Department of Physics
Ch. Devi Lal University, Sirsa-125055, Haryana

Subject: Minutes of the meeting of Post-Graduate Board of Studies and Research (PGBOS&R) in Physics held on 13.07.2016.

A meeting of Post-Graduate Board of Studies and Research (PGBOS&R) in Physics was held on 13.07.2016 at 11:30 p.m. in the office of Chairperson, Department of Physics, Chaudhary Devi Lal University, Sirsa. Following members were present:

1. Prof. Sushil Kumar, Deptt. of Physics, CDLU, Sirsa.	Chairperson (Ex-Officio)
2. Prof. S.K. Tripathi, Deptt. of Physics, P.U. Chandigarh	Outside Expert
3. Prof. P. Aghamkar Deptt. of Physics, CDLU Sirsa	Member
4. Dr. Rachna, Deptt. of Physics, CDLU, Sirsa.	Member
5. Dr. Dharamvir Singh, Deptt. of Physics, CDLU, Sirsa.	Member

Following points were resolved in the meeting of the PGBOS&R of the Department:

1. Confirmation of the minutes of the meeting of previous PGBOS&R held on 09.04.2016.
2. The PGBOS&R considered and approved the Scheme of Examination and Syllabi of M.Sc. Physics Programme under Choice Based Credit System w.e.f. session 2016-17.

The meeting ended with vote of thanks to the chair.

13.7.16
(Dharamvir Singh)

(Rachna)

13/7/16
(P. Aghamkar)

(S.K. Tripathi) 13/7/16

13.7.16
(Sushil Kumar)

Department of Physics
Chaudhary Devi Lal University, Sirsa

M. Sc. Physics (Four Semesters Programme)
Scheme and Syllabi w.e.f. Session 2016-17

Semester-I

Type of course	Course Code	Title of Course	Teaching Hours per week	Credits	Internal Assessment/ Evaluation	End term Examination	Total	Duration of Exam. (Hrs.) Theory/ Practical
Core	PHY-101	Mathematical Physics	4	4	30	70	100	3
Core	PHY-102	Classical Mechanics	4	4	30	70	100	3
Core	PHY-103	Electronics-I	4	4	30	70	100	3
Core	PHY-104	Quantum Mechanics-I	4	4	30	70	100	3
Core	PHY-105	Physics Lab. – I (General)	8	4	-	100	100	6
Core	PHY-106	Physics Lab. – II (Electronics)	8	4	-	100	100	6
	PHY-107	Seminar	1	1	25	-	25	-
Total				**25**			**625**	

Semester-II

Type of course	Course Code	Title of Course	Teaching Hours per week	Credits	Internal Assessment/ Evaluation	End term Examination	Total	Duration of Exam. (Hrs.) Theory/ Practical
Core	PHY-201	Solid State Physics	4	4	30	70	100	3
Core	PHY-202	Classical Electrodynamics-I	4	4	30	70	100	3
Core	PHY-203	Electronics-II	4	4	30	70	100	3
Core	PHY-204	Quantum Mechanics-II	4	4	30	70	100	3
Core	PHY-205	Physics Lab. – III (General)	8	4	-	100	100	6
Core	PHY-206	Physics Lab. – IV (Electronics)	8	4	-	100	100	6
	PHY-207	Seminar	1	1	25	-	25	-
Total				25			625	

Semester-III

Type of course	Course Code	Title of Course	Teaching Hours per week	Credits	Internal Assessment/ Evaluation	End term Examination	Total	Duration of Exam.(Hrs.) Theory/ Practical
Core	PHY-301	Statistical Mechanics	4	4	30	70	100	3
Core	PHY-302	Classical Electrodynamics-II	4	4	30	70	100	3
Any one of the following discipline electives (PHY-303A or PHY-303B)								
Discipline elective	PHY-303A	Laser & Spectroscopy-I	4	4	30	70	100	3
	PHY-303B	Computational Physics-I						
Any one of the following discipline electives (PHY-304A or PHY-304B)								
Discipline elective	PHY-304A	Materials Science-I	4	4	30	70	100	3
	PHY-304B	Optical Fibers & Optoelectronic Devices-I						
Any one of the following discipline electives (PHY-305A or PHY-305B)								
Discipline elective	PHY-305A	Physics Lab. -V(A) (Laser & Spectroscopy-I)	8	4	-	100	100	6
	PHY-305B	Physics Lab. -V(B) (Computational Physics-I)						
Any one of the following discipline electives (PHY-306A or PHY-306B)								
Discipline elective	PHY-306A	Physics Lab. – VI (A) (Materials Science-I)	8	4	-	100	100	6
	PHY-306B	Physics Lab. – VI (B) (Optical Fibers & Optoelectronic Devices-I)						
	PHY-307	Seminar	1	1	25	-	25	-
Total				**25**			**625**	

Semester-IV

Type of course	Course Code	Title of Course	Teaching Hours per week	Credits	Internal Assessment/ Evaluation	End term Examination	Total	Duration of Exam.(Hrs.) Theory/ Practical
Core	PHY-401	Nuclear & Particle Physics	4	4	30	70	100	3
Core	PHY-402	Atomic & Molecular Physics	4	4	30	70	100	3
Same discipline elective is to be taken as in third semester								
Discipline elective	PHY-403A	Laser & Spectroscopy-II	4	4	30	70	100	3
	PHY-403B	Computational Physics-II						
Same discipline elective is to be taken as in third semester								
Discipline elective	PHY-404A	Materials Science-II	4	4	30	70	100	3
	PHY-404B	Optical Fibers & Optoelectronic Devices-II						
Same discipline elective is to be taken as in third semester								
Discipline elective	PHY-405A	Physics Lab. – VII(A) (Laser & Spectroscopy-II)	8	4	-	100	100	6
	PHY-405B	Physics Lab. – VII (B) (Computational Physics-II)						
Same discipline elective is to be taken as in third semester								
Discipline elective	PHY-406A	Physics Lab. – VIII (A) (Materials Science-II)	8	4	-	100	100	6
	PHY-406B	Physics Lab. VIII (B) (Optical Fibers & Optoelectronic Devices-II)						
	PHY-407	Seminar	1	1	25	-	25	-
Total				25			625	

Open Elective Courses: For the students of M.Sc. Physics

The student will earn minimum **ten** credits by choosing some open elective courses offered by the different departments in the university other than the Department of Physics.

Open Elective Course: For the students of other departments of the university

The Department of Physics offers the following open elective course for the students of first, second, third and/or fourth semesters of other departments of the university.

Type of course	Course Code	Title of Course	Teaching Hours per week	Credits	Internal Assessment/ Evaluation	End term Examination	Total	Duration of Exam. (Hrs.)
Open elective	OEC-PHY	Environmental Physics	4	4	30	70	100	3

Total Credits & Marks for all the Four semesters

Semester	**Credits**	**Marks**
Semester-I	25	625
Semester-II	25	625
Semester-III	25	625
Semester-IV	25	625
Open Elective Courses	10	250
Grand Total	**110**	**2750**

General instructions:

1. Each student will deliver one seminar on the topic to be allotted by the departmental seminar committee in each semester of M.Sc. Physics programme. The marks will be awarded by the seminar committee on the basis of his/her attendance (5 marks), seminar report (5 marks), ppt presentation (10 marks) and discussion (5 marks).
2. The discipline elective courses will be allotted to the students on the basis of their preference and percentage of marks in the first semester examination of M.Sc. Physics.
3. New experiments in the Laboratory Courses may be added from time to time.
4. The ordinance (Choice Based Credit System) of the university shall be followed by the department.

PHY-101: MATHEMATICAL PHYSICS

Credits: 4 Max. Marks: 70
Periods per week: 4 Hrs. Duration of Exam.: 3 Hrs.

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I

Introduction to gradient, divergence and curl operator and their physical significance, Frobenious method for series solutions, Legendre equation and its solution: generating function, recurrence relations, Orthogonality of $P_n(x)$, Associated Legendre polynomials (Introductory idea), Bessel equation: Bessel's functions of first kind, generating function, recurrence relations, Hermite's and Laguerre's equation: generating functions, recurrence relations.

Unit-II

Function of complex variables, Cauchy Riemann conditions, Cauchy integral theorem and formula, Taylor and Laurent's Series, Cauchy's residue theorem, Singular points and evaluation of residues, Jordans lemma, Evaluation of real definite integrals.

Unit-III

Introductory ideas of Fourier series and integrals transform, Fourier transform, Laplace transform: Ist and IInd shifting theorem and important applications of Fourier and Laplace transform. Matrices: Inverse Matrix, Orthogonal, Unitary and Hermitian Matrices, Independent elements of Orthogonal and Unitary Matrices, Matrix diagonalization, Eigen values & Eigen vectors.

Unit-IV

Introductory group theory, Group representation by matrices: SU(2), O(3). The elements of the group of Schrödinger equation. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem. Green's function, Tensors.

Text and Reference Books:

1. G. B. Arfken : Mathematical Methods for Physicists
2. B. S. Rajput : Mathematical Physics
3. J. K. Goyal : Laplace and Fourier Transforms
4. S. Prakash : Mathematical Physics

PHY-102: CLASSICAL MECHANICS

Credits: 4
Periods per week: 4 Hrs.

Max. Marks: 70
Duration of Exam.: 3 Hrs.

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I

Constraints of motion and their classification, Generalized coordinates, D'Alembert's principle, Hamilton's principle, Lagrange's equations from Hamilton's principle, Application of Lagrange's equations; Symmetry properties of space and time and conservation laws, Inertial and non-inertial frames, Rotating frames, Centrifugal and Coriolis forces, Foucault's pendulum.

Unit-II

Two body central force problem: Reduction to the equivalent one body problem, Equation of motion and first integrals, Classification of orbits, Virial theorem, Differential equation of the orbit, Kepler's problem, Rutherford scattering formula, Angular momentum and kinetic energy of a rigid body, Moment of inertia tensor.

Unit-III

Hamilton's equations of motion, Cyclic coordinates, Hamilton's equations from variational principle, Principal of least action and its applications, Canonical transformation, Legendre transformation, Poisson bracket, Poisson theorem, Invariance of Poisson bracket under canonical transformation, Angular momentum and Poisson bracket, Jacobi identity.

Unit-IV

Hamilton-Jacobi equations and their solutions, Use of Hamilton-Jacobi method for the solution of harmonic oscillator problem, Hamilton's Principal and Characteristic functions and their properties, Small oscillations, Two coupled oscillators, Theory of small oscillations, Eigen value equation, Frequencies of free vibrations, Normal coordinates, Free vibrations of a linear triatomic molecule.

Text and Reference Books:

1. H. Goldstein : Classical Mechanics
2. N. C. Rana & P. S. Joag : Classical Mechanics
3. V.D. Barger & MG Olsson : Classical Mechanics
4. Atam P. Arya : Classical Mechanics
5. Kiran C. Gupta : Classical Mechanics

PHY- 103: ELECTRONICS –I

Credits: 4 | **Max. Marks: 70**
Periods per week: 4 Hrs. | **Duration of Exam.: 3 Hrs.**

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I: Semiconductors Electronics

Introduction, Charge densities in p & n- type materials, Conduction by drift and diffusion of charge, The pn- junction, The pn- diode equation, Forward resistance of the pn-diode, Capacitance of the pn-junction, Diode switching, Clipping and clamping circuits, The junction transistor, Transistor current components, Transistor as an amplifier, Transistor construction, Transistor configuration and characteristics(CE,CB), The Ebers- Moll model.

Unit-II: Active Networks and Amplifiers

Two port network analysis, Controlled sources, Active circuit models, Gain in decibels, Equivalent circuit for BJT, Transconductance model, Analysis of CE, CB & CC amplifiers, Amplifier with feedback, effect of negative feedback on gain, Distortion, Input and output impedances of amplifier, Location of quiescent (Q) point, Biasing circuits for amplifiers : Fixed bias, Emitter feedback bias and voltage feedback bias, Bias source for integrated circuits,

Unit-III: Field Effect Transistors

Introduction, Junction field effect transistor (J-FET), Volt ampere characteristics of J-FET, FET small signal Model, The FET Biasing, Applications of FET, Metal oxide semiconductor field effect transistor MOS-FET (Depletion & Enhancement), Metal semiconductor field effect transistor (MESFET), Comparison of p and n channel MOSFET, Comparison of JFET, MOS FET and BJT, FET as voltage variable resistor, Low frequency common source and common drain amplifiers, Complementary MOSFET (CMOS), Vertical MOSFET (VMOS), Uni-junction transistor.

Unit-IV: Digital Electronics

Definition of digital signal, Digital(Binary) operation of a system, Basic logic gates- OR, AND , NOT gates, Universal logic gates-NAND & NOR gates, Exclusive OR gate, Boolean algebra, De-Morgan's law, K-Map up to four variables, Half adder, Full adder, Binary adder, Multiplexer and demultiplexer, Encoder and decoder, ROM and its applications, Random access memory (RAM), Flip-flops : RS, JK, T-type, D-Type & Master Slave JK flip-flop, Shift register , Asynchronous and Synchronous counters.

Text and Reference Books:

1. J. D. Ryder : Electronics Fundamental & Applications
2. Donald P Leach, AP Malvino : Digital Principles and Applications
3. J. Millman & C. C. Halkias : Integrated Electronics
4. A. P. Malvino & J. Brown : Digital Computer Electronics
5. R. P. Jain : Modern Digital Electronics
6. J. Millman & A. Grabel : Microelectronics
7. Electronic devices and Circuits : Sanjeev Gupta

PHY-104: QUANTUM MECHANICS-I

Credits: 4 — **Max. Marks: 70**
Periods per week: 4 Hrs. — **Duration of Exam.: 3 Hrs.**

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I: General formulation of quantum mechanics

Basic concepts of Quantum Mechanics, Time dependent and time independent Schrödinger wave equation, Hermitian operators and their properties, Physical interpretation of wave function, Expectation values, Probability current density, Ehrenfest's theorem, Wave packet, Form of Gaussian wave packet and its time spreading, Uncertainty principle, Eigenvalues and eigenfunctions, degeneracy and orthogonality, Schrödinger equation for spherically symmetric potentials, Hydrogen atom.

Unit-II: Matrix formulation of quantum mechanics

Matrix algebra, Hermitian and unitary matrices, Transformation and diagonalization of matrices, Representation of dynamical variables and wave functions as matrices, Hilbert space, Dual space: Dirac's Bra & Ket notation, Equation of motion : Schrödinger, Heisenberg and Interaction pictures, Link with classical equation of motion, Quantization of a classical system, Matrix theory of harmonic oscillator.

Unit-III: Quantum theory of angular momentum

The orbital angular momentum operator and its representation in Cartesian and spherical polar coordinates, Eigenvalues and Eigenfunction for L^2, L_z, Spin angular momentum, Total angular momentum, Eigenvalues and Eigenfunction for J^2, J_z, Commutation relation for angular momentum, Addition of angular momenta: Clebsch Gordon coefficients and their calculations for (i) $j_1 = j_2 = 1/2$ (ii) $j_1 = 1$, $j_2 = 1/2$.

Unit-IV: Stationary perturbation theory

Introduction, Non-degenerate case - First and second order corrections to energy eigenvalues and eigenfunctions, Fine structure of hydrogen atom (Relativistic and spin-orbit coupling correction), Degenerate case, Removal of degeneracy in second order , Zeemaneffect without electron spin, First order stark effect in hydrogen atom, The variational (Rayleigh-Ritz) method: Expectation value of the energy, Application to excited states, Ground state of helium.

Text and Reference Books:

1. L. I. Schiff : Quantum Mechanics
2. B. Crasemann and J. L. Powell : Quantum Mechanics
3. P. M. Mathews and K. Venkateson : Quantum Mechanics
4. A. Ghatak and S. Loknathan : Quantum Mechanics
5. Nouredine Zettili : Quantum Mechanics
6. B.H. Bransden and Joachain : Quantum Mechanics
7. S. Gasiorowicz : Quantum Mechanics
8. J.J. Sakurai : Modern Quantum Mechanics
9. David J.Griffiths : Introduction to Quantum Mechanics

PHY-105: Physics Lab – I
(General)

Credits: 4
Periods per week: 8 Hrs.

Max. Marks: 100
Duration of Exam.: 6 Hrs.

1. To study the various types of Logic Gates and verify their truth tables.
2. To study of various types of Logic Gates using NAND Gates and verify their truth tables.
3. To study the switching action of BJT.
4. To study CRO Demonstrator.
5. Find out the ionization potential of a given sample using Thyratron .
6. To study the characteristic curve of a G.M counter.
7. To study the parity checker and generator.
8. Calibration and determination of the resolution of gamma ray spectrometer.
9. To study Fourier analysis of different wave trains.
10. To measure phase shift , deflection sensitivity & frequency of unknown ac signal using CRO.
11. To verify various Boolean expressions and De morgan's theorems.
12. To study the e/m of an electron by Helical method.

PHY-106: Physics Lab – II
(Electronics)

Credits: 4
Periods per week: 8 Hrs.

Max. Marks: 100
Duration of Exam.: 6 Hrs.

1. To demonstrate and realize the transistor as a feed back amplifier.
2. To study the full adder and subtractor.
3. To study the four bit adder and subtractor.
4. Demonstration and realization of Multiplexer/Demultiplexer and Encoder/Decoder circuits.
5. To study the switching action of FET.
6. To study of input and output characteristics of JFET.
7. To study of input and output characteristics of MOSFET.
8. To study of various types of Flip-Flop and verify their truth table.
9. To study the behavior of clipping and clamping circuits.
10. To study op-amp as differentiator & integrator.
11. To study shift registers & counters.
12. To study the op-amp as Schimitt trigger.

PHY-201: SOLID STATE PHYSICS

Credits: 4 **Max. Marks: 70**
Periods per week: 4 Hrs. **Duration of Exam.: 3 Hrs.**

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I
Crystalline solids, Unit cell, Direct lattice, Two and three dimensional Bravais lattices, Miller indices, Close packed structures, Reciprocal lattice and its application to diffraction technique, Brillouin zones, Diffraction of waves by crystals: X-ray diffraction, Laue, Powder and Rotating crystal methods, Scattered wave amplitude, Crystal structure factor.

Unit-II
Quantization of elastic waves, Phonon momentum, Dispersion relation for the Vibrations of one dimensional monoatomic and diatomic lattices, Acoustical and optical phonon modes, Inelastic scattering of neutrons by phonons, Lattice specific heat (Einstein & Debye model), Free electron Fermi gas, Energy levels and density of orbitals in one dimension, Free electron gas in three dimensions.

Unit-III
Fermi-Dirac distribution, Electronic specific heat of a metal, Electrons in a periodic lattice (Crystal Potential), Bloch theorem, Crystal potential, Kronig-Penny model, Nearly free electron model, Cyclotron resonance, Hall effect, Fermi surface, de Hass Von Alfen effect, Magneto-resistance, Quantum Hall effect.

Unit-IV
Superconductivity: Meissner effect, Critical field, Critical temperature, London equations, London penetration depth, Coherence length, Energy gap, Isotope effect, BCS theory, Type I & II superconductors, Flux quantization, Normal tunneling & Josephson effect, High T_c superconductors, Fullerenes (Elementary idea).

Text and Reference Books:

1. C. Kittel : Introduction to Solid State Physics
2. A. J. Decker : Solid State Physics
3. Ashcroft & Mermin : Solid State Physics
4. M. A. Omar : Elementary Solid State Physics
5. J. P. Srivastava : Elements of Solid State Physics
6. M. A. Wahab : Solid State Physics

PHY-202: CLASSICAL ELECTRODYNAMICS-I

Credits: 4
Periods per week: 4 Hrs.

Max. Marks: 70
Duration of Exam.: 3 Hrs.

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I

Electrostatics in Vacuum: Coulomb's Law, Gauss's Law, Scalar potential, Laplace and Poisson's equations. Electrostatic potentials, energy and energy density of the electromagnetic field. Multipole Expansion: 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. Magnetostatics: Differential equations of magnetostatics, Vector potential. Magnetic field of a localized current distribution.

Unit-II

Electrostatics of Dielectrics: Static fields in material media, Polarization vactor macroscopic equations, Molecular polarizability, Electric susceptibility, Clasusius-Mossetti relations, Models of molecular poliarizability, Energy of charges in dielectic media. Boundary value Problems: Uniquencess theorm, Dirichlet and Neumann boundary conditions, Green's theorem, Formal solution of electrostatic boundary value problem with Green function, Method of images with examples, Magnetostatic boundary value problems.

Unit-III

Time Varying Fields and Maxwell Equations: Faraday's law of induction, Displacement current, Maxwell equations, Schalar and vector potentials, Gauge transformations, Lorentz and Coulomb gauges, General Expression for the electromagnetic field energy, Conservation of energy, Poynting's theorem, Conservation of momentum. EM waves in various unbounded media: Wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, Poynting's theorem for a complex vector field, Waves in conducting media, skin depth, EM waves in rarefied plasma and their propagation in ionosphere.

Unit-IV

EM Waves in Various Bounded Media-Applications: Reflection and refraction of EM waves at plane dielectrics interface, Fresnel's amplitude relations. Reflection and transmission coefficients. Polarization by reflection. Brewster's angle, Total internal reflection, Wave guide: Derivation of field equations between parallel plates and propagation parameters, TE and TM waves, Rectangular wave guides and cavity resonators. Radiation from Localized Time Varying Sources: Solutions 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 linear antenna.

Text and Reference Books:

1. J. D. Jackson : Classical Electrodynamics
2. D. J. Griffiths : Introduction to Electrodynamics
3. M. J. Jordan &.R. J. Balment : Electromagnetic Waves
4. S.P. Puri : Classical Electrodynamics
5. G.S.N. Raju : Electromagnetic Field Theory and Transmission Lines
6. Bhag Singh Guru and H.R. Hiziroglu : Electromagnetic Field Theory Fundamentals
7. F.F. Chen : Introduction to Plasma Physics

PHY- 203: ELECTRONICS -II

Credits: 4
Periods per week: 4 Hrs.

Max. Marks: 70
Duration of Exam.: 3 Hrs.

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I: Frequency Response of Amplifier

The amplifier pass band, Midrange response with a CE cascade, The high frequency equivalent circuit : Miller effect, The high frequency response, The RC coupled CE amplifier, The frequency response of the RC amplifier, Gain frequency plots of amplifier response, Bandwidth of cascaded amplifier, Band width criteria for the transistor, Gain bandwidth product, Amplifier noise figure, Noise in amplifier.

Unit-II: Operational Amplifier

Differential amplifier- Circuit configuration, Dual input balanced out put differential amplifier : D.C. & A.C. analysis , The operational amplifier and its block diagram, Schematic symbol, Op-Amp parameters, Ideal Op-Amp, Equivalent circuit of Op-Amp, Open loop Op-Amp configurations, Block diagram representation of feedback configuration, Voltage series feedback amplifier- effect of negative feedback on closed loop voltage gain, Input resistance , Output resistance and Band width, Integrator, Differentiator, Summing, Scaling and Averaging amplifier.

Unit-III: Analog and Digital Systems

Active filters, First order low pass and high pass butterworth filter, Second order low pass and high pass butterworth filter, Oscillators- Oscillator principle, frequency stability, Phase shift and Wein bridge oscillator, Square wave and triangular wave generator, Comparators, Digital to analog(D/A) converter- ladder and weighted resistor types, Analog to digital(A/D) converter-counter type, Successive approximation, Parallel comparator.

Unit-IV: Microprocessor

Microcomputer systems and hardware, Microprocessor architecture and Microprocessor system, Instruction and timing diagram, Introduction to 8085 basic instructions (arithmetic operation , logic operation, branch operation) 16 bit arithmetic instructions, Arithmetic operation related to memory, Rotate and compare instructions, Stack and subroutines, Programming of 8085 using instructions, Introduction to microcontroller.

Text and Reference Books:

1. J. D. Ryder : Electronics Fundamental & Applications
2. R. A. Gayakwad : Op-Amp and Linear Integrated Circuits
3. J. Millman & C. C. Halkias : Integrated Electronics
4. J. Millman & A. Grabel : Microelectronics
5. S.Gaonkar : Microprocessor Architecture Prog. & Appls.
6. Microprocessor and Interfacing : D.V. Hall

PHY-204: QUANTUM MECHANICS-II

Credits: 4 Max. Marks: 70
Periods per week: 4 Hrs. Duration of Exam.: 3 Hrs.

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I: Approximation Methods
The WKB approximation: Introduction, The WKB solutions, The connection formulae, Energy level of a potential well, Tunneling through a barrier, Time Dependent Perturbation Theory : First order perturbation, Transition probability for constant and harmonic perturbation, Transition into a continuum of final states- Fermi Golden rule, Semi-Classical Theory of Radiation: Interaction of an atom with electromagnetic radiation, Transition probability for absorption and induced emission.

Unit-II: Quantum Theory of Scattering
Basic concept of scattering , Scattering cross section , Scattering amplitude, Laboratory and Centre of mass system, Method of partial wave analysis: Differential cross section, Total cross section, Optical theorem and phase shift, Relation of phase shift with potential, Scattering by perfectly rigid sphere and by square well potential, Born approximation, Validity of Born approximation and its applications to scattering of electron by screened Coulomb potential.

Unit-III: Identical Particles and Spin
Physical meaning of identity, Symmetric and anti- symmetric wave function, Construction of symmetric and anti- symmetric wave function from unsymmetrized functions, Distinguishability of identical particles, Pauli exclusion principle, Collision of identical particles, Pauli spin operators, Commutation relations, Spin - Statistics connection, Spin matrices and eigen functions, Electron spin function, The helium atom (Para and ortho helium).

Unit-IV: Relativistic Quantum Mechanics
Introduction, The Klein-Gordan (KG) equation: Free particle, Electromagnetic potential, Probability and current densities, Difficulties of KG equation, The Dirac's relativistic equation: Free particle equation, Matrices for α and β, Free particle solution (plane wave solution), Probability and current densities, Electromagnetic potential, Existence of spin angular momentum, Spin-orbit energy, Negative energy states.

Text and Reference Books:

1. L. I. Schiff : Quantum Mechanics
2. B. Craseman and J. D. Powel : Quantum Mechanics
3. P.M. Methews and K. Venkatesan : Quantum Mechanics
4. A. Ghatak and S. Loknathan : Quantum Mechanics
5. Nouredine Zettili : Quantum Mechanics
6. B.H. Bransden and Joachain : Quantum Mechanics
7. S. Gasiorowicz : Quantum Mechanics
8. J.J. Sakurai : Modern Quantum Mechanics
9. David J.Griffiths : Introduction to Quantum Mechanics

PHY-205: Physics Lab – III
(General)

Credits : 4
Periods per week: 8 Hrs.

Max. Marks: 100
Duration of Exam.: 6 Hrs.

1. To study the analog to digital (A/D) & digital to analog (D/A) converters.
2. To determine the Stefan's constant with the help of given apparatus.
3. To estimate the efficiency of G.M counter for gamma ray source.
4. To determine capacitance of an unknown capacitor using flashing and quenching kit.
5. To study the e/m of an electron by Thomson method.
6. To study the characteristics of RC coupled amplifier.
7. Experimental verification of Network theorems: Kirchoff's law, Superposition, Thevenin and Norten theorem for a given circuit.
8. To verify inverse square law using G.M. counter.
9. To study the regulated power supply using (a) Zener diode only (b) Zener diode with series transistor (c) Zener diode with shunt transistor .
10. To measure the capacitance and permittivity of a given Sample.
11. To determine the Planck's constant using LEDs.

PHY-206: Physics Lab – IV
(Electronics)

Credits: 4
Periods per week: 8 Hrs.

Max. Marks: 100
Duration of Exam.: 6 Hrs.

1. To determine the h- parameters of a PNP transistor in CE configuration.
2. To study the Class A , B & AB Push Pull amplifier.
3. To study the RF Oscillator using tuned (i) Hartley's Oscillator (ii) Colpitt's Oscillator.
4. To study the various types of Active filters.
5. To design and demonstrate the Passive filters.
6. Applications of Op-Amp as: subtracting, summing, scaling amplifier.
7. To study the Op-Amp in inverting and non-inverting mode.
8. To study the D.C gate control characteristics and anode current characteristics of SCR.
9. To design and demonstrate the various programmes on 8085 microprocessor kit.
10. To study the UJT characteristics.
11. To study the triangular wave generator.
12. To study the Chopper Amplifier
    a. To study the chopped wave forms and the leakage current compensation for FET switch.
    b. To measure the gain of Chopper Amplifier and to study the recovery of original signal

PHY-301: STATISTICAL MECHANICS

Credits: 4 | **Max. Marks: 70**
Periods per week: 4 Hrs. | **Duration of Exam.: 3 Hrs.**

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I

Review of Thermodynamic concepts/laws required for Statistical mechanics, Thermodynamic potentials, Maxwell's relations, Chemical potential, Macroscopic and Microscopic states, Postulate of equal a priori probability, Contact between Statistics and Thermodynamics, Equipartition theorem, Entropy of mixing, Gibbs paradox, Sackur-Tetrode equation.

Unit-II

Phase space, Liouville's theorem, Concept of ensemble, Ensemble average, Microcanonical, canonical and grand canonical ensembles and partition functions, Thermodynamics of Classical ideal gas in Microcanonical, Canonical and Grand canonical ensembles, Energy and density fluctuations.

Unit-III

Density matrix, Statistics of indistinguishable particles, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics, Statistics of occupation numbers, Thermodynamic behavior of ideal Bose and Fermi gases, Bose-Einstein condensation, Laser cooling of atoms as an example of Bose condensate, Black body radiation and Planck's black body radiation formula.

Unit-IV

First and second order phase transitions, Critical exponents, Landau theory of phase transition, Diamagnetism, paramagnetism and ferromagnetism, Ising model, Thermodynamic fluctuations, Random walk and Brownian motion, Langevin theory of Brownian motion.

Text and Reference Books:

1. R. K. Pathria : Statistical Mechanics
2. K. Huang : Statistical Mechanics
3. B. K. Agrawal & M. Eisner : Statistical Mechanics
4. S. K. Sinha : Statistical Mechanics
5. C. Kittel : Elementary Statistical Mechanics

PHY-302: CLASSICAL ELECTRODYNAMICS -II

Credits: 4 | **Max. Marks: 70**
Periods per week: 4 Hrs. | **Duration of Exam.: 3 Hrs.**

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I

Charged Particle Dynamics: Non-relativistic motion in uniform constant fields: Constant uniform electric field, Constant uniform magnetic field, Crossed uniform and constant electric and magnetic fields. Non-relativistic motion of a charged particle in a slowly varying magnetic field: Time varying magnetic field, Space varying magnetic field, Gradient drift, Curvature drift, Adiabatic magnetic field invariance of flux through an orbit, magnetic mirror.

Unit-II

Concepts of Relativity and Relativistic Motion of Charged Particles: Postulates of special theory of relativity, Lorents transformation in four dimensions, Structure of space time: Four vectors, Invariant interval, Minkowski diagrams, Four velocity, Four momentum, Relativistic energy and momentum, Conservation laws of energy and momentum. Relativistic motion of a charged particle: Constant magnetic field, Constant electric field, Electromagnetic field of a plane wave.

Unit-III

Covariant Formulation of Electrodynamics in Vacuum: Four vectors in electrodynamics, four current density, four-potential, convariant continuity equation, wave equation, covariance of Maxwell equations. Electromagnetic field tensor, Transformation of EM fields. Invariants of the EM fields. Energy momentum tensor of the EM fields and conservation laws. Lagrangian and Hamiltonian of a charged particle in an EM field.

Unit-IV

Radiation From Accelerated Charges: Lienard-Wiechert Potentials, Field of a charge in arbitrary motion and uniform motion, Radiated power from an accelerated charge at low velocities-Larmour-power formula. Radiation from a charged particle with collinear velocity and acceleration. Radiation from a charged particle in a circular orbit, Radiation from an ultra-relativistic particle, Radiation reaction. Line –width and level shift of an oscillator.

Text and Reference Books:

1. J. D. Jackson : Classical Electrodynamics
2. D. J. Griffiths : Introduction to Electrodynamics
3. F. F. Chain : Introduction to Plasma Physics
4. J. A. Bittencourt : Fundamental of Plasma Physics
5. S.P. Puri : Classical Electrodynamics
6. J.B. Marion and M.A. Heald : Classical Electromagnetic Radiation
7. G.S.N. Raju : Electrodynamics Field Theory and Transmission Lines

PHY-303 A: LASER & SPECTROSCOPY -I

Credits: 4
Periods per week: 4 Hrs.

Max. Marks: 70
Duration of Exam.: 3 Hrs.

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I
Einstein's coefficients and their relationships, Active medium, Cavity radiation and modes (one, two and three dimensions), Population inversion, Important properties of lasers and their aspects: Coherence (experimental evidence for spatial and temporal conference), Monochromaticity, Directionality, Intensity, Brightness and Ultra short pulse duration.

Unit-II
Gaussian (real) laser beam and its properties, Physical description of lowest order modes, Preliminary considerations of optical resonator, Energy stored in optical resonator, Types of resonators, Stability diagram, Different types of losses in optical resonators: diffraction and transmission losses.

Unit-III
Origin of broadening of spectral line (Line shape function), Homogeneous (natural and collisional) and Inhomogeneous (Doppler) broadening mechanisms, Threshold condition for laser oscillation, laser oscillation and amplification in a homogeneous broadened system and its gain saturation.

Unit-IV
Photodiode arrays and charged coupled device (CCD) arrays, Principle, design, construction and applications of spectrometer: UV-VIS, FTIR, Raman, Brillnon, Fabry-Perot.

Text and Reference Books:

1. J.T. Verdeyen : Laser Electronics
2. C. C. Davis : Lasers and Electro-optics
3. W. T. Silfwast : Lasers Fundamentals
4. O. Svelto : Principles of Lasers
5. L. V. Tarasov : Laser Physics
6. A. Yariv : Quantum Electronics
7. A. Ghatak & K. Tayagrajan : Laser (Theory & Applications)
8. K. Shimoda : Introduction to Laser Physics
9. W. Demtroder : Laser Spectroscopy
10. Dharamvir Singh Ahlawat :Basic Concepts of Laser Physics

PHY- 303B: COMPUTATIONAL PHYSICS-I

Credits: 4 | **Max. Marks: 70**
Periods per week: 4 Hrs. | **Duration of Exam.: 3 Hrs.**

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit I: Computer Basics
Input Unit, Output Unit, Storage unit, Arithmetic logic unit, Control unit, Central processing unit , System concept, Basic idea of operating system, Assembler, Compiler, Linkers and Interpreters, Programming in Fortran-77 : Flow charts, Fortran constants and variables, Arithmetical and logical expressions, Input-output statements, DO, IF and GO TO statements, Arrays and subscripted variables, Function and subroutines.

Unit II: Interpolation & Spline functions
Finite differences- Forward differences, Backward differences, Central differences, Newton's formula for interpolation, Central difference interpolation - Gauss Central difference formula , Stirling formula, Bessel's formula, Lagrange's and Hermite's interpolation formula, Linear splines, Quadratic splines, Cubic splines, Surface fitting by cubic splines

Unit III: Systems of Algebaric Equations and Linear Algebra
Bisection method, Method of false position, Iteration method, Newton-Raphson method, Muller's method, Gauss elimination method, Gauss Jordan elimination method, Matrix inversion method, Ill-conditioned matrix and error correction, Jacobi Method, Gauss seidel iterative method, Matrix eigenvalues and eigenvectors: Polynomial method, Power method.

Unit IV: Errors & Curve Fitting
Errors- Round off error, Truncation error, Machine error, Random error, Propagation of errors. Loss of Significance: Significant digits, Computer caused loss of significance, Avoiding loss of significance in subtraction, Least square curve fitting: The principle of least square fitting, Linear regression, Polynomial regression, Fitting exponential and trigonometric functions, Data fitting with cubic splines.

Text and Reference Books:

1. Pardeep K. Sinha and Priti Sinha : Computer Fundamentals
2. V. Rajaraman : FORTRAN Programming
3. R.S. Salaria : Programming in FORTRAN
4. R. C. Desai : FORTRAN Programming and Numerical Methods
5. S. Chandra : Computer Application in physics
6. S. S. Sastry : Introductory Methods of Numerical Analysis
7. V. Rajaraman : Computer Oriented Numerical Method
8. P.B. Patil and U.P. Verma : Numerical Computational Methods

PHY - 304 A: MATERIALS SCIENCE - I

Credits: 4
Periods per week: 4 Hrs.

Max. Marks: 70
Duration of Exam.: 3 Hrs.

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I

Crystal Imperfections: Point defects: Vacancy, Substitutional, Interstitial, Schottky and Frenkel defects; Line defects/Dislocations: Slip planes and slip directions, Edge and screw dislocations, Burger's vector and circuit, Energy of dislocation; Planar defects: Grain boundaries, Tilt and twist boundaries, twin interfaces, Stacking faults in close packed structures (fcc and hcp).

Unit-II

Semiconductors: Energy bands, Direct and indirect band gap, Motion of electrons in an energy band, Holes, Effective mass and its physical interpretation, Hall effect, Cyclotron resonance, Hot electrons and Gunn effect, Optical absorption, transmission and reflection, Refractive index, Colour, Photoconductivity, Photoluminescence.

Unit-III

Dielectrics: Polarization, Dielectric constant, Complex permittivity, Dielectric loss factor, Local field, Clausius-Mossotti relation, Electronic, Ionic & Dipolar Polarizabilities, Classification of dielectrics, Frequency dependence of dielectric constant. Ferroelectrics: Peizo-, Pyro- and Ferro-electricity, Transition temperature, Classification and general properties of ferroelectric materials, Polarization catastrophe, Landau theory of first and second order phase transitions, Ferroelectric domains, Antiferroelectricity.

Unit-IV

Magnetism: Larmor frequency, Diamagnetism, Magnetic susceptibility of a diamagnetic material, Langevin's diamagnetism equation, Paramagnetism, Curie constant, Ferromagnetism, Curie temperature, Curie-Weiss law, Exchange interactions, Ferromagnetic domains, Antiferromagnetism, Magnetic susceptibility of an antiferromagnetic material, Ferrimagnetism and Ferrites.

Text and Reference Books :

1. C. Kittel : Introduction to Solid State Physics
2. Ashcroft & Mermin : Solid State Physics
3. H. Ibach and H. Luth : Solid State Physics: An introduction to Principles of Materials Science
4. M. A. Omar : Elements of Solid Sate Physics
5. M. A. Wahab : Solid State Physics
6. Rajni Kant : Applied Solid State Physics
7. L. V. Azaroff & J. J. Brophy : Electronic Processes in Materials
8. J. C. Anderson, K. D. Leaver, J. M. Alexander & R. D. Rawlings : Materials Science

PHY- 304 B: Optical Fibers & Optoelectronic Devices-I

Credits: 4
Periods per week: 4 Hrs.

Max. Marks: 70
Duration of Exam.: 3 Hrs.

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I: Introduction

Need for optical fiber communication, Block diagram, Basic structure and ray theory of propagation, Wave propagation in plane wave guide, Total internal reflection, Numerical aperture, Acceptance angle, Advantages of optical fibers, Types of rays, Attenuations in optical fibers: Material absorption losses, Linear and non-linear scattering losses, bending losses, Core & cladding losses.

Unit-II: Types & Fabrication Techniques

Fiber materials for glass fibers and plastic fibers, Preparation of optical fibers: Liquid phase techniques, Double crucible method, Fiber drawing process, Vapor-Phase deposition techniques, Outside vapor-Phase oxidation process, Vapor axial deposition, Modified chemical vapor deposition, Plasma-activated chemical vapor deposition, Types of optical fibers: Multimode step index fibers, Multimode graded index fibers, Single mode fibers.

Unit-III: Light emitting diodes

Radiative and non-radiative transition, Concept of homojunction and heterojunctions, Principle of LEDs, LED power and efficiency, LED structures: planer LED, Dome LED, Surface emitter LEDs, Edge emitter LEDs, Superluminescent LEDs, Advantages of Light emitting diodes, LED characteristics: Optical output power, Output spectrum, Modulation bandwidth, Reliability, Numeric and alphanumeric display units.

Unit-IV: Laser diodes

Laser diodes: Principle of action, Structure of gain and index guided lasers Quantum well and quantum dot lasers, Single frequency lasers: Distributed feedback lasers, Vertical cavity surface emitting lasers (VCSELs), Characteristics of laser diodes: Threshold current temperature dependence and reliability, Short and coupled-cavity lasers, Non semiconductor lasers for optical fiber communication.

Text and References Books:

1. G. Keisser : Optical Fiber Communication
2. J.M. Senior : Optical Fiber Communication- Principle and Practicals
3. A. Ghatak & K Tyagrajan : Introduction to Fiber Optics
4. D. Jafer : Fiber Optics Communication and Technology
5. S.M. Sze : Physics of Semiconductors

PHY-305A: Physics Lab – V(A)
(Laser & Spectroscopy-I)

Credits: 4
Periods per week: 8 Hrs.

Max. Marks: 100
Duration of Exam.: 6 Hrs.

1. To determine the wavelength of Diode/ He-Ne laser using transmission grating.
2. Determination of applied magnetic field and resonance frequency of a given sample using Electron spin resonance spectrometer.
3. To calibrate the prism spectrometer with mercury vapors and find out the Cauchy's constant.
4. To determine the size of tiny particle using laser.
5. To determine the distance of an object by Triangularization method using He-Ne Laser/ diode laser as source.
6. To determine the refractive index of a given sample using Abbe refractometer.
7. Determine the refractive index of a given liquid using diode laser.
8. To study the polarization characteristics of laser beam.
9. To demonstrate temporal coherence by Michelson interferometer.
10. To determine the wavelength of He-Ne laser/ diode laser using engraved metal scale.
11. Determine the power distribution, spot size and divergence of a laser beam.

PHY-305B: Physics Lab – V(B)
(Computational Physics-I)

Credits: 4 | **Max. Marks: 100**
Periods per week: 8 Hrs. | **Duration of Exam.: 6 Hrs.**

1. Program to sort an array in ascending order by using Bubble sort method.
2. Finding the eigenvalues and eigenvectors of square matrices
3. Program to compute product of two Matrices.
4. Program to sort an array in descending order by using Bubble sort method.
5. Program to compute Addition & Subtraction of two Matrices.
6. To find root of Non linear equation using Bisection method.
7. To find the root of an algebraic equation using Muller method.
8. To find a root of a Non-Linear equation by using false position method.
9. To solve a system of linear equation by using Gauss elimination method.
10. To solve a system of linear equation by using Gauss-Jordon method.
11. Program to find the inverse of a matrix using Gauss-Jordan elimination technique.
12. To solve a system of linear system of equations by Gauss-Seidel method.
13. To solve a system of linear system of equations by matrix inversion method.
14. To compute the interpolation value at a specified value given a set of table points.
15. Program to fit a straight line of Y on X

PHY-306A: Physics Lab – VI (A)
(Materials Science-I)

Credits: 4
Periods per week: 8 Hrs.

Max. Marks: 100
Duration of Exam.: 6 Hrs.

1. To determine the Dielectric constant for given samples.
2. To study temperature variation of resistivity of a semiconductor and to obtain energy gap using Four probe method.
3. To determine the carrier concentration, mobility & Hall coefficient using Hall effect experiment.
4. To determine the area of the B-H curve, saturation of magnetization, coercivity, retentivity of a given magnetic material.
5. To determine the velocity of sound waves in a liquid using ultrasonic interferometer.
6. To determine the Fermi energy of copper.
7. Determination of compressibility of a given liquid by using ultrasonic diffraction grating method.
8. To determine the quantized energy state of an atom by using Frank –Hertz experiment.
9. Measurement of susceptibility of Ferric Chloride ($FeCl_3$)/ Manganese Sulphate ($MnSO_4$) paramagnetic solution.
10. To determine the refrective index of glass material by Brewster angle measurement.
11. To study the magnetic susceptibility of a sample using Guy balance method.

PHY-306B: Physics Lab – VI (B)
(Optical Fibers & Optoelectronic Devices-I)

Credits: 4
Periods per week: 8 Hrs.

Max. Marks: 100
Duration of Exam.: 6 Hrs.

1. To determine the Planck's constant using Photocell.
2. To determine the value of forbidden energy gap of a diode and LED
3. To study the various optoelectronic devices.
4. To study the characteristics of LED and Laser Diode using fiber optics trainer kit.
5. To determine the numerical aperture of monomode/multimode optical fiber.
6. Study of loss attenuation in optical fibers.
7. Study of pulse width modulation and demodulation.
8. Demonstration and realization of amplitude modulation & demodulation.
9. Demonstration and realization of frequency modulation & demodulation.

PHY-401: NUCLEAR & PARTICLE PHYSICS

Credits: 4
Periods per week: 4 Hrs.

Max. Marks: 70
Duration of Exam.: 3 Hrs.

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I

Basic nuclear properties: size, shape, charge distribution, spin and parity, moments and statistics, binding energy, Fundamental forces of nature, charge independence and charge symmetry of nuclear forces, Isospin, deuteron problem: ground state of deuteron, magnetic dipole and electric quadruple moments of the deuteron, square well solution for the deutron, central and non-central forces, Meson theory of nuclear forces.

Unit-II

Weizsacher's semi-empirical mass formula, liquid drop model of the nucleous, mass parabolas: prediction of stability against β-decay for members of an isobaric family. Shell model of the nucleus: evidences that led to the shell model, assumptions of the single particle shell model, spin orbit coupling of an electron bound in an atom, spin orbit coupling in nuclei for a single particle shell model. Single particle shell model for parabolic and square well potentials.

Unit-III

Disintegration energy of spontaneous α-decay, Alpha decay paradox- barrier penetration, Fermi's theory of β-decay, Selection rules for β-decay, Parity non-conservation in β-decay, γ-ray emission- selection rules, Internal conversion, Types of nuclear reactions, Balance of mass and energy in nuclear reactions, Q-value equation and its solution, Basics of nuclear fission and fusion reaction.

Unit-IV

Classification of elementary particles, Conservation laws & symmetries: conservation of baryon and lepton numbers, concept of isospin, isospin multiplets, isospin & strangeness conservation and violation in different types of interactions, Gell–Mann–Nishijima formula, Baryons octet ($1/2^+$) and decuplet ($3/2^+$), Quark structure of hadrons and quark flavours, Introductory concept of colour quantum number and gluons, Charge conjugation (C) and parity (P) operators, C & P non-conserving property of neutrino, CPT theorem.

Text and Reference Books:

1. W. E. Mayerhof : Elements of Nuclear Physics
2. D. H. Perkins : Introduction to High Energy Physics
3. D. C. Tayal : Nuclear physics
4. W. E. Burcham & M. Jobes : Nuclear & Particle Physics
5. S.B. Patel : Nuclear Physics
6. Deep Chandra Joshi : Introduction to Quantum Electrodynamics and Particle Physics
7. V.K. Mittal, R.C. Verma and S.C. Gupta : Introduction to Nuclear and Particle Physics

PHY-402: ATOMIC & MOLECULAR PHYSICS

Credits: 4
Periods per week: 4 Hrs.

Max. Marks: 70
Duration of Exam.: 3 Hrs.

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I

One electron system: Quantum states of an electron in an atom, Electron Probability density, Space Quantization, Electron Spin, Stern-Gerlach experiment, Spectroscopic terms and selection rules, Spin – orbit interaction energy, Quantum mechanical relativity correction, Hydrogen fine structure, Hyperfine structure, Pauli exclusion principle, Exchange symmetry of wave function.

Unit-II

Two electron system: Atomic states arising due to two electron valence system: L-S and J-J coupling for equivalent non-equivalent electrons, Helium atom and its spectra: Ortho and para modification, Interaction with external field: Zeeman effect, Paschen-Back effect, Stark effect and their important example, Characteristics X-ray Spectra: Kossel's Explanation and Moseley Law.

Unit-III

Vibration-rotational spectra of diatomic molecules: Types of molecules, Diatomic linear symmetric-top, Asymmetric-top and Spherical-top, The diatomic molecule as rigid rotator, Harmonic oscillator, Non rigid rotator, Anharmonic oscillator and vibrating rotator (energy levels and infrared spectra), Isotopic effect on vibrational-rotational spectra, Intensity of rotation-vibration spectra, Raman spectra of diatomic molecules.

Unit-IV

Electronic spectra: Resolution of the eigen function, Electronic and total energy: Born-Oppenheimer approximation, Classification of electronic states, Vibrational structure of electronic transitions, Rotational fine structure, P, Q, R branches of a band, The Fortrat parabola, Intensity of electronic bands, Franck-Condon principle: Absorption & emission, Isotopic effect on electronic states.

Text and Reference Books:

1. H. E. White : Introduction to Atomic Spectra
2. G. Herzberg : Atomic Spectra and Structure
3. G. Herzberg : Molecular Spectra and Structure
4. C.N. Banwell : Fundamentals of Molecular Spectroscopy
5. Raj Kumar : Atomic and Molecular Spectra: Laser
6. K. P. Nair : Atomic & Molecular Spectra: Laser

PHY- 403 A: LASER & SPECTROSCOPY –II

Credits: 4
Periods per week: 4 Hrs.

Max. Marks: 70
Duration of Exam.: 3 Hrs.

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I

Amplification in an inhomogeneously broadened system, Spacial and spectral hole burning, Lamb dip, Multi-mode oscillation, Efficiency of laser and its various factors, Rate equations for three and four level laser systems, Variation of laser power around threshold, Optimum output coupling.

Unit-II

Pumping process: Optical and electrical pumping, Conversion efficiency, Excitation mechanisms, structure and important applications of laser systems: He-Ne, Ruby, Nd:YAG, Dye, CO_2 , Argon Ion, Semiconductor, Semiconductor Quantum well.

Unit-III

Index ellipsoid, Pockel and Kerr effects, Pockel effect in KDP crystal: Longitudinal and elementary idea of its transverse configuration, Magneto-optic and Acousto-optic effect, Theory of Q-switched laser, Theory of mode locking (active & passive), Methods for Q-switching and mode locking via passive and active methods in particular electro-optic effect.

Unit-IV

Introductory idea of Maxwell's equations in a non-linear optical medium. Principle, design, construction and applications: Laser Raman spectroscopy, High sensitivity methods of absorption spectroscopy; Frequency modulation and interactivity absorption (using single and multimode operation), Fluorescence excitation spectroscopy, Laser induced fluorescence.

Text and Reference Books:

1. J.T. Verdeyen : Laser Electronics
2. C. C. Davis : Lasers and Electro-optics
3. W. T. Silfwast : Lasers Fundamentals
4. O. Svelto : Principles of Lasers
5. L. V. Tarasov : Laser Physics
6. A. Yariv : Quantum Electronics
7. A. Ghatak & K. Tayagrajan : Laser (Theory & applications)
8. K. Shimoda : Introduction to Laser Physics
9. W. Demtroder : Laser Spectroscopy
10. Dharamvir Singh Ahlawat : Basic Concepts of Laser Physics
11. Robert W. Boyd : Non Linear Optics

PHY – 403B: COMPUTATIONAL PHYSICS-II

Credits: 4
Periods per week: 4 Hrs.

Max. Marks: 70
Duration of Exam.: 3 Hrs.

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit I: Numerical Differentiation and Integration
Taylor series method, Numerical differentiation by Newton's forward and backward difference formula, Stirling's formula, Cubic spline method, Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rule, Gaussian integration - Gaussian quadrature, Legendre-Gauss quadrature, Numerical double integration.

Unit II: Numerical Solutions of Ordinary Differential Equations
Taylor series method, Picard's method, Euler's method, Modified Euler's method, Second and fourth order Runge-Kutta method, Predicator and corrector method, Cubic splines method , Boundary value problems, Numerical solution of radial Schrodinger equation for Hydrogen atom using Fourth order Runge-Kutta method (eigen value is given).

Unit III: Random Numbers and Chaos
Random number generators, Mid-square methods, Multiplicative congruential method, Mixed multiplicative congruential methods, Modeling radioactive decay, Hit and miss Monte-Carlo methods, Monte-Carlo calculation of π, Monte -Carlo evaluation of integrals, Chaotic dynamics : Some definitions, Simple pendulum, Potential energy of a dynamical system, Portrait in Phase space : Undamped motion, Damped motion, Driven and damped oscillator.

Unit IV: Simulation in Physics
Algorithm to stimulate interference, diffraction and polarization of light, Simulation of charging and discharging of a capacitor, Current in LR and LCR circuit, Computer models of LR and LCR circuit driven by sine and square function, Computer model for Rutherford scattering experiment, Simulation of electron orbit in H_2 ion.

Text and Reference Books:

1. S. Chandra : Computer Application in physics
2. S. S. Sastry : Introductory Methods of Numerical Analysis
3. M L De Jong : Introduction to Computation Physics
4. RC Verma, PK Ahluwalia and KC Sharma : Computational Physics an Introduction
5. V. Rajaraman : Computer Oriented Numerical Method
6. P. Thangaraj :Computer Oriented Numerical Methods
7. P.B. Patil and U.P. Verma : Numerical Computational Methods

PHY- 404A: Materials Science -II

Credits: 4 | **Max. Marks: 70**

Periods per week: 4 Hrs. | **Duration of Exam.: 3 Hrs.**

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I

Free electron theory (qualitative idea) and its features, Idea of band structure, Metals, insulators and semiconductors, Density of state in bands, Variation of density of states with energy, Variation of density of state and band gap with size of crystal, Quantum size effect. Electron confinement in infinitely deep square well, confinement in one and two dimensional well.

Unit-II

Idea of quantum well structure, Quantum wires and dots. Determination of particle size, Increase in width of XRD peaks of nano-particles, Shift in photoluminescence peaks, Variation in Raman spectra of nano-materials, Carbon Nanotubes: Synthesis, Structure, Properties and Applications.

Unit-III

Different methods of preparation of Nanostructured materials: Brief idea of some important physical and chemical techniques, Ball milling, Pulsed laser deposition, Ion beam deposition, Chemical vapour deposition, Sol-gel, Co-precipitation, Electro-chemical deposition.

Unit-IV

Different methods of characterization of Nanostructured materials: X-ray diffraction (XRD), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, UV-visible spectroscopy, Photoluminescence (PL).

Text and Reference Books:

1.	G. Cao	:	Nanostructures & Nanomaterials
2.	C.P. Poole & F.J. Qwens	:	Introduction to Nanotechnology
3.	M. Wilson et al.	:	Nanotechnology
4.	K.P. Jain	:	Physics of Semiconductor Nano Structures
5.	John H. Davies	:	Physics of Low Dimensional Semiconductors
6.	J. H. Fendler (Ed.)	:	Nanoparticles and Nanostructured Films
7.	Paul Harrison	:	Quantum Wells, Wires and Dots
8.	A.S. Edelstein & R. C. Cammarata	:	Nanomaterials: Synthesis, Properties & Applications
9.	M.S. Dresselhaus, G. Dresselhaus & Ph. Avoris	:	CNT- Carbon Nanotubes: Synthesis, Structure, Properties and Applications.
10.	D. Bimerg, M. Grundmann & NN Ledenstoy	:	Quantum dot heterostructures

PHY- 404B: Optical Fibers & Optoelectronic Devices-II

Credits: 4
Periods per week: 4 Hrs.

Max. Marks: 70
Duration of Exam.: 3 Hrs.

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit-I: Electromagnetic mode theory
Electromagnetic plane wave equation, Modes in a planer guide, Phase and groups velocity, Idea of evanescent field and Goos Haechen shift, Wave equation for cylindrical waveguides, Modal equation for step index fibers, Types of modes, Mode conditions, Mode coupling, Linearly polarized modes, Dispersion in optical waveguides: Chromatic dispersion, Intermodal dispersion.

Unit-II: Cable Designs and Power Launching
Optical fiber cables: Fiber strength and durability, stability of the fiber transmission Characteristics, Cable design: Fiber buffering, Cable structural and strength members, Few example of fiber cables, Power Launching in fiber: Source output pattern, Power coupling calculation, Equilibrium NA, Lensing scheme for coupling improvement, Fiber to fiber joints: Connectors, Couplers, Splicing.

Unit-III: Photodiodes
Principle of action, Quantum efficiency, Long-wavelength cutoff, Responsivity, Semiconductor photodiodes with and without internal gain: P-N, P-i-N and Avalanche Photodiodes, Mid-IR and far-IR photodiodes, Different types of noises in photodiodes, Phototransistors: Principle and characteristics, Solar cells and its characteristics: Open circuit voltage, Short circuit current, Fill factor.

Unit-IV: Optical amplifiers
General considerations, Principle of operation of a semiconductor optical amplifier, Fabry-Perot amplifiers, Travelling wave amplifiers, Optical gain and bandwidth, System applications, Advantages and drawbacks, Rare-earth-doped fiber amplifiers, Gain and noise in an erbium-doped fiber, Raman and Brillion fiber amplifiers, Concept of waveguide amplifiers.

Text and References Books:

1. G. Keisser : Optical Fiber Communication
2. J.M. Senior : Optical Fiber Communication- Principle and Practicals
3. A. Ghatak & K Tyagrajan : Introduction to Fiber Optics
4. D. Jafer : Fiber Optics Communication and Technology
5. S.M. Sze : Physics of Semiconductors

PHY-405A: Physics Lab – VII (A)
(Laser & Spectroscopy-II)

Credits: 4
Periods per week: 8 Hrs.

Max. Marks: 100
Duration of Exam.: 6 Hrs.

1. To study the Laser beam parameter using a He- Ne laser source.
2. To determine the wavelength of He-Ne/ diode laser using reflection grating.
3. To determine the strength of a given source using gamma ray spectrometer.
4. Determination of applied magnetic field and resonance frequency of a given sample using Electron spin resonance spectrometer.
5. To study the complete spectra of source such as Cs-137, Co-57 and Co-60 etc.
6. To study the rotational spectra of iodine vapor with a spectrometer.
7. To study the Kerr effect from the given apparatus.
8. To find out the e/m by Zeeman effect.
9. Acousto-optic modulation.
10. Febry-Perrot interferometer.
11. Electro-optic modulation

PHY-405B: Physics Lab – VII (B) (Computational Physics-II)

Credits: 4
Periods per week: 8 Hrs.

Max. Marks: 100
Duration of Exam.: 6 Hrs.

1. Program to solve a first order differential equation using Euler's method.
2. Program to solve first order differential equation using second order Runge-Kutta method.
3. Simulation of nuclear radioactivity by Monte carlo technique.
4. To find a root of non linear equation by Newton's Raphson's method.
5. Program to solve first order differential equation using fourth order Runge-Kutta method.
6. Program to solve first order differential equation using predictor corrector method.
7. Program to interpolate a value of dependent variable y for a given value of independent variable x using Newton forward interpolation method.
8. Programm to fit the given data using polynomial fitting.
9. To perform the numerical differentiation using Newton's method.
10. To perform the numerical differentiation using Taylor series method.
11. To compute integration of a given function by Simpson's 1/3 Rule.
12. To compute the integral of function by Trapezoidal rule.
13. To perform the numerical integration using Legendre-Gauss quadrature
14. To find the radial wave function of deuteron in its ground state using Runge-Kutta method.
15. To perform the numerical differentiation using strilling formula.

PHY-406A: Physics Lab – VIII (A) (Materials Science-II)

Credits: 4
Periods per week: 8 Hrs.

Max. Marks: 100
Duration of Exam.: 6 Hrs.

1. To determine the Curie temperature for a given Ferroelectric material.
2. To determine the Boltzmann's constant of a given sample using the Silicon diode.
3. To study of heat capacity of a given Sample
4. To determine the magnetic susceptibility using quinck tube apparatus
5. To study the dispersion relation for monoatomic and diatomic lattices.
6. To determine the Curie temperature for a given Ferrite sample.
7. To study the ultrasonic interferometer for the given solid samples.
8. To study the dispersion relation for mono-atomic & di-atomic lattice.
9. To determine the ionization potential of Argon with the help of Frank-Hertz tube.
10. To study the variation of magnetic field due to circular coil using Stewart and Gee's apparatus.
11. To determine the magneto-resistance of a semiconductor.

PHY-406B: Physics Lab – VIII (B)
(Optical Fibers & Optoelectronic Devices-II)

Credits: 4
Periods per week: 8 Hrs.

Max. Marks: 100
Duration of Exam.: 6 Hrs.

1. To Determine the response of silicon solar cell and the effect of prolonged irradiation and to calculate the efficiency and fill factors of a variety of solar cells.
2. Polarization of light.
3. To study the characteristics of LED and Laser diode.
4. To study characteristics of Fiber optic photo-detectors.
5. Design and evaluation of a Laser diode linear Intensity Modulation system.
6. Design and evaluation of a Laser diode digital IM system.
7. Laser free space communication.
8. To study various characteristics of PN junction:
   a) Reverse saturation current and material constant.
   b) To determine the temperature coefficient of junction and energy band gap.

8

OEC-PHY: Environmental Physics

Credits: 4 | Max. Marks: 70
Periods per week: 4 Hrs. | Duration of Exam.: 3 Hrs.

Note: There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all, selecting one question from each unit.

Unit -I

Structure and thermodynamics of the atmosphere; Troposphere, Stratosphere, Mesosphere, Ionosphere, Exosphere; Temperature, pressure and density variations with height; Composition of air; RADAR, SODAR, LIDAR: Principle and application.

Unit -II

Radiation, Radiant energy; Solar and terrestrial radiation; Rayleigh and Mie scattering; Ultraviolet (UV) radiation, Ozone depletion problem; Infrared (IR) absorption, Green House Effect, Global warming; Solar energy, Solar cells.

Unit -III

Concept of heat, energy and work; Types of heat transfer (conduction, convection and radiation); Thermodynamic state of a system, First law of thermodynamics; Energy transformations, Law of conservation of energy; Isothermal and adiabatic processes; Carnot cycle, Second law of thermodynamics, Heat pump and Refrigerator; Entropy and disorder.

Unit -IV

Radioactivity; Characteristics of radioactive radiations; Radioisotopes and application; Units of radiation dose; Biological effects of nuclear radiation and safety measure; Age of earth-radioactive dating; Nuclear energy, Nuclear reactor.

Books and references:

1. E. Boeker & R.V. Groundelle : Environmental Physics (John Wiley)
2. M.L. Salby, : Fundamentals of Atmospheric Physics (Academic Press)
3. Gerand Guyo : Physics of the Environment and Climate (John Wiley & Sons)
4. J. Monteith, & M. Unsworth : Principles of Environmental Physics (Elsevier)
5. R.A. Hinrichs & M. Kleinbach : Energy, Its Use and the Environment.