PANJAB UNIVERSITY CHANDIGARH- 160 014 (INDIA)

(Estted. under the Panjab Univerasity Act VII of 1947-enacted by the Govt. of India)

FACULTY OF SCIENCE

SYLLABI

FOR

M.Sc. (HONOUR SCHOOL)
PHYSICS & ELECTRONICS

1st TO 4th SEMESTER EXAMINATIONS

2013 – 2014 session onwards

Syllabus applicable for admissions in 2013

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OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR M. Sc. (HONS. SCHOOL) IN PHYSICS & Electronics

FIRST AND SECOND YEAR (SEMESTER SYSTEM) Examinations 2012-13 onwards.

M.Sc. (H.S.) First Year*		Teaching hours per week	Marks**	Credits
First Semester				
MPEH6101	Mathematical Physics I	4	75	3
MPEH6102	Classical Mechanics	4	75	3
MPEH6103	Quantum Mechanics	4	75	3
MPEH6104	Electronics I – Semiconductor Devices & Analogue Electronics	4	75	3
MPEH6151	Physics Laboratory I & Project	9	150	6
MPEH6152	Computational Techniques I	4	50	2
Second Semester				
MPEH6201	Relativistic Quantum Mechanics and Quantum Field Theory	4	75	3
MPEH6202	Statistical Mechanics	4	75	3
MPEH6203	Electronics II - Digital Electronics and IC Technology	4	75	3
MPEH6204	Classical Electrodynamics	4	75	3
MPEH6251	Physics Laboratory II & Project Work	9	150	6
MPEH6252	Computational Techniques II	4	50	2

M.Sc. (H.S.) Second Year*

Third Semester

		Teaching hours per week	Marks**	Credits
MPEH7101	Electronics III - Advanced Microprocessors	4	100	4
MPEH7102	Electronics IV- Electronics Instrumentation & Power Electronics	4	75	3
MPEH7103	Condensed Matter Physics I	4	75	3
MPEH7104	Nuclear Physics I	4	75	3
MPEH7105	Particle Physics I	4	75	3
MPEH7151	Physics Laboratory III and Project Work	9	100	4

Fourth Semester

MPEH7201	Electronics-V Microcontrollers and embedded systems	4	100	4
MPEH7202	Electronics-VI Integrated and VLSI Circuit design	4	75	3
MPEH7203	Electronics-VII Digital Signal Processing	4	75	3
MPEH7251	Project work and Introduction to Intellectual Property Regulations	4	150	6

Special papers (One of the following papers)***

MPEH7503	Condensed Matter Physics II	4	100	4
MPEH7504	Nuclear Physics II	4	100	4
MPEH7505	Particle Physics II	4	100	4
MPEH7506	Electronics VIII- Digital Communication	4	100	4
MPEH7507	Physics of Nano-materials	4	100	4
MPEH7508	Experimental techniques in Nuclear Physics and Particle Physics	4	100	4

* If a course is being taught by two teachers, they should coordinate among themselves the coverage of material as well as the assessment of the students to maintain uniformity.

** Internal assessment in all the papers will be as per university rules and has been indicated for individual papers along with the syllabus.

*** The special papers will be offered depending upon the availability of teachers, and the students will be allotted one of the courses being taught, on the basis of their option and percentage of marks in M.Sc. (H.S.) I examination. Students may opt for Electronics as additional Special Paper if that is not the paper allotted to them as requirement of the degree. Marks secured in this paper will be shown on the marks card but will not be counted in determining the division.

AIMS AND OBJECTIVES OF DIFFERENT COURSES

MPEH 6101
The aim and objective of the course on **Mathematical Physics-I** is to equip the M.Sc (H.S.) student with the mathematical techniques that he/she needs for understanding theoretical treatment in different courses taught in this class and for developing a strong background if he/she chooses to pursue research in physics as a career.

MPEH 6102
The aim and objective of the course on **Classical Mechanics** is to train the students of M.Sc.(H.S.)class in the Lagrangian and Hamiltonian formalisms to an extent that they can use these in the modern branches like Quantum Mechanics, quantum Field Theory, Condensed Matter Physics, and Astrophysics.

PHYS 6103
The aim and objective of the course on **Quantum Mechanics** is to introduce the students of M.Sc.(H.S.) class to the formal structure of the subject and to equip them with the techniques of angular momentum, perturbation theory and scattering theory so that they can use these in various branches of physics as per their requirement.

MPEH 6104
The **Electronics-I** course **Semiconductor devices & Analogue Electronics** covers Semiconductor physics, Semiconductor devices and their basic applications, Circuit analysis techniques, First-order nonlinear circuits, Analysis of Passive and Active filters using Laplace transform technique, OPAMP and related analog circuits, and introduction to various communication techniques.

MPEH 6151
The aim and objective of the courses on **Physics Laboratory I** is to expose the students of M.Sc.(H.S.) class to experimental techniques in general physics, electronics, nuclear physics and condensed matter physics so that they can verify some of the things read in theory here orin earlier classes and develop confidence to handle sophisticated equipment.

MPEH 6152
The aim and objective of the course on **Computational Techniques I** is to familiarize the students of M.Sc.(H.S.) students with the numerical methods used in computation and Programming using C++ so that they can use these in solving simple problems pertaining to physics.

MPEH 6201
The aim and objective of the course on **Relativistic Quantum Mechanics and Quantum Field Theory** is to introduce the M.Sc. (H.S.) student to the formal structure of the subject and to equip him/her with the techniques of quantum field theory so that he/she can use these in various branches of physics as per his/her requirement.

MPEH 6202
The aim and objective of the course on **Statistical Mechanics** is to equip the M.Sc.(H.S.) student with the techniques of Ensemble theory so that he/she can use these to understand the macroscopic properties of the matter in bulk in terms of its microscopic constituents.

MPEH 6203
The **Electronics-II** course **Digital Electronics and IC Technology** covers revisit of binary arithmetic, Logic gates, sequential and combinational circuits, Logic families and semiconductor memories, Inter-conversion of analog and digital signals, basics of integrated circuit technology, Microprocessor 8085 Architecture, instruction set, interfacing with memory and I/O devices.

MPEH 6204
The **Classical Electrodynamics** course covers Electrostatics and Magnetostatics including Boundary value problems, Maxwell equations and their applications to propagation of electromagnetic waves in dielectrics, metals and plasma media; EM waves in bounded media, waveguides, Radiation from time-varying sources. It also covers motions of relativistic and non-relativistic charged particles in electrostatic and magnetic fields.

MPEH 6251
The aim and objective of the courses on **Physics Laboratory II** is to expose the students of M.Sc.(H.S.) class to experimental techniques in general physics, electronics, nuclear physics and condensed matter physics so that they can verify some of the things read in theory here orin earlier classes and develop confidence to handle sophisticated equipment.

MPEH 6252
The objective of the course **Computational Techniques II** is to solve advanced physics problems using C++ programming. Acquaint the students to the electronics related software like PSPICE, ORCAD and MATLAB.

MPEH 7101
The **Electronics-III** course **Advanced Microprocessors** covers Advanced programming techniques for 8085 microprocessor, Interfacing data converters –A/D and D/A, Programmable interface devices, Interfacing Programmable Peripheral Devices, 8086 microprocessor, MACRO programming, interrupts. Assembly language programming: addressing mode and instructions for Serial communications.

MPEH 7102
The **Electronics-IV** course **Electronics Instrumentation & Power Electronics** covers basics of electronics instrumentation, Active Electrical transducers, Sensors and Transducers for biological applications, Feedback Transducer systems. Second part of the syllabus covers Power electronics, semiconductor power devices, Devices of Thyristor family and their Switching characteristics, choppers, converters and UPS, DC and AC drives, Pulse shaping and Time pickoff techniques relevant to nuclear detectors, and data acquisition systems.

MPEH 7103
The aim and objective of the course on **Condensed Matter Physics I** is to expose the students of M.Sc.(H.S.) class to the topics like elastic constants, lattice vibrations, dielectric properties, energy band theory and transport theory so that they are equipped with the techniques used in investigating these aspects of the matter in condensed phase.

MPEH 7104
The aim and objective of the course on **Nuclear Physics I** is to familiarize the students of M.Sc.(H.S.) class to the basic aspects of nuclear physics like static properties of nuclei, radioactive decays, nuclear forces, neutron physics and nuclear reactions so that they are equipped with the techniques used in studying these things.

MPEH 7105
The aim and objective of the course on **Particle Physics I** is to introduce the M.Sc.(H.S.) students to the invariance principles and conservation laws, hadron-hadron interactions, relativistic kinematics, static quark model of hadrons and weak interactions so that they grasp the basics of fundamental particles in proper perspective.

MPEH 7151
The aim and objective of the course on **Physics Laboratory III and Project Work** is to train the students to advanced experimental techniques in general physics, nuclear physics, particle physics and condensed matter physics, so that they can investigate various relevant aspects and are confident to handle sophisticated equipment and analyze the data. Special emphasis is laid on electronics which covers study of characteristics of Semiconductor devices, power supplies, Digital IC's and OPAMP applications, 8085 microprocessor kit and PC parallel port based controls.

MPEH 7201
The **Electronics-V course Microcontrollers and embedded Systems** covers basics of Microcontrollers. The architecture and programming of 8051 family has been covered in details both in assembly language and C. Introduction to advanced microcontrollers like PIC ARM is also covered.

MPEH 7202
The **Electronics-VI course Integrated and VLSI Circuit Design** course covers Crystal growth techniques, Wafer preparation and its shaping, growth of oxide and dielectric layers, fabrication steps for the electronic devices, MEMS and NEMS devices, layouts for gates and introduction to different molecular electronic and optoelectronic devices.

MPEH 7203
The **Electronics-VII course Digital Signal Processing** covers Sampling of analog signals, Frequency analysis of continuous and discrete-time Signals, mathematical tools for DSP, Analysis of Linear Time-Invariant Systems, FIR and IIR Digital filters, Multirate Digital signal processing, Adaptive filters and applications, and Architectural features of DSP hardware.

MPEH 7251
The aim of the **Major project work** is to expose the students to Instrumentation, Power Electronics, Microcontroller and DSP, Digital communication; Development of pulse processing electronic modules, power supplies, control equipment in a research laboratory, or fabrication of a device. The aim of the second part of the paper is to make the students aware of the **Intellectual Property Regulations** and understand rights and responsibilities as a researcher.

MPEH 7503
The aim and objective of the course on **Condensed Matter Physics II** is to familiarize the M.Sc.(H.S.) students with relatively advanced topics like optical properties, magnetism,

superconductivity, magnetic resonance techniques and disordered solids so that they are confident to use the relevant techniques in their later career.

MPEH 7504
The aim and objective of the course on **Nuclear Physics II** is to expose the students of M.Sc.(H.S.) class to the relatively advanced topics in nuclear models and nuclear reactions so that they understand the details of the underlying aspects and can use the techniques if they decide to be nuclear physicists in their career.

