FACULTY OF SCIENCES

SYLLABUS FOR THE

SUBJECT: PHYSICS

for the award of the Degree in

BACHELOR OF ARTS/ BACHELOR OF SCIENCE/ HONOURS
(Offered under 4-year UG Degree Programme)

(Credit Based Grading System)
under NEP 2020

Batch: 2026–30

GURU NANAK DEV UNIVERSITY AMRITSAR

SCHEME

PHYSICS

Sr. No.	Course Code	Course Title	Credits L-T-P	Total Credits	Total Marks
SEMESTER-I					
Discipline Specific Course (DSC)					
1.		ELECTRICITY AND MAGNETISM (THEORY)	4-0-0	4	100
2.		ELECTRICITY AND MAGNETISM LAB (PRACTICAL)	0-0-1	1	25
SEMESTER-II					
3.		MECHANICS (THEORY)	4-0-0	4	100
4.		MECHANICS LAB (PRACTICAL)	0-0-1	1	25
SEMESTER-III					
5.		STATISTICAL PHYSICS & THERMODYNAMICS (THEORY)	4-0-0	4	100
6.		OPTICS LAB (PRACTICAL)	0-0-1	1	25
SEMESTER-IV					
7.		QUANTUM PHYSICS & SPECTROSCOPY (THEORY)	4-0-0	4	100
8.		THERMAL & MODERN PHYSICS LAB (PRACTICAL)	0-0-1	1	25
SEMESTER-V					
9.		SOLID STATE PHYSICS & ELECTRONICS (THEORY)	4-0-0	4	100
10.		ELECTRONICS LAB (PRACTICAL)	0-0-1	1	25
SUMMER INTERNSHIP					
11.		SUMMER INTERNSHIP (02 WEEKS)	0-0-2	2	50

SEMESTER-VI					
12.		NUCLEAR PHYSICS (THEORY)	4-0-0	4	100
13.		NUCLEAR PHYSICS & MATERIALS LAB (PRACTICAL)	0-0-1	1	25
SEMESTER-VII					
14.		ANALOG & DIGITAL ELECTRONICS (THEORY)	4-0-0	4	100
15.		MATHEMATICAL PHYSICS (THEORY)	4-0-0	4	100
16.		CLASSICAL MECHANICS (THEORY)	4-0-0	4	100
17.		COMPUTATIONAL TECHNIQUES (THEORY)	4-0-0	4	100
18.		ELECTRONICS LAB (PRACTICAL)	0-0-2	2	50
19.		COMPUTER LAB (PRACTICAL)	0-0-2	2	50
MINOR COURSE					
20.		WAVES AND VIBRATION (THEORY)	3-0-0	3	75
SEMESTER-VIII					
21.		QUANTUM MECHANICS-I (THEORY)	4-0-0	4	100
22.		ELECTRODYNAMICS-I (THEORY)	4-0-0	4	100
23.		ATOMIC AND MOLECULAR SPECTROSCOPY (THEORY)	4-0-0	4	100
24.		CONDENSED MATTER PHYSICS-I (THEORY)	4-0-0	4	100
25.		CONDENSED MATTER PHYSICS LAB (PRACTICAL)	0-0-2	2	50
26.		SPECTROSCOPY LAB (PRACTICAL)	0-0-2	2	50
MINOR COURSE					
27.		FABRICATION OF ELECTRONIC DEVICES (THEORY)	3-0-0	3	75

SEMESTER–I
PHYSICS
ELECTRICITY AND MAGNETISM
(THEORY)

Time: 3 Hrs. **L-T-P**
Credits : 4-0-0
Marks: 100
(4 Hrs./week)
Course Hrs.: 60

Note: There should be 20% numerical in each paper.

Instructions for the Paper Setters:-

Eight questions of equal marks (specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION–A

Basic ideas of Vector Calculus Gradient, Divergence, curl and their physical significance. Laplacian in rectangular, cylindrical and spherical coordinates. Coulomb's Law for point charges and continuous distribution of charges. Electric field due to dipole, line charge and sheet of charge. Electric flux, Gauss's Law and its applications. Gauss's divergence theorem and differential form of Gauss's Law. Green's theorem.

