॥ ಶ್ರದ್ಧಾಹಿ ಪರಮಾ ಗತಿಃ ॥

The National College

Department of Post-Graduate Studies in Physics

Jayanagar,Bangalore-70

Proposed Syllabus for M.Sc. Physics
CBCS Scheme
2020 Onwards

Details of the Courses and Credits for the four Semesters

Semester	Theory (Hardcore)	Credits	Theory Soft Core/Open Elective	Credits	Labs	Credits	Total
I	4	4 x 4 = 16	Soft core-1	1 x 2 = 2	2	2 x 4 = 8	26
II	4	4 x 4 = 16	Soft core-1	1 x 2 = 2	2	2 x 4 = 8	26
III	4	4 x 4 = 16	Open Elective and Project	1 x 2 = 2	2	2 x 4 = 8	26
IV	4	4 x 4 = 16	Project	1 x 2 = 2	1	1 x 4 = 4	22
Total number of credits for the 4 Semester M.Sc. course							**100**

Total Marks for the 4 semester:

I Semester – 700 marks
II Semester – 700 marks
III Semester – 700 marks
IV Semester – 600 marks

Grand Total -- 2700 marks

COURSE DETAILS:

I Semester: 4 Theory (Hardcore)+ 1Theory (soft core) + 2 Labs = 26 credits

Paper Code	Paper Title	Credits	Exam Max. Marks	Internal Assessment marks	Total
P 101	Classical Mechanics	4	70	30	100
P 102	Electronic Circuits and Devices	4	70	30	100
P 103	Quantum Mechanics- I	4	70	30	100
P 104	Mathematical Methods of Physics	4	70	30	100
P 105	Soft Core : Experimental Techniques in Physics	2	70	30	100
P 106 a	General Physics Lab-1	2	35	15	50
P 106 b	General Physics Lab-2	2	35	15	50
P 107 a	Electronics Lab 1	2	35	10	50
107 b	Electronics Lab 2	2	35 T	15	50

o

Total Marks: 700

II Semester: 4 Theory (Hardcore)+ 1Theory (soft core) + 2 Labs = 26 credits

Paper Code	Paper Title	Credits	Exam Max. Marks	Internal Assessment marks	Total
P 201	Statistical Mechanics & Thermodynamics	4	70	30	100
P 202	Electrodynamics& Plasma Physics	4	70	30	100
P 203	Quantum Mechanics- II	4	70	30	100
P 204	Numerical Analysis and Computational Physics	4	70	30	100
P 205	Soft Core : Radiation Biophysics & Medical Instrumentation	2	70	30	100
P 206 a	General Physics Lab-3	2	35	15	50
P 206 b	General Physics Lab-4	2	35	15	50
P 207 a	Computer Lab 1	2	35	15	50
P 208 b	Computer Lab 2	2	35	15	50

Total Marks: 700

I SEMESTER

P 101: Classical Mechanics (4 credits, 4 lectures per week)

Unit-I

Classical Formalism

Lagrangian Formulation: Constraints and their classification, degrees of freedom, generalized co-ordinates, virtual displacement, D'Alembert's principle, Lagrange's equations of motion of the second kind.

Hamiltonian formulation: Generalized momenta, canonical variables, Legendre transformation and the Hamilton's equations of motion.

Canonical transformation: Generating functions (four basic types), examples of canonical transformations, the harmonic oscillator in one dimension, Poisson brackets, equations of motion in terms of Poisson brackets, properties of Poisson brackets (anti-symmetry, linearity and Jacobi identity), Poisson brackets of angular momentum.

(13 hours)

Unit- II

Calculus of variations and Non-linear methods: Concept of variation, Euler's equation, Missing dependent variables, Applications of the Euler equation, Several independent variables, Hamilton's principle and Lagrange's equations, Lagrangian multipliers, Examples. Autonomous and non-autonomous systems, fixed points, their classification, phase space trajectories, limit cycle motion, logistic map.

(13 hours)

Unit- III

Central forces & Non- central Forces: Reduction of two particle equations of motion to the equivalent one-body problem, reduced mass of the system, conservation theorems (First integrals of the motion),equations of motion for the orbit, classification of orbits, conditions for closed orbits, the Kepler problem (inverse square law force).

Motion in non-central reference frames: Motion of a particle in a general non-inertial frame of reference, notion of pseudo forces, equations of motion in a rotating frame of reference, the Coriolis force, deviation due east of a falling body, the Foucault pendulum.

(13 hours)

Unit -IV

Rigid body dynamics: Degrees of freedom of a free rigid body, angular momentum and kinetic energy of a rigid body, moment of inertia tensor, principal moments of inertia, classification of rigid bodies as spherical, symmetric and asymmetric, Euler's equations of motion for a rigid body, Torque free motion of a rigid body.

Small oscillations: Types of equilibria, quadratic forms for kinetic and potential energies of a system in equilibrium, Lagrange's equations of motion, normal modes and normal frequencies, examples of (i) longitudinal vibrations of two coupled harmonic oscillators, (ii) Normal modes and normal frequencies of a linear, symmetric, triatomic molecule.

(13 hours)

References

1. Classical mechanics, H. Goldstein, C. Poole, J. Saflco, 3rd edition, Pearson Education Inc.(2002).
2. Classical mechanics, K. N. Srinivasa Rao, University Press (2003).
3. Classical mechanics, N. C. Rana and P. S. Joag, Tata McGraw-Hill (1991).
4. Classical dynamics of particles and systems, J. B. Marian, Academic Press (1970)
5. Classical mechanics, L. D. Landau and E. M. Lifshitz, 4th edition, Pergamon press (1985).
6. Mathematical Methods for Physicists – G. B. Arfken and H. Weber, Seventh Edition, Academic Press, 2012
7. Introduction to Classical Mechanics, R.G. Takawale and P.S. Puranik, Tata McGraw- Hill (1979)

2002), Tata McGraw Hill.

P102: Electronic Circuits and Devices (4 credits, 4 lectures per week)

Unit- I
Physics of devices: p-n junction , abrupt junction – band structure – thermal equilibrium – Depletion region – depletion capacitance – current and voltage characteristics – BJT – band Structure - transistor action – static characteristics.JFET structure, working, characteristics. MOS structure – MOSFET working – MOSFET characteristics – width of depletion region – Junction capacitance-threshold voltage. Metal semiconductor contacts – ohmic and Schottky Contacts. Principle of operation of photoelectronic devices: photoconductor – efficiency, current gain, response time.

(13 hours)

Unit -II
Operational amplifiers: Block diagram of an operational amplifier – Characteristics of an ideal operational amplifier – comparison with 741 – Operational amplifier as a open loop amplifier - Limitations of open loop configuration – Operational amplifier as a feedback amplifier: closed loop gain, input impedance, output impedance of inverting and non-inverting amplifiers - Voltage follower - Differential amplifier: voltage gain. Applications of op-amp: Linear applications – Phase and frequency response of low pass, high pass and band pass filters(first order), summing amplifier – inverting and non-inverting configurations, subtractor, difference summing amplifier, ideal and practical Differentiator, Integrator. Non - linear applications: comparators, positive and negative clippers, positive and negative clampers, small signal half wave rectifiers.

(13 hours)

Unit -III
Digital circuits: Review of gates (AND, OR, NAND, NOR, NOT, EX-OR), - Boolean laws and Theorems – simplification of SOP equations – Simplification of POS equations - Simplification using Karnaugh Map technique (4 variables)- conversion of binary to Grey Code - Flip flops: Latch using NAND and NOR gates- RS flip flop , clocked RS flip flop, JK Flip flop, JK master slave flip flop - racing –Shift Registers basics - Counters: Ripple counters truth Table-timing diagram, Synchronous counters-truth table-timing diagram, Decade counters.

(13 hours)

Unit- IV
Digital to Analog converters: ladder and weighted resistor types. Analog to digital Converters-counter method, successive approximation and dual slope converter. Application of DACs and ADCs. Read Only Memory (ROM) and applications, Random Access Memory (RAM) and Applications. Microprocessors and Microcontrollers basics.

(13 hours)

References
1. Semiconductor Devices Physics and Technology, S M Sze, (Second Edition, 2002), John Wiley and Sons Inc. Asia.
2. Solid State Electronic Devices, Ben G Streetman, Sanjay Banerjee, (Fifth edition, 2000), Pearson Education, Asia.
3. Semiconductor Optoelectronic Devices, Pallab Bhattacharya, (Second Edition, 1997), Pearson education, Asia.
4. The art of electronics, Paul Horowitz and Winfield Hill, (Second Edition, 1992), Foundation Books, New Delhi.
5. Electronic Principles, A P Malvino, (Sixth Edition, 1999), Tata McGraw Hill, New Delhi.
6. Op-Amps and Linear Integrated Circuits, Ramakant A Gayakwad, (Third Edition, 2004), Eastern Economy Edition.
7. Operational Amplifiers with Linear Integrated Circuits, William Stanley, (1988), CBS Publishers and Distributors.
8. Linear Integrated Circuits, D Roy Choudhury and Shail Jain, ((1991), New Age International (P) Limited.
9. Digital principles and applications, Donald P Leach and Albert Paul Malvino, (Fifth Edition,

P103: Quantum Mechanics-I (4 credits, 4 lectures per week)

Unit-I

Introductory concepts: wave-particle duality, The wave function and its interpretation, free particle wave function, Wave packets, Gaussian wave packet evolution, Heisenberg Uncertainty principle and illustrations, Time - energy uncertainty, complementarity principle Time dependent Schrodinger equation, Conservation of probability, expectation values and operators, Ehrenfest's theorems, Time-independent Schrodinger equation, stationary states, energy quantization, properties of the energy eigenfuntions, general solution for a timeindependent potential, Schrodinger equation in momentum space. (13 hours)

Unit-II

One-dimensional problems

Free-particle solution, momentum eigen functions, box normalization, particle in square well potential, transmission through a potential barrier, simple harmonic oscillator.
(13hours)

Unit-III

General formalism of quantum theory: operator methods

Review on linear vector spaces and matrices**,** Hilbert space and observables, linear operators and observables, Dirac notation, degeneracy and simultaneous observables, generalized uncertainty principle for two non-commuting observables, Unitary dynamics, projection operators and measurements, time-dependence of observables: Schrodinger, Heisenberg and interaction pictures, Simple harmonic oscillator byoperator method. (13 hours)

Unit-IV

Angular momentum

Orbital angular momentum commutation relations, Eigen values and eigen functions.
General operator algebra of angular momentum operators J_x, J_y, J_z. Ladder operators, Eigen values and eigenkets of J_2 and J_z, Matrix representations of angular momentum operators, Pauli matrices, Addition of angular momentum, Clebsch-Gordan coefficients, computation of Clebsch-Gordan coefficients in simple cases ($j_1 = j_2=1/2$). (13 hours)

References

1. Introduction to Quantum Mechanics – David J. Griffiths, Second Edition, Pearson PrenticeHall 2005.
2. Quantum Physics – H.C. Verma, Surya Publication, 2012
3. Quantum Mechanics – Aruldhas
4. Quantum Mechanics – V.K. Thankappan, Second Edition, Wiley Eastern Limited, 1993.
5. Quantum Mechanics Vol I & II – C. Cohen-Tannoudji, B. Diu and F. Laloe, SecondEdition, Wiley Inter science Publication, 1977.
6. Quantum Mechanics- L.I. Schiff, Third Edition, McGraw Hill Book Company, 1955.
7. Quantum Mechanics – B.H. Bransden and C.J. Joachain, Second Edition, PearsonEducation, 2007.
8. Modern Quantum Mechanics – J.J. Sakurai, Revised Edition, Addison-Wesley, 1995.
9. Principles of Quantum Mechanics - R. Shankar, Second Edition, Springer, 1994.
10. Quantum Mechanics – E. Merzbacher, John Wiley and Sons, 1998.
11. Quantum Physics – S. Gasiorowicz, John Wiley and Sons.
12. Linear Algebra – Seymour Lipschutz, Schaum Outlines Series

P104: P104: Mathematical Methods of Physics

UNIT - I: Integral Transforms: Fourier Transforms: Properties of Fourier transforms – Fourier sine and cosine transforms- Power in Fourier series – Modulation theorem, Fourier transform of impulse function, Constants, Unit step function and Periodic (square wave, triangular wave &sawtooth wave) functions. Laplace Transforms: Definition and notation – Properties of Laplace transforms – Laplace transforms of Dirac delta function and periodic functions (Square wave, sawtooth wave and triangular wave) – Inverse Laplace transforms – properties – Solution of linear differential equations with constant coefficients

(13 Hours)

UNIT – II: Complex Variables Functions – Complex differentiation - Analytic function - Cauchy – Reimann equations –Derivatives of elementary functions – Singular points and classification. Complex integration - Cauchy's theorem – Integrals of special functions – Cauchy's integral formula – Taylor's and Lorentz theorem (statements only) – Residues, calculations of residues - Residue theorem – evaluation of definite integrals.

(13 Hours)

UNIT - III: Partial Differentiations Equations: Review of ODE's- Properties of Dirac delta Function, Laplace equation – Method of separation of variables – Application of Laplace equation to two dimensional steady state of heat flow in a thin rectangular plate and a long cylinder. Wave equation in two dimensions – Application to the vibration of a rectangular membrane and circular membrane.

(13 Hours)

UNIT - IV: Special Functions Beta and Gamma Functions – Definitions and properties – Evaluation of integrals, Legendre, Bessel and Hermite differential equations – Solutions – Generating functions – Orthogonal properties of Legendre, Bessel and Hermite Functions – Recurrence relations - (Proof for Legendre polynomials only)

(13 Hours)

Reference Books

1. Mathematical Methods for Physicists – G. B. Arfken and H. Weber, Seventh Edition, Academic Press, 2012
2. Mathematical methods of physics - J. Mathews and R. L. Walker, Second Edition, Addison-Wesley
3. Mathematical Methods in the Physical Science- Mary L Boas, Wiley Publication, (2005)
4. Functions for Scientists and Engineers, W.W. Bell, Van Nostrand Co., London (1968).
5. Fourier Analysis, Hsu P. Jewi, Unitech Division.
6. Laplace Transforms, Murray Spiegle, Schaum's outline series, McGraw Hill, New York.
7. Applied Mathematics for Engineers, Pipes and Harval, III Edition, McGraw Hill Books Co.
8. Theory and Properties of Complex Variables, S. Lipschutz, Schaum's Series, McGraw Hill.
9. Mathematical Physics, H.K. Das and Ramaverma, S. Chand & Co. Ltd., New Delhi (2011).
10. Mathematical Physics, B. Bhattacharyya, New Central Book Agency Pvt. Ltd., (2010).

SOFT CORE

P105: Experimental Techniques in Physics (4 credits, 3 lectures per week)

Unit-I
Safety measures in Experimental Physics
Occupational health and safety, chemical substances, radiation safety, general electrical testing standards, General laboratory and workshop practice.
Instrumentation Electronics
Transducers, Transducer characteristics, selection of a instrumentation transducer, Transducer as an electrical element, modelling external circuit components, circuit calculations, ac and dc bridge measurements.

(13 hours)

Unit-II
Vacuum techniques
Units of pressure measurement, characteristics of vacuum, applications of vacuum, Vacuum pumps: Rotary, oil diffusion, turbo molecular pumps, Ion pumps. Vacuum gauges: Pirani and Penning gauges. Pumping speed of a vacuum pump.
Thin film techniques
Thin film techniques(overview), film thickness monitors, film thickness measurement.
Measurement of low temperature
Resistance, thermometers, thermocouples.

(13 hours)

Unit-III
Error and Computational Analysis.
Physical measurement
Measurement, result of a measurement, sources of uncertainty and experimental error, Systematic error, random error, Reliability- chi square test, Analysis of repeated measurement, Precision and accuracy, Elementary data fitting. Gaussian Fit, Lorentz Fit, Voigt profile, FWHM, Softwares for Data Analysis – Maple, Mathematica, Origin Pro (Qualitative)

(13 hours)

References
1. Measurement, Instrumentation and Experimental design in Physics and Engineering- Michael Sayer and AbhaiMansingh, Prentice Hall of India 2005
2. Data Reduction and Error Analysis for the Physical Sciences, P.R. Bevington and K.D Robinson, McGraw Hill, 2003
3. Electronic Instrumentation- H.S. Kalsi, TMH Publishing Co. Ltd. 1997
4. Instrumentation Devices and Systems-C.S. Rangan, G.R. Sharma, V.S.V. Mani, 2nd Edition, Tata McGraw Hill, New Delhi, 1997
5. Instrumentation Measurement Analysis-B.C. Nakra, K.K. Chaudhary.

II SEMESTER

P201: Statistical Mechanics & Thermodynamics (4 credits, 4 lectures per week)

Unit-I

Thermodynamics

Postulates of equilibrium thermodynamics, Intensive and extensivevariables, Thermodynamic definition of Entropy –Calculation of entropy changes irreversible processes, Equilibrium between two thermodynamic systems, Thermodynamicpotentials –Enthalpy, Helmholtz and the Gibbs functions, The Maxwell relations, Exergy Analysis

(13 hours)

Unit- II: Statistical Formulation : Phase space – Concept of ensembles – Types of ensembles - Ensemble average - Liouville's Theorem – Micro canonical ensemble: ideal gas – Gibb's paradox – Entropy and probability – Canonical ensemble – Ideal gas in canonical ensemble – Grand canonical ensemble – Ideal gas in grand canonical ensemble – Comparison of various ensembles. Canonical partition function

(13 hours

UNIT – III: Maxwell – Boltzmann and Bose – Einstein Statistics)

Maxwell - Boltzmann distribution - Distribution of velocities – Experimental verification - Calculation of mean values – Equipartition theorem. Bose – Einstein distribution, Bose – Einstein condensation, Black body radiation and the Planck's radiation law - Dulong and Petit's law -) Einstein and Debye's theories of heat capacities.

(13 hours)

UNIT – IV: Fermi – Dirac Statistics & Fluctuations

Fermi - Dirac distribution – Electrons in metals – Thermionic emission – Magnetic susceptibility of free electrons.

Fluctuations in ensembles, Onsagar's one dimensional and reciprocal rotations and their applications to thermoelectric phenomena, Kelvin's first and second equations: One dimensional random walk – Random walk and Brownian motion.

(13 hours)

References

1. K. Huang, Statistical Mechanics,Wiley Eastern Limited, New Delhi, (1963).
2. F. Reif, Fundamentals of Statistical and Thermal Physics, McGraw Hill, Singapore(1985).
3. R.K. Pathria, Statistical Mechanics, Bufferworgh Heinemann (2ndEdition)
4. Silvio R A Salinas, Introduction to Statistical Physics, Springer, (2001)
5. B.B.Laud, Fundamentals of Statistical Mechanics, New Age International Publication
6. Statistical Physics, Bhattacharjee
7. Thermal Physics, Kittel and Kremer
8. Statistical Mechanics, B.K. Agarwal, Melvin Eisner, 2nd Edition, New Age International (P)Ltd.
9. Statistical Mechanics and properties of Matter by ESR Gopal — Student Edition (EllisHorwood)

P202. Electrodynamics and Plasma Physics

Unit I

Electrostatics and Magnetostatics: Gauss's law and applications, Electric potential, Poisson's equations, Work, Energy in electrostatics, Laplace and Laplace's equation in one, two and three dimension cartesian co-ordinates, boundary conditions and uniqueness theorem, Method of images with applications, Multipole expansion of potential, Dipole field, Field inside dielectrics, Biot - Savart law and applications, Ampere's law and applications, Magnetic vector potential, Multipole expansion of the vector potential, Magnetic field inside matter.

(13 Hours)

Unit II

Electrodynamics and Electromagnetic waves: Review of Maxwell's equations, scalar and vector potentials, Gauge transformations, Coulomb and Lorentz gauges, energy and momentum of c waves, propagation through linear media, reflection and transmission of electromagnetic waves, plane waves in conducting media, dispersion in non conductors, wave guides, TE waves in rectangular wave guide.

(13 Hours)

Unit III

Electromagnetic Radiation: Fundamentals of Radiation: Waves in Free space, Radiation & Reception.
Radiation effects: Reflection, Refraction, Interference of electromagnetic waves & Diffraction of radio waves.
Interaction of electromagnetic radiation: Retarded potentials, electric and magnetic dipole radiation, Lienard -Wiechert potentials, fields of a point charge in motion, power radiated by a point charge, Review of Lorentz transformations.
Propagation of Electromagnetic Radiation: Ground wave, Sky- wave, Space wave, Extra terrestrial Communication

(13 Hours)

Unit IV

Plasma physics. Definition of Plasma, Debye shielding, charged particle motion in electric and magnetic fields at right angles, time varying E and B fields, Adiabatic invariants, Dielectric constant of a plasma, the equations of motion of a plasma fluid, Drift velocities, plasma oscillations, plasma waves, propagation of electromagnetic waves in plasma.

(13 Hours)

References:

1. Introduction to electrodynamics, D.J. Griffths, PHI, Third Edition.(2004).
2. Electromagnetics,B.B. Laud, New Age International PVT. LTD.(1987).
3. Electromagnetic fields and waves. P. Lorrain and D. Corson, CBS (1986)
4. Electromagnetism, I.S Grant and W.R Phillips, John Wiley and Sons Ltd.(1975).
5. Electromagnetism, Pramanik, PHI
6. Electronic Communication Systems, George Kennedy & Bernard Davis, Fourth Edition, TMH Publication, (1999)

P203: Quantum Mechanics –II (4 credits, 4 lectures per week)

Unit-I

Approximation methods for stationary problems

Time independent perturbation theory*:* Time independent perturbation theory for a non degenerate energy level, time independent perturbation theory for a degenerate energy level, Applications: (1) one dimensional harmonic oscillator subjected to a perturbing potential in x, x^2 and x^3. Variational Method*:* Bound states (Ritz Method), Expectation value of the energy, ground state of Helium WKB approximation: the ―classical region‖, connection formulae, tunneling.

(13 hours)

Unit -II

Time dependent perturbation theory

Statement of the problem, approximate solution of the Schrodinger equation, constantperturbation, harmonic perturbation, transition to a continuum, the Fermi golden rule

Scattering theory: The scattering experiment, relationship of the scattering cross section to the wave function, scattering amplitude and scattering cross-section, Born approximation, scattering by a spherically symmetric potential, cross-section for scattering in a screenedcoulomb potential, validity of Born's approximation.

(13 hours)

Unit-III

Symmetry principles and conservation laws

Continuous symmetries: Spatial translation symmetry and conservation of linear momentum, time translation symmetry and conservation in energy, Rotations in Space: Conservation of angular momentum

Discrete symmetries: Parity, Time reversal, Permutation symmetry, symmetric and antisymmetric wave functions, scattering of identical particles, ortho and para helium states.

(13 hours)

Unit-IV

Relativistic quantum mechanics

Klein-Gordan equation for a free relativistic particle, Plane wave solutions, probability density and probability current density.

Dirac Hamiltonian for a free relativistic particle, properties of alpha and beta matrices, probability density and probability current, positive and negative energy solutions, orthogonality and completeness of the solutions, intrinsic spin of the Dirac particle, Negative energy sea, gamma matrices, covariant form of Dirac equation.

(13 hours)

References

1. Introduction to Quantum Mechanics – David J. Griffiths, Second Edition, Pearson Prentice Hall 2005.
2. Quantum Physics – H.C. Verma, Surya Publication, 2012
3. Quantum Mechanics – Aruldhas
4. Quantum Mechanics – V.K. Thankappan, Second Edition, Wiley Eastern Limited, 1993.
5. Quantum Mechanics Vol I & II – C. Cohen-Tannoudji, B. Diu and F. Laloe, Second Edition, Wiley Interscience Publication, 1977.
6. Quantum Mechanics- L.I. Schiff, Third Edition, McGraw Hill Book Company, 1955
7. Quantum Mechanics – B.H. Bransden and C.J. Joachain, Second Edition, Pearson Education, 2007.
8. Modern Quantum Mechanics – J.J. Sakurai, Revised Edition, Addison-Wesley, 1995.
9. Principles of Quantum Mechanics - R. Shankar, Second Edition, Springer, 1994.
10. Quantum Mechanics – E. Merzbacher, John Wiley and Sons, 1998.
11. Quantum Physics – S. Gasiorowicz, John Wiley and Sons.

P204: Numerical Analysis and Computational Physics (4 credits, 4 lectures per week)

Numerical methods

Interpolation, solution of linear algebraic equations using Gauss elimination method, Curve Fitting by least square fit method, Numerical integration, Trapezoidal and Simpson's rules, Numerical differentiation, Euler and Runge-Kutta methods, Finding roots, bisection method, Newton-Raphson method.

(13 hours)

Unit-II

Probability and Statistics

Radom Variables,Fundamental probability laws; permutation and combinations,binomial distributions, Poisson distributions, Gauss normal distribution and general properties of distributions, multivariate Gaussian distributions, Errors of observation and measurements, Fitting of experimental data.

(13 hours)

Unit-III

Programming-I

Elementary information about digital computer principles, compilers, interpreters and Operating systems, Constants and variables, arithmetic expressions, data types, input and Output statements, control statements, switch statements, the loop statements, format Specifications, arrays, algorithms, flowcharts, functions and some simple programming, Examples in C Programming.

(13 hours)

Unit-IV

Programming -II

C program for (i) finding roots using Newton-Raphson method, Bisection method, (ii) solving Simultaneous linear algebraic equations, (iii) evaluating integrals using Simpson's and Trapezoidal rules, (iv) solving ordinary differential equations using Euler and Runge-Kutta Method, (v) least square fitting (vi) Lagrange's interpolation

(13 hours)

References

1. Mathematical methods of physics - J. Mathews and R. L. Walker, Second Edition, Addison-Wesley
2. Mathematical methods for Physicists – G. B. Arfken and H. Weber, Seventh Edition, Academic Press, 2012
3. Introductory Methods of Numerical analysis – S.S. Sastry, Third Edition, Prentice – Hall of India, 2003
4. Programming in ANSI – C, E. Balaguruswamy, Second Edition, Tata McGraw Hill, 1992
5. Computational *Physics* - The University of Texas at Austin
6. Web link: http://www.phys.unsw.edu.au/~mcba/phys2020/#numint

SOFT CORE

P205: Radiation Biophysics and Medical Instrumentation (4 credits, 3 lectures per week)

Unit-I

Radiation biophysics: Radiation sources, Interaction of radiation with matter (general discussion), energy transfer process, measurement of radiation, Dosimetry, effect of radiation on living systems, radiation protection and radiation therapy.

Medical applications of nuclear radiations: Radioisotopes for diagnosis and medicines, gamma camera, positron emission tomography, single photon emission computed tomography (SPECT), principle of magnetic resonance imaging (MRI), boron neutron capture therapy and ion beam in cancer therapy.

(13 hours)

Unit-II

Biomedical Applications of Sensors: Physical Sensors: Variable Resistance Sensor, Strain Gauge, Force & Pressure Measurement, Bio potential Electrodes: Sensing Bioelectric Signals, Electrical Characteristics, pH Sensors, Diagnostic Devices: Mass Spectrometry and Electrophoresis.

(13 hours)

Unit-III

Medical Instruments: Bio electrical Devices: Biomedical Lasers- Interaction and Effects of UV IR Laser Radiation on Biological Tissues: Absorption & Scattering process, Effects of Continuous & Pulsed visible laser radiation & Associated Temperature rise.

Cardiac Pacemakers- Block diagram of Pace maker, Pulse Generators, Sensing mechanism and output measurements, Blood Glucose Monitoring- Development of Colorimetric Test Strips, Emergence of Electrochemical Strips and Optical reflectance meters.

(13 hours)

References

1. Medical Devices & Human Engineering, Joseph D Borinzo & Donald R Peterson, CRC Press,4th Edition, 2016 .
2. Aspects of Biophysics- William Hughes, John Wiley and Sons, 1979
3. Biochemistry of Nucleic acids- Adams et al. Chapman and Hall, 1992

LABORATORY COURSES

A general list of experiments is given below under different topics taught in the theory paper.

Optics experiments
Part A
1. Determination of the size of the lycopodium particles by diffraction method using
a. Spectrometer b) Young's method.
2. Diffraction of laser light by single slit and diffraction grating – (a) determination of wavelength of laser (b) Determination of distance between two slits using interference of laser light through double slit
a. Determination of refractive index of glass and perspex using total internal reflection.
b. Determination of refractive index of liquids using shift in the diffraction pattern.
3. Determination of wavelength of iron arc spectral lines using constant deviation
a. spectrometer.
4. Determination of Rydberg constant
5. Hartmann's method of spectral calibration using mercury spectrum and characterization of electronic absorption band of $KMnO_4$ based on Hartmann's formula.
6. Determination of elastic constants of glass (and perspex) by Cornu's interference method.

Part B
1. Determination of wavelength of sodium light by Michelson's interferometer.
2. Determination of wavelength of sodium light using Fabry Perot etalon.
3. Verification of Malus' law
4. Study of intensity distribution of elliptically polarized light
5. Study of elliptically polarized light using Babinet compensator.
6. Determination of thickness of mica sheet using Edser Butler Fringes
7. Optical rotatory Dispersion
8. Determination of velocity of ultrasonic waves in liquids using the method of diffraction and comparison with the mechanical method.
9. Verification of Beer-Lambert law

Part C
1. Determination of difference in wavelengths of D lines of Na using Michelson's interferometer.
2. Spatial and temporal coherence of He-Ne laser.
3. Experiments with lasers and fibre optics kit.
4. Experiments with lasers and reflection grating.
5. To photograph the spectra of Fe (standard) and Cu arc using CDS spectrograph and to determine the wavelengths of Cu spectrum using Hartman formula

Mechanics experiments
1. Young's modulus of steel by flexural vibrations of a bar
2. Torsional vibrations and determination of rigidity modulus

Heat and Temperature experiments
Part A
1. Thermal Conductivity of a material of a rod by Forbe's method
2. Thermal Diffusivity of a material (Angstrom's method)
3. Verification of Stefan's Law by electrical method.
4. Relaxation (thermal) time of a serial light bulb
5. Determination of Stefan's constant
6. Variation of surface tension with temperature.
7. Thermal and electrical conductivities of copper to determine the Lorentz number; Temperature coefficient of resistance of copper

Part B

1. Calibration of silicon diode and copper constantan thermocouple as temperature sensors.
2. Thermal conductivity of a poor conductor
3. Energy band gap of silicon
4. Verification of Curie-Weiss law for a ferroelectric material – temperature dependence of a ceramic capacitor
5. Thermal expansion -- Determination of coefficients of thermal expansion of some materials (Al, Cu, Brass, NaCl, KCl)

Electronics experiments

Part A

1. Active low pass filter using op-amp
2. Active high pass filter using op-amp
3. RC phase shift oscillator
4. Astablemultivibrator using 555 timer
5. Sine wave and square wave generators
6. Summing, scaling and averaging amplifier using op-amp.
7. Half adder and full adder
8. Differentiator and integrator using op-amp.
9. Twin T-notch filter using op-amp
10. Boolean expression implementation
11. Measurement of offset voltage and offset current

Part B

1. Monostablemultivibrator using 74121
2. 555 timer as a monostablemultivibrator
3. Butterworth low pass filter using Sallen Key circuit
4. Voltage controlled oscillator using IC741 and 555
5. Phase locked loop using 565

Part C

1. Calibration of the lock-in amplifier
2. Mutual inductance with the lock-in amplifier
3. Measurement of low resistance with the lock-in amplifier
4. Measurement of high resistance by leakage
5. First order band pass filter using Op-amp

Computational Physics: C programming

Part A: Basics of C-programming – some simple programs

1. Printing Large Block letters
2. Program to check vowel or consonant
3. Computing powers of 2
4. Program to find the largest among three numbers
5. Program to check whether a number is positive, negative or zero
6. Program to find sum of natural numbers
7. Adding two integers
8. Adding n integers
9. Adding a sequence of positive integers
10. Swapping two numbers
11. Computing the factorial of a number
12. Program to display Fibonacci series
13. Programs to find HCF and LCM of two numbers
14. Computing area of a circle
15. Fahrenheit to Celsius conversion (°F to °C)
16. Program to (i) add and (ii) multiply two matrices and (iii) find transpose of a matrix

Part B: Numerical analysis with C- programs

1. Finding roots of a function using bisection method
2. Finding roots of a function using Newton-Raphson method
3. Solving algebraic equations using Gauss elimination method
4. Fitting the data to a straight line -- Least square fit method
5. Integration using Trapezoidal rule
6. Integration using Simpson's 1/3rd rule
7. Integration using Simpson's 1/8th rule
8. Differentiation of a function using Euler's method
9. Differentiation using Runge-Kutta 2nd order method
10. Differentiation using Runge-Kutta 4th order method

I Semester

P106: General Physics Lab-1
A minimum of **TEN** experiments to be performed. Experiments to be chosen from
(i) Optics: Part A
(ii) Mechanics
(iii) Heat and Temperature: Part A

P107: Electronics Lab
A minimum of **TEN** experiments to be performed. Experiments to be chosen from
Electronics Part A

II Semester
P206: General Physics Lab-2
A minimum of **TEN** experiments to be performed. Experiments to be chosen from
(i) Optics: Part B
(ii) Heat and Temperature Part B

P207: Optics Lab:
A minimum of **TEN** experiments to be performed. Experiments to be chosen from
(i) Optics Part C and
(ii) from Part A, B **(other than those already done in General Lab-I and II)**

Question Paper Pattern for CBCS Scheme

THEORY QUESTION PAPER PATTERN
Each hard core, soft core and open elective theory paper examination is for 70 marks.

QUESTION PAPER PATTERN FOR HARD CORE 70 MARKS THEORY PAPER:
Each hard core theory paper syllabus is divided into 4 units. The semester ending examination will be aimed at testing the student's proficiency and understanding in every unit of the syllabus. The blue print for the question paper pattern is as follows:
Each question paper will consists of 3 sections: A B and C.
Part A:Six questions of 5 marks each out of which **four** to be answered (4 x 5 =20 marks). Short answer conceptual/reasoning questions shall be asked in this section to test conceptual understanding of the student.
Part B: **Six** questions of 10 marks each, out of which **four** to be answered (4 x 10 = 40 marks). Descriptive/derivation questions shall be asked in this section.
Part C:Three problems (or questions on conceptual extensions) of 5 marks each, out of which **two** to be answered. (2 x 5 = 10 marks)

QUESTION PAPER PATTERN FOR SOFT CORE 70 MARKS THEORY PAPER:
Each soft core theory paper is divided into 3 units. Each question paper will consists of two sections **Part A** and **Part B.**
Part A: Consists of 9 questions (three questions being drawn from each unit). Each question carries 5 marks. The candidate is required to answer any 6 questions. (5 x 6 = 30 marks). Short answer conceptual/reasoning questions shall be asked in this section to test conceptual understanding of the student.
Part B : Consists of 6 questions (2 questions each being drawn from each unit). Each question carries 10 marks. The candidate is required to answer any 4 questions. (10 x 4 = 40 marks). Descriptive/derivation questions shall be asked in this section.
Total: 30+40 = 70 marks

QUESTION PAPER PATTERN FOR OPEN ELECTIVE 70 MARKS THEORY PAPER:
Open elective theory paper syllabus is divided into 2 units. Question paper consists of 2 parts: Part A and Part B.
Part A: Consists of 4 questions (2 questions being drawn from each unit). Each question carries 15 marks. The candidate is required to answer any 2 questions. (15 x 2 = 30 marks). The 15 marks question may be broken into 2 or 3 parts. The maximum marks for each part will be 10 and minimum will be 5 marks.
Part B : Consists of 4 questions (2 questions each being drawn from each unit). Each question carries 20 marks. The candidate is required to answer any 2 questions. (20 x 2 = 40 marks). The 20 marks question may be broken into 2 or 3 parts. The maximum marks for each part will be 10 and minimum will be 5 marks.
Total : 30 + 40 = 70 marks.

INTERNAL ASSESSMENT

There is NO internal assessment for soft core and open elective papers.
Internal Assessment for each hard core theory paper is for 30 marks. One internal test shall be conducted for 25 marks in each paper. 5 marks are reserved for attendance.

Allotment of marks for attendance:
Attendance greater than 95 % - 5 marks
Attendance between 95 – 90 % - 4 marks
Attendance between 90 – 85 % - 3 marks
Attendance between 85 – 80 % - 2 marks
Attendance between 80 – 75 % - 1 marks
Attendance less than 75% - ineligible to appear for examination.

Attendance Make-up: Students who have obtained attendance less than 75% have to abide by the rules and regulations as framed by the PG department of Physics from time to time.

PRACTICAL EXAMINATION
Semester end practical examination for each practical course is for 100 marks. Internal assessment for each practical course is for 30 marks. Marks for internal assessment shall be awarded on the basis of the performance of the student throughout the practical course.

Changes Made In Current Syllabus

Semester	Subject	Inclusion	Exclusion
I	Classical Mechanics	-	Scattering Part in Central Forces
I	Electronic Circuits & Devices	-	-
I	Quantum Mechanics I	-	Computation of Celbsch Gordon Coefficient. Or Hydrogen atom
II	Statistical Mechanics	-	White Dwarfs
II	Electrodynamics & Plasma Physics	**Electromagnetic Radiation**: Fundamentals of Radiation: Waves in Free space, Radiation & Reception. **Radiation effects:** Reflection, Refraction, Interference of electromagnetic waves & Diffraction of radio waves. **Propagation of Electromagnetic Radiation:** Ground wave, Sky- wave, Space wave, Extra terrestrial Communication	Relativistic Electrodynamics
II	Quantum Mechanics II		Methods of Partial Wave Analysis
II	Elementary Biophysics		