperature dependent term. Interpretation of batch reactor data. Constant volume batch reactor. Varying volume batch reactor.

Module II [15 hrs]

Introduction to reactor design. Ideal reactors for a single reaction. Design for single reaction and multiple reactions. Multiple reactor systems. Size comparison of reactors. Recycle reactor. Autocatalytic reactor.

Module III [15 hrs]

Heat effects in reactors. Non isothermal reactor design. General graphical design procedure. Energy balance for batch, mixed flow and plug flow reactor – isothermal, adiabatic and non-adiabatic operation. Optimum temperature progression. Multiple steady states.

Basics of non-ideal flow. Residence time distribution. Measurement of the RTD. Pulse and step input . C,E,F curves. Calculation of mean residence time. RTD in ideal reactors.RTD in laminar flow reactor. Segregation model and conversion in non-ideal reactors (Dispersion and tanks-in series models are not included).

Module IV [15 hrs]

Heterogeneous catalytic processes. Classification of catalysts, promoters, inhibitors, catalyst poisons. Adsorption. Rates of adsorption, desorption, and surface reaction. Rate equations for fluid-solid catalytic reactions.. Mass Transfer between fluid and catalyst surface. Internal transport effects. Effectiveness factor for a straight cylindrical catalyst pore for a first order reaction.

Commercially significant types of heterogeneous catalytic reactors (description only) like fixed bed reactor, trickle bed reactor, moving bed reactor, fluidized bed reactor and slurry reactor.

Text book/References

1. Octave Levenspiel ―*Chemical Reaction Engg*‖ Wiley student Education.
2. H.Scott Fogler ―*Elements of Chemical Reaction Engg*‖. – Pearson – Prentice Hall.
3. J.M.Smith ―*Chemical Engineering Kinetics*‖ – McGraw Hill International.
4. Hill C G . An Introduction to Chemical Engg Kinetics & Reactor Design, John Wiley

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be problem solving using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO

and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 503 ENZYME SCIENCE AND ENGINEERING

Teaching Scheme:
3 Hrs lecture and 1 hr tutorial per week **Credit: 4**

Objective:

- *To impart the basic concepts of enzymes and the reactors involved in free and immobilized enzyme system*
- *To understand the kinetics and physicochemical characteristics of enzymes*

Module I [15 hrs]

Classification of enzymes. Production and purification of crude enzymes. Extracts from plant, animal and microbial sources. Mechanism of Enzyme action, Concept of active site, enzyme-substrate complex and enzyme action, Role of co factors. Specificity of enzymes, Activity of enzymes, Commercial application of enzymes in food, pharmaceutical and other industries. Enzymes for analytical and diagnostic applications. .

Module II [15 hrs]

Michaelis - Menten kinetics. Evaluation of parameters in the Michaelis-Menten kinetics Equation. Multi substrate enzyme reaction kinetics (ping- pong, random order, compulsory order) Methods of characterization of enzymes. Development of enzymatic assays. Hydrolysis of starch and cellulose using enzymes. Types of inhibition. Influences of pH, temperature, chemical agents , enzyme concentration on enzyme activity, Deactivation kinetics.

Module III [15 hrs]

Enzyme immobilization. Physical and chemical techniques for enzyme immobilization adsorption, matrix entrapment, encapsulation, cross – linking, covalent binding. Advantages and disadvantages of different immobilization techniques. Over view of application of immobilized enzyme systems. Mass transfer effects in immobilized enzyme systems. Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions. Effectiveness factors.

Module IV [15 hrs]

Batch Operation of a stirred reactor Time course for batch enzyme reaction. Continuous operation in a stirred tank reactor. Immobilized enzyme reaction in a CSTR and plug flow reactor. Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors. Enzyme biosensors, clinical application of enzymes, design of enzyme electrodes and their application in industry, health care and environment.

Text books

1. Harvey W. Blanch, Douglas S. Clark, ―Biochemical Engineering‖, Marcel Dekker, Inc.
2. James M. Lee, ―Biochemical Engineering‖, PHI, USA.
3. Lehninger , Principles of Biochemistry CBS Publications

References

1. Zubay G, *Biochemistry*, Maxwell Macmillan International Education
2. A. R. Fersht, W.H. Freeman, Structure and Mechanism In Protein Science: A Guide To Enzyme Catalysis and Protein Folding; 1999.
3. H. Dugas Bioorganic Chemistry;, Springer Verlag, 1999.
4. Tailer, R.F. ―*Protein Immobilization – Fundamentals and applications*‖.
5. Pauline M Doran ―*Bioprocess Engg. Principles*‖ – Academic press
6. Nooralabettu Krishna Prasad, Enzyme Technology, PHI
7. James E Bailey & David F Ollis ―*Biochemical Engineering Fundamentals*‖ Mc Graw Hill Book Company

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of continuous systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions *4 x 15 marks=60 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 504 THERMODYNAMICS AND HEAT TRANSFER

Teaching Scheme:

3 Hrs lecture and 1 hr tutorial per week **Credit: 4**

Objective:

- *To impart the basic concepts of thermodynamics and heat transfer*
- *To study the design of various types of heat exchangers*

Module – I [15 hrs]

Introduction and fundamental concepts of thermodynamics. First law of thermodynamics. Work equivalent of heat. Classification of energy, thermodynamic state function and path function. Enthalpy and specific heat. Application of first law to steady state flow processes and reversible process.

Limitations of first law. Statement of second law. Entropy. Heat reservoirs, heat engines and heat pumps.

Applications of the laws of thermodynamics to refrigeration. Thermodynamic properties of pure fluids-fugacity, Activity. Properties of solutions-partial molar properties-chemical potential. Phase equilibria in single component system- criteria of phase equilibrium,criterion of stability. Chemical reaction equilibrium-criteria of chemical reaction equilibrium, Equilibrium constant, Feasibility of a reaction

Module – II [15 hrs]

Modes of heat transfer: conduction, convection and radiation. Heat transfer by conduction. Fourier's law.

Thermal conductivity Steady state conduction through a composite solid. Steady state conduction through cylinder and spheres. Heat transfer coefficient: Convective heat transfer and the concept of heat transfer coefficient. Overall heat transfer without heat transfer between fluids separated by a plane wall. Heat transfer between fluids separated by a cylindrical wall

Module – III [15 hrs]

Forced convection. Flow over a flat plate. Thermal boundary layer. Dimensionless groups in heat transfer. Correlations for the heat transfer coefficient. Laminar flow through a circular pipe. Turbulent flow through a circular pipe. Flow through a non-circular duct. Heat transfer with co-current and counter current operations. LMTD. Momentum and heat transfer analogy. Radiation heat transfer – basic concepts. Blackbody radiation. Planck's, Wien's, Stefan – Boltzmann and Kirchoff's Laws. Grey body. Boiling liquids and condensing vapours – basic ideas.

Module –IV [15 hrs]

Heat exchangers. Construction ,working and applications of a shell and tube heat exchanger. Fouling of a heat exchanger–the fouling factor. Construction, working and applications of a double pipe heat exchanger. Evaporators (single effect only). Thermal design of an agitated vessel. Design of cooling coils. Steam jacketing and heat transfer fluids

1. Binay K Dutta, *Heat Transfer – Principles and applications*, Prentice Hall of India.
2. McCabe and Smith , *Unit operations of Chemical Engg* , McGraw Hill International editions.
3. Badger and Banchero , *Introduction to Chemical Engg.* , McGraw Hill International Edition.

Reference Books

1. Kern D Q, *Process Heat Transfer*, Mc Graw Hill
2. Smith J M Van Ness H V, *Introduction to Chemical Engg Thermodynamics*, Mc Graw Hill
3. J P Holman, *Heat Transfer* ,9th edn , Tata Mc Graw Hill Edn
4. Kyle B.G., Chemical and Process Thermodynamics, Prentice-Hall of India
5. Y.V.C. Rao, Chemical Engineering Thermodynamics, Universities Press

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of systems using any technical computing software

University of Calicut

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions *4 x 15 marks=60 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

Note:- Use of Heat and Mass Tansfer data book, Steam Tables and attested copies of relevant charts are permitted for examination.

BT14 505 BIOINFORMATICS

Teaching Scheme:
3 hours lecture and 1 hour tutorial per week **Credits: 4**

Objective:

- *To understand the fundamental principles of bioinformatics and using the knowledge to tackle various research problems in molecular biology*

Module I [15 hrs]

Scope of Bioinformatics – Internet basics, www, protocols – FTP – Telnet – HTTP, Elementary commands in UNIX, Introduction to PERL (Basic commands, pattern and string matching),BIOPERL (Programme, to transcribe and translate nucleotide sequences). Installation of bioperland its applications.

Module II [15 hrs]

Introduction of databases, Biological databases and their ruse, Databanks – nucleotide databanks– Genebank, NCBI, EMBI, DDBJ –Protein databanks – sequence databanks – PIR, SWISSPROT, TrEMBL – structural databases –PDB, SCOP, CATH, SSEP, CADB, Pfam and GDB. Data base search, sequence submission,Sequin, Bankit, Sakura, Database search – FASTA-BLAST.

Module III [15 hrs]

Sequence alignment, Pairwise alignment Dynamic programming, Multiple sequence alignment.

Methods of MSA, Clustal W, Phylogenetic analysis. Tree building methods – Distance, Parsimony, Maximum likelihood, Phylogenetic Software, Phylip. Scoring Matrix – PAM, BLOSUM.

Module IV [15 hrs]

Special topics in bioinformatics

Methods for prediction of secondary and tertiary structures of proteins knowledge based structure prediction: fold recognition, ab initio methods for structure prediction, Comparative protein modeling, Gene predictions, Genscan, Precustes, Grail, DNA Mapping and sequencing. Map alignment – Shotgun DNA sequencing – Sequence assembly. Protein structure visualization.

Text Books :

1. Introduction to Bioinformatics: T K Attwood & D J Parry Smith
2. Dan E Krane, Michael L Raymer. Fundamental concepts of Bioinformatics, Benjamin Cummings

References:

1. Andreas D.Baxevanis, B.F.Francis Oouellette, *Bioinformatics,*Wiley.
2. Dam Gusfield. *Algorithms on Strings Trees and Sequences*, Cambridge University Press.
3. D.Mount, *Bioinformatics Sequence Analysis.* Cold Spring Harbor Laboratory.
4. Vittal R Srinivas Bioinformatics, A modern Approach, PHI Learning Pvt Ltd
5. Rastogi, Mendiratta, & Rastogi, Bioinformatics Methods & Applications, PHI Learning Pvt Ltd

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of continuous systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 506 MOLECULAR BIOLOGY

Teaching Scheme:
3 Hrs lecture and 1 hr tutorial **Credits: 4**

Objectives:

- *To get a proper understanding about the central dogma of the molecular mechanism*
- *To study the analytical techniques used in molecular biology*

Module – I [15 hrs]

Introduction to genetics: Mendelian laws of inheritance – monohybrid and dihybrid inheritance, Co dominance, Epistatis,Identification of the genetic material - classical experiments, Hershey Chase, Avery McLeod etc ,Structure of DNA. DNA replication: Enzymes involved. Mechanism of prokaryotic and eukaryotic DNA replication. Telomerase. Rolling circle and theta model of replication. Regulation of DNA replication

Module – II [15 hrs]

Concept of the gene: Gene structure and architecture. Central dogma. Genetic code: An overview of genetic code Fidelity of translation, Wobble hypothesis. Ambiguity of genetic code. Deviation from standard. Genomes and mapping :Genomes, ploidy and chromosome number. Physico-chemical property of the genome. Genome organization and c value Paradox .Gene mapping-physical and genetic mapping, Comparative genomics. Gene transfer in bacteria: conjugation, transformation, transduction.

Module – III [15 hrs]

Gene expression: Role of RNAs, enzymes and other factors. Mechanism of transcription and translation in prokaryotes and eukaryotes. Post- translational modifications. Regulation of gene expression regulation of transcription. Different mechanisms Regulatory proteins. Induction and repression. Concept of operon. . Examples (Lac and Trp operon) Positive and negative regulations. Post-transcriptional regulation.

Module – IV [15 hrs]

Mutation: Mutagenesis. Types of mutation. Classes of mutagens, Replica plating. Mutation in genetic analysis. Site directed mutagenesis .DNA repair mechanism .Recombination: Homologous and non-homologous recombination, site-specific recombination .Transposable elements and transposition,

Text Books:

1. Freifelder ―*Molecular Biology*‖ James and Bartletyt Publishers.
2. R C Dubey *Text book of Molecular Biology* S Chand Publishers
3. Cell and molecular Biology, Concepts and experiments Gerald Karp, John Wiley and Sons.