MPEH 7505
The aim and objective of the course on **Particle Physics II** is to expose the students of M.Sc.(H.S.) class to the relatively advanced topics like internal symmetries and quark model, details of different types of fundamental interactions and unifaction schemes so that they understand these aspects properly and are well equipped to pursue a career in high energy physics.

MPEH 7506
The **Electronics-VIII course Digital Communication** covers data communication techniques, Pulse Modulation, digital modulation, Information and Coding
Theory, Modern communication Systems, Data transfer and computer networking, Satellite communication, Mobile communication, Optical Communication systems.

MPEH 7507
The aim and objective of the course **MPEH 7507 on Physics of Nano-materials** is to familiarize the students to the physics of quantum dots and nano-structured materials, various techniques related to preparation and characterization of nano-materials.

MPEH 7508
The aim and objective of the course on **Experimental Techniques in Nuclear Physics and Particle Physics** is to expose the students of M.Sc. (H.S.) class to theoretical aspects of different equipment and methods used in the fields of nuclear physics and particle physics.

M.Sc. (H.S.) in Physics & Electronics
FIRST SEMESTER

MPEH 6101 : MATHEMATICAL PHYSICS – I **Max. Marks: 15+60= 75**

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 12. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I Complex Variables : Introduction, Cauchy-Riemann conditions, Cauchy's Integral formula, Laurent expansion, singularities, calculus of residues, evaluation of definite integrals, Dispersion relation.

II Delta and Gamma Functions : Dirac delta function, Delta sequences for one dimensional function, properties of delta function, Gamma function, factorial notation and applications, Beta function.

III Differential Equations : Partial differential equations of theoretical physics, boundary value, problems, Neumann & Dirichlet Boundary conditions, separation of variables, singular points, series solutions, second solution.

IV Special Functions : Bessel functions of first and second kind, Generating function, integral representation and recurrence relations for Bessel's functions of first kind, orthogonality. Legendre functions : generating function, recurrence relations and special properties, orthogonality, various definitions of Legendre polynominals. Associated Legendre functions: recurrence relations, parity and orthogonality, Hermite functions and Laguerre functions, Recurrence relations and special properties.

V Elementary Statistics: Introduction to probability theory, random variables, Binomial, Poisson and Normal distribution

TUTORIALS : Relevant problems given at the end of each section in Book 1.

Books :

1. Mathematical Methods for Physicists : G. Arfken and H.J. Weber (Academic Press, San Diego) 7th edition, 2012.
2. Mathematical Physics : P.K. Chattopadhyay (Wiley Eastern, New Delhi) (2004).
3. Mathematical Physics : A.K. Ghatak, I.C. Goyal and S.J. Chua (MacMillan, India, Delhi) (1986)
4. Mathematical Methods in the Physical Sciences – M.L. Boas (Wiley, New York) 3rd edition, 2007.
5. Special Functions : E.D. Rainville (MacMillan, New York) 1960.
6. Mathematical Methods for Physics and Engineering : K.F.Riley, M.P.Hobson and S.J. Bence (Cambridge University Press, Cambridge) 3rd ed. 2006.

MPEH 6102 CLASSICAL MECHANICS

Max. Marks: 15+60= 75

Note:

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 12. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I **Lagrangian Formulation:** Mechanics of a system of particles; constraints of motion, generalized coordinates, D'Alembert's Principle and Lagrange's velocity - dependent forces and the dissipation function, Applications of Lagrangian formulation.

II **Hamilton's Principles:** Calculus of variations, Hamilton's principle, Lagrange's equation from Hamilton's principle, extension to nonholonomic systems, advantages of variational principle formulation, symmetry properties of space and time and conservation theorems.

III **Hamilton's Equations:** Legendre Transformation, Hamilton's equations of motion, Cyclic-co-ordinates, Hamilton's equations from variational principle, Principle of least action.

IV **Canonical Transformation and Hamilton-Jacobi Theory:** Canonical transformation and its examples, Poisson's brackets, Equations of motion, Angular momentum, Poisson's Bracket relations, infinitesimal canonical transformation, Conservation Theorems. Hamilton-Jacobi equations for principal and characteristic functions, Action-angle variables for systems with one-degree of freedom.

V **Rigid Body Motion:** Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler's theorem, infinitesimal rotation, Rate of change of a vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top.

VI **Small Oscillations:** Eigenvalue equation, Free vibrations, Normal Coordinates, Vibrations of a tritomic molecule.

TUTORIALS : Relevant problems given at the end of each chapter in different books.

Books :

1. Classical Mechanics: H. Goldstein, C.Poole and J.Safko (Pearson Education Asia, New Delhi) 3rd edition 2002.
2. Classical Mechanics of Particles and Rigid Bodies: K.C. Gupta (Wiley Eastern, New Delhi), 1988.

MPEH 6103 QUANTUM MECHANICS I Max. Marks: 15+60 = 75

Note:

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 12. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I **Linear Vector Space and Matrix Mechanics:** Vector spaces, Schwarz inequality, Orthonormal basis, Schmidt orthonormalisation method, Operators, Projection operator, Hermitian and Unitary operators, change of basis, Eigenvalue and Eigenvectors of operators, Dirac's bra and ket notation, commutators, Simultaneous eigenvectors, Postulates of quantum mechanics, uncertainty relation. Harmonic oscillator in matrix mechanics, Time development of states and operators, Heisenberg and Schroedinger representations, Exchange operator and identical particles. Density Matrix and Mixed Ensemble.

II **Angular Momentum :** Angular part of the Schroedinger equation for a spherically symmetric potential, orbital angular momentum operator. Eigenvalues and eigenvectors of L_2 and L_z. Spin angular momentum, General angular momentum, Eigenvalues and eigenvectors of J_2 and J_z. Representation of general angular momentum operator, Addition of angular momenta, C.G. co-efficients.

III **Stationary State Approximate Methods:** Non-Degenerate and degenerate perturbation theory and its applications, Variational method with applications to the ground states of harmonic oscillator and other sample systems.

IV **Time Dependent Perturbation:** General expression for the probability of transition from one state to another, constant and harmonic perturbations, Fermi's golden rule and its application to radiative transition in atoms, Selection rules for emission and absorption of light.

V **Scattering Theory :** Scattering Cross-section and scattering amplitude, partial wave analysis, Low energy scattering, Green's functions in scattering theory, Born approximation and its application to Yukawa potential and other simple potentials. Optical theorem, Scattering of identical particles.

TUTORIALS : Relevant problems given in the text and reference books.

Books :

1. Quantum Mechanics : M.P. Khanna, (Har Anand, New Delhi), 2006.
2. A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan (Tata McGraw Hill, New Delhi) 2nd edition, 2004.
3. Modern Quantum Mechanics : J.J. Sakurai (Addison Wesley, Reading), 2004.
4. Quantum Mechanics : V.K. Thankappan (New Age, New Delhi), 2004.
5. Quantum Mechanics : J.L. Powell and B. Crasemann (Narosa, New Delhi) 1995.
6. Quantum Physics : S. Gasiorowicz (Wiley, New York), 3rd ed. 2003.

MPEH 6104: ELECTRONICS I (Semiconductor Devices and Analog Electronics)

Max. Marks: 15+60= 75

Note:

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 12. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I Circuit Analysis : Lumped circuits, Non-linear resistors-series and parallel connections, D.C. operating point, small signal analysis, Thevenin and Norton theorems, Mesh and Node analysis. Admittance, impedance, hybrid and Transmission matrices for two and three-port networks and their applications.

First-order nonlinear circuits, Dynamic route, jump phenomenon and relaxation oscillator, triggering of bistable circuits.

Relation between time and frequency domains (Laplace transforms), Transfer function, Location of poles and zeros of response functions of active and passive systems (Nodal and modified nodal analysis), pole-zero cancellation, Sinusoidal frequency and phase response, Bode plot, Analysis of passive circuits/filters, Phase distortion and and equalizers, Transformer - equivalent circuit and transfer function, Autotransformer.

II Semiconductor Devices and applications: Direct and indirect semiconductors, Drift and diffusion of carriers, Photoconductors, Energy band diagrams, Semiconductor junctions, Metal-semiconductor junctions - Ohmic and rectifying contacts, Capacitance of p-n junctions, Varactors, Zener diode, Regulated power supplies, Schottky diode, switching diodes, Tunnel diode, Light emitting diodes, Semiconductor laser, Photodiodes, Solar cell, UJT, Gunn diode, IMPATT devices, pnpn devices and applications, Liquid crystal displays, MOSFET, Enhancement and depletion mode, FET as switch and amplifier configurations.

III Analog Circuits : Differential amplifiers, common mode rejection ratio, Transfer characteristics, OPAMP configurations, open loop and close loop gain, inverting, non-inverting and differential amplifier, Basic characteristics with detailed internal circuit of IC Opamp, slew rate, Comparators with hysteresis, Window comparator, wave generators, Summing amplifier, Analogue computation, Logarithmic and anti-logarithmic amplifiers, Current-to-voltage and Voltage-to-current converter, Voltage regulation circuits, Precision rectifiers, Instrumentation amplifiers, True RMS voltage measurements. 555 timer based circuits.

Electronic circuits - Phase shift oscillator, Wien-bridge oscillator, Sample and hold circuits, Phase Locking Loop basics and applications.

Filters - Sallen and Key configuration and Multifeedback configuration, LP, HP, BP and BR active filters, Delay equalizers.

IV Communication systems (Broad aspects): Digital transmission, ASK, FSK, PSK, Differential PSK, modulators and detectors, Scrambling and descrambling. Broadband Communication Systems – Coaxial cables, Optical Fibre comm., Submarine cables, Satellite and cellular mobile systems, Integrated Services Digital Network.

TUTORIALS : Relevant problems given in the books.

Books :

1. Semiconductor Devices - Physics and Technology by S.M. Sze (John Wiley), 2002.
2. Solid State Electronic Devices: Ben Streetman, Sanjay Banerjee (Prentice Hall India) 6th Edition, 2005.
3. Electronic Principles by A.P. Malvino (Tata McGraw, New Delhi) 7th edition, 2009.
4. Linear and Non-linear Circuits by Chua, Desoer and Kuh (Tata McGraw), 1987.
5. Applications of Laplace Transforms by Leonard R. Geis (Prentice Hall, New Jersey), 1989.
6. Circuit theory Fundamentals and Applications, Aram Budak (Prentice-Hall) 1987.
7. Integrated Electronics by Millman and Halkias (Tata McGraw Hill) 1991.
8. Electronic Devices and Circuits Theory, Boylested and Nashelsky, (Pearson Education) 10^{th} ed. 2009.
9. OPAMPS and Linear Integrated circuits by Ramakant A Gayakwad (Prentice Hall) 1992.
10. Operational amplifiers and Linear Integrated circuits, R.F. Coughlin and F.F. Driscoll, (Prentice Hall of India, New Delhi), 2000.
11. The Elements of Fibre Optics : S.L. Wymer (Regents/Prentice Hall), 1993.
12. Modern Electronic Communication: Gary M. Miller and Jeffrey S. Beasley (Prentice Hall) 8^{th} Edition, 2004.
13. Communication Systems : Simon Haykin, (John Wiley and Sons) 2001.
14. Digital Signal Transmission : C.C. Bissell and D.A. Chapman (Cambridge University Press) 1992.