Lectures 15

SECTION–B

Work and potential difference. Potential difference as line integral of field. Electric potential due to a point charge, a group of point charges, dipole and quadrupole moments, long uniformly charged wire, charged disc. Stokes' Theorem and its applications in Electrostatic field, curl E=0. Electric fields as gradient of scalar potential. Calculation of E due to a point charge and dipole from potential. Potential due to arbitrary charge distribution and multipole moments.

Lectures 15

SECTION–C

Poisson and Laplace's equation and their solutions in Cartesian and spherical coordinates. Concept of electrical images. Calculation of electric potential and field due to a point charge placed near an infinitely conducting sheet. Current and current density, equation of continuity. Microscopic form of Ohm's Law ($J=\sigma E$) and conductivity, Failure of Ohm's Law.

Lectures 15

SECTION–D

Interaction between moving charges and force between parallel currents. Behaviour of various substances in magnetic field. Definition of M and H and their relation to free and bound currents. Permeability and susceptibility and their interrelationship. Orbital motion of electrons and diamagnetism, Paramagnetism and Ferromagnetism, Maxwell's equations, boundary conditions, electromagnetic induction and applications. **Lectures 15**

Books Suggested:

1. Fundamentals of Electricity and Magnetism: Arthur F. Kipp.
2. Electricity and Magnetism, Berkeley Physics Course: Vol. II, E. M. Purcell.
3. Introduction to Classical Electrodynamics: David Griffith.
4. EM Waves and Radiating System: Edward C. Jordan and K.G. Balmain.
5. Fields and Waves Electromagnetic: David K. Cheng.

SEMESTER–I
PHYSICS

ELECTRICITY AND MAGNETISM LAB

(PRACTICAL)

Time: 2 Hrs.

L-T-P
Credits : 0-0-1
Marks: 25
(2 Hrs./week)

General Guidelines for Practical Examination:

I. The distribution of marks is as follows :

i) One experiment	**10 Marks**
ii) Brief Theory	**5 Marks**
iii) Viva–Voce	**5 Marks**
iv) Record (Practical file)	**5 Marks**

II. There will be one sessions of 2 hours duration. The paper will have one session. Paper will consist of 8 experiments, out of which an examinee will mark 6 experiments and one of these is to be allotted by the external examiner.

III. The number of candidates in a group for practical examination should not exceed 12.

IV. In a single group, no experiment should be allotted to more than three examinees.

1. To determine low resistance with Carey-Foster's Bridge.
2. To study the magnetic field produced by a current carrying solenoid using a search coil and calculate permeability of air.
3. To study the induced e.m.f. as a function of the velocity of the magnet.
4. Study of phase relationships using impedance triangler for LCR circuit and calculate impedance.
5. Resonance in a series LCR circuits for different R–value and calculate Q–value.
6. Resonance in a parallel LCR circuits for different R-value and calculate Q-value.
7. Capacitance by flashing and quenching of a neon lamp.
8. To compare capacitance of two capacitors by de–Sauty's bridge.
9. To determined L using Anderson Bridge.
10. To find the value of B_H, the horizontal component of earth's magnetic field in the lab using a deflection & vibration magnetometer.
11. To study the variation of the magnetic field with distance along the axis of a coil carrying current by plotting a graph.

SEMESTER–II
PHYSICS
MECHANICS
(THEORY)

L-T-P
Time: 3 Hrs. **Credits: 4-0-0**
Marks: 100
(4 Hrs./week)
Course Hrs.: 60

Note: There should be 20% numerical in each paper.

Instructions for the Paper Setters:-

Eight questions of equal marks (specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Co-ordinate Systems and Motion of a particle: Reference frames, Displacement, velocity & acceleration in Cartesian, Plane polar, Spherical & Cylindrical coordinate systems, Solid angle, Forces in nature (Qualitative), Conservative forces, Central Forces, Motion of a particle under a central force field, Two-body problem and its reduction to one-body problem and its solution, Reduced mass, Equation of motion of a reduced mass under central force and energy, Differential equation of the orbit, Equation of orbit under inverse square force field, Turning points, Kepler's Laws, Satellite in circular orbit and applications, Geo-synchronous orbits, Weightlessness. **Lectures 15**

SECTION-B

Fundamentals of Dynamics: Momentum of variable-mass system: motion of rocket, Dynamics of a system of particles: internal & external forces and momentum conservation, Centre of Mass, Impulse.