References:

1. Banjamin Levin: ―*Genes VI*, Oxford University Press, Oxford, New York.
2. Bruce Albert and James, DWatson: ―*Molecular Biology of the cell*‖. Garland publishing.
3. Essentials of molecular Biology, Malacinski and Freifelder Jones and Bartlelt Publishers.
4. Genomes, T. A. Brown, John Wiley and Sons PTE Ltd.
5. The Cell - A molecular approach, Gm Cooper Asm Press.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 507(P) MOLECULAR BIOLOGY LAB

Teaching Scheme:
3 hours practical per week **Credits: 2**

Objectives:

- *To understand the fundamental techniques of molecular biology and genetic Engineering*

Experiments:

1. Isolation and quantification of genomic DNA from prokaryotic and eukaryotic cells.
2. Gel electrophoretic separation of DNA and molecular weight determination
3. Isolation, separation and quantification of RNA from eukaryotic and prokaryotic cells
4. Gel extraction of DNA
5. Restriction analysis of DNA
6. Transformation in E.coli
7. Isolation of plasmid DNA from prokaryotic cells
8. Cloning of DNA into plasmid vector.
9. Transblot analysis of DNA
10. PCR amplification of DNA
11. Conjugation in E.coli
12. Isolation of proteins from prokaryotic and eukaryotic cells
13. Gel electrophoretic separation of proteins
14. Induction of lac operon (expression of beta –galactosidase and assay)
15. ELISA

Sessional work assessments

Lab Practical and Record = 60%
Test/s = 30%
Regularity = 10%
Total marks = 50

Semester End examination

Fair record = 10%
Viva voce = 20%
Procedure and tabulation form,
Conducting experiments and results = 70 %
Total marks = 100

BT14 508 (P) BIOINFORMATICS LAB

Teaching Scheme:
Three hours practical per week **Credits: 2**

Objectives:

- *To understand the fundamental principles of bioinformatics and using the knowledge to tackle various research problems*

Experiments:

1. Unix commands
2. PERL programming
3. Biological databases i. Nucleotide sequence databases ii. Protein sequence databases iii. Protein structure databases.
4. Sequence Analysis – blastn, blastp, blast2, fasta
5. Multiple sequence alignment and phylogenetic interpretation – Clustal, Phylip, Phylodraw.
6. Gene prediction-Genscan, ORF finder, Genmark
7. Protein prediction-Conserved domain databases, Protparam, Signalp, Motif
8. Molecular visualization – Rasmol, Cn3D, Swiss PDB Viewer
9. Structure prediction – GOR, nnpredict, Swissmodel server
10. Structure alignment and docking – Calpha match, VAST, SAT, Hex
11. Primer design-Primer3.
12. Drawing tool - Chemisketch

Sessional work assessments

Lab Practical and Record = 60%
Tests = 30%
Regularity = 10%
Total marks = 50

Semester End examination

Fair record = 10%
Viva voce = 20%
Procedure and tabulation form,
Conducting experiments and results = 70 %
Total marks = 100

SIXTH SEMESTER

BT14 601 BIOPROCESS ENGINEERING

Teaching Scheme:
3 Hrs lecture and 1 hour tutorial **Credits: 4**

Objectives:

- *To impart knowledge on the design analysis, monitoring, modelling and simulation aspects of a bioreactor*
- *To strengthen the knowledge of the design, operation and stability analysis of a bioreactor*

Module – I [15 hrs]

Introduction to fermentation process. Batch growth. Quantifying cell concentration Kinetics in batch culture. Environmental conditions on growth. Monod model. Growth kinetic with plasmid instability. Product formation kinetics. Structured and unstructured models. Thermal death kinetics of cell and Spores. Continuous culture. Monod chemostat model.

Module – II [15 hrs]

Media design for fermentation Medium requirements and formulation. Antifoams. Medium optimization. Medium sterilization – batch and continuous sterilization. Spiral heat exchanger. Sterilization of air. Inoculum preparation for industrial fermentation – operation of a typical aseptic aerobic fermentation process.

Module – III [15 hrs]

The oxygen requirements of industrial fermentation. Oxygen supply. The determination of KLa values . The sulphite oxidation method. Gassing out method. Factors affecting oxygen transfer rate in fermenters like bubble size, gas hold-up, gas velocity, temperature, pressure etc. Power required for sparged and agitated vessels. The relationship between power consumption and operating variables. Role of shear in stirred fermenters. The structural components of the fermenter involved in aeration and agitation.

Module – IV [15 hrs]

Basic functions of a fermenter. Bioreactor configurations. Design of stirred batch fermenter, chemostat, chemostat with cell recycle, fed batch fermenter. Plug flow reactor, packed bed, bubble column, fluidized bed bioreactor, trickle bed reactor, Immobilized cell bio-reactor. Air lift fermenter. Reactors for animal cell and plant cell. Scale up of fermenters. Solid state fermentation

Text Books:

1. P.F Stanbury, A. Whitaker And S.J Hall. ―*Principles of Fermentation Technology*‖ Aditya Books
   (P) Ltd, New Delhi.
2. James E Bailey & David F Ollis ―*Bio chemical Engineering Fundamentals Second Edition*. McGraw Hill Book Company.
3. Pauline M Doran ―*Bio process Engineering Principles*‖ Academic Press
4. Michael L Shuler & Fikret Kargi. ―*Bio process Engineering – Basic concepts*‖. Prentice – Hall of India Pvt Ltd.

Reference Books

1. Fermentation & Biochemical Engineering Hand Book (1983), Principles, Process Design and Equipment. HC Vogel, Noyes.
2. Principal of Microbe & Cell Cultivation (1975), SJ Prit, Blackwell Scientific co.).
3. Bioprocess Computations in Biotechnology (Vol. 1) TK Ghose, Ellis howard Ltd.
4. Bioprocess Technology- fundamentals and applications, S O Enfors & L Hagstrom (1992), RIT, Stockholm.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of continuous systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 602 FOOD BIOTECHNOLOGY AND ENGINEERING

Teaching Scheme:
3 hours lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To impart the basic concepts of food biotechnology*
- *To impart knowledge on food processing and preservation techniques and packaging techniques*

Module – 1 [15 hrs]

Role of micro organisms in manufacture and spoilage of fermented products, Cereals, Pulses, Nuts and Oil seeds, Fruits and Fruit products, Vegetables and Vegetable Products, Fish and Meat products. Adulteration in foods – milk, pulses and others, Rules and regulations

Module – II [15 hrs]

Microbiological role in food process operation and production: new protein foods: SCP; mushroom; food yeasts, algal proteins. Fermentation as a, method of preparing and preserving foods. Food additives like colouring, flavors and vitamins. Organisms and their use in pickling, alcoholic beverages and other products.

Module – III [15 hrs]

Mechanism of enzyme functions and reactions in process techniques: starch and sugar conversion process or baking by amylases; de-oxygenation and desugaring by glucose oxidase; beer mashing and chill-

proofing or cheese making by proteases and various other enzymes, catalytic actions in food processing. Process wastes: whey; molasses; starch substances and other food wastes for bioconversion to useful products.

Module – IV [15 hrs]

Introduction to Food Packaging, interaction of food material with packaging material, preservation of food products. Genetically modified and transgenic food development processing- nutritional and economic aspects.

Reference Books

1. Food Microbiology: Fundamentals and frontiers by M.P. Doyle, L.R. Beuchat and Thoma J. Montville, (2001), 2nd edition, ASM press, USA.
2. Food Science and Food Biotechnology by G.F.G. Lopez & G.V.B. Canovas (2003), CRC Press, Florida, USA.
3. Lindsay, Willis, Biotechnology, *Challenges for the flavour and food industries*, Elsvier Applied Science.
4. W.C. Frazier: *Food Microbiology (II edition or later*) Mcgraw Hill Book Company, New York (1968)
5. Fundamentals of Food Engineering , D G Rao, PHI Learning

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 603 FINANCIAL MANAGEMENT AND COST ESTIMATION OF PROCESS INDUSTRIES

Teaching Scheme:

3 Hrs lecture and one hour tutorial per week **Credits: 4**

Objectives:

- *To impart the basic concepts of financial management of process industries*
- *To impart knowledge on the cost estimation based on plant and products*

Module – I [15hrs]

Overview of financial management. Financial decisions. Capital budgeting decision. Financing decision. Dividend decision. Current asset management. Time value of money and equivalence. Compounding and discounting. Current worth and future worth of cash flows. Interest: simple interest. Compound interest. Continuous interest. Nominal and effective interest rates cost of capital. Depreciation and taxes. Nature of depreciation. Method of determining depreciation.

Straight line method. Sinking fund method. Declining balance method. Double declining balance method. Sum of digits method. Units of production method. Comparison of depreciation methods. Taxes. Effect of taxes on depreciation methods. Taxes. Effect of taxes on depreciation method. Present worth after taxes. Capital recovery factor capitalized cost. Inflation. Cost comparison under inflation.

Module – II [15 hrs]

Capital budgeting appraisal methods. Investment evaluation. Mathematical methods for profitability evaluation. Payback period. Accounting rate of return. Discounted cash flow methods. Net present value. Internal rate of return. Payback reciprocal and rate of return. Profitability index. Comparison between NPV and IRR methods. Ranking mutually exclusive projects, Capital rationing. Financing decision. Financial leverage. Effect of financial leverage on share holders earnings. Earnings per share. Return on equity. EBIT – EPS analysis Graphic representation. Risk and financial leverage. Measures of financial leverages.

Module – III [15 hrs]

Capital requirements and cost of production of process plants. Fixed capital and working capital. Estimation of capital investment. Direct costs and indirect costs. Types of capital cost estimated cost indices. Nelson refinery construction index. Material cost indices. Process equipment cost index. Labour cost index. Equipment costs. William‘s six-tenth factor. Cost components in capital investment. Purchased equipment. Installation Instrumentation and controls. Piping. Electrical items. Buildings. Yard improvements. Service facilities. Health safety and environment functions land and development.

Engineering and supervision. Legal expenses. Construction expenses. Contractor‘s fee. Contingencies.

Methods of estimating capital investment. Estimation of revenue. Estimation of total product cost. Manufacturing costs General expenses. Direct production costs. Administrative expenses. Distribution and marketing costs. Research and development costs.

Module – IV [15 hrs]

Profitability. Breakeven and minimum cost analysis. Types of costs. Variables and fixed costs. Economic production charts. Differential analysis of economic production charts.

Critique in the use of break-even and minimum cost analysis. Financial statements. Balance sheet. Profit and loss account. Ratios used for analyzing balance sheet and profit and loss account.

Text Books/Reference books.

1. Peters & Timmerhaus ―*Plant Design and Economics for chemical Engineers*‖ 5th edition, McGraw Hill
2. I.M Pandey ―*Financial Management*‖. Vikas Publishing House Pvt Ltd.
3. F.C Jellen ―*Cost and Optimization Engineering*‖.
4. Schweyer, Process Engineering Economics

5. Vilbrandt & Dryden ―*Chemical Engg Plant Design*‖.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT 14 604 PROCESS DYNAMICS AND CONTROL

Teaching scheme:

3 hours lecture and 1 hour tutorial Credits :4

Objectives:

- To impart the basic ideas of chemical process control
- To study the methods of analysis of process systems

Module-1 (15 hours)

General introduction of a process control system. Classification of variables in a chemical process. Design elements of a control system. Control aspects of a complete chemical plant. Introduction to mathematical modelling. Basics and examples of mathematical modeling. Linearization of non-linear systems. Deviation variables.

Laplace transforms-transforms, definitions. Laplace transforms of derivatives and integrals, problems. Solution of linear differential equations using Laplace transforms. Inversion of Laplace transforms. Transfer functions. Poles and zero of a transfer function.

Qualitative analysis of the response of a system. Dynamic behavior of first order systems. Study of different first order systems, problems. Dynamic behavior of higher order systems. Different examples.

Module II (15 hours)

Concept of feedback control. Types of feedback control. Types of feedback controllers.

Block diagrams. Effect of proportional, integral, derivative and composite control. Control actions on the dynamic response of a system. Notion of stability. Characteristic equation. Routh- Hurvitz criterion for stability, problems. Root locus analysis

Module III (15 hours)

Design of feedback controllers. Brief outline. Simple performance criteria. Time –integral performance criteria, selection of the type of feedback controller.

Controller tuning-ZN tuning, Cohen Coon Tuning, Problems. Frequency response analysis of linear process. Bode diagram, Nyquist plots. Bode stability criteria. Nyquist stability criterion, problems.

ModuleIV (15 hours)

A general introduction to advanced control systems. Dead time compensation, inverse response, cascade control, selective control systems, split-range control, feedback control, ratio control, adaptive control, inferential control. Introduction to direct digital control systems. Supervisory control. Distributed control system.

Process control in bioprocess systems. Direct regulatory control. Cascade control of metabolism. Advanced control strategies. Programmed batch bioreactor. Design and operating strategies for batch plants and continuous process control.

Text and references

1. Stephanopoulos, Introduction to Chemical Process Control

2.Coughanower& Koppel, Process System Analysis and Control

3.James E Bailley & DavidF Ollis, ,Biochemical Engineering Fundamentals, Mc Graw Hill

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

BT14 605 GENETIC ENGINEERING

Teaching Scheme:
3 hours lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To impart the basic concepts of genetic engineering*
- *To impart the knowledge of various techniques involved in genetic engineering*

Module- I [15 hrs]

Introduction to genetic engineering. Tools of genetic engineering. Restriction enzymes. DNA modifying enzymes. Principles of molecular cloning. Sources of DNA for cloning. Isolation of DNA. Mechanism of DNA cleavage, and end modifications. Mechanism of DNA joining. CDNA cloning. Screening strategies.

Module – II [15 hrs]

Salient features of vectors. Plasmids (plasmid biology, purification of plasmid DNA, Desirable properties of plasmid closing vehicles) Bacteriophages (Bateriophage) – others (cosmids BACS, PACS, YACS) Eucaryotic vectors. Expression vectors. Shuttle vectors. Ti plasmid of agrobacteria. DNA transfer to host: Chemical transfection, lipofection, electroporation, microinjection, gene gun, uses of viruses.

Module – III [15 hrs]

Expression of closed genes: Rationale for expression. Stability of expression vector. Functionability of expression system. Expression signals. Expression strategies. Native and fusion proteins. Construction of libraries: c DNA library, c DNA synthesis, proportion, construction uses. CDNA library Vs genomic DNA library. Sequencing; Maxim– Gilbert sequencing, Sanger sequencing, Shortgun approach.

Module – IV [15 hrs]

Application of rDNA technologies: Nucleic acid sequences as diagnostic tools. Applications in SAGE, EST, FISH, Micro array, Restriction mapping, blot analysis – southern, Northern and western blot. PCR and its applications. Molecular markers: RFLP, RAPD, AFLP, gene cloning in medicine (insulin Blood clotting factor VIII) High level.