MPEH 6151 Laboratory I and Project work 120 Hrs.

Max. Marks:30+120= 150

Note:
(i) Students are expected to perform at least 10 experiments in each semester. The experiments performed in first semester cannot be repeated in second Semester.
(ii) Each student will complete a project work and give seminar on one of the topics on Advances in Electronics during first year. Project work will consist of understanding, handling and repair of Audio-Video and communication Electronics Equipment.
(iii) The examination for both the courses will be of 4 hours duration.
(iv) There will be a 30 minutes written comprehensive test containing short answer questions for the whole class before the actual laboratory examination. This test will have a weight-age of 25 marks in each semester, will be jointly set by the teachers involved in the examination and will be of general nature.

List of Experiments :

Unit 1 : Introduction to experimental techniques

Measurement techniques: Data and error analysis, Plotting and curve fitting software, Introduction to electronic components & use of instruments: Oscilloscope, Digital storage oscilloscope, Multimeter, Wave-form generator. Experience in electronics & mechanical workshops.

Unit 2 : Analog and Digital electronics

1. To study the power dissipation in the SSB and DSB side bands of AM wave.To study the demodulation of AM wave.
2. To study various aspects of frequency modulation and demodulation.
3. To study the frequency response of an operational amplifier & to use operational amplifier for different mathematical operations.
4. To study the characteristics of a regulated power supply and voltage multiplier circuits.
5. To design a rectangular/triangular waveform generator using Comparators and IC8038.
6. To study Hartley and Wien-Bridge oscillators.
7. UJT characteristics and its application as relaxation oscillator or triggering of triac.
8. Hybrid parameters of a transistor and design an amplifier. Determination of k/e ratio.
9. FET/MOSFET characteristics, biasing and its applications as an amplifier.
10. To design (i) Low pass filter (ii) High pass filter (iii) All-pass filter (iv) Band pass filter (v) Band-reject passive filter.
11. To study logic gates and flip flop circuits using on a bread-board.
12. To configure various shift registers and digital counters. Configure seven segment displays and drivers.
13. Use of timer IC 555 in astable and monostable modes and applications involving relays, LDR.

Unit 3 : Material science

17. To study temperature-dependence of conductivity of a given semiconductor crystal using four probe method.
18. To determine the Hall coefficient for a given semi-conductor.
19. To determine dipole moment of an organic molecule, Acetone.

20. To study the lattice dynamics using LC analog kit.
21. To study the characteristic of J-H curve using ferromagnetic standards.
22. To determine the velocity of ultrasonic waves using interferometer as a function of temperature.
23. Temperature dependence of a ceramic capacitor - Verification of Curie-Weiss law for the electrical susceptibility of a ferroelectric material.
24. To determine Percolation threshold and temperature dependence of resistance in composites.
25. Tracking of the Ferromagnetic-paramagnetic transition in Nickel through electrical resistivity.
26. To study the characteristics of a PN junction with varying temperature & the capacitance of the junction.
27. To study the characteristics of a LED and determine activation energy.
28. Measurement of vacuum using the pirani/thermocouple gauge.
29. (i) Study of the characteristics of klystron tube and to determine its electronic tuning range; (ii) To determine the standing wave ratio and reflection coefficient; (iii) To determine the frequency & wavelength in a rectangular waveguide working on TE10 mode; (iv) To study the square law behaviour of a microwave crystal detector.

Unit 4 : Nuclear Radiation detectors and measurement techniques

30. To study the characteristics and dead time of a GM Counter.
31. To study Poisson and Gaussian distributions using a GM Counter.
32. To study the alpha spectrum from natural sources Th and U.
33. To determine the gamma-ray absorption coefficient for different elements.
34. To study absorption of beta rays in Al and deduce end-point energy of a beta emitter.
35. To calibrate the given gamma-ray spectrometer and determine its energy resolution.

Unit 5 : Optics

35. Laboratory spectroscopy of standard lamps
36. Stellar spectroscopy
37. To study the Kerr effect using Nitrobenzene
38. To study polarization by reflection - Determination of Brewester's angle.
39. To measure numerical aperture and propagation loss and bending losses for optical fibre as function of bending angle and at various wavelengths.
40. To study the Magnetorestriction effect using Michelson interferometer.

Unit 6 : Fundamental constants in Physics

14. To determine Planck's constant using photocell.
15. To determine the electric charge of an electron using Millikan drop experiment.
16. To determine the Hubble's constant (expansion rate of universe) using astronomical data and deduce the large scale structure of the universe.

Unit 7 : Mechanics

42. To study the potential energy curve of the magnet-magnet interaction using air-track setup along with the simple experiments in mechanics.
43. To estimate the rotational period of sun using sunspots observations.
44. To estimate the mass of Jupiter using rotational periods of Galilean satellites.
45. To estimate the distance between sun and earth (1AU) using GONG project results of Venus and Mercury transits.

MPEH 6152 COMPUTATIONAL TECHNIQUES I **Max. Marks: 10+40=50**

Note : The examination will be of 4 hours duration.

1. Introduction to Computational Physics: Computer algorithms, interpolations – cubic spline fitting, Numerical differentiation – Lagrange interpolation, Numerical integration by Simpson and Weddle's rules, random generators, Numerical solution of differential equations by Euler, predictor-corrector and Runge-Kutta methods, eigen-value problems, Monte Carlo simulations

II. Programming with C++: Introduction to the Concept of Object Oriented Programming; Advantages of C++ over conventional programming languages; Introduction to Classes, Objects; C++ programming syntax for Input/Output, Operators, Loops, Decisions, simple and inline functions, arrays, strings, pointers; some basic ideas about memory management in C++, Inheritance, constructors.

III **List of Numerical Problems using "Classes":**

1. Data handling: find standard deviation, mean, variance, moments etc. of at least 25 entries.
2. Choose a set of 10 values and find the least squared fitted curve.
3. Generation of waves on superposition like stationary waves and beats.
4. Fourier analysis of square waves.
5. To find the roots of quadratic equations.
6. Wave packet and uncertainty principle.
7. Find y for a given x by fitting a set of 9 values with the help of cubic spline fitting technique.
8. Find first order derivative at given x for a set of 10 values with the help of Lagrange interpolation.
9. To generate random numbers between (i) 1 and 0, (ii) 1 and 100.
10. Perform numerical integration on 1-D function using Simpson and Weddle rules.
11. To find determinant of a matrix - its eigenvalues and eigenvectors.
12. Use Monte Carlo techniques to simulate phenomenon of Nuclear Radioactivity. Modify your program to a case when the daughter nuclei are also unstable.

Books

1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford & IBH Book Co.), 6^{th} ed. 1979.
2. A first course in Computational Physics: P.L. DeVries (Wiley) 2^{nd} edition, 2011.
3. Computer Applications in Physics: S. Chandra (Narosa) 2^{nd} edition, 2005.
4. Computational Physics: R.C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age) 2000.
5. Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill) 4^{th} edition 2008.

SECOND SEMESTER

MPEH 6201: RELATIVISTIC QUANTUM MECHANCIS AND QUANTUM FIELD THEORY

Max. Marks: 15+60= 75

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 12. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I **Relativistic Quantum Mechanics** : Klein-Gordon equation, Dirac equation and its plane wave solutions, significance of negative energy solutions, spin angular momentum of the Dirac particle. The nonrelativistic limit of Dirac equation, Electron in electromagnetic fields, spin magnetic moment, spin-orbit interaction, Dirac equation for a particle in a central field, fine structure of hydrogen atom, Lambshift.

II **Quantum Field Theory** : Resume of Lagrangian and Hamiltonian formalism of a classical field, Quantization of real scalar field, complex scalar field, Dirac field and e.m. field, Covariant perturbation theory, Feynman diagrams and their applications, Wick's Theorem. Scattering matrix. QED.

TUTORIALS : Relevant problems given in each chapter in the books listed below.

Books:

1. A first book of Quantum Field Theory, A. Lahiri & P. Pal, (Narosa Publishers, New Delhi), 2nd ed. 2005.
2. Quantum Mechanics : M.P. Khanna, (Har Anand, New Delhi), 2006.
3. Lectures on Quantum Field Theory, A. Das (World Scientific), 2008.
4. A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan, (Tata McGraw Hill, New Delhi), 2004.
5. Quantum Mechanics : V.K. Thankappan, (New Age, New Delhi) 2004.
6. Quantum Field Theory : H. Mandl and G. Shaw, (Wiley, New York) 2010.
7. Advanced Quantum Mechanics : J.J. Sakurai (Addison-Wesley, Reading), 2004.

MPEH 6202 STATISTICAL MECHANICS **Max. Marks: 15+60= 75**

Note : (i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 12. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I The Statistical Basis of Thermodynamics: The macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution.

II Ensemble Theory: Phase space and Liouville's theorem, the microcanonical ensemble theory and its application to ideal gas of monatomic particles; The canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, equipartition and virial theorems, a system of quantum harmonic oscillators as canonical ensemble, statistics of paramagnetism; The grand canonical ensemble and significance of statistical quantities, classical ideal gas in grand canonical ensemble theory, density and energy fluctuations.

III Quantum Statistics of Ideal Systems: Quantum states and phase space, an ideal gas in quantum mechanical ensembles, statistics of occupation numbers; Ideal Bose systems: basic concepts and thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation, discussion of gas of photons (the radiation fields) and phonons (the Debye field); Ideal Fermi systems: thermodynamic behaviour of an ideal Fermi gas, discussion of heat capacity of a free-electron gas at low temperatures, Pauli paramagnetism.

IV Elements of Phase Transitions: Introduction, a dynamical model of phase transitions, Ising model in zeroth approximation.

V Fluctuations: Thermodynamic fluctuations, random walk and Brownian motion, introduction to nonequilibrium processes, diffusion equation.

TUTORIALS: Relevant problems given in the end of each chapter in the text book.

Books:

1. Statistical Mechanics: R.K. Pathria and P.D. Beale (Butterworth-Heinemann, Oxford), 3rd edition, 2011.
2. Statistical Mechanics: K. Huang (Wiley Eastern, New Delhi), 1987.
3. Statistical Mechanics: B.K. Agarwal and M. Eisner (Wiley Eastern, New Delhi) 2^{nd} edition, 2011.
4. Elementary Statistical Physics: C. Kittel (Wiley, New York), 2004.
5. Statistical Mechanics: S.K. Sinha (Tata McGraw Hill, New Delhi), 1990.

MPEH 6203 ELECTRONICS-II (Digital Electronics and IC Technology)

Max. Marks: 15+60 = 75

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 12. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I **Digital circuits :** Boolean algebra, de Morgans theorem, Karnaugh maps.

Data processing circuits : Multiplexers, Demultiplexers, Arithmetic building blocks, Encoders, Decoders, Parity generators, PLA.

Sequential circuits : Flip-Flops – RS, JK, D, clocked, preset and clear operation, race-around conditions in JK Flip-flops, master-slave JK flip-flops, Switch contact bounce circuit.

Shift registers, Asynchronous and Synchronous counters, Counter design and applications.

A/D Converters : Successive approximation, Counter-type, Dual slope, voltage to frequency and voltage to time conversion techniques, accuracy and resolution.

D/A converter using resistive network, accuracy and resolution.

Applications: ADC 0804, Multiplexed displays, Frequency Counters, Time Measurement, Digital Voltmeters,

II **Digital logic families :** RTL, DTL, TTL, ECL, CMOS, MOS, Tri-state logic - switching and propagation delay, fan out and fan in, TTL-CMOS and CMOS-TTL interfaces.

III **Basic concepts of Integrated Circuits :** IC technology, Fabrication of monolithic IC's - epitaxial growth, diffusion of impurities, masking and etching; Active and Passive components, MSI, LSI and VLSI chips, FPGA.

IV **Microprocessor :** Buffer registers, Bus oraganised computers, SAP-I, Microprocessor (μP) 8085 Architecture, memory interfacing, interfacing I/O devices. Assembly language programming : Instruction classification, addressing modes, timing diagram, Data transfer, Logic and Branch operations- Programming examples.

V **Semiconductor Memories :** ROM, PROM and EPROM, RAM, Static and Dynamic Random Access Memories (SRAM and DRAM), content addressable memory, Other advanced memories.

TUTORIALS : Relevant problems given at the end of each chapter in the books listed below.

Books :

1. Digital Principles and Applications by Malvino and Leach (Tata McGraw Hill), 2010.
2. Microelectronics by Millman and Grabel (Tata McGraw Hill), 1999.
3. A text book of Digital Electronics, R.S. Sedha (S. Chand Publishers), 2004.
4. Integrated Electronics by Millman and Halkias (Tata McGraw Hill), 2010.
5. Semiconductor Devices : Physics and Technology by S.M. Sze (John Wiley), 2007.
6. Digital Computer Electronics : Albert P. Malvino, Jerald A Brown (Tata-McGraw Hill) 3rd ed. 2004.
7. Microprocessor Architecture, Programming and Applications with 8085 : R.S. Gaonkar (Prentice Hall), 2002.

MPEH 6204 CLASSICAL ELECTRODYNAMICS

Max. Marks: 15+60 = 75

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 12. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I. **Electrostatics :** Laplace and Poisson's equations, Electrostatic potential and energy density of the electromagnetic field, Multipole expansion of the scalar potential of a charge distribution, dipole moment, quadrupole moment, Multipole expansion of the energy of a charge distribution in an external field, Static fields in material media, Polarization vector, macroscopic equations, classification of dielectric media, Molecular polarizability and electrical susceptibility, Clausius-Mossetti relation, Models of Molecular polarizability, energy of charges in dielectric media (Maxwell stress tensor).

II. **Magnetostatics :** The differential equations of magnetostatics, vector potential, magnetic fields of a localized current distribution, Singularity in dipole field, Fermi-contact term, Force and torque on a localized current distribution. (Magnetic stress tensor)

III. **Boundary value problems :** Uniqueness theorem, Dirichlet and Neumann Boundary conditions, Earnshaw theorem, Green's (reciprocity) theorem, Formal solution of electrostatic boundary value problem with Green function, Method of images with examples, Magnetostatic boundary value problems.

IV. **Time varying fields and Maxwell equations :** Faraday's law of induction, displacement current, Maxwell equations, scalar and vector potential, Gauge transformation, Lorentz and Coulomb gauges, Hertz potential, General expression for the electromagnetic fields energy, conservation of energy, Poynting Theorem, Conservation of momentum.

V. **Electromagnetic Waves :** wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, Poynting theorem for a complex vector field, waves in conducting media, skin depth, Reflection and refraction of e.m. waves at plane interface, Fresnel's amplitude relations, Reflection and Transmission coefficients, polarization by reflection, Brewster's angle, Total internal reflection, Stoke's parameters, EM wave guides, Cavity resonators, Dielectric waveguide, optical fibre waveguide, Waves in rarefied plasma (ionosphere) and cold magneto-plasma, Frequency dispersive characteristics of dielectrics, conductors and plasmas.

VI. **Radiation from Localized Time varying sources:** Solution of the inhomogeneous wave equation in the absence of boundaries, Fields and radiation of a localized oscillating source, electric dipole and electric quadrupole fields, centre fed antenna.

VII. **Charged Particle Dynamics:** Non-relativistic motion in uniform constant fields and in a slowly varying magnetic field, Adiabatic invariance of flux through an orbit, magnetic mirroring, Cross electrostatic and magnetic fields and applications, Relativistic motion of a charged particle in electrostatic and magnetic fields.

TUTORIALS : Relevant problems are given in each chapter in the text and reference books.

Books :

1. Classical Electrodynamics : S.P. Puri (Narosa Publishing House) 2011.
2. Classical Electrodynamics : J.D. Jackson, (Mew Age, New Delhi) 2009.
3. Classical Electromagnetic Radiation : J.B. Marion and M.A. Heald, (Saunders College Publishing House) 3rd edition, 1995.
4. Introduction to Electrodynamics: D.J. Griffiths (Prentice Hall India, New Delhi) 4th edition, 2012.
5. Electromagnetic Fields, Ronald K. Wangsness (John Wiley and Sons) 2nd ed.,1986.
6. Electromagnetic Field Theory Fundamentals : Bhag Singh Guru and H.R. Hiziroglu (Cambridge University Press) 2nd edition, 2004.
7. Introduction to Electrodynamics : A.Z. Capri and P.V. Panat (Narosa Publishing House) 2010.

MPEH 6251 Laboratory II and Project work 120 Hrs.

Max. Marks: 30+120=150

Note:

(i) List of experiments is same as mentioned in **MPEH 6251 Laboratory I and Project work** Course.
(ii) Students are expected to perform at least 10 experiments in each semester. The experiments performed in first semester cannot be repeated in second Semester.
(iii) Each student will complete a project work and give seminar on one of the topics on Advances in Electronics during first year. Project work will consist of understanding, handling and repair of Audio-Video and communication Electronics Equipment.
(iv) The examination for both the courses will be of 4 hours duration.
(v) There will be a 30 minutes written comprehensive test containing short answer questions for the whole class before the actual laboratory examination. This test will have a weight-age of 25 marks in each semester, will be jointly set by the teachers involved in the examination and will be of general nature.

List of Experiments:

Unit 1 : Introduction to experimental techniques

Measurement techniques: Data and error analysis, Plotting and curve fitting software, Introduction to electronic components & use of instruments: Oscilloscope, Digital storage oscilloscope, Multimeter, Wave-form generator. Experience in electronics & mechanical workshops.

Unit 2 : Analog and Digital electronics

1. To study the power dissipation in the SSB and DSB side bands of AM wave. To study the demodulation of AM wave.
2. To study various aspects of frequency modulation and demodulation.
3. To study the frequency response of an operational amplifier & to use operational amplifier for different mathematical operations.
4. To study the characteristics of a regulated power supply and voltage multiplier circuits.
5. To design a rectangular/triangular waveform generator using Comparators and IC8038.
6. To study Hartley and Wien-Bridge oscillators.
7. UJT characteristics and its application as relaxation oscillator or triggering of triac.
8. Hybrid parameters of a transistor and design an amplifier. Determination of k/e ratio.
9. FET/MOSFET characteristics, biasing and its applications as an amplifier.
10. To design (i) Low pass filter (ii) High pass filter (iii) All-pass filter (iv) Band pass filter (v) Band-reject passive filter.
11. To study logic gates and flip flop circuits using on a bread-board.
12. To configure various shift registers and digital counters. Configure seven segment displays and drivers.
13. Use of timer IC 555 in astable and monostable modes and applications involving relays, LDR.

Unit 3 : Material science

17. To study temperature-dependence of conductivity of a given semiconductor crystal using four probe method.
18. To determine the Hall coefficient for a given semi-conductor.

19. To determine dipole moment of an organic molecule, Acetone.
20. To study the lattice dynamics using LC analog kit.
21. To study the characteristic of J-H curve using ferromagnetic standards.
22. To determine the velocity of ultrasonic waves using interferometer as a function of temperature.
23. Temperature dependence of a ceramic capacitor - Verification of Curie-Weiss law for the electrical susceptibility of a ferroelectric material.
24. To determine Percolation threshold and temperature dependence of resistance in composites.
25. Tracking of the Ferromagnetic-paramagnetic transition in Nickel through electrical resistivity.
26. To study the characteristics of a PN junction with varying temperature & the capacitance of the junction.
27. To study the characteristics of a LED and determine activation energy.
28. Measurement of vacuum using the pirani/thermocouple gauge.
29. (i) Study of the characteristics of klystron tube and to determine its electronic tuning range; (ii) To determine the standing wave ratio and reflection coefficient; (iii) To determine the frequency & wavelength in a rectangular waveguide working on TE10 mode; (iv) To study the square law behaviour of a microwave crystal detector.

Unit 4 : Nuclear Radiation detectors and measurement techniques

30. To study the characteristics and dead time of a GM Counter.
31. To study Poisson and Gaussian distributions using a GM Counter.
32. To study the alpha spectrum from natural sources Th and U.
33. To determine the gamma-ray absorption coefficient for different elements.
34. To study absorption of beta rays in Al and deduce end-point energy of a beta emitter.
35. To calibrate the given gamma-ray spectrometer and determine its energy resolution.

Unit 5 : Optics

35. Laboratory spectroscopy of standard lamps
36. Stellar spectroscopy
37. To study the Kerr effect using Nitrobenzene
38. To study polarization by reflection - Determination of Brewester’s angle.
39. To measure numerical aperture and propagation loss and bending losses for optical fibre as function of bending angle and at various wavelengths.
40. To study the Magnetorestriction effect using Michelson interferometer.

Unit 6 : Fundamental constants in Physics

14. To determine Planck’s constant using photocell.
15. To determine the electric charge of an electron using Millikan drop experiment.
16. To determine the Hubble's constant (expansion rate of universe) using astronomical data and deduce the large scale structure of the universe.