Inertial & Non-Inertial Systems: Inertial frames, non-inertial frames, Galilean transformations, Galilean invariance of space & time intervals, Fictitious forces in non-inertial frames having translational and uniform rotational motion, Laws of Physics in rotating coordinate systems, Centrifugal force, Effect of rotation of earth on acceleration due to gravity, Effect of Coriolis force on a particle falling freely under gravity, Effect of Coriolis force on a particle moving on the surface of Earth, Foucault's pendulum and its equation of motion.

Lectures 15

SECTION-C

Collisions: Elastic and inelastic collisions between particles, Relationship of velocities, angles and energies of the colliding particles in Centre of Mass and Laboratory frames, Rutherford scattering.

Rotational Dynamics: Moment of Inertia, Moment of inertia of a rigid body, Motion involving both translation and rotation, Principle of conservation of angular momentum, Kinetic energy of rotation, Theorems of parallel and perpendicular axes, Rotational motion of a rigid body in general, Angular momentum and kinetic energy of a rigid body about principal axes, Euler's equations, Precession and Elementary Gyroscope, Motion of a spinning top.

Lectures 15

SECTION-D

Special Theory of Relativity: Concept of Ether and Michelson–Morley experiment, Postulates of special theory of relativity, Lorentz transformations, observer and viewer in relativity. Relativity of simultaneity, Length contraction, synchronization and time dilation, Einstein's velocity addition rule, Relativistic Doppler effect, Variation of mass with velocity, mass–energy equivalence, Rest mass in an inelastic collision, Relativistic momentum & energy and their transformation, Transformations of force, Concepts of Minkowski space, Four vector formulation.

Lectures 15

Books Suggested:

1) Mechanics, Berkeley Vol.–I, C. Kittle.
2) Mechanics, H.S. Hans & S.P. Puri
3) Introduction to Relativity, Robert Resnick
4) Physics, Resnick, Halliday and Walker 9/e. 2010, Wiley.
5) Feynman Lectures, Vol.1, R.P. Feynman, R.B. Leighton, M.Sands, 2008, Pearson Education

SEMESTER–II

PHYSICS

MECHANICS LAB

(PRACTICAL)

Time: 2 Hrs. **L-T-P**
Credits : 0-0-1
Marks: 25
(2 Hrs./week)

General Guidelines for Practical Examination:

I. The distribution of marks is as follows:

i)	One experiment	**10 Marks**
ii)	Brief Theory	**5 Marks**
iii)	Viva–Voce	**5 Marks**
iv)	Record (Practical file)	**5 Marks**

II. There will be one sessions of 2 hours duration. The paper will have one session. Paper will consist of 8 experiments out of which an examinee will mark 6 experiments and one of these is to be allotted by the external examiner.
III. Number of candidates in a group for practical examination should not exceed 12.
IV. In a single group no experiment be allotted to more than three examinee in any group.

1. To study the dependence of moment of inertia on distribution of mass (by noting time periods of oscillations using objects of various geometrical shapes but of same mass).
2. To establish relationship between torque and angular acceleration using flywheel.
3. To find the moment of inertia of a flywheel.
4. Study of bending of beams and determination of Young's modulus.
5. Determination of Poisson's ratio for rubber.
6. To determine energy transfer, coefficient of restitution and verify laws of conservation of linear momentum and kinetic energy in elastic collisions using one dimensional collisions of hanging spheres.
7. To verify the laws of vibrating string by Melde's experiment.
8. Measure time period as a function of distance of centre of suspension (oscillation) from centre of mass, plot relevant graphs, determine radius of gyration and acceleration due to gravity.
9. Find the value of 'g' by Kater's pendulum.
10. Measure time period of oscillation of a Maxwell needle and determine modulus of rigidity of the material of a given wire.
11. To measure logarithmic decrement, coefficient of damping, relaxation time, and quality factor of a damped simple pendulum.