Text Books:

1. Old RW, Primose SB ―*Principles of gene manipulation-An introduction to genetic engineering*‖. Blackwell Scientific Publications, 1993.
2. T.A.Brown. ―*gene cloning*‖.
3. Gene Cloning & DNA Analysis: An Introduction (4th edition) by T.A. Brown.
4. B.R.Glick & Jack J Pasternak ―*Molecular Biotechnology*‖.

Reference Books:

1. From Genes to Clones by Winnacker. PANIMA
2. From Genes to Genomes: Concepts & Applications of DNA Technology by J.W. Dale & M.V. Schartz.
3. Molecular Cloning by Sambrook, *et al*.
4. Principles of Gene Cloning by Old and Primrose

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 606 METABOLIC ENGINEERING

Teaching Scheme:
3 hours lecture and 1 hour tutorials per week **Credits: 4**

Objectives:

- *To understand how to regulate the metabolic pathways of bioconversion*
- *To understand the catabolite regulation pathways and also the primary metabolite synthesis pathways*

Module I [15 hrs]
Review of cellular metabolism (Transport processes, fuelling reactions, biosynthesis, growth energetic) Review of cellular stoichiometry. Regulation of metabolic pathways: Levels of regulation of enzymatic activity (overview of kinetics, reversible and irreversible inhibitions, allosteric enzymes and co-operativity) – regulation of enzymes concentration (Control of transcription and translation – example with respect of lacoperon and catabolite repression)- Global control- regulation of metabolic networks (Branch point classification, coupled reactions and global currency metabolities and energy regulation)

Module II [15 hrs]
Metabolic engineering in practice: Concept of directed cellular energy utilization – analytical and synthetic elements of metabolic engineering – targets of metabolic engineering. Metabolic Pathway analysis (Typical case study: Lysine Biosynthesis) Strategies for redirecting branched and linear pathways: (Alteration of feedback regulation; limiting accumulation of end product feedback resistant mutants, alteration of permeability).

Module III [15 hrs]

Metabolic Flux Analysis: Concept and utility of MFA – Theory – case studies – over determined systems – experimental determination of MFA by isotope labeling – applications of MFA: Case studies- concept & fundamentals of metabolic control analysis (Basic concept only).

Module IV [15 hrs]

Application of pathway manipulations: Strategies for overproduction of primary metabolites. Strategies for overproduction of secondary metabolites (precursor effects, prophophase idiophase relationship, enzyme induction, feedback regulation.) Bioconversions: (ME concepts applied in process decisions for enhanced bioconversion). Examples of pathway manipulations: Enhancement of product yield (alcohol, amino acids)– extension of substrate ranges (lignocelluloses utilization) – extension of product spectrum (antibiotic, biopolymers) - improvement of cellular properties (alteration of metabolism, enhanced efficiency and yield, genetic stability).

Text Books/References

1. G Stephanopoulos et al; *Metabolic Engineering principles & Methodologies*
2. T. Scheper R Faurie, J. Thommel *Advances in Biochemical engineering Biotechnology: Microbial production of L – Aminoacid*
3. 3 Jens Hoiriis Nielsen, Sabine Arnold: *Biotechnology for the future*.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 607 (P) HEAT AND MASS TRANSFER LAB

Teaching Scheme:
3 hours practical per week **Credits: 2**

Objective:

- *To study about the experiments in heat and mass transfer*

Experiments:

1. Conduction -Determination of thermal conductivity
2. Heat transfer through composite wall
3. Heat transfer in natural conviction.
4. Heat transfer in forced convection
5. Double pipe heat exchanger
6. Shell and tube heat exchanger
7. Simple distillation
8. Steam distillation
9. Sieve place distillation column
10. Solid -liquid extraction – Bonnotto type 11.Solid-liquid extraction- packed bed type 12.Ternary liquid equilibrium
13. Leaching – simple leaching, cross current and counter current leaching.
14. Rotary dryer
15. Adsorption isotherms
16. Batch crystallizer

Sessional work assessments

Lab Practical and Record = 60%
Tests = 30%
Regularity = 10%
Total marks = 50

Semester End Examination
Fair record = 10%
Viva voce = 20%
Procedure and tabulation form,
Conducting experiments and results = 70 %
Total marks = 100

BT14 608 (P) BIOPROCESS ENGINEERING LAB

Teaching Scheme:
3 hours practical per week **Credits: 2**

Objectives:

- *To do experiments based on enzymes and microbial cells*
- *To study about bioreactors and mass transfer effects*
-

Experiments: (has to do a minimum of 15 experiments)

1. Culturing of different types of micro organisms (Bacteria, Yeast, fungi) used in the production of commercially imported products.
2. Formulation of simple and complex culture media
3. Estimation of biomass, substrate and product analysis
4. Growth of micro organisms-estimation of Monod parameters
5. Study of growth, substrate utilization and citric acid formation kinetics in shake flask cultures
6. Enzyme isolation and assay of enzymatic activity.

7. Estimation of Michaelis – Menten parameter
   (a) Effect o substrate concentration
   (b) Determination of Km value
8. Effect of pH on enzyme activity.
9. Effect of temperature on enzyme activity.
10. Techniques of enzyme immobilization
11. Bio-conversion studies with immobilized cells or enzymes
12. Isolation of secondary metabolites (eg. Antibiotic producing microorganisms) producing organisms
13. Production of secondary metabolite (eg. Antibiotics) in industrial media.
14. Production and estimation of Ethanol using bioreactors
15. Mass transfer rate determination in bio reactors – dynamic gassing out method.
16. Oxygen transfer rate in diffused air system (aeration unit)
17. Screening of process variable-Single dimensions research, Plackett –Burman design
18. Study of rheology of fermentation broth and power determination

Sessional work assessments

Lab Practical and Record = 60%
Tests = 30%
Regularity = 10%
Total marks = 50

Semester End examination

Fair record = 10%
Viva voce = 20%
Procedure and tabulation form,
Conducting experiments and results = 70 %
Total marks = 100

SEVENTH SEMESTER
BT14 701 BIOPROCESS EQUIPMENT DESIGN

Teaching Scheme:
2 hours lecture and 1 hour tutorial and 1 hour drawing per week **Credits: 4**

Objectives:

- *To impart the basic concepts of mechanical and process design of process plants*
- *To impart design principles for bioreactor*

Module I [30 hrs]
Introduction. General design information for chemical biochemical processes plants. Development of flow sheet. Piping and instrumentation diagram and its description. General design consideration, optimum design, property estimation and material and energy balance.

Mechanical design of process equipment - Design of cylindrical and spherical vessels for internal and external pressures, Design of heads, closures and supports. Design of supports- skirt support, saddle support.

Detailed process design and drawing of double pipe heat exchanger and shell and tube heat exchangers. Design and drawing of single effect evaporators employed in bioprocess operations.

Materials of construction for process and bioprocess plants. A brief idea (no detailed design; design approach only) about the design of flanges and nozzles – Classification of flanges- Flange thickness calculation- Gasket and Bolt selection and design.

Module II [30 hrs]

Design of distillation columns: Detailed process design and drawing of perforated plate, bubble cap columns and packed towers.

Design of fermenters: Design considerations for maintaining sterility of process streams and process equipments; Process design of mechanically agitated fermenters (STR or CSTR) and non-mechanically agitated (bubble column and air lift) fermenters.

Design principles of fluidized bed bioreactor, photo bioreactor, packed column bioreactor, plug flow reactor.

Note:- Use of Perry's Chemical Engineers Handbook, IS Codes, Steam Tables and attested copies of relevant charts, data tables and empirical correlations are permitted for examination.

Text Books

1. Perry & Chilton (Ed) *Chemical Engineers Handbook* (7th and 8th edn.)
2. Peters and Timmerhaus: *Plant design and Economics for Chemical Engineers*
3. Joshi, M.V *Process Equipment design. McMillan India Ltd, Delhi*
4. S.B Thakore, B.I Bhatt, ―*Introduction to Process Engineering and Design*‖, The McGraw Hill Companies.
5. Michael L Schuler & Fikret Kargi ―*Bioprocess Engineering*‖ Prentice Hall of India Pvt Ltd.
6. Pauline M Doran ―*Bioprocess Engineering Principles*‖ Academic Press.
7. Brownell and Young, Process Equipment Design-Vessel Design, John Wiley
8. LudwigE E, Applied Process Design for Chemical and Petrochemical Plants, (Vol. 1,2 and 3) ,3rd Ed., Gulf Publishing Company, Houston
9. Roger Harrison et al., Bioseparations Science and Engineering, Oxford University Press, 2003
10. Najafpour,G.D.,Biochemical Engineering and Biotechnology, Elsevier, 2007.
11. Blanch, H. W. and Clark, D. S., Biochemical Engineering, Marcel Dekker, Inc., 1999

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be design using any software

University Examination Pattern

One question from module I involving design of equipments — *50 marks*

Candidates have to answer ONE questions out of TWO.

One question from module II involving design of equipments — *50 marks*

Candidates have to answer ONE questions out of TWO.

BT14 702 DOWN STREAM PROCESSING

Teaching Scheme:
3 hours lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *Define the fundamentals of downstream processing for biochemical product recovery.*
- *Address centrifugation, cell disruption, chromatography, crystallization, filtration, liquid-liquid extraction, membrane processes, process economics, process synthesis and simulation, protein refolding, and regulatory issues and validation*

Module I [15 hrs]

Role of downstream processing in biotechnology - role and importance of downstream processing in biotechnological processes - problems and requirements of bio-product purification. Economics of downstream processing in biotechnology - post cutting-strategies - characteristics of biotechnological mixtures – process design criteria for various classes of bio-products (high volume, low-value products and low volume, high value products - physiochemical basis of bio-separation processes.

Module II [15 hrs]

Primary Separations and Recovery Processes: Cell disruption methods for intracellular products - removal of insolubles - biomass (and particulate- debris) separation techniques –flocculation and sedimentation - centrifugation and filtration methods.

Module III [15 hrs]

Enrichment operations: Membrane based separations - classification and range of membrane systems - molecular weight cut off- types, of membranes and manufacture (isotropic and anisotropic) module types and their advantages (flat plate/hollow tube/spiral wound etc) modes of operation (cross flow and dead end)micro and ultra filtration theory - membrane characteristics (rejection factor, concentration polarization) gel concentration model - fouling and its prevention- basic design and configuration of membrane systems (batch and multi state) - industrial applications of membrane systems-

Precipitation methods (with salts, organic- solvents and polymers, extractive separations, aqueous two phase extraction, super critical extraction) - in situ product removal - integrated bioprocessing.

Module IV [15 hrs]

Classification of chromatographic separations. Typical liquid chromatographic set up - principles and working of ion exchange chromatography / adsorption chromatography / partition chromatography and affinity chromatography, chromatographic theory retention time and factor-selectivity factor plate model and rate theory. Van Deemter equation and band broadening. Electrophoretic separations (isoelectric focusing /gel electrophoresis /native and SDS page/southern and western blot techniques/capillary electrophoresis) -

Hybrid separation technologies (membrane chromatography and electro chromatography) Product polishing gel permeation chromatography, dialysis and crystallization.

Text Books :

1. Protein: Biochemistry and Biotechnology by Gary Walsh (2002 John Wiley & Sons Ltd.)
2. Process Biotechnology Fundamentals by S.N. Mukhopadhyay (2001). Viva Books Private

Limited.

3. N. Krishna Prasad. Down Stream Processing Technology – A New Horizon in Biotechnology, PHI

Reference books:

1. Belter P.A and Cussler E. Bioseparations, Wiley.
2. Product Recovery in Bioprocess Technology, BIOTOL series VCH.
3. Asenjo J. M. Separation process in Biotechnology, Marcel Dekker Inc.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 703 ENVIRONMENTAL ENGINEERING

Teaching Scheme:
3 hours lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To impart basic concepts of air pollution, water pollution and pollution due to solid waste*
- *To impart knowledge about the design of equipment for controlling air and water pollution and pollution due to solid waste*
- *To study the waste treatment of major industries*

Module – I [15 hrs]

Sources and classification of waste water. Physical, chemical and biological characteristics of waste water. Waste water sampling and analysis. Waste water microbiology Air pollution. Sampling and analysis of air pollutants. Air pollution control methods and equipment. Setting chambers, cyclone separators, fabric filters, electrostatic precipitator, wet scrubber. Control of gaseous emission – absorption and adsorption. Noise pollution – monitoring and control methods.

Module – II [15 hrs]
Wastewater treatment methods. Preliminary treatment, primary treatment. Secondary treatment. Design of activated sludge process. Aeration of activated sludge. Tricking filter, biotower, rotating biological contactor. Aerobic fluidized bed bioreactor. Chemical precipitation, coagulation, sedimentation. Design of clarifier. Disinfection. – chlorination and ozonation, ultra violet light, activated carbon adsorption, Membrane method of wastewater treatment. Sewage treatment and disposal.

Module – III [15 hrs]
Anaerobic digestion. Slow rate and high rate biomethanation. Anaerobic filter. Anaerobic contact process. Anaerobic fluidized bed bioreactor. Design of upflow Anaerobic Sludge Blanket (UASB) process. Sludge treatment and disposal Solid waste treatment – composting (aerobic, anaerobic and vermi). Landfill method of solid waste disposal. Landfill operation. Incineration. Design of an incinerator. Recycling of materials found in municipal solid waste. Soil bioremediation.

Module IV [15 hrs]
Wastewater treatment for industrial waste. Treatment methods for effluents from pulp and paper mill, dairy, distillery, tannery, food and allied industries, Edible oil refinery, soap and detergent industry, textile mill, cane sugar industry, rubber industry, drugs and pharmaceutical industry. slaughter house and meat processing industry. Common Effluent treatment Plants. Biomedical waste management. Hazardous waste management. Use of Genetically engineered organisms and emerging biotechnological processes in waste management.