Unit 7 : Mechanics and Astrophysics

42. To study the potential energy curve of the magnet-magnet interaction using air-track setup along with the simple experiments in mechanics.
43. To estimate the rotational period of sun using sunspots observations.
44. To estimate the mass of Jupiter using rotational periods of Galilean satellites.
45. To estimate the distance between sun and earth (1AU) using GONG project results of Venus and Mercury transits.

MPEH 6252 COMPUTATIONAL TECHNIQUES II **Max. Marks: 10+40=50**

Section- A

1. Use of PSPICE for electronic circuit design.
2. Use of ORCAD for electronic printed circuit board design.
3. Use of MATLAB software for basic applications on signal processing.
4. Computer hardware - I/O devices and controls, device drivers (with examples).

Section- B

List of Physics problems to done using C++:
1. Write a program to study graphically the EM oscillations in a LCR circuit (use Runge-Kutta Method). Show the variation of (i) Charge vs Time and (ii) Current vs Time.
2. Study graphically the motion of falling spherical body under various effects of medium (viscous drag, buoyancy and air drag) using Euler method.
3. Study of launching and trajectory of motion of an artificial satellite.
4. Study the motion of (a) 1-D harmonic oscillator (without and with damping effects). (b) two coupled harmonic oscillators.
5. To obtain the energy eigenvalues of a quantum oscillator using the Runge-Kutta method.
6. Study the motion of a charged particle in: (a) Uniform electric field, (b) Uniform Magnetic field, (c) in combined uniform E and M fields. Draw graphs in each case.

Books

1. A First Course in Computational Physics: P.L. DeVries (John Wiley) 2000.
2. An introduction to Computational Physics: Tao Pang (Cambridge), 2nd ed. 2006.
3. Computer Applications in Physics: S. Chandra (Narosa), 2006.
4. Computational Physics: R.C. Verma, P.K.Ahluwalia and K.C. Sharma (New Age), 2005.
5. Object Oriented Programming with C++: Balagurusamy,(Tata McGrawHill), 5th ed. 2011.

THIRD SEMESTER

MPEH7101: Electronics-III ADVANCED MICROPROCESSORS

Max. Marks:20+80= 100

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 16. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 50% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

Advanced programming techniques for 8085 microprocessor, Counters and timer delays, Stack and subroutines, Code conversion, BCD, Arithmetic and 16-bit Data operations, Interrupts of 8085, Vectored and nonvectored, maskable and nonmaskable interrupts.

Interfacing data converters – A/D and D/A, Programmable interface devices – 8255A programmable interface, Interfacing keyboard/Display and Seven-segment display

Interfacing Programmable Peripheral Devices – interfacing keyboard and seven segment display, 8254 programmable interval timer, 8259A programmable interval timer, 8259 Programmable Interrupt Controller.

Serial communications, Software controlled Asynchronous Serial I/O, Programmable communications interface 8251, RS232

8086 Architecture- Hardware specifications, Pins and signals, Internal data operations and Registers, Minimum and maximum mode, System Bus Timing, Linking and execution of Programs, Assembler Directives and operators.

Software & instruction set- Assembly language programming: addressing mode and instructions of 8086, MACRO programming, 8086 interrupts.

Analog interfacing & Digital interfacing, Programmable parallel ports, Memory interfacing and Decoding, DMA controller.

Introduction and basic features of 286, 386, 486 and Pentium processors.

Books:

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and Applications with 8085, (Prentice Hall) 2002.
2. Microcomputer Systems: The 8086/8088 Family- Yu Cheng Liu and G.A. Gibson, (Prentice Hall of India), 1991.
3. The 8086/8088 Family Design, programming and interfacing- John Uffenbeck, (Prentice Hall of India), 1987.
4. Badri Ram, Advanced Microprocessors and Interfacing, (Tata McGraw Hill), 2001.
5. Douglas V. Hall, Microprocessors and Interfacing programming and Hardware (Tata McGraw Hill) 2005.

MPEH 7102 Electronics-IV

ELECTRONICS INSTRUMENTATION & POWER ELECTRONICS

Max. Marks:15+60= 75

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 12. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 50% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

Electronics Instrumentation

Electrical Transducers: Active Types - Thermoelectric, Piezoelectric, Magnetostrictive, Hall effect type, Electromechanical, Accelerometer, Photoelectric, Ionization, Electrochemical, Measurement of Power and RF Power, Transducers for biological applications. Measurements of electrical parameters and non-electrical parameters. Digital Sensors: Chemical sensors, Optochemical sensors, Electrochemical sensors, Biosensors, IR / PIR Sensors and motion detectors, Semiconductor sensors, Smart sensors, Charge coupled devices and its applications in imaging.

Feedback Transducer Systems - Inverse transducers, Temperature balance system, Self-balancing potentiometers and bridges, Heat-flow balance Systems, Beam balance systems, Servo-operated Manometer, Feedback Pneumatic Load Cell, Servo-operated Electromagnetic flow meter, Feedback accelerometer System, Integrating Servo, Other applications of feedback system.

Wave analyzers and Harmonic distortion: Frequency selective wave analyzer, Heterodyne Wave analyzer, Spectrum analyzer, Digital Fourier Analyzer.

Power electronics

Regulated Power Supplies – Regulated Power Supplies, Supply characteristics, Domestic and industrial Power backup systems, Diodes for high voltage power supplies, Shunt and series regulators, Monolithic linear regulators, Current boosters, DC-to-DC converters, Switching regulators

Semiconductor power devices - Basic characteristics & working of Power Diodes, Diac, SCR, Triac, Power Transistor, MOSFETs, IGBT, and GTO.
Devices of Thyristor family and their Switching characteristics, GTO, MOSFET, IGBT, Thyristor, triggering and commutation circuits, Thyristor protection circuits, SCR Crowbar circuit.

Principle of operation of choppers - Step up, Step down and reversible choppers.
High frequency electronic ballast, Switch Mode Power Supply: Fly back converter, forward/buck converter, Boost converter and buck-boost converter.
Uninterruptible Power Supply.
Phase controlled rectifiers for different loads with and without freewheeling diode.

Inverters – single phase series and parallel inverters, single phase and three phase inverters, Pulse width modulated inverters, Cycloconverters

DC and AC drives – Single-phase and three-phase converter drives, Chopper drives, Induction motor drives, Microprocessor controlled electrical drives

Books:

1. Transducers and Instrumentation by D.V.S. Murty, (Prentice-Hall of India Private Limited, New Delhi), 2004.
2. Modern Electronic Instrumentation and Measurement Techniques, A.D. Helfrick and William D. Cooper, (Prentice Hall of India, New Delhi), 1990.
3. Design of Medical Electronic Devices by Reinaldo Perez, (Academic Press), 2002.
4. Introduction to Instrumentation and Control, A.K. Ghosh, (Prentice Hall of India), 2000.
5. Measurement and Instrumentation Principles, Alan S Morris, (Prentice Hall of India), 2001.
6. Power Electronics by C.W. Lander, (McGraw Hill Book Company, Singapore) 1993.
7. Mohammed H. Rashid, Power Electronics-Circuits, Devices and Applications, (Prentice Hall of India, New Delhi) 2001.

MPEH7103 CONDENSED MATTER PHYSICS-I Max. Marks: 15+60=75

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 12. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I Elastic constants :
Binding in solids; Stress components, stiffness constant, elastic constants, elastic waves in crystals.

II Lattice Dynamics and Thermal Properties :
Rigorous treatment of lattice vibrations, normal modes; Density of states, thermodynamic properties of crystal, anharmonic effects, thermal expansion.

III Energy Band Theory :
Electrons in a periodic potential: Bloch theorem, Nearly free electron model; tight binding method; Semiconductor Crystals, Band theory of pure and doped semiconductors; elementary idea of semiconductor superlattices.

IV Transport Theory :
Electronic transport from classical kinetic theory; Introduction to Boltzmann transport equation; electrical and thermal conductivity of metals; thermoelectric effects; Hall effect and magnetoresistance.

V Dielectric Properties of Materials :
Polarization mechanisms, Dielectric function from oscillator strength, Clausius-Mosotti relation; piezo, pyro- and ferro-electricity.

VI Liquid Crystals :

Thermotropic liquid crystals, Lyotropic liquid crystals, long range order and order parameter, Various phases of liquid crystals, Effects of electric and magnetic field and applications, Physics of liquid crystal devices.

TUTORIALS : Relevant problems given in the books listed below.

Books :

1. Introduction to Solid State Physics : C. Kittel (Wiley, New York), 2005.
2. Quantum Theory of Solids : C. Kittel (Wiley, New York), 1987.
3. Principles of the Theory of Solids : J. Ziman (Cambridge University Press) 1972.
4. Solid State Physics : H. Ibach and H. Luth (Springer Berlin), 3rd ed. 2002.
5. Solid State Theory : Walter A. Harrison (Tata McGraw-Hill, New Delhi) 1970.
6. Liquid Crystals : S. Chandrasekhar (Cambridge University), 2nd ed. 1992.
7. The Liquid Crystal Phases : Physics & Technology : T.J. Sluckin, Contemporary Physics (Taylor & Francis), 2000.

MPEH7104: NUCLEAR PHYSICS-I — Max. Marks: 15+60 = 75

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 12. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I Static properties of nuclei : Nuclear radii and measurements, nuclear binding energy (review), nuclear moments and systematic, wave-mechanical properties of nuclei, hyperfine structure, effect of external magnetic field, Nuclear magnetic resonance.

II Radioactive decays : Review of barrier penetration of alpha decay & Geiger-Nuttal law. Beta decays, Fermi theory, Kurie plots and comparative half lives, Allowed and forbidden transitions, Experimental evidence for Parity-violation in beta decay, Electron capture probabilities, Double beta decay, Neutrino, detection of neutrinos, measurement of the neutrino helicity.

Multipolarity of gamma transitions, internal conversion process, transition rates, Production of nuclear orientation, angular distribution of gamma rays from oriented nuclei.

III Nuclear forces : Evidence for saturation of nuclear density and binding energies (review), types of nuclear potential, Ground and excited states of deuteron, dipole and quadrupole moment of deuteron, n-p scattering at low energies, partial wave analysis, scattering length, spin-dependence of n-p scattering, effective-range theory, coherent and incoherent scattering, central and tensor forces, p-p scattering, exchange forces & single and triplet potentials, meson theory of nuclear forces.

IV Neutron physics : Neutron production, slowing down power and moderating ratio, neutron detection.

V Nuclear reactions: Nuclear reactions and cross-sections, Resonance, Breit-Wigner dispersion formula for l=0 and higher values, compound nucleus, Coulomb excitation, nuclear kinematics and radioactive nuclear beams.

TUTORIALS : Relevant problems given in the books listed below:

Books :

1. Nuclear Physics : Irving Kaplan (Narosa), 2002.
2. Basic Ideas and Concepts in Nuclear Physics by K. Hyde (Institute of Physics) 2004.
3. Introduction to Nuclear Physics ; Herald Enge (Addison-Wesley) 1971.
4. Nuclei and Particles : E. Segre, (W.A. Benjamin Inc), 1965.
5. Theory of Nuclear Structure : R.R. Roy and B.P. Nigam (New Age, New Delhi) 2005.
6. Nuclear Physics: Experimental and Theoretical, H.S. Hans (New Academic Science) 2nd ed. 2011.

MPEH7105 PARTICLE PHYSICS – I Max. Marks: 15+60 = 75

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 12. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I Introduction : Fermions and bosons, particles and antiparticles, quarks and leptons, interactions and fields in particle physics, classical and quantum pictures, Yukawa picture, types of interactions - electromagnetic, weak, strong and gravitational, units.

II Invariance Principles and Conservation Laws : Invariance in classical mechanics and in quantum mechanics, Parity, Pion parity, Charge conjugation, Positronium decay. Time reversal invariance, CPT theorem.

III Hadron-Hadron Interactions : Cross section and decay rates, Pion spin, Isospin, Two-nucleon system, Pion-nucleon system, Strangeness and Isospin, G-parity, Total and Elastic cross section, Particle production at high energy.

IV Relativistic Kinematics and Phase Space : Introduction to relativistic kinematics, particle reactions, Lorentz invariant phase space, two-body and three-body phase space, recursion relation, effective mass, dalitz, K-3π-decay, τ-θ puzzle, Dalitz plots for dissimilar particles, Breit-Wigner resonance formula, Mandelstem variables.

V Static Quark Model of Hadrons : The Baryon decuplet, quark spin and color, baryon octer, quark—antiquark combination.

VI Weak Interactions : Classification of weak interactions, Fermi theory, Parity non-conservation in β-decay, experimental determination of parity violation, helicity of neutrino, K-decay, CP violation in K- decay and its experimental determination.

TUTORIALS : Relevant problems given at the end of each chapter in the books listed below.

Books :

1. Introduction to High Energy Physics : D.H. Perkins (Cambridge University Press), 4th ed. 2000.
2. Elementary Particles : I.S. Hughes (Cambridge University Press), 3rd ed. 1991.
3. Introduction to Quarks and Partons : F.E. Close (Academic Press, London), 1979.
4. Introduction to Particle Physics : M.P. Khanna (Prentice Hall of India, New Delhi), 2004.

MPEH7151 Physics Laboratory III **Max. Marks: 20+80=100**

Note:

(i) Students are expected to perform at least **10** experiments in the semester with equal coverage from each unit.
(ii) The examination for the course will be of 4 hours duration.
(iii) There will be a 30 minutes written comprehensive test containing short answer questions for the whole class before the actual laboratory examination. This test will have a weight-age of **25** marks in each semester, will be jointly set by the teachers involved in the examination and will be of general nature.

List of Experiments :

1. To determine the g-factor of free electron using ESR.
2. To measure dielectric constant of barium titanate as function of temperature and frequency and hence study its phase transition.
3. To study structural and melting transition in KNo_3 using Differential Thermal Analyser.
4. To study Martensite to Austenite phase transition in Shape memory alloy Nitinol.
5. To study Metal-Insulator transition in a thin film of strontium doped lanthanum mangenite
6. To study thermoluminescence of F-centres in alkali halide crystals.
7. To study Raman scattering in CCl_4 .
8. To study Zeeman effect by using Na lamp.
9. Determination of velocity of light using modulated Laser method
10. Hands on experience on X-ray diffractometer for studying (i) Crytal structure (ii) Phase identification and (iii) size of nanoparticles.
11. Experiments with microwave (Gunn diode): Young's double slit experiment, Michelson interferometer, Febry-Perot interferometer, Brewester angle, Bragg's law, refractive index of a prism.
12. To measure (i) dielectric constant of solid/liquid; (ii) Q of a cavity. Use of Klystron-based microwave generator.
13. To plot polar pattern and gain characteristics of Pyramidal horn antenna and parabolic dish for microwaves.
14. Scanning tunneling microscope – hardware and software familiarization, Atomic lattice image of graphite, Study of thin film and nanogrid .
15. Energy calibration of a gamma-ray spectrometer and determination of the energy resolution by using multi-channel analyzer.
16. To study time resolution of a gamma-gamma ray coincidence set-up.
17. To study anisotropy of gamma-ray cascade emission in ^{60}Ni (^{60}Co source) using a coincidence set-up.
18. Time calibration and determination of the time resolution of a coincidence set-up using a multi- channel analyzer.
19. To study calibration of a beta-ray spectrometer.
20. To study scattering of gamma rays from different elements.
21. To determine range of Alpha-particles in air at different pressure and energy loss in thin foils.
22. To determine strength of alpha particles using SSNTD.
23. *To measure* $p\beta$ of a particle using emulsion track.
24. To study p-p interaction and find the cross-section of a reaction using a bubble chamber.

25. To study n-p interaction and find the cross-section using a bubble chamber.
26. To study k-d interaction and find its multiplicity and moments using a bubble chamber.
27. To study a $\pi\mu$ event using emulsion track.
28. To design (i) Low pass filter (ii) High pass filter (iii) All-pass filter (iv) Band pass filter (v) Band-reject filter using 741 OPAMP.
29. To study of Switched-mode power supply.
30. To study Phase Locked Loop (PLL) – (i) adjust the free running frequency (ii) determination of lock range and capture range (iii) determine the dc output from Frequency modulated wave.
31. Measurement of (i) low resistance (ii) Mutual inductance using LOCK- IN-AMPLIFIER
32. Frequency modulation using Varactor and Reactance modulator and Frequency demodulation using Quadrature detector and Phased Locked Loop detector.
33. Dynamics of non-linear systems – (i) Feigenbaum Circuit and (ii) Chua Circuit.
34. Computer controlled experiments and measurements (Phoenix kit and Python language) – Digital and analog measurements based experiments.
35. Control of devices and data logger using parallel port of PC – programming using Turbo C.
36. Programming of parallel port of PC using C-language and control of devices connected.
37. Microprocessor kit: (a) hardware familiarization
    (b) programming for (i) addition and subtraction of numbers using direct and indirect addressing modes (ii) Handling of 16 bit numbers (iii) use of CALL and RETURN instructions and block data handling.
38. (a) Selection of port for I & O and generation of different waveforms (b) control of stepper motor.
39. Microcontroller kit: hardware familiarization of µController and universal programmer and programming for four digit seven segment multiplexed up-conter upto 9999.
40. (a) EEPROM based 8 to 3 encoder using microcontroller (b) interfacing with ADC (temperature sensor) and DAC (variable voltage source).
41. Digital signal processing – TMS 320 C6713 Processor board, hardware familiarization, audio/speech applications using stereo CODEC device.
42. Microcontroller based Data Logger for PC.
43. Microcontroller AVR/ARM/PIC and interface with LCD, Temperature measurements,Traffic light, Stepper motor, Accelerometer, ADC and DAC modules, Colour, Proximity, Humidity and Pressure sensors. DTMF, RF and IR control modules.
44. Use of Digital storage oscilloscope for (a) plotting v-i characteristics; and (b) measuring speed of e.m. waves in coaxial cables.

Project Work : Develop a new experiment or perform open-ended thorough investigations using the available set-up. Weightage of the project work equal to few experiments to be decided by the teachers.

FOURTH SEMESTER

MPEH 7201: Electronics-V MICROCONTROLLERS AND EMBEDDED SYSTEMS

Max. Marks: 20+80 = 100

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 16. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 50% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

Microcontrollers and embedded processors - Overview of the 8051 family, Architecture of 8051, assembly language programming, Jump, Loop and Call instructions, Instruction set, Time delay for various 8051 chips.

I/O programming, Addressing modes, Arithmatic and Logic instructions and Programs, 8051 programming in C.

8051 hardware connection and Intel HEX file, 8051 timer programming in assembly and C, Serial port programming, Interrupts programming.

LCD and Keyboard interfacing, ADC, DAC and sensor interfacing, Interfacing to external memory, Interfacing with 8255 I/O chip, DS12887 RTC interfacing and programming.

Application of Microcontrollers in interfacing, Robotics, MCU based measuring instruments.

Real Time Operating System for System Design, Multitasking System.

Introduction to Advanced Microcontrollers: PIC and ARM controllers.

Introduction to embedded system, Classification of embedded systems.

Books :

1. The 8051 Microcontroller and embedded Systems by M. Ali Mazidi, J.G. Mazidi and R.D.M. Mckinley (Pearson Education) 2009.
2. The 8051 Microcontroller – I. Scott Mackenzie, R. Chung Wei Phan (Dorling Kindersley (India)), 4th ed. 2007.
3. Microcontrollers - A.J. Ayala, (Penram International), 2nd ed. 1996.
4. Microcontrollers : Arch., Programming, Interfacing & System design, Rajkamal, (Dorling Kindersley (India)), 2009.
5. Microcontroller (Theory & Applications), Ajay V Deshmukh (Tata McGraw Hill) 2012.
6. Embedded System Design, Rajeshwar Singh (Dhanpat Rai), 2nd Ed. 2009.
7. Embedded C Programming & the Microchip PIC, Barnett Cox and O' Cull (Thomson Learning Asia), 2004.

MPEH 7202: Electronics VI Integrated and VLSI Circuit design

Max. Marks: 15+60=75

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 12. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 25% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

Introduction to technologies- Semiconductor Substrate-Crystal defects, Electronic Grade Silicon, Czochralski Growth, Float Zone Growth, Characterization & evaluation of Crystals; Wafer Preparation- Silicon Shaping, Etching and Polishing, Chemical cleaning. Diffusion & ion implantation- Ficks diffusion Equation, Diffusion in SiO_2, Ion Implantation, Oxidation. Growth mechanism and Deal-Grove Model of oxidation, Linear and Parabolic Rate co-efficient, Structure of SiO_2, Oxidation techniques and system.

Chemical vapour deposition and layer growth- CVD for deposition of dielectric and polysilicon, Introduction to atmospheric CVD of dielectric, low pressure CVD of dielectric and semiconductor, Epitaxy-Vapour Phase Epitaxy, Defects in Epitaxial growth, Metal Organic Chemical Vapor Deposition, Molecular beam epitaxy.

Pattern transfer- Introduction to photo/optical lithography, Contact/ proximity printers, Projection printers, Mask generation, photoresists. Wet etching, Plasma etching, VLSI process integration- Junction and Oxide Isolation, LOCOS methods, Trench Isolation, SOI; Metallization, NMOS and CMOS IC Technology, Bipolar IC Technology. Packaging of VLSI devices

MicroElectro-Mechanical Systems (MEMS), Working principles of microsensors and microactuation, scaling laws in geometry, Physical Microsensors, Optical MEMS (MOEMS), fluidic, RF and Bio-MEMS, e.g., DNA-chip, micro-arrays, Materials for MEMS, Microfabrication and Micromachining processes, Isotropic Etching and Anisotropic Etching, Bulk Micromachining, Deep Reactive Ion Etching (DRIE), high aspect ratio Si structures, LIGA process, Surface micromachining, pressure sensors, accelerometers, flow sensors, gas sensors, micromotors, microgears, lab-on-a-chip systems, Microactuators, Electromagnetic and Thermal microactuation, Mechanical design and examples.

Physics of nanomaterials, quantum transport phenomenon, Overview of quantum dots, resonant tunneling devices, Introduction to Nano electromechanical systems (NEMS), Introduction to Molecular electronic devices, self assembled monolayers (SAM), Diodes, Optoelectronic devices, switches, Nanowires.

Books :

1. VLSI Technology by Simon Sze, (Tata McGraw Hill), 2nd ed. 2003.
2. VLSI Design Techniques for Analog and Digital Circuits, Randall Geiger, (McGraw Hill) 2000.
3. An introduction to Microelectromechanical system Engineering, Nadim Maluf, (Artech House) 1998.

4. MEMS and MICROSYSTEMS – design and Manufacture, Tai-Ran Hsu (Tata McGraw Hill) 2002.
5. Fundamentals of Microfabrication, Marc Madou, (CRC Press) 1990.
6. MEMS and NEMS by Sergey Edward Lyshevski, (CRC Press) 2002.

MPEH 7203 Electronics-VII Digital Signal Processing

Max. Marks: 15+60 = 75

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 12. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

Introduction to DSP Systems, Continuous and discrete-time signals, frequency ranges of various signals, Noise types.

Sampling of analog signals, Sampling theorem, Aliasing , Quantization, SQNR, noise.
Classification of Discrete-Time (DT) systems, Analysis of Discrete-Time Linear Time-Invariant (LTI) systems and their implementation, DT systems described by difference equations, Correlation sequences of DT signals and Input-output of LTI systems.

Z-Transform and its properties, Analysis of Discrete time LTI Systems in Z-domain.
Phase and Frequency response of LTI systems, Computation of response from a rational system function, Input-output correlation functions and spectra, correlation function and power spectra for random input signals, LTI systems as frequency-selective filters, system functions for LP, HP, BP, BR and AP filters, comb filters, digital resonators.

Frequency analysis of Discrete-Time signals, Fourier series for Discrete-time periodic signals and power density spectrum, Fourier transform of Discrete-time Aperiodic signals and energy density spectrum, frequency-domain classification of signals, properties of Fourier transform for discrete-time signals.

Frequency domain sampling and reconstruction of discrete-time signals, Discrete Fourier Transform (DFT) and its inverse, DFT as linear transformation, properties of DFT and applications in digital signal processing, Linear filtering of long data sequences, Overlap-save method, Overlap-add method.

Efficient computation of DFT– Divide-and Conquer approach, Radix-2 FFT algorithm, decimation-in-time algorithm, decimation-in-frequency algorithm.

Implementation of DT system – structures of FIR and IIR systems
Finite impulse response (FIR) filters, Symmetric and Antisymmetric FIR filters, design of Linear-Phase FIR filters using windows.

Infinite impulse response (IIR) digital filter design by - Approximation of derivatives, Impulse invariance and Bilinear transformation.

Multirate Digital signal processing, Decimation and interpolation of sample rate, Sampling rate conversion by a rational factor I/D, Noble identities, cascaded integrator comb filters.

Concepts of Adaptive digital filters and applications.

DSP arithmetic - Fixed-point and floating-point processors, main errors.
Architectures for signal processing, pipelining instructions, Replication, Extended parallelism–SIMD, VLIW and static superscalar processing, Circular Buffering, Barrel shifters, ADSP and TMS series of processor architectures, Selecting digital signal processors.

Books :

1. Digital Signal Processing: Principles, Algorithms, and Applications by J. G. Proakis and D. G. Manolakis (Pearson) 4th Ed. 2007.
2. Digital signal processing-A practical approach by Emmanuel C. Ifeachor and Barrie W. Jervis, (Pearson education, Asia) 2nd edition, 2001.
3. Digital Signal Processing – S. Salivahanan, A. Vallavaraj and C. Gnanapriya, (Tata McGraw Hill) 2010.
4. Digital Signal Processing – Sanjay Sharma, (S.K. Kataria and Sons, New Delhi), 2008.
5. Digital Signal Processing by Avtar Singh and S. Srinivasan, (Thomson Publications) 2004.

MPEH7251 - Project work and Introduction to Intellectual Property Regulations

Max. Marks: 150

The paper consists of two parts :

(i) PROJECT WORK **Max. Marks: 125**

The aim of project work in M.Sc (H.S.) 4th semester is to expose the students to **Instrumentation, Power Electronics, Microcontroller and DSP, Digital communication.** It may include development of pulse processing **electronic modules, power supplies,** software-controlled equipment in a research laboratory, or fabrication of a device. Project work based on participation in some ongoing research activity or analysis of data or review of some research papers is excluded. A student will work under the guidance of a faculty member from the department before the end of the 3rd semester. **Scientists and Engineers from other departments of the university and Institutes in and around Chandigarh can act as co-supervisors.** A report of nearly 50 pages about the work done in the project (typed on both the sides of the paper and properly bound) will be submitted by a date to be announced by the PGAPMEC. Assessment of the work done under the project will be carried out by a committee on the basis of grasp of the problem assigned, effort put in the execution of the project, degree of interest shown in learning the methodology, report prepared, and viva-voce/seminar, etc as per guidelines prepared by the PGAPMEC.

(ii) Introduction to Intellectual Property Regulations (Theory paper – 10 hours)

Max. Marks: 25

Introduction to Intellectual Property (IP), Intellectual Property Rights and Responsibilities, Legal means to protect unique ideas, inventions, and other non-tangible property, - patents, copyrights, trademarks, and trade secrets, Intellectual Property laws, penalties on infringement of IPR.

Presentation of Research Findings, Documentation – preparing document for publishing Research works in Books, Journals, Internet Data bases and Archives; Research work and Publishing ethics, Plagiarism.
Basics and practices about patents, Patentable inventions, Overview of the patenting process, Patenting institutions, Standard Operating Procedures (SOPs) for Patent Filing and Licensing at Panjab University. Translating patents to products: some case studies.

Books :

1. Intellectual Property Law for Engineers and Scientists, Howard B. Rockman, (John Wiley & Sons) 2004.
2. Intellectual Property Rights for Engineers, 2nd Edition, by Vivien Irish, (The institute of Engineering and Technology, London) 2005.
3. Intellectual Property- Economic and Legal Dimensions of Rights and Remedies by Roger D. Blair *and* Thomas F. Cotter, (Cambridge University Press) 2005.
4. Research Methodology: Methods and Techniques, C.R. Kothari, (New Age International Publishers) 2nd. Edition, 2004.

MPEH7503: CONDENSED MATTER PHYSICS -II

Max. Marks: 20+80= 100

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 16. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I Optical Properties : Macroscopic theory – generalized susceptibility, Kramers- Kronig relations, Brillouin scattering, Raman effect; interband transitions.

II Magnetism : Dia- and para-magnetism in materials, Pauli paramagnetism, Exchange interaction. Heisenberg Hamiltonian – mean field theory; Ferro-, ferri- and antiferro-magnetism; spin waves, Bloch $T^{3/2}$ law.

III Principles of Magnetic Resonance : ESR and NMR – equations of motion, line width, motional narrowing, Knight shift.

IV Superconductivity : Experimental Survey; Basic phenomenology; BCS pairing mechanism and nature of BCS ground state; Flux quantization; Vortex state of a Type II superconductors; Tunneling Experiments; High Tc superconductors.

V Disordered Solids : Basic concepts in point defects and dislocations; Noncrystalline solids: diffraction pattern, glasses, amorphous semiconductors and ferromagnets, heat capacity and thermal conductivity of amorphous solids, nanostructures – short expose; Quasicrystals.

TUTORIALS : Relevant problems given at the end of each chapter in the books listed below.

Books :

1. Introduction to Solid State Physics : C. Kittel (Wiley, New York) 2005.
2. Quantum Theory of Solids : C. Kittel (Wiley, New York) 1987.
3. Principles of the Theory of Solids : J. Ziman (Cambridge University Press) 1972.
4. Solid State Physics : H. Ibach and H. Luth (Springer, Berlin), 3rd. ed. 2002.
5. A Quantum Approach to Solids : P.L. Taylor (Prentice-Hall, Englewood Cliffs), 1970.
6. Intermediate Quantum Theory of Solids : A.O.E. Animalu (East-West Press, New Delhi), 1991.
7. Solid State Physics : Ashcroft and Mermin (Reinhert & Winston, Berlin), 1976.

MPEH7504: NUCLEAR PHYSICS-II **Max. Marks: 20+80 = 100**

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 16. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

Review of Fermi gas model and liquid drop model.

I Shell model : Coupling of angular momenta, C.G., Racah coefficients, Wigner's 3j,6j and 9j symbols and properties, Extreme particle model with square-well & harmonic oscillator potentials, spin-orbit coupling, shell model predictions, static electromagnetic moments of nuclei, LS & jj coupling, seniority wave function, magnetic moment-Schmidt lines, Single particle model, Total spin 'J' for various configurations, electric quadrupole moment, configuration mixing, independent particle model, coefficient of fractional parentage, Two nucleon wavefunction, Matrix elements of one and two body operators, Correlation in nuclear matter.

II Collective model : Rotation-D matrices and properties, Collective modes of motion, nuclear vibrations, iso-scalar vibrations, Giant resonance, derivation of collective Hamiltonian and applications, Rotation and vibration of even-even nuclei, β and γ-vibrations, Rotational-vibrational coupling, odd-mass nuclei - coupling of particle to even-even core, Nilsson model, Rotational motion at high spin, Kinematic and dynamic moment of inertia, Routhian and alignment plots, backbending behaviour.

III Nuclear reactions : Review of Statistical and Optical model for compound nucleus, Direct reactions : Kinematics and theory of stripping, pick up and reverse reactions. Fusion-evaporation & transfer reactions and various models, Heavy-ion induced nuclear reactions and various phenomena at low, intermediate and high energies.

TUTORIALS : Relevant problems given at the end of each chapter in the books listed below.

Books :

1. Theory of Nuclear Structure : M.K. Pal (East-West Press, New Delhi), 1982.
2. Nuclear Physics : R.R. Roy and B.P. Nigam (New Age, New Delhi), 2005.
3. Basic Ideas and Concepts in Nuclear Physics by K. Hyde (Institute of Physics), 2004.
4. Elementary theory of Angular Momentum by M.E. Rose (Dover), 2011.
5. Quantum Mechanics, V.K.Thankappan (New Age Publications), 2012.
6. Concepts of Nuclear Physics by B.L. Cohen (Tata McGraw Hill), 2004.
7. Nuclear physics: Experimental and Theoretical, H.S. Hans (New Academic Science) 2^{nd} ed. (2011).
8. Angular Momentum Techniques in Quantum mechanics, V. Debanathan (Kluwar Academic), 1999.

MPEH7505 PARTICLE PHYSICS – II   Max. Marks: 20+80 = 100

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 16.The first question will be compulsory and will consist of several short questions/problems covering the entire syllabus. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I Review of Relativistic Quantum Mechanics and Quantum Field theory.

II Electromagnetic Interactions. Form factors of nucleons . Parton model and Deep inelastic scattering structure functions.

III Symmetries and Symmetry Breaking.

(a) Continuous groups: U(1)~SO(2), SO(3) ~SU(2)~spin(3), SU(3) and Unitary groups. Lorentz group SO(1,3) and its representations. Dirac, Weyl and Majorana fermions.

(b) Global and Local invariances of the Action. Approximate symmetries. Noether's theorem. Spontaneous breaking of symmetry and Goldstone theorem. Higgs mechanism.

IV Abelian and Non-Abelian gauge fields. Lagrangian and gauge invariant coupling to matter fields. Elements of Quantization and Feynman rules.

V. Standard Model of Particle Physics : SU(3) x SU(2) x U(1) gauge theory, Coupling to Higgs and Matter fields of 3 generations. Gauge boson and fermion mass generation via spontaneous symmetry breaking, CKM matrix . Low energy Electroweak effective theory and the V-A 4-fermion interactions. Elementary electroweak scattering processes. Neutrino masses and Neutrino Oscillations.

VI. QCD and quark model: Asymptotic freedom and Infrared slavery , confinement hypothesis. Approximate flavor symmetries of the QCD Lagrangian: Chiral symmetry and it's breaking.
Classification of hadrons by flavor symmetry : SU(2) and SU(3) multiplets of Mesons and Baryons.

TUTORIALS : Relevant problems given at the end of each chapter in the books listed below.

Books :

1. An Introduction to High Energy Physics, D.H. Perkins (Cambridge Press) 4th ed. 2000.
2. An Introduction to Elementary Particles : D. Griffiths (Wiley-Vch), 2008.
3. Unitary Symmetry and Elementary Particles : Litchtenberg (Academic, NY) 1978.
4. Introduction to Quarks and Partons : F.E. Close (Academic Press, London), 1979.
5. Introduction to Particle Physics : M.P. Khanna (Prentice-Hall of India, New Delhi), 2004.
6. Gauge Theories of Weak, Strong and Electromagnetic Interactions : C. Quigg (Addison-Wesley), 1994.
7. Gauge Theory of Elementary Particle Physics : T.P Cheng and L.F. Li (Oxford University Press, Oxford), 2000.
8. Particle Physics and introduction to Field Theory, T.D. Lee, (Harwood Academic), 1988.
9. First Book of Quantum Field Theory , A. Lahiri and P. Pal , (Narosa, New Delhi), 2nd ed. 2007.

MPEH 7506 : Electronics VIII - DIGITAL COMMUNICATION

Max. Marks: 20+80= 100

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 16. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 50% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

Digital Radio Communication Systems: Transmission media, sampling, multiplexing, digital modulation and multiple access techniques.

Data Communication: General communication system, Modulation and demodulation techniques, Baseband signal receiver, probability of error, Optimum filter, Matched filter correlator.

Pulse Modulation: Sampling, Nyquist theorem, Calculation of percentage distortion due to undersampling, Spectrum of sampled signal, sampling with narrow pulses, Pulse amplitude modulation, Pulse width modulation, pulse position modulation, digital modulation principles , pulse code modulation, intersymbol interference, eye patterns, equalization, compounding, Bandwidth and noise of PCM systems, Delta modulation, Limitations, Adaptive DM, Comparison between various techniques.

Modern communication Systems :

Data transfer and computer networking - Techniques, packet switching, ISDN, ATM, LAN, WAN, Internet and WAP, ASK, FSK, PSK, DPSK, QPSK.

Satellite communication Systems - Principles of satellite communication, modulation, multiplexing and multiple access techniques; satellite services like DSB, VSAT, DTH services.

Mobile communication - Specifications, design approach and details, GPRS application.

Optical Fibre Communication systems - Network topologies, Fiber Distributed Data Interface network, Optical Time Domain Recognizer, Synchronous Optical Network (SONET/SDH), Asynchronous Transfer Mode, Wavelength Division Multiplexing and its network implementation

Information and Theory: Information, Entropy, Mutual information, redundancy and channel capacity, Shannon-Hartley theorem, Bandwidth S/N Trade off

Coding Theory: Shannon's Theorem, Coding of η, Shannon-Fano coding, Huffman coding, Hamming coding, bit error detection and correction, Modern Transmission characteristics, Modern features, compatibility, selection criteria

Books:

1. Communication systems : Haykin, (John Wiley), 2001.
2. Communication Systems : B.P. Lathi, (Wiley Eastern Limited),1988.
3. Introduction to Modern communication by P.D. Sharma (Nem Chand & Bros), 1971.
4. Digital Communications : J.G. Proakis (Tata McGraw Hill), 4^{th} ed. 2001.
5. Digital Signal Transmission : Bissell and Chapman, (Cambridge University Press), 1992.

MPEH7507 PHYSICS OF NANOMATERIALS Max. Marks: 20+80 = 100

Note :

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 16. The first question will be compulsory and will consist of several short questions/problems covering the entire syllabus. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I Introductory Aspects : Free electron theory and its features, Idea of band structure-metals, insulators and semiconductors. Density of state in one, two and three dimensional bands and its variation with energy, Effect of crystal size on density of states and band gap. Examples of nanomaterials.

II Preparation of Nanomaterials : Bottom up: Cluster beam evaporation, ion beam deposition, chemical bath deposition with capping techniques and Top down: Ball Milling.

III General Characterization Techniques : Determination of particle size, study of texture and microstructure, Increase in x-ray diffraction peaks of nanoparticles, shift in photo luminescence peaks, variation in Raman spectra of nanomaterials, photoemission microscopy, scanning force microscopy.

IV Quantum Dots : Electron confinement in infinitely deep square well, confinement in one and two-dimensional wells, idea of quantum well structure, Examples of quantum dots, spectroscopy of quantum dots.

V Other Nanomaterials : Properties and applications of carbon nanotubes and nanofibres, Nanosized metal particles, Nanostructured polymers, Nanostructured films and Nano structured semiconductors.

TUTORIALS : Relevant problems pertaining to the topics covered in the course.

Books

1. Nanotechnology - Molecularly Designed Materials : G.M. Chow & K.E. Gonsalves (American Chemical Society) 1996.
2. Nanotechnology Molecular Speculations on Global Abundance : B.C. Crandall (MIT Press), 1996.
3. Quantum Dot Heterostructures: D. Bimerg, M. Grundmann and N.N. Ledentsov (Wiley), 1998.
4. Nanoparticles and Nanostructured Films–Preparation, Characterization and Application : J.H. Fendler (Wiley), 1998.
5. Nanofabrication and Bio-system: H.C. Hoch, H.G. Craighead and L. Jelinski (Cambridge Univ. Press), 1996.
6. Physics of Semiconductor Nanostructures: K.P. Jain (Narosa), 1997.
7. Physics of Low-Dimension Semiconductors: J.H. Davies (Cambridge Univ. Press), 1998.
8. Advances in Solid State Physics (Vo.41) : B. Kramer (Ed.) (Springer), 2001.

MPEH7508: EXPERIMENTAL TECHNIQUES IN NUCLEAR PHYSICS AND PARTICLE PHYSICS

Max. Marks: 20+80 = 100

Note:

(i) The question paper for end-semester examination will consist of seven questions of equal marks, viz. 16. The first question will be compulsory and will consist of 6-8 short questions/problems on the UGC-NET (objective type) pattern. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt five questions in all, including the compulsory question. The question paper is expected to contain problems to the extent of 40% of total marks.

(ii) The books indicated as text-book(s) are suggestive of the level of coverage. However, any other book may be followed.

I **Detection of radiations:** Interaction of gamma-rays, electrons, heavy charged particles, neutrons, neutrinos and other particles with matter.

General properties of Radiation detectors, energy resolution, detection efficiency and dead time. Statistics and treatment of experimental data.

Gas-filled detectors, Proportional counters, space charge effects, energy resolution, time characteristics of signal pulse, position-sensitive proportional counters, Multiwire proportional chambers, Drift chamber, Time projection chamber.

Organic and inorganic scintillators and their characteristics, light collection and coupling to photomultiplier tubes and photodiodes, description of electron and gamma ray spectrum from detector, phoswich detectors, Cherenkov detector.

Semiconductor detectors, Ge and Si(Li) detectors, Charge production and collection processes, detector structures and fabrication aspects, semiconductor detectors in X- and gamma-ray spectroscopy, Pulse height spectrum, Compton suppressed Ge detectors, Semiconductor detectors for charged particle spectroscopy and particle identification, Silicon strip detectors, Radiation damage.

Electromagnetic and Hadron calorimeters.

Motion of charged particles in magnetic field, Magnetic dipole and quadrupole lenses, beta ray spectrometer.

Detection of fast and slow neutrons - nuclear reactions for neutron detection.

General Background and detector shielding.

II **Electronics associated with detectors :** Electronics for pulse signal processing, CR-$(RC)_n$ and delay-line pulse shaping, pole-zero cancellation, baseline shift and restoration, preamplifiers (voltage and charge-sensitive configurations), overload recovery and pileup, Linear amplifiers, single-channel analyser, anolog-to-digital converters, multichannel analyzer.
Basic considerations in time measurements, Walk and jitter, Time pickoff methods, time-to-amplitude converters, Systems for fast timing, fast-slow coincidence, and particle identification, NIM and CAMAC instrumentation standards and data acquisition system.

III **Experimental methods :** Detector systems for heavy-ion reactions : Large gamma and charge particle detector arrays, multiplicity filters, electron spectrometer, heavy-ion reaction analysers, nuclear lifetime measurements (DSAM and RDM techniques), production of radioactive ion beams.
Detector systems for high energy experiments : Collider physics (brief account), Particle Accelerators (brief account), Secondary beams, Beam transport, Modern Hybrid experiments- CMS and ALICE.

Tutorials: Relevant problems pertaining to the topics covered in the course.

Books :

1. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001.
2. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010.
3. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994.
4. Detectors for particle radiation by Konrad Kleinknecht (Cambridge University Press), 1999.

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