SEMESTER–III

PHYSICS

STATISTICAL PHYSICS & THERMODYNAMICS

(THEORY)

Time: 3 Hrs. **L-T-P**
Credits : 4-0-0
Marks: 100
(4 Hrs./week)
Course Hrs : 60

Note : There should be 20% numericals in each paper.

Instructions for the Paper Setters:-
Eight questions of equal marks (specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Basic ideas of Statistical physics, Scope of Statistical physics, basic ideas about probability, distribution of four distinguishable particles into compartments of equal size. Concept of macrostates, microstates, thermodynamic probability, effects of constraints on the system. Distribution of particles in two compartments. Deviation from the state of maximum probability. Equilibrium state of dynamic system. Distribution of distinguishable n particles in k compartments of unequal sizes.

Lectures 15

SECTION-B

Phase space and division into elementary cells. Three kinds of statistics. The basic approach in three statistics. Maxwell Boltzmann (MB) statistics applied to an ideal gas in equilibrium. Experimental verification of law of distribution of molecular speeds. Need for Quantum Statistics – B.E. Statement of Planck’s law of Radiation Wien’s Displacement and Stefan’s law. Fermi Dirac (FD) statistics. Comparison of M.B, B.E and F.D statistics.

Lectures 15

SECTION-C

Statistical definition of entropy, change of entropy of system, additive nature of entropy, Law of increase of entropy, reversible and irreversible processes, and their examples, work done in reversible process, examples of increase in entropy in natural processes, entropy and disorder, brief review of terms, laws of thermodynamics, Carnot Cycle, Entropy changes in Carnot cycle, applications of thermodynamics to thermoelectric effect, change of entropy along reversible path in P-V diagram. Heat death of universe.

Lectures 15

SECTION-D

Derivation of Maxwell thermodynamics relations, Cooling produced by adiabatic stretching, Adiabatic Compression, change of internal energy with volume, specific heat and constant pressure and constant volume. Joule-Thomson effect, Expression for C_P-C_v, Change of state and Claussis-Claypron equation

Lectures 15

Books Suggested:-

1. Statistical Mechanics: B.B. Laud, (Macmillan India Ltd.) 1981.
2. Statistical Physics: J. K. Bhattacharjee, (Allied Pub., Delhi) 2000.
3. Statistical Physics and Thermodynamics: V.S. Bhatia
4. A Treatise on Heat: M.N. Saha & B.N. Srivastava (The Indian Press Pvt. Ltd., Allahabad), 1965.
5. Heat and Thermodynamics, Mark Zemansky and Richard Dittman McGraw Hill and Co.
6. Thermal and Statistical Physics-Concepts and Applications : S. Sharma, (Ane Books Pvt. Ltd. 2021)

SEMESTER–III

PHYSICS

OPTICS LAB

(PRACTICAL)

Time: 2 Hrs. **L-T-P**
Credits : 0-0-1
Marks: 25
(2 Hrs./week)

General Guidelines for Practical Examination:

I. The distribution of marks is as follows :

i)	One experiment	**10 Marks**
ii)	Brief Theory	**5 Marks**
iii)	Viva–Voce	**5 Marks**
iv)	Record (Practical file)	**5 Marks**

II. There will be one sessions of 2 hours duration. The paper will have one session. Paper will consist of 8 experiments out of which an examinee will mark 6 experiments and one of these is to be allotted by the external examiner.

III. Number of candidates in a group for practical examination should not exceed 12.

IV. In a single group no experiment be allotted to more than three examinee in any group.

1. To determine refractive index of glass and liquid using spectrometer.
2. To determine the Cauchy’s constants.
3. To study the refractive index of a doubly refracting prism.
4. To set up Newton’s rings to determine wavelength of sodium light.
5. To determine the wavelength of light by using plane diffraction grating (Use Hg source)
6. To determine dispersive power of plane diffraction grating.
7. To determine resolving power of a telescope.
8. To determine resolving power of a grating.
9. To measure an accessible (Horizontal and vertical) height using sextant.
10. To measure inaccessible height by using sextant.