Text Books/References

1. Met calf & Eddy ―*Waste water Engg, disposal & Reuse*‖ McGraw Hill
2. Peavy ―*Environmental Engg*‖ McGraw Hill
3. Rao M.N ―*Air Pollution*‖ Tata McGraw Hill
4. S.P Mahajan ―*Pollution control in Process Industries*‖ Tata MGgraw Hill Publishing Company.
5. Aarne Vesilind, A., William A Worrel and Debra R. Reinhart 2004. Solid Waste Engineering.Cengage Learning India Pvt. Ltd, New Delhi
6. Iqbal H Khan and Naved Ahsan 2009. Text Book of Solid Waste Management. CBS

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

Note: One of the assignments shall be simulation of systems using any technical computing software

University Examination Pattern
PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum

of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ELECTIVE I

BT14 704 (A) TRANSPORT PHENOMENA IN BIOPROCESS SYSTEMS

Teaching Scheme:
3 hours lecture and 1 hour tutorial per week **Credits: 4**

Objectives:
- *To impart the basic concepts of transport phenomena in process systems*
- *To develop a better understanding about momentum transfer, heat transfer and mass transfer*

Module – I [15 hrs]
Momentum transfer**:** Momentum transfer in bioprocess, comparison with other transport processes, effect of flow properties in momentum transfer and oxygen mass transfer. Oxygen transport**:** Oxygen transport to microbial cultures-Gas liquid mass transfer fundamentals, oxygen requirement of microbial cultures. Oxygen requirements of microbial cultures; oxygen mass transfer fundamentals. Oxygen transfer and oxygen demand.

Module-II [15 hrs]
Oxygen transport**:** Oxygen transfer by aeration and agitation Determination of oxygen mass transfer coefficient by various methods including dynamic gassing out and oxygen balance methods. Momentum transport by agitation**:** Power requirements and mixing characteristics of ungassed and gassed systems. Concept of power number, use of monographs. Defining impeller Reynolds number for Newtonian and non-Newtonian fluids. Concept of aeration rate to calculate impeller power requirement of gassed systems.

Module – III [15 hrs]
Mixing**:** Mixing and bioreaction interactions-flow regimes with and without baffles, various types of impellers and mixing equipment. Scale up**:** Scale up criteria for mixing equipment. Application of mixing in bioprocessing.

Module _IV [15 hrs]
Heat transfer **I**: Various modes of heat transfer. viz conduction, convection and radiation. Mechanism of heat transfer by conduction. Fourier‘s law .conductive heat transfer through a series of resistances.

Heat transfer II**:** Analogy between heat, mass and momentum transfer. Application of heat transfer in bioprocesses.

Text Books/ References
1. *Introduction to Biochemical Engineering*, D.G.Rao. Tata Mc Hill (2005)

2. *Bioprocess Engineering Principles* Paul M.Doran. Academic press (1995)

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of continuous systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 704 (B): COMPUTER BASED NUMERICAL METHODS

Teaching Scheme:
3 hours lecture and 1 hour tutorial per week **Credits: 4**

Objectives

- *To impart the basic concepts of mathematical modelling of problems in science and engineering*
  - *To know procedures for solving different kinds of problems.*
  - *To understand the various numerical techniques which provide solutions to non linear equations, partial differential equations etc that describe the mathematical models of problems.*

Module I [15 hrs]

Errors in numerical computation - mathematical preliminaries - errors and their analysis – machine computations - computer software. Algebraic and Transcendental Equations - bisection method – iteration method - method of false position - rate of convergence - method for complex root - Muller‘s method - quotient difference method - Newton-Raphson method.

ModuleII [15 hrs]

Interpolation – introduction - errors in polynomial interpolation - finite differences - decision of errors -

Newton‘s formula for interpolation. Gauss, Sterling, Bessel‘s, Everett‘s Formula - interpolation by unevenly spaced points - Lagrange interpolation formula - divided difference - Newton‘s general interpolation formula.

ModuleIII [15 hrs]

Numerical Integration and Differentiation – introduction - numerical differentiation - numerical integration - trapezoidal rule - Simpson 1/3 rule - Simpson 3/8 rule - Boole‘s and Weddle‘s rules - Euler-Maclariaun formula - Gaussian formula - numerical evaluation of singular integrals.

Module IV [15 hrs]

Statistical Computations - frequency Chart - method of least square curve fitting procedures - fitting a straight line - curve fitting by sum of exponential - data fitting with cubic splines - approximation of functions. Regression Analysis - linear and nonlinear regression - multiple regression - statistical quality control methods.

Text Books

1. E. Balagurusamy, *Numerical Methods*, Tata McGraw-Hill Pub.Co.Ltd, New Delhi, 1999.
2. C.F. Gerald and P.O. Wheatley, *Applied Numerical Analysis, 6th Ed.*, Pearson Education Asia, New Delhi, 2002.

Reference Books

1. P. Kandasamy, K. Thilagavathy and K. Gunavathy, *Numerical Methods*, S.Chand Co. Ltd., New Delhi, 2003.
2. R.L. Burden and T.D. Faires, *Numerical Analysis, 7th Ed.*, Thomson Asia Pvt. Ltd., Singapore,2002.
3. Shastri, *Introductory methods of numerical analysis*, Prentice Hall International.
4. V. Rajaraman, *Introduction to Numerical Methods*, Tata McGraw Hill.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of continuous systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 704 (C) BIOPOLYMERS

Teaching scheme:

3 hours lecture and 1 hour tutorial per week **Credits: 4**

Objectives

- To impart the knowledge of the biopolymers
- To know about the production of important biopolymers
- To know about the mechanism of biodegradation and natural fibers

Module I [15 hrs]

Polymer, monomer, degree of polymerization, amorphous and crystalline properties, glass transition temperature, weight average and number average molecular weight, molecular weight distribution, polydispersity index, What are biopolymers? Plant and animal biopolymers-polynucleotides, polyamides polysaccharides, polyisoprene, lignin, polyphosphate and polyhydroxyalkanoate, property improvements by blending, grafting applications

Module II [15 hrs]

Biosynthesis,Collagen,gelatin,casein,pectin,lignin-isolation,structure and applications, polysaccharide-starch,cellulose,dextran,pullulan,carrageenan,chitin,chitosan, hyaluronan, alginate, gums (guar, gum arabic, gum karaya, gum tragacanth, locust bean gum) ,humic acid. Superabsorbent polymers

Module III [15 hrs]

Synthesis and applications of poly hydroxy butyrate,polylactate, polyhydroxyvalerate,cutan, hydrocarbon biopolymers, production via fermentation, specific applications. Production and applications of polycaprolactone, polyhydroxy butyrate,copolymer of poly hydroxyl butyrate-poly hydroxyl valerate, polylactic acid,bionel,biopol

Module IV [15 hrs]

Natural fibers: Silk, wool, flax ,jute, linen, cotton, sisal, bamboo, pineapple leaf, and oil palm fibers, kenaf, properties and applications, property improvement b y biochemical treatment

Biodegradation, modes of biodegradation, enzymatic degradation of biopolymers and synthetic polymers. Microbial degradation of synthetic polymers

Textbook and references:

1. Johnson R.M, Mwaikambo,L.Y. and Tucker.n, Biopolymers, Rapra Technologies

2. Richard wool , and susan Sun, Biopolymers and composites

3. Platt.K, Biodegradable polymers, Rapra technologies

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of continuous systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions *4 x 15 marks=60 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 704 (D) HAZARDOUS WASTE MANAGEMENT

Teaching Scheme:
3 hours lecture and 1 hour tutorial per week **Credits :4**

Objectives:

- *To study the different types of hazardous wastes found in industries and other types of environment*

- *To gain knowledge of the methods used for hazardous waste treatment*

Module – I [15 hrs]

Classification of hazardous waste-Hazardous waste designation system-Hazardous Waste (Management and Handling) Rules-European and US and Indian Acts.
Preparation of a waste inventory-procedure and considerations-specific and non specific sources – hazardous waste numbers and codes.

Module – II [15 hrs]

Generator requirement-transporter requirements-treatment, storage and disposal requirements-ground water monitoring The hazard ranking system-prioritization of actions-contingency plans-liabilities

Module – III [15 hrs]

Hazardous waste minimization-benefits-elements of effective waste minimization programme waste audit-waste exchange-recycling

Module – IV [15 hrs]

Treatment technologies-Physical, Chemical and Biological Treatment-Management of specific recyclable hazardous waste like precious metals, lead acid batteries.
Land disposal-land treatment-deep well injection-the secure land fill-construction.

Text books/Reference

1. Davis, M.L and Cornwell, D.A. *Introduction to Environmental Engineering*, McGrawn Hill.
2. Liu I (Ed), *Environmental Engineers'Handbook*, Lewis publishers.
3. 3. Jain R. K. And Rao S. S., Industrial safety, Health and Environment Management Systems, Khanna Publishers

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 704 (E): PROCESS MODELING AND SIMULATION (Global)

University of Calicut

Teaching Scheme:

3hours lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To impart the basic ideas on the modelling and simulation of process plans*
- *To represent processes in the form of mathematical models to simplify their design*

Module I [15 hrs]

Basic modelling principles-uses of mathematical modeling - classification of modeling techniques-fundamental laws-energy equations-continuity equation-equations of motion-transport equations-equations of state-equilibrium states and chemical kinetics-examples.

Module II [15 hrs]

Mathematical models for chemical engineering systems-continuous flow tanks-, enclosed vessel-mixing - reversible reaction-steam jacketed vessel-boiling of single component liquid-open and closed vessel-continuous boiling system-batch distillation.

Module III [15 hrs]

Gas flow systems-hydraulic transients between two reservoirs-reaction kinetics-general modelling scheme-liquid phase CSTR-batch reactor-ideal binary distillation column-distributed systems-jacketed tubular reactor-laminar flow in a pipe-counter current heat exchanger.

Module IV [15 hrs]

Digital simulation-numerical integration-Euler and fourth order Runge Kutta methods- simulation of gravity flow tank – CSTR in series-non isothermal CSTR binary distillation column-batch reactor

References

1. Luben W.L., *Process Modelling Simulation and Control for Chemical Engineers* McGraw Hill
2. Franks RGE, *Mathematical Modelling in chemical Engg.* JohnWiley
3. Bequette B. W., *Process Dynamics- Modelling analysis with simulation*
4. John Ingham et.al., Chemical Engineering Dynamics- Modeling with PC Simulation, VCH Publishers

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of continuous systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum

of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 704 (F) CANCER BIOLOGY

Teaching Scheme:
3hours lecture and 1 hour tutorial per week **Credits :4**

Objectives:

- *To study the principles of carcinogenesis*
- *To study the various treatments of cancer*

Module – I [15 hrs]

Fundamentals of Cancer Biology: Regulation of Cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer. Different forms of cancers, Diet and cancer.

Module – II [15 hrs]

Principles of Carcinogenesis: Chemical Carcinogenesis, Metabolism of Carcinogenesis, Principles of Physical Carcinogenesis, X-Ray radiation – mechanisms of radiation Carcinogenesis.

Module – III [15 hrs]

Principles of Molecular Cell Biology of Cancer: Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, detection of Oncogenes. Oncogenes/Proto Oncogene activity. Growth factors related to transformation. Clinical significances of invasion, heterogeneity of metastatic phenotype. Metastatic cascade. Basement Membrane disruption. Three step theory of Invasion, Proteinases and tumour cell invasion.

Module – IV [15 hrs]

New Molecules for Cancer Therapy: Different forms of therapy, Chemotherapy, Radiation. Therapy, Detection of Cancers, Prediction of aggressiveness of cancer, advances in cancer detection.

Text Books:

1. King R.J.B., *Cancer Biology*, Addision Wesley Longmann Ltd, U.K., 1996.
2. Ruddon.R.W., *Cancer Biology*, Oxford University Press, Oxford, 1995.

Reference books:

1. ―An *Introduction top Cellular and Molecular Biology of Cancer*‖, Oxford Medical

Publications., 1991.
2. Maly B.W.J ―*Virology a practical approach*‖. IRL Press. Oxford, 1987.
3. Dunmock N.J.and Primrose S.B., ―*Introduction to Modern Virology*‖. Blackwell Scientific Publications, Oxford, 1988.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ELECTIVE II
BT14 705 (A) DEVELOPMENTAL BIOLOGY

Teaching Scheme:
3hours lecture and 1 hour tutorial per week **Credits: 4**

Objectives:
- Learn the basic principles of human embryology and development.
- Develop critical thinking skills, and will learn to visualize three-dimensionally.
- Correlate development with postnatal anatomy

Module I [15 hrs]
History & Basic Concepts: The origins of developmental biology, Concepts in development – Developmental signals in cell division & differentiation, Role of gene expression in development, Identifying developmental genes, Cell commitment & differentiation, Determination & induction of cell fate, Concept of morphogen & positional information.

Module II [15 hrs]
An Introduction to Model Systems: Model vertebrate organisms: *X. laevis*, Chicken, Mouse, Zebrafish,

Model invertebrate organisms: *D. melanogaster, C. elegans*, Model plant:*A. thaliana*

Germ Cells & Sex, Genotypic & phenotypic sex-determination in mammals, D. melanogaster and C. elegans, Structure & Formation of germ cells, Fertilization

Patterning the Vertebrate Body Plan : Axes & Germ Layers, Setting up the body axes, The origin & specification of the germ layers, The Mesoderm & Early Nervous System, Somite formation & Patterning, Role of the organizer region & neural induction

Module III [15 hrs]

Development of the Drosophila: Body Plan, Specification of body axes & role of maternal genes, Polarization of body axes during oogenesis, Patterning of early embryo & role of zygotic genes, Segmentation & role of pair-rule genes, Compartments & role of segment polarity genes, Selector & Homeotic genes

Development of Nematodes & Cellular Slime Molds: Developmental axes determination in C. elegans, Cell-fate specification in C. elegans, larval development in C. elegans, Vulva development in C. elegans, Patterning of the slug in slime mold, Cell differentiation in slime mold, Aggregation

Module IV [15 hrs]

Morphogenesis: Kinds of cleavage & blastulation, Types of tissue movement in gastrulation, Gastrulation in amphibians & mammals, Neural tube formation & neural crest migration. Cell Differentiation & Organogenesis: Models of cell differentiation, Insect imaginal disc & wing development. Molting & Metamorphosis: Amphibian metamorphosis, Insect metamorphosis.

Plant Development: Pattern development in early embryogenesis of angiosperms, Floral development

Text /Reference Book:

1. Developmental Biology, by Scott F. Gilbert (1997), Sinauer Associates, Inc.
2. Browder, Erickson, and Jeffery, Developmental Biology, Third Edition, 1991
3. Di Berardino, Genomic Potential of Differentiated Cells, 1997
4. Gerhart and Kirschner, Cells, Embryos, And Evolution, 1997

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 705 (B) MOLECULAR MEDICINE

Teaching Scheme:
3 hours lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To impart knowledge on molecular medicine*
- *To know the techniques used for treatment of diseases*

Module –I [15 hrs]
Basic biochemistry, molecular biology and genetics relevant to Molecular Medicine. Human genome: implications and applications. Single Nucleotide Polymorphism.

Module – II [15 hrs]
Gene therapy as a potential tool to cure human diseases Recombinant molecules in medicine. Transgenic and knock out animal models.

Module – III [15 hrs]
Stem cell research and its application in human health. Intellectual property right issues and ELSI (Evaluation of the Ethical, Legal and Social Implications program).

Module – IV [15 hrs]
Personalized medicine- Challenges faced- Basic concepts in systems Biology - Transcription networks, basic concepts**,** Auto-regulation, a network motif, The feed forward loop network motif**,** Network motifs in developmental, signal-transduction and neuronal networks**,** Robustness of protein circuits, the example of bacterial chemotaxis.

Text books/ Reference Books:

1. *Encyclopedic Reference of Genomics and Proteomics in Molecular Medicine*. Ganten, Dettv; Ruckpaul, Klaus
2. Bertarand Jordan ,*Travelling Around the Human Genome: An in Situ investigation*,.
3. J.Larry Jameson , *Principles of Molecular Medicine*,
4. R.J.Trent *Molecular Medicine: An Introductory Text*,
5. Alan David Blair Malcolm *Molecular Medicine*,
6. *Molecular Medicine: Insight into the Cellular and Molecular Basis of Disease* Published by Johns Hopkins University Press.
7. Dennis W.Ross *Introduction to Molecular Medicine*, Pounds.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions *4 x 15 marks=60 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 705 (C) GENE AND STEM CELL THERAPY

Teaching Scheme:
3hours lecture and 1 hour tutorial per week **Credits :4**

Objectives:

- *To impart knowledge on the transfer and expression of genetic materials*
- *To obtain a basic knowledge of the treatment of diseases using gene and stem cell therapy*

Module I [15 hrs]

Stem cell: Introduction – stem-cells-properties and importance of stem cells – sources of stem cells- adult, embryonic, cord blood stem cells-classification of stem cells-multi-potent, pluripotent, toti-potent, uni-potent stem cells, and clinical application of stem cells.

Module – II [15 hrs]

Stem cell therapy: Overview of stem cell therapy -harvesting of stem-embryonic, fetal and adult stem cell therapy- therapeutic cloning-current and potential stem cell treatments.

Module – III [15 hrs]

Gene therapy: Understanding gene therapy –types of gene therapy –germ line gene therapy and somatic gene therapy-vectors in gene therapy-viral and non viral methods-using stem cells for gene therapy-developments in gene therapy-clinical applications.

Module – IV [15 hrs]

Ethics of gene and stem cell therapy: Stem cell research-stem cell problems-concerns about stem cells-immunological challenges for stem-controversy and safety of stem cells-problems and ethics of gene therapy.

Reference Books

1. *Stem cell biology and gene therapy*: Edited by Peter J. Quesenberry, Gary S. Stein, Bernard Forget.
2. *Stem cells* by ariff bongso, Eng Hin Lee, Sydney (FRW) Brenner

3. *Embryonic stem cells* by Kursad Turksen
4. *Cell therapy* by George Morstyn,William Sheridan.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions *4 x 15 marks=60 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 705 (D) MODELING AND SCALE UP OF BIOREACTORS

Teaching Scheme:
3hours lecture and 1 hour tutorial per week **Credits :4**

Objectives:

- *To impart knowledge on applications of modeling in bioreactor design*
- *To obtain a basic knowledge of scaling up operations*

Module I [15 hrs]

A brief outline of types and structure elements of bioreactors: Reactors with mechanical and compressed air energy input, membrane reactors for bubble free aeration; modes of operation of a bioreactor- Batch, fed-batch, continuous cultivation, cultivation with cell retention, repeated (cyclic batch) cultivation; aerobic , anaerobic and micro aerobic processes.

Modeling basics: Definition of a model; types of models (physical, mathematical and verbal); the need for modeling and control in biotechnical processes; steps in model building. Approach to modeling, Unstructured and structured modeling, Deterministic and stochastic models, Segregated and unsegregated models. Stochastic model for thermal sterilization of the medium

Module II [15 hrs]

Bioreactor Models: Stirred tank reactors- Description of physical processes in the stirred tank reactor, Modeling of gas/liquid flow in stirred tank reactors, single phase flow- transport equations; gas /liquid flow- multiphase conservation equations, interfacial forces, drag force, virtual mass force- turbulence and impeller models; Bubble column bioreactors. Recirculation and compartment models; Bubble column and Airlift tower loop reactors- description of physical processes, Flow models, Reactor models. Basic equations of motion- fundamental laws (mass conservation, momentum conservation, Navier Stoke‘s

equation system); Two fluid model, Euler-Lagrange approach- Dynamics of dispersed gas phase, effective viscosity, Mass transfer with chemical reaction, mixing due to bubble rise, Problems of bubble coalescence and redispersion; modeling particular aspects of bubble column reactors- velocity patterns, fate of individual cells, influence of tilted columns, oxygen distribution-design procedure for bubble columns.

Module III [15 hrs]

Sub models of bioreactor processes: Engineering components- Temperature control system, Pressure behavior, Aeration behavior; pH model, reaction model (A brief introduction is only desired).

Principles of similarity, pilot plants and models: Introduction to scale-up methods, pilot plants and models and principles of similarity. Dimensional Analysis and Scale-Up Criterion: Dimensional analysis, regime concept, similarity criterion and scale up methods used in chemical engineering. Scale up and scale down issues: Regime analysis of bioreactor processes. Correlations for oxygen transfer Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development, nutrient availability and supply.

Module IV [15 hrs]

Bioreactor scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer coefficients. Scale-up of stirred tank bioreactors. Scale up of downstream processes: Adsorption (LUB method); Chromatography(constant resolution etc.); Filtration (constant resistance etc.); Centrifugation (equivalent times etc.); Extractors (geometry based rules). Scale-down related aspects.

Text Books/ References

1. Schugerl K., Bellgardt K.H, Bioreaction Engineering- Modeling and control, Springer.
2. Harvey.W. Blanch, Douglas. C. Clark, Biochemical engineering, Marcel Dekker.
   K.Schugerl, Measuring, Modeling and Controlling Biotechnology- a multivolume comprehensive treatise (Rehm and Reed eds.) VCH, Weinheim.
3. Johnstone and Thring, Pilot Plants Models and Scale-up methods in Chemical Engg., McGraw Hill, New York, 1962.
4. Marko Zlokarnik, Dimensional Analysis and Scale-up in Chemical Engg.,Springer Verlag, Berlin, Germany, 1986.
5. Donald G. Jordan, Chemical Process Development (Part 1 and 2), Interscience Publishers, 1988.
6. 7.Nauman Bruce, Handbook of Chemical Reactor Design, Optimization and Scale up McGraw Hill, 2002
7. Nauman, E. B, Chemical Reactor Design, Optimization and Scale up, 2nded., John Wiley and Sons. 2008
8. Pauline. M. Doran, Bioprocess engineering principles, Academic press, 1995.
9. Najafpour, G. D, Biochemical Engineering and Biotechnology,Elsevier, 2007.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 705 (E) MOLECULAR MODELING AND DRUG DESIGN (Global)

Teaching Scheme:

3hours lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To impart knowledge on various molecular modeling structures*
- *To impart knowledge on analog and structure based drug design*

Module –I [15 hrs]
Introduction to Molecular Modelling: Introduction to molecular modelling. Use of models. Areas of application – Single molecule calculation, assemblies of molecules. Reaction of the molecules. Drawbacks of mechanical models as compared to graphical models. Co ordinate systems twomatrix, potential energy surface. Quantum Mechanics:Postulates of quantum mechanics, electric structure calculations, abinitio, semi-empirical and density functional theory calculations, molecular size versus accuracy. Approximate molecular orbital theories.

Module – II [15 hrs]
Empirical Force Field Models: Molecular Mechanisms, energy calculations, Bond stretch, angle bending, tensional term Electrostatic interaction – Van der Waals interactions. Miscellaneous interaction. Molecular Dynamics: Introduction, molecular Dynamics using simple models. Dynamics with continuous potentials. Constant temperature and constant dynamics. Conformation searching. Systematic search applications to protein folding.

Module – III [15 hrs]
Comparative protein modeling :Modelling by Homology the alignment, construction of frame work, selecting variable regions, side chain placement and refinement, validation of protein models – Ramchandran plot, threading and ab initio modelling. Analog based drug design: Introduction to QSAR, lead module linear and nonlinear modeled equations, biological activities, physicochemical parameter and

molecular descriptions, molecular modeling in drug discovery.

Module – IV [15 hrs]
Structure based drug design : 3D pharmacophores, molecular docking, De Novo Ligand design, free energies and solvation, electrostatic and non electrostatic contribution to free energies.

Further applications on the design of new molecules: 3D data base searching and virtual screening. Source of data, molecular similarity and similarity searching, combinatorial libraries – generation and utility.

Text Books
1. *Principles and applications of modeling* by Leach
2. *Molecular modeling* by the Hans Peter Heltie & Gerd Falkens, VCH.

References
1. *Chemical Applications of Molecular Modelling* by Jonathan Goodman.
2. *Computational Chemistry* by Guy H, Grant &W Graham Richards, Oxford University.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 705 (F) GENOMICS AND PROTEOMICS

Teaching Scheme:
3 hours lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To provide an advanced knowledge of gene expression and gene therapy*
- *To understand the various technologies of gene mapping, proteomic techniques and new target identification for drug discovery*

Module I [15 hrs]

Structure and organization of prokaryotic and eukaryotic genomes nuclear, mitochondrial and chloroplast genomes; Computational analysis of sequences- finding genes and regulatory regions; Gene annotation; Similarity searches; Pairwise and multiple alignments; Alignment statistics; Prediction of gene function using homology, context, structures, networks; Genetic variation-polymorphism, deleterious mutation; Phylogenetics; Tools for genome analysis–PCR,RFLP, DNA fingerprinting, RAPD, Automated DNA sequencing; Linkage and pedigree analysis; Construction of genetic maps; Physical maps, FISH to identify chromosome landmarks.

Module II [15 hrs]

Human genome project-landmarks on chromosomes generated by various mapping methods; BAC libraries and shotgun libraries preparation; Physical map-cytogenetic map, restriction map, DNA sequence; DNA sequencing and sequence assembly; Model organisms and other genome projects; Comparative genomics of relevant organisms such as pathogens and non-pathogens; Evolution of a pathogen e.g. Hepatitis C virus or a bacterial pathogen; Taxonomic classification of organisms using molecular markers- 16S rRNA typing/sequencing;

Module III [15 hrs]

Overview of protein structure-primary, secondary, tertiary and quarternary structure; Relationship between protein structure and function; Outline of a typical proteomics experiment; Identification and analysis of proteins by 2D analysis; Spot visualization and picking; Tryptic digestion of protein and peptide fingerprinting; Mass spectrometry : ion source (MALDI, spray sources); analyzer (ToF, quadrupole, quadrupole ion trap) and detector; clinical proteomics and disease biomarkers; Prions; proteins in disease; Protein-protein interactions: Solid phase ELISA, pull-down assays (using GST-tagged protein), far western analysis, by surface plasmon resonance technique, Yeast two hybrid system, Phage display; Protein interaction maps; Protein arrays-definition, applications- diagnostics, expression profiling.

Module IV [15 hrs]

Human disease genes; DNA polymorphism including those involved in disease; Hemoglobin and the anemias; Phenylketonuria (monogenic) and diabetes (multigenic) genetic disorders; ‗disease' gene vs. ‗susceptibility' gene; SNP detection: hybridization based assays (allele specific probes); Polymerization based assays (allele specific nucleotide incorporation, allele-specific PCR); Ligation based assays (allele specific oligonucleotide ligation); Polymorphism detection without sequence information: SSCP; Proteomics and drug discovery; High throughput screening for drug discovery; Identification of drug targets; Pharmacogenomics and pharamacogenetics and drug development; Toxicogenomics; Metagenomics.

Text Books:

1. Introduction to Genomics . Arthur Lesk. Oxford University Press, 2008
2. Brown TA, Genomes, 3rd Edition, Garland Science, 2006.
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, Benjamin Cummings, 2007.
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.

Reference Books:

1. Saccone, Graziano Pesole. Wiley-LISS Publication (2003).
2. Comparative Genomics by Melody S. Clark. Kluwer Academic Publishers (2001).
3. Essentials of Genomics & Bioinformatics C.W. Sensen, Wiley (2003).
4. Discovering Genomics, Proteomics & Bioinfo, A.M. Campbell, C.S.H. Press, (2003)
5. Various research and review journals like Nature Biotechnology, Current Opinion,
6. Trends and Annual Reviews.
7. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 706 (P) DOWNSTREAM PROCESSING LAB

Teaching Scheme:

3hours practical per week **Credits: 2**

Objectives:

- *To conduct experiments in downstream processing operations*

Experiments:

1. Cell disruption techniques
2. Filtration
3. Centrifugation
4. Sedimentation
5. Leaching
6. Membrane based filtration – Ultra Filtration and Micro Filtration
7. Protein precipitation methods and its recovery
8. Two-phase aqueous extraction

9. Liquid chromatographic techniques
10. Electrophoretic separation techniques
11. Dialysis
12. Crystallization
13. Drying

Sessional work assessments

Lab Practical and Record = 60%
Tests = 30%
Regularity = 10%
Total marks = 50

Semester End examination

Fair record = 10%
Viva voce = 20%
Procedure and tabulation form,
Conducting experiments and results = 70 %
Total marks = 100

BT14 707 (P) REACTION ENGINEERING AND PROCESS CONTROL LAB

Teaching Scheme:
3 Hrs practical per week **Credits: 2**

Objectives:

- *To conduct experiments in reaction engineering and process control*

Experiments: [Minimum 12 experiments needs to be conducted]

1. Kinetics of hydrolysis of esters
2. Determination of activation energy
3. Batch reactor
4. Stirred tank reactor
5. Plug flow reactor
6. Fixed bed reactor
7. Fluidized bed reactor
8. Recycle bed reactor
9. UV photo reactor
10. RTD in CSTR
11. Time constant of manometer
12. Calibration of thermo couple
13. Dynamics of liquid level systems-interacting and non-interacting
14. Measurement of level by capacitance method
15. Characteristics of P.I.D controller
16. Control valve characteristics

Sessional work assessments
Lab Practical and Record = 60%
Tests = 30%
Regularity = 10%
Total marks = 50

Semester End examination
Fair record = 10%
Viva voce = 20%
Procedure and tabulation form,
Conducting experiments and results = 70 %
Total marks = 100

BT14 708 (P) PROJECT

Teaching Scheme:
4 hours per week **Credit: 4**

Objectives:

- *To judge the capacity of the students in converting the theoretical knowledge into practical systems/investigative analysis.*

Project work is for duration of two semesters and is expected to begin in the seventh semester and completed in the eighth semester. Each student group consisting of not more than five members is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. Project evaluation committee consisting of the guide and three/four faculty members will perform the screening and evaluation of the projects. Each project group should submit project synopsis within three weeks from the start of the seventh semester. Project evaluation committee shall study the feasibility of each project work before giving consent. Literature survey and 40 % of the work has to be completed in the seventh semester.

Students should execute the project work using the facilities of the institute. However, external projects can be taken up in reputed industries, if that work solves a technical problem of the external firm. Prior sanction should be obtained from the head of the department before taking up external project work and there must be an internal guide for such projects. The objective of the project is to test the ability of the student to coordinate the entire knowledge of biotechnology engineering and to judge the student‘s capacity in the design of plant/ process system. The project can be experimental or design based. The students are required to prepare the project report on a complete process showing the selection of alternatives, preparation of flow sheet, bioprocess calculations and detailed design calculations of the major items of equipments. The project should include mechanical design, capital cost; product cost estimation, profitability, breakeven analysis, plant location and lay out. The project selected should be an industrial problem. Any laboratory experimental data generated may be used for the design of the industrial plant. The assessment shall be based on individual and group performance.

Each student has to submit an interim report of the project at the end of the 7th semester. Members of the group will present the project details and progress of the project before the committee at the end of the 7th semester. 50% of the marks is to be awarded by the guide and 50% by the evaluation committee.

Internal Continuous Assessment

20%- Technical relevance of the project
40%- Literature survey and data collection
20%- Progress of the project and presentation
10%- Report
10%- Regularity in the class
Total Marks: 100

EIGHTH SEMESTER

BT 14 801 BIOPROCESS INSTRUMENTATION

Teaching Scheme:

3 hours lecture and 1 hour tutorial per week. Credits : 4

Objectives:

- To impart the basic ideas about instruments
- To evaluate the operating principles of different instruments
- To study about biosensors and instrumentation of bioprocesses

Module I [15 hrs]

Introduction .Definition of instrumentation concept of an instrument. Functional elements and functions of an instrument. Classification of instruments. Static and dynamic characteristics of measuring instruments. Accuracy, reproducibility, sensitivity, static error, dead zone, dynamic error, fidelity ,lag, and speed of response

Sensing elements-various types, sensors for temperature, pressure and fluid flow, transducers- their principles and working, transmission methods, indicating and recording means. Temperature measurements, temperature scales, basic principles and working of thermometers, mercury in glass thermometers, thermocouples, ranges of different types of temperature measuring instruments. Sources of errors and precautions to be taken in temperature measurements

Module II [15 hrs]

Pressure measurement. Mcleod gauge, Knudsen gauge, Bourden gauge,bellow, diaphragm.Transducers of electrical and mechanical types. Piezo-electric manometers, thermal conductivity gauges, ionization gauge ,liquid level measurements, gas density detector

Moisture content determination by thermal drying. Instruments for measuring humidity .Composition analysis using spectroscopic methods like absorption, emission and mass spectrometers. Gas analysis by thermal conductivity, polarography and chromatography.

Module III [15 hrs]

Biosensors, types and features, various components of biosensors, Transducers, calorimetric, optical, potentiometric/ amperometric, conductometric/ resistometric biosensors, Biosensors for glucose, alcohol, carbon dioxide, cell population, BOD

Module IV [15 hrs]

Instrumentation for bioprocesses, schematic summary of biochemical reactor instrumentation, Physical and chemical sensors for the medium and gases. On -line sensors for cell properties. Off-line analytical

methods. Foam sensing and control unit, , measurement and control of dissolved oxygen ,pH measurement and control. Components of a computer linked system, logging of process data, data analysis, and process control

Text books /references

1. Eckmann D.P., Industrial Instrumentation, Wiley Eastern
2 Fribance, Industrial Instrumentation Fundamentals, TMH edition
3 Jain R.K, Mechanical and Industrial Measurements, Khanna Publishers
4 Bailley and Ollis, Biochemical engineering Fundamentals, McGraw Hill
5 Mukhopadhyay S.N., Process Biotechnology Fundamentals, Viva Books
6 Stansbury, Whitaker, Hall, Principles of Fermentation Technology, Elsevier

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

Note: One of the assignments shall be simulation of systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 802 SAFETY AND BIOSAFETY IN PROCESS PLANTS

Teaching Scheme:
3 Hrs lecture and 1 hour tutorial **Credits: 4**

Objectives:

- *To impart the basic concepts of safety procedures carried out in chemical process plants and bioprocess plants*
- *To impart knowledge on safety and biosafety guidelines*

Module – I [15 hrs]

Operational Parameters in a process plant, duties and responsibilities of operator, supervisor and process engineer and manager in a process plant. Raw materials scheduling, start-up, shut down. Common operational problems in process plants, Trouble shooting methods. The role of preventive maintenance and break-down maintenance. Plant utilities –water, power, steam, air and fuels. Elementary aspects of

quality management systems, Environment management systems-benefits of EMS certification, Requirements of EMS-Environmental policy, planning, implementation and operation, checking and corrective action management review. Occupational Health and safety Management Systems:- BS 8800, OHSAS 18001 & 18002, ISO 9000. Good Manufacturing Practice in industry.

Module – II [15 hrs]

Chemical hazards, Toxic chemicals-dusts, gases, fumes, mists, vapours and smoke. Exposure evaluation. The concept of threshold limit, chronic and acute exposure effects. Safety equipments in chemical plants – working principles. Safety in chemical reactions and storage and explosive or flammable dust, gases, vapours etc. Identification of hazards. Chemistry of fire, composition of combustion – flame, heat, fire, gases, smoke, ignition temperature, LFL – UFL-Flash point, Fire point. Spontaneous combustion. Classification of fires, flammability principles. Fire prevention, Fire protection in process plants. Fire and Explosion rating of process plants- Introduction to the modeling of fire explosion and toxic gas dispersion, pool fire, torch, BLEVE, HAZOP and HAZAN. Event probability and failure frequency analysis (Fault and Event Tree analysis). Designing for safety, emergency planning and disaster management.

Module – III [15 hrs]

Biosafety guidelines and regulations, FAO, USDA & DBT guidelines on biosafety. Containment of equipment and apparatus in biotechnology industry and research, Good laboratory Practices.

Biosafety levels- Containment in BSL-1, BSL -2, BSL-3, BSL-4 levels, design requirements and standard microbiological laboratory practices in each level. Design for Good Laboratory Practices, Waste disposal, shipping transportation and treatment of bio-hazardous materials and waste products. Decontamination of industrial and laboratory wastes:- agents, selection and methods for decontamination.

Module –IV [15 hrs]

Hazards of genetic engineering, bio-safety for human health and environment, social and ethical issues pertaining to genetic engineering, bio-safety in relation to transgenic research, r- DNA guidelines and applications. Bio-safety and cartagene protocol, Environmental monitoring of GM crops and organisms. Risk assessment of GM organisms and crops released into the environment.

References:

1. F.P Lease: *Loss prevention in Process plants worth*, London
2. G.LWells: *Safety in Process Plant Design*, IChem E/ Godwin
3. *Comprehensive Bio technology* Vol IV, Murray Moov –Young.
4. D.A Shapton and R.G Board: *Safety in microbiology*, Academic Press London.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 803 INDUSTRIAL BIOTECHNOLOGY AND BIOPHARMACEUTICALS

Teaching Scheme:
3 Hrs lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To describe the various technologies involved in manufacture of industrial products in biotechnology*
- *To give knowledge about the manufacture of major biopharmaceuticals*

Module I [15 hrs]
A review of industrial fermentation and enzymatic processes and products. Role of a bioprocess engineer in bioprocess industry. Outline of the various unit operations involved in the upstream and downstream operation of a bioprocess plant. Process flow sheeting,Strain development. General fermentation process.

Development of Drug and Pharmaceutical Industry, Economics of drug industry, pharmaecoaomics, Good manufacturing practice.

Module II [15 hrs]
Production of citric acid, gluconic acid, lactic acid, acetic acid, ethanol, acetone/butanol, glutamic acid, lysine, pencillins, cephalosporin, baker's yeast, alcoholic beverages, high-fructose corn syrup.

Module III [15 hrs]
Vitamins B12, riboflavin, protease, amylase, glucose isomerase, SCP. Insulin**,** Interferon, erythropoietin, streptokinase, interleukin, blood factor VIII, monoclonal antibodies, vaccines

Module IV [15 hrs]
Biophamaceutics- Drug absorption, distribution, chemical principles affecting all the above plasma models, Pharmacogenomics. and metabolism, Pharmacokinetics &. Physico drug concentration - time profile – Pharmacokinetic Models, Pharmacogenomics

Text Books/references

1. Gary Walsh ―*Biopharmaceuticals: Biochemistry and biotechnology*‖ John Willey & Sons Ltd
2. L.E Casida ―*Industrial Microbiology*‖ New Age International Publishers
3. S.N Jogdand ―*Bio pharmaceuticals*‖ Himalaya Publishing House.
4. Mooray Muyoung ―*Comprehensive Bio technology*‖ Pergames press.
5. Prescott and Dunn: ―*Industrial Microbiology*‖ CBS Publishers.
6. Leon Lachman etal, *Theory and practice of IndustrialPharmacy*, Lea arid Febiger.
7. Richard B. Silverman, *The Organic Chemistry of Drug Design and Drug Action, Elsevier, Publications*

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz,

literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ELECTIVE III

BT14 804 (A) BIOETHICS AND INTELLECTUAL PROPERTY RIGHTS (Global)

Teaching Scheme:

3 Hrs lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To impart knowledge on bioethics and intellectual property rights*
- *To study the various ethical issues occurring in biotechnology*

Module – I [15 hrs]

Biotechnology and Bioethics. Ethical biotechnology? (Rights, Confidentiality, Animal Rights, Environmental Ethics, Decision Making) – Ethical Aspects of Designer Babies, genetic screening and prenatal testing – issues of ethics in biomedicine. Transgenic plants. The debates of GM foods. Terminator technology, Ethical, issues of the Human Genome Project. Ethical issues in pharmaceutical drug research. Orphan drugs.

Module – II [15 hrs]

Intellectual Property Rights – Development and need for IPR in knowledge based industries. Various types of intellectual Property Rights with examples (Trademarks, Copyrights, Industrial Designs, Patents, Geographical Indicators etc) – Objectives of the patent system – Basic principles and general requirements of Patents (Novelty, Utility Non obviousness. Etc) and tenets of patent law – Product and Process Patents)

Module – III [15 hrs]

The patenting process in India – Exercising and enforcing of Intellectual Property Rights. Rights of IPR owner Brief overview of patent filing in India. Criteria for patent infringement – Various Amendments to Patent Law in India. Comparison of Patent Law in India and the US. International conventions and

treaties: TRIPS. Evolution and present status. WIPO and its functioning. CBD Treaty. Paris and Berne Conventions Enforcement and Dispute Settlement in WTO – Patent Cooperation Treaty IPR andWTO regime.

Module – IV [15 hrs]

Biotechnological inventions and patent law – patentable subjects and protection in biotechnology. The patentability of microorganisms – Diamond vs. Chakrabarty Case – Bioprospecting & Biopiracy (Case studies of Neem / Turmeric / Arogyapacha of Kani Tribals in Kerala/Rosy Periwinkle of Madagascar)- Traditional knowledge Systems (TKS) – Options for protection of Traditional Knowledge Systems. Need for Sui Generics Systems. TKS and the National and International Arena. Biodiversity and Farmers rights – IPR and Plant Genetic Resources – Plant Breeder Rights .UPOV Treaty.

Text Books/ Reference books

1. *Ethical Issues in Biotechnology*. Edited by Richard Sherlock and John D.Morrey. 2002 Publishers Lanham, Md: Rowman and Littlefield.
2. J.Rehm and G.Reed, *Biotechnology*, Second Edition, Multi Volume Treatise, Volume 12
3. Legal Economic and Ethical Dimensions, VCHPublishers.
4. Prabuddha Ganguli *Intellectual Property Rights-Unleashing the Knowledge Economy*. Tata McGraw Hill Publishing Company Limited, New Delhi.
5. Beier, F.K, Crespi, R.S and Straus, T.*Biotechnology and Patent protection* – Oxford and IBH Publishing Co. New Delhi.
6. Sasson A, *Biotechnologies and Development*, UNESCO Publications.
7. Jeffrey M.Gimble, *Academia to Biotechnology,* Elsevier, Academic Press.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of continuous systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 804 (B) BIOMATERIALS

Teaching Scheme:
3 Hrs lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To study the structure and characteristics of different types of biomaterials of natural and synthetic origin*
- *To give an idea on the effective uses of these materials*

Module I [15 hrs]

Structure of solids. Review of basic concepts. Biomaterials: definition, classification. Polymers, metals, alloys, ceramics and composites, physical, chemical and mechanical aspects of bulk and surface properties of metallic, polymer and ceramic biomaterials (in vivo and in vitro) Corrosion studies. Structure property relation. Characterization of biomaterials. Bulk analysis-XRD, FTIR, SEM, TGA etc. Surface analysis-XPS, SIMS, AES, STM etc.

Module II [15 hrs]

Hard tissue replacement implant: orthopaedic implants (hip, knee), dental implants, adhesives and sealants. Soft tissue replacement implant. Skin implant, burn (wound), dressings/ synthetic skin, dialysis membranes, scaffolds, vascular implants, heart valve implants. Artificial kidneys and livers. Sutures, biomaterials for gene delivery. Hydrogel as stimuli- sensitive biomaterials, ophthalmologic implants, biomaterials for drug delivery

Module III [15 hrs]

Blood and tissue compatibility of biomaterials and their in vitro and in vivo assessment. Tissue response to biomaterials. Importance of interfacial tissue reaction (eg. Ceramic bone tissue reaction). Qualification of implant (in vivo and in vitro) Blood materials interaction. Mineralization and encrustation, microbial biofilm formation, bacterial adhesion toxicology, degradation of biomaterials in biological environments. Toxicity of biomaterials, acute and chronic toxicity studies. Implant associated infection

Module IV [15 hrs]

Biopolymers, definition, plant and animal biopolymers- polynucleotide, polyamides, polysaccharides, polyisoprene, lignin, polyphosphate and poly hydroxyl alkanoates. Application and chemical synthesis of super absorbent polymers, polyethylene glycol, polypropylene glycol, poly tetra methylene glycol, polyglycerine. Bioplastics and environment, commercial bioplastics. Natural fibers like silk, wool, flax, jute, linen, cotton, sisal, bamboo. Biocomposite- properties and applications

Text books/ references

1. Ratner, Hoffman, Schoen *Biomaterial science- an introduction to materials in medicine* Academic press
2. Park .J.B. *Biomaterials- science and engineering*, Plenum press
3. Sharma C.P., Szycher.M *Blood compatible materials and devices* Technomic publishing company
4. Raghavan.V, *Materials Science & Engineering – A First Course*, 5th edition, Prentice Hall of India, New Delhi,2005
5. Sujata V. Bhat, *Biomaterials*, 2nd edition, Narosa Publishing House, New Delhi, 2006.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be simulation of continuous systems using any technical computing software

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 804 (C) NANOBIOTECHNOLOGY

Teaching Scheme:
3 Hrs lecture and 1 hour tutorial per week **Credits: 4**

Objective:

- *To impart basic ideas on nanoparticles*
- *To impart knowledge on the use of bionanoparticles and their applications in biotechnology*

Module – I [15 hrs]

Introduction to Nanobiotechnology and Nanomedicine, Visualization and manipulation on nanoscale. Atomic Force Microscopy, Magnetic Resonance Force Microscopy, ScanningProbe Microscopy, Nanoscale Scanning Electron Microscopy, Optical Imaging with a Silver Superlens.

Module – II [15 hrs]

QuantumDots, Gold Nanoparticles, Lipoparticies, Assembly of Nanoparticles into Micelles, Biomedical applications of self-assembly of nanoparticles, Paramagnetic and superparamagnetic nanoparticles, Fluorescent nanoparticles.

Module – III [15 hrs]

Bacterial structure relevant to nanobiotechnology, Cubosomes, Dendrimers, DNANanoparticleConjugates, DNA Octahedron, Fullerenes, Nanoshells, Carbon Nanotubes,Nanopores, Nano structured Silicon.

Module – IV [15 hrs]

Molecular motors, Nanoparticles for molecular diagnostics, Nanobiosensors, Nanopharmaceuticals, Nanoparticle – Based Drug Delivery, Nanostructures for Tissue Engineering/Regenerative. Medicine, Ethical safety, and regulatory issues of nanomedicine.

References

1. *Nanobiotechnology: Bioinspired Devices and Materials of the Future*: Oded Shoseyov and llan Levy.
2. *Nanomaterials and Nanosystems for Biomedical Applications*: M.Reza Mozafari.
3. *The Handbook of Nanomedicine*, Kewal K.Jain
4. *Bio Nanotechnology*, Elisabeth S.Pappazoglou, Aravind Parthasarathy
5. *Biomedical Nanostructures*, Kenneth E.Goonsalves, Craig R.Halberstadt, Cate T. Laurecin, Lakshmi S.Nair.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 804 (D) IMMUNOLOGY AND IMMUNOTECHNOLOGY

Teaching Scheme:

3 Hrs lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To impart knowledge on the immune system*
- *To impart knowledge on immunity to infection and molecular immunology*

Module – I [15 hrs]

The Immune System*:* Introduction – hematopoiesis and blood cell formation – cells of the immune system – lymphocytes – their origin and differentiation – antigens – their structures and classification-complement and their biological functions.

Module – II [15 hrs]

Humoral immunity*:* Structure and function of immunoglobulin – Immunoglobulin classes and subclasses-genetic control of antibody production. B-Lymphocytes, their generation, activation and differentiation. Cellular immunology –Major histocompatibility complex, Antigen processing and presentation-Tcell receptor-Tcell maturation, activation and differentiation, cytokines and the role in immune response.

Module – III [15 hrs]

Immunity to infection*:* Hypersensitivity reactions – Gell and Coombs classification –IgE mediated hypersensitivity- antibody meditated hypersensitivity- immune complex meditated hypersensitivity – delayed type hypersensitivity. Transplantation*:* Graft rejection – evidence and mechanisms of graft rejection – immunosuppressive drugs – HLA and disease Auto immunity*:* Auto antibodies in humans-pathogenic mechanisms-experimental models of autoimmune diseases-treatment of autoimmune disorder.

Module – IV [15 hrs]

Molecular Immunology*:* Preparation of vaccines – application of recombinant DNA technology for the study of the immune systems-catalytic antibodies-immunotherapy with genetically engineered antibodies. Current topics in Immunology*:* Hybridoma technique and monoclonal antibody production – Diagnostics methods: Immunodiffusion, immunoelectrophoresis. Radioimmunoassay ELISA, Western blot.

Text Books:

1. Janis Kuby, *Immunology*,W.H Freeman & Company.
2. Roitt I.M., Brostoff J and Male D.K *Immunology* Mosby Publication
3. Ivan I., *Immunological Methods manual*, academic Press.
4. Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York, 1988.

Reference Books

1. Ashim K. Chakravarthy, Immunology, Tata McGraw-Hill, 1998.
2. Antibodies A laboratory Manual: Harlow and David Lane (1988), Cold spring harbor laboratory.
3. Charles Janeway, *Immunobiology: The Immune System in Health and Disease*, Garland Science, 2005.
4. Richard Coico, Geoffrey Sunshine, *Immunology: A Short Course*, John Wiley & Sons, 2007.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions 8x 5 marks=40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 804(E) RECOMBINANT DNA TECHNOLOGY

Teaching Scheme:

3 Hrs lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To impart the basic concepts of recombinant DNA technology*
- *To study the application of recombinant DNA technology*

Module – I [15 hrs]

Introduction of recombinant DNA into a host (Bacteria, plants & animals by various methods) Transformation – in vitro packaging into phages – transfection – reporter genes and gene targeting. Recombinant selection and Screening – use of probes – RNA, DNA and DNA – nucleic acid hybridization – southern, northern blotting – colony and plaque hybridization – Screening by immunochemical methods.

Module – II [15 hrs]

Salient features of prokaryotic and eukaryotic expression systems – fusion proteins – secreted proteins – in vitro gene expression. Polymerase chain reaction (PCR) – basic reactions – inverse PCR – RT PCR-RACE applications of PCR. Mutagenesis – deletion mutagenesis – oligonucleotide directed mutagenesis – PCR based mutagenesis – Site directed mutagenesis and its applications.

Module – III [15 hrs]

Chemical method of Maxam & Gilbert – enzymatic (dideoxy chain termination) method of Sanger – automated sequencing. Restriction mapping – DNA fingerprinting – chromosome walking – chromosome jumping.

Module – IV [15 hrs]

Safety aspects of recombinant DNA technology. Diagnostics – pathogenesis – genetic diversity – RELP analysis and DNA finger printing. Therapeutic proteins, novel proteins, vaccine, antibodies, herbicide resistance, insecticides. CaPO4 coprecipitation – electroporation – lipofection – microinjection. Transgenic mouse – transgenic fish – Antisense technology and applications.

Text Books / Reference Books

1. Watson.J.D GTliman, N, *Recombinant DNA*. Scientific American Books,W.H.Freeman and Co.New York.
2. Bemur, R.Pastmek.J.J, *Molecular Biology Principles and Applications in Recombinant DNA*, Panima Publishing Cooperation, New Delhi.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 804 (F) BASICS OF PLANT AND ANIMAL BIOTECHNOLOGY

Teaching Scheme:
3 hours lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To understand the basic and important aspects of biotechnology in plant and animal science*
- *To make the students understand the concepts of transgenics*
- *To help in the understanding of cell culture and related techniques*

Module I [15 hrs]

Plant Biotechnology and its scope. Fundamentals of plants tissues culture. Gene transfer techniques- Direct gene transfer, Agrobactrium medicated gene transfer cloning. Types of plant vectors, use of plant vectors in gene manipulation. Plant viruses, plant viruses as a tool to deliver foreign DNA.

Module II [15 hrs]

Molecular aspects of diseases susceptibility and resistance: Transposable elements, factors influencing disease resistances and susceptibility. Transgenics- herbicide tolerance, insect resistance, viral resistance stress tolerance

Module III [15 hrs]

Animal Biotechnology and its scope. History and development of cell culture. Manipulation of reproduction in animals and improvements of livestock – Artificial insemination. In vitro fertilization technology.

Basic requirements for growing animal cell culture. Isolation and desegregation of explants. Commonly used cell lines. Preservation and characterization of animal cells. Cytotoxicity and viability assays. Organ culture – techniques, advantages and applications.

Module IV [15 hrs]

Methods for Transfection of animal‘s cells.Methods for cell fusion. Transgenic Animal Technology: general methods for production of transgenic animals. Selectable markers, HAT selection and antibiotic resistances. Hybridoma technology . Basic understanding of scaling up of animal cell cultures. Bioreactors for animal cell culture.

Text Books:

1. P.R Yadav, rajiv Tyagi, *Biotechnology of Animals tissues*, Discovery Publishing House
2. R.C Dubey, *A Text Book of Biotechnology*, S Chand & Company.
3. M.M Ranga, *Animal Biotechnology*, second Edition, Agrobios India

Reference Books:

1. Dodd‘s J.H *Plant Genetic Engineering*, Cambridge University Press
2. Mental S.H, Mathews J.A, Mickee R.A *Principles of Plant Biotechnology an Introduction to Genetic Engineering in Plants. Blackwell Scientific Publications.*
3. Bernur R Pasternak J.J., Molecular Biology, *principles and Applications in recombinant DNA*, Panimia Publishing Cooperation.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions *4 x 15 marks=60 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ELECTIVE IV

BT14 805 (A) PROJECT ENGINEERING

Teaching scheme:
3 Hrs lecture & 1 hour tutorial per week **Credits: 4**

Objectives

- *To impart the basic concepts of project management*

Module I [15 hrs]
Scope of project engineering - the role of project engineer - R & D - TEFR - plant location and site selection - preliminary data for construction projects - process engineering - flow diagrams - plot plans - engineering design and drafting

Module II [15 hrs]
Planning and scheduling of projects - bar chart and network techniques - procurement operations- office procedures - contracts and contractors - project financing - statutory sanctions

Module III [15 hrs]
Details of engineering design and equipment selection I - design calculations excluded - vessels -heat exchangers - process pumps - compressors and vacuum pumps - motors and turbines – other process equipment

Module IV [15 hrs]
Details of engineering design and equipment selection II - design calculations excluded – piping design - thermal insulation and buildings - safety in plant design - plant constructions, start up and commissioning

Text books :
1. Rase & Barrow, Project Engineering of Process Plants, John Wiley

References:
1. Peter S. Max & Timmerhaus, Plant design and economics for chemical engineers. Mc Graw Hill (2002).
2. Srinath L. S., ―PERT AND CPM.‖ affiliated east press pvt. Ltd., new york (1973)
3. Perry J. H.,‖Chemical Engineering Handbook‖ 7TH ed. Mc Graw Hill (1997).
4. Jelen. F. C., ―Cost and Optimization in Engineering‖. Mc Graw Hill (1983).
5. Frederick B. Plummer, Project Engineering, BH
6. Ernest E. Ludwig, Applied project engineering and management, Gulf Pub. Co., (1988) VV Mahajani S M Mokashi, Chemical Project Economics, Macmillan

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions 8x 5 marks=40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 805 (B) ENTREPRENEURSHIP DEVELOPMENT (Global)

Teaching scheme:
3 Hrs lecture & 1 hour tutorial per week **Credits: 4**

Objectives

- *To give an idea on entrepreneurial perspectives*

Module I [15 hrs]
Entrepreneurial perspectives- understanding of entrepreneurship process- entrepreneurial decision process- entrepreneurship and economic development- characteristics of entrepreneurial competencies- managerial functions for enterprise.

Module II [15 hrs]
Process of business opportunity identification and evaluation- industrial policy- environment market

survey and market assessment- project report preparation-study of feasibility and viability of a project-assessment of risk in the industry

Module III [15 hrs]

Process and strategies for starting venture- stages of small business growth- entrepreneurship in international environment- entrepreneurship- achievement motivation- time management, creativity and innovation structure of the enterprise- planning, implementation and growth

Module IV [15 hrs]

Technology acquisition for small units- formalities to be completed for setting up a small scale unit-forms of organizations for small scale units-financing of project and working capital-venture capital and other equity assistance available- break even analysis and economic ratios technology transfer and business incubation

Text Books/References

1. Harold Koontz & Heinz Weihrich, *Essentials of Management*, McGraw hill International
1. Hirich R.D. &Peters Irwin M.P., *Entrepreneurship*, McGraw Hill
2. Rao T.V., Deshpande M.V., Prayag Mehta &Manohar S. Nadakarni, *Developing Entrepreneurship a Hand Book*, Learning systems
3. Donald Kurado & Hodgelts R.M., *Entrepreneurship A contemporary Approach*, The Dryden Press
4. Dr. Patel V.G., *Seven Business Crisis*, Tata McGraw hill
5. Timmons J.A., *New venture Creation- Entrepreneurship for 21st century*, McGraw Hill International
6. Patel J.B., Noid S.S., *A manual on Business Opportunity Identification*, selections, EDII
7. Rao C.R., *Finance for small scale Industries*
8. Pandey G.W., *A complete Guide to successful Entrepreneurship*, Vikas Publishing

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 805 (C) ENERGY ENGINEERING

Teaching Scheme:
3 hours lecture and 1 hour tutorial per week **Credits: 4**

Objectives:

- *To impart the knowledge of energy sources and their harnessing technologies.*
- *To understand about energy audit and conservation in industries*

Module I [15 hrs]
Energy-units of energy-conservation factors-general classification of energy-world

energy resources and energy consumption-Indian energy resources and energy consumption, energy crisis-energy alternatives-electrical energy from conventional energy resources-internal combustion engines-steam turbines-gas turbines-hydro turbines (thermodynamic cycles not included)-nuclear reactors-thermal, hydel and nuclear power plants(process outlines only)- efficiency, merits and demerits of the above power plants, combined cycle power plants-fluidized bed combustion-small hydropower.

Module II [15 hrs]
Solar energy-solar thermal systems-flat plate collectors-focussing collectors-solar water heating solar cooling-solar distillation-solar refrigeration-solar dryers-solar pond-solar thermal power generation-solar photovoltaic systems-solar cells-solar photovoltaic power generation-solar energy application in India-energy plantations. Wind energy-types of wind mills-types of wind rotors-darrieus rotor and gravian rotor-wind electric power generation-wind power in India economics of wind farm-ocean wave energy conversion-ocean thermal energy conversion-tidal energy conversion-geothermal energy conversion.

Module III [15 hrs]
Biomass energy resources-thermo chemical and biochemical methods of biomass conversion, combustion-gasification-pyrolysis-biogas production-ethanol-fuel cell-alkaline fuel cell-phosphoric acid fuel cell-molten carbonate fuel cell-solid oxide fuel cell-solid polymer electrolyte fuel cell-magneto hydro dynamics-open cycle and closed cycle systems-magneto dynamic power generation-energy storage routes like thermal energy storage, chemical,
mechanical, electrical storage.

Module IV [15 hrs]
Energy conservation in chemical process plants.- energy audit- energy saving in heat exchangers, distillation columns, dryers, ovens, furnaces and boilers- steam economy in chemical plants energy conservation in petroleum, fertilizer and steel industries-cogeneration, pinch technology recycling for energy saving- electrical energy conservation in chemical plants, energy conservation in bioprocess plants- environmental aspects of energy use.

Reference Books

1. Bansal N.K., Kleeman M.and Meliss M., *Renewable energy sources and conversion tech*., Tata McHraw H.
2. Pandey G.N.A *Text book on energy systems and engineering*, Vikas publishing house.
3. Rao, S, & Parulekar B.B, *Energy Technology*, Khanna publishers
4. Rai G.D., *Non-conventional energy sources*, Khanna publishers
5. Nagpal G.R., *Power plant Engineering*, Khanna publishers

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions *4 x 15 marks=60 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 805 (D) TOTAL QUALITY MANAGEMENT

Teaching scheme:
3 Hrs lecture and 1 hour tutorial per week **Credits: 4**

Objectives

- *To impart knowledge on the concept of quality tools for analyzing quality statistical tools in quality acceptance sampling life tests*

Module I [15 hrs]

Definition of quality-internal and external customers- vision statement – mission statements – objectives – goals – targets- evolution of TQM – Defining TQM – stages in TQ M implementation-TQM models

Module II [15 hrs]

SWOT analysis-strategic planning-customer focus-quality function deployment-customer satisfaction measurement-seven new management tools-Deming wheel-zero defect concept-bench marking-six sigma concepts-failure mode and effect analysis-poke yoke

Module III [15 hrs]

Five S for quality assurance-quality circle philosophy-failure rate analysis-mean failure rate-mean time to failure (MTTF)-Mean time between failure (MTBF)-hazard models-system reliability availability-maintenance

Module IV [15 hrs]

Quality and cost-characteristics of quality cost-micro analysis of quality cost-measurement of quality-TQM road map- ISO 9000 series certification-ISO 9001:2000 certification-ISO 14000 certification-QS 9000 auditing-Quality auditing- quality awards

Text Books
1. L Suganthi, Anand A Samuel, *Total Quality Management*, PHI
2. Lt.Gen. Lal H, *Total Quality Management*, Wiley Eastern Limited

Reference Books
1. Greg Bounds, *Beyond Total Quality Management*, McGraw Hill Publishers
2. Menon H G, *TQM in New Product Manufacturing*, McGraw Hill Publishers

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions *4 x 15 marks=60 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 805 (E) MEMBRANE SEPARATION TECHNOLOGY

Teaching Scheme:
3 Hrs lecture and 1 hour tutorial per week **Credits: 4**

Objectives:
- *To impart knowledge on the uses of different membranes for separation procedures*
- *To study membrane separation techniques*

Module – I [15 hrs]
Introduction: Separation process, introduction to membrane processes definition of a membrane, classifications membrane processes. Preparation of synthetic membranes: Types of membrane materials, preparation of synthetic membrane, phase inversion membranes, preparation technique for immersion precipitation, and preparation technique for composite membranes.

Module – II [15 hrs]
Characterization of membranes: introduction, membrane characterization. Characterization of porous membranes, characterization of non-porous membranes. Transport in membranes: introduction, driving forces, non equilibrium thermodynamics, transport through porous, non-porous and ion exchange membranes.

Module-III [15 hrs]

Membrane Processes: Introduction, osmosis, pressure driven membrane processes. , Micro filtration, membranes for micro filtration, industrial applications, Ultra filtration, membranes for ultra filtration, industrial applications, Reverse osmosis and Nano filtration: membranes for reverse osmosis and nanofiltration, industrial applications, Electrically Driven processes. Introduction, electro dialysis, process parameters, membranes for electro dialysis, applications, Membrane electrolysis, Biopolar membranes, Fuel Cells. Concentration driven membrane processes: gas separation in porous and non porous membranes, membranes for gas separation, applications, pervaporation, membranes for pervaporation, applications, dialysis, membranes for dialysis applications, liquid membranes: aspects, liquid membrane development, choice of the organic solvent and carrier, applications, introduction to membrane reactors.

Module – IV [15 hrs]

Polarization phenomenon and fouling: introduction to concentration polarization, turbulence promoters, pressure drop, gel layer model, osmotic pressure model, boundary layer resistance model, concentration polarization in diffusive membrane separators and electro dialysis, membrane fouling, method to reduce fouling, compaction. Module and process design: Introduction, plate and frame module spiral wound module, tabular module, capillary module, hollow fiber module, comparison of module configurations.

Text books/ Reference books:

1. S.P.Nunes , K.V, Peinemann, *Membrane Technology in the chemical industry* Wiley-VCH
2. Rautanbach and R.Abrecht, *membrane Process*, John Wiley & Sons.
3. J.G.Crespo, K.W.Bodekes, *Membrane Processes in separation and Purification*, Kuwer Academic Publications.
4. C.J. Geankoplis. *Transport processes and Unit Operations*

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 805 (F) PROTEIN ENGINEERING

Teaching Scheme:
3 hours lecture and 1 hour tutorials per week **Credits: 4**

Objectives:

- *To impart advance knowledge on how to engineer proteins through a detailed study of protein structure, its characteristic properties and its significance in biological systems*

Module – I [15 hrs]

Protein – Bond interactions in protein structure; primary structure and its determination; secondary structure and its prediction methods; tertiary structure and domain in proteins; proteins folding pathways; quaternary structures; methods to determine 3D structures; X-ray crystallography and NMR method; post translational modifications.

Module II [15 hrs]

Structure function relationship of Proteins: DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eucaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers, Membrane proteins: General characteristics, Transmembrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis other commercial applications.

Module III [15 hrs]

Protein phosphorylation – Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes – ribonuclease – lyzozyme. Epidermal growth factor. Insulin and PDGF receptors and their interactions with effectors, immunoglobulins; classes and its biological functions;

Module IV [15 hrs]

Protein engineering and Protein Design: Protein data base analysis – methods to alter primary structure of proteins – Examples of engineered proteins – Protein design, principles and examples. Methods in Proteins engineering; Immunotoxins; mechanism and its applications; Drug designing; structure based approach, receptor based approach.

Text Books:

1. Voet D. and Voet G., ―Biochemistry‖, Third Edn. John Wiley and Sons, 2001
2. Branden C. and Tooze J., ―Introduction to Protein Structured, Second Edition‖, Garland Publishing, NY, USA, 1999

Reference:

1. Moody PCE, and AJ Wilkinson, Protein Engineering, IRL Press, oxford. 2. Creighton TE Proteins, Freeman WH.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions *4 x 15 marks=60 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

BT14 806 (P) SEMINAR

Teaching scheme:
3 Hrs per week

Credits: 2

Objective:

- *To assess the ability of the student to study and present a seminar on a topic of current relevance in biotechnology engineering and allied areas.*

It enables the students to gain knowledge in any of the technically relevant current topics and acquire the confidence in presenting the topic. The student will undertake a detailed study on the chosen topic under the supervision of a faculty member, by referring papers published in reputed journals and conferences. Each student has to submit a seminar report, based on these papers; the report must not be reproduction of any original paper. A committee consisting of three/four faculty members will evaluate the seminar.

Internal continuous assessment

40% -Design and development
30% -Presentation and demonstration of results
20 % -Report
10 %- Regularity in the class

Total Marks : 100

BT14 807 (P) PROJECT

Teaching scheme
7 Hrs practical per week **Total Credits: 7**

This project work is the continuation of the project initiated in seventh semester. The performance of the students in the project work shall be assessed on a continuous basis by the project evaluation committee through progress seminars and demonstrations conducted during the semester. Each project group should maintain a log book of activities of the project. It should have entries related to the work done, problems

faced, solution evolved etc.

There shall be at least an interim evaluation and a final evaluation of the project in the 8th semester. Each project group has to submit an interim report in the prescribed format for the interim evaluation. Each project group should complete the project work in the 8th semester. Each student is expected to prepare a report in the prescribed format, based on the project work. Members of the group will present the relevance, design, implementation, and results of the project before the project evaluation committee comprising of the guide and three/four faculty members specialized in biotechnology engineering and allied areas 50% of the marks is to be awarded by the guide and 50% by the evaluation committee.

Internal continuous assessment

40% -Design and development
30% -Presentation and demonstration of results
20 % -Report
10 %- Regularity in the class
Total Marks : 100

BT14 808 (P) VIVA – VOCE

Credits: 3

Objective :

- *To examine the knowledge acquired by the student during the B. Tech.. course, through an oral examination*

The students shall prepare for the oral examination based on the theory and laboratory subjects studied in the B. Tech.. course, seminar, and project. There is only university examination for viva-voce. University will appoint two external examiners and an internal examiner for viva-voce. These examiners shall be senior faculty members having minimum five years teaching experience at engineering degree level. For final viva-voce, candidates should produce certified reports of, seminar, and project (two interim reports and main report). If he/she has undergone industrial training/industrial visit/educational tour or presented a paper in any conference, the certified report/technical paper shall also be brought for the viva-voce. Allotment of marks for viva-voce shall be as given below.

Assessment in viva-voce

40 %- Subject
30% - Project
20%- Seminar
10%- Industrial training/ Industrial visit/ Papers presented at national level

Maximum marks: 100