SEMESTER–IV

PHYSICS

QUANTUM PHYSICS & SPECTROSCOPY

(THEORY)

Time: 3 Hrs. **L-T-P**
Credits : 4-0-0
Marks: 100
(4 Hrs./week)
Course Hrs : 60

Note : There should be 20% numericals in each paper.

Instructions for the Paper Setters:-
Eight questions of equal marks (specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Formalism of Wave Mechanics: Brief introduction to the need and development of quantum mechanics, photoelectric effect, Compton effect, wave-particle duality, De broglie hypothesis, Uncertainity principle, Gaussian wave packet. Operator correspondence. Normalization and probability interpretation of wave function. Superposition principle. Expectation value, Ehrenfest theorem, eigen function and eigenvalue. Operator formalism, orthogonal system, expansion in eigen functions, Hermitian operator, simultaneous eigen function, equation of motion.

Lectures 15

SECTION-B

Application of Schrodinger wave equation to one dimensional problems: Fundamental postulates of wave mechanics, Schrodinger's wave equation for a free particle and equation of a particle subject to forces. One-dimensional step potential for $E>V_0$, one-dimensional step potential for $0<E<V_0$, one dimensional potential barrier of finite height and width, Quantum mechanical tunnelling effect, particle in one dimensional box with infinitely hard walls, one dimensional square well of finite depth.

Lectures 15

SECTION-C

Application of Schrodinger equation to three dimensional problems: Free particle in three dimensional rectangular box, eigen wave function, eigenvalues of momentum, energy and degeneracy, three dimensional harmonic oscillator (Cartesian coordinates) wave function, energy levels, degeneracy, Schrodinger's wave equation in spherical polar coordinates, Schrodinger wave equation for spherically symmetric potential for hydrogen atom, wave function of H atom, solution of $R(r), \Theta(\theta), \Phi(\phi)$ equations.

Lectures 15

SECTION-D

Spectroscopy: Spectroscopy as a tool for studying structure of atoms and molecules, Hydrogen spectrum, Franck Hertz experiment, Stern Gerlach experiment, Introduction to quantum numbers, total angular momentum of electron, space quantization, spectroscopic terms and notation, LS coupling, JJ coupling, X-rays Spectra: Production of X-rays, Origin of X-rays from electromagnetic theory, Characteristics and Applications of X-Rays, X-ray diffraction, Bragg's law, X-ray Spectra: Continuous X-ray spectrum, Characteristics absorption and emission Spectra.

Lectures 15

Books Suggested:-

1. A Text book of Quantum Mechanics: P.M. Mathews and K.Venkatesan, (Tata McGraw Hill Pub. Co, Delhi) 2002.
2. Quantum Mechanics: J. L. Powell and B. Craseman (Narosa Pub. House, New Delhi) 1997.
3. Elements of Modern Physics: S.H. Patil, (McGraw Hill), 1998.
4. Introduction to Quantum Mechanics, L. Pauling and E.B. Wilson (Tata McGraw Hill Pub. Co., Delhi), 2002.
5. Atomic and Molecular Spectra, Raj Kumar, Kadar Nath Ram Nath, New Delhi
6. Atomic Spectra and Atomic Structure, Gerhard Herzberg, NY, 1944.

SEMESTER–IV

PHYSICS

THERMAL & MODERN PHYSICS LAB

(PRACTICAL)

Time: 2 Hrs. **L-T-P**
Credits : 0-0-1
Marks: 25
(2 Hrs./week)

General Guidelines for Practical Examination:

I The distribution of marks is as follows:

One experiment	**10 Marks**
i) Brief Theory	**5 Marks**
ii) Viva–Voce	**5 Marks**
iii) Record (Practical file)	**5 Marks**

II. There will be one sessions of 2 hours duration. The paper will have one session. Paper will consist of 8 experiments out of which an examinee will mark 6 experiments and one of these is to be allotted by the external examiner.
III. Number of candidates in a group for practical examination should not exceed 12.
IV. In a single group no experiment be allotted to more than three examinee in any group.

1. To study adiabatic expansion of gas and hence to calculate value of Volume.
2. To find the coefficient of Thermal Conductivity of a bad conductor by Lee's method.
3. To plot a calibration curve of a given thermocouple (copper constantan) using a potentiometer.
4. To study the photoelectric effect and determine the value of Planck's constant.
5. To determine the ionization potential of mercury.
6. Study of variation of light intensity with distance using photovoltaic cell (Inverse Square Law)
7. To determine the heating efficiency of an electric kettle with varying voltage.
8. To study the absorption spectra of iodine vapours.
9. To study the rotation of plane of polarization by using polarimeter.
10. To determine the specific rotation of sugar using Laurent's half shade polarimeter
11. To study the characteristics of Photovoltaic cell.

SEMESTER–V

PHYSICS

SOLID STATE PHYSICS & ELECTRONICS

(THEORY)

Time: 3 Hrs. **L-T-P**
Credits : 4-0-0
Marks: 100
(4 Hrs./week)
Course Hrs : 60

Note : There should be 20% numericals in each paper.

Instructions for the Paper Setters:-
Eight questions of equal marks (specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION–A

Crystal structure, symmetry operations for a two and three dimensional crystal, two-dimensional Bravais lattices, three dimensional Bravais lattices, basic primitive cells, crystal planes and miller indices, Packing fraction of SC, BCC and FCC, Hexagonal closed packed diamond and NaCl structure, Crystal Diffraction: Bragg's law, Experimental methods for crystal structure studies, Laue equations, reciprocal lattices of SC, BCC and FCC, Bragg's law in reciprocal lattice, Brillouin zones and their construction in two and three dimensions,

Lectures 15

SECTION–B

Interatomic forces and types of bonding: Ionic bonds, Covalent bonds, Metallic bonds, Van der waals bonds, Hydrogen bonds, Binding energy in ionic crystals: Evaluation of Madelung constant, determination of range –bulk modulus of crystals, Binding energy of crystals of Inert gases-London and repulsive interaction.
Free electron theory of metals: Drude - Laurent's classical theory, Somerfield's quantum theory: free electron gas in a one dimensional box, free electron gas in three dimensions, Applications of free electron gas model: electronic specific heat.

Lectures 15

SECTION-C

Semiconductors, Intrinsic and Extrinsic semiconductors, Qualitative discussion of the following: conductivity and its variation with temperature in semiconductors, Fermi levels in intrinsic and extrinsic semiconductors, band gap in semiconductors; p-n junction diode, biasing of diode, V-I characteristics, rectification: half wave, full wave rectifiers and bridge rectifiers, efficiency, ripple factor, qualitative ideas of filter circuits (LC and π filters), Zener diode and voltage regulation, introduction to Photonic devices (solar cell, photodiode and LED).

Lectures 15

SECTION-D

Bipolar Junction transistor: structure and working, relation between different currents in transistors, sign conventions, different configurations of a transistor and their comparison, CB and CE characteristics, amplifying action, transistor biasing and stabilization of operating point, Hybrid parameters, equivalent circuits, CE amplifier analysis using h-parameters and determination of current gain, voltage gain, power gain, input impedance, output impedance. Structure and Characteristic of JFET, MOSFET: Depletion and Enhancement type, Feedback: different types, voltage gain, advantages of negative feedback.

Lectures 15

Books Suggested:

1. Introduction to Solid State Physics: C. Kittel (Wiley Eastern)
2. Elements of Modern Physics: S.H. Patil (Tata McGraw Hill, 1985.
3. Solid State Physics: R. K. Puri and V. K. Babbar, S. Chand and Co.
4. Basic Electronics and Linear Circuits by N.N. Bhargave, D.C. Kulshreshtha and S.C. Gupta.
5. Electronic Devices & Circuits: Millman & Halkias
6. Solid State Electronic Devices: Ben G. Streetman
7. Electronics, D. C. Dube
8. Physics of Semiconductor Devices: S.M. Sze and Kwok K. Ng.

SEMESTER–V

PHYSICS

ELECTRONICS LAB

(PRACTICAL)

Time: 2 Hrs. **L-T-P**
Credits : 0-0-1
Marks: 25
(2 Hrs./week)

General Guidelines for Practical Examination:

I. The distribution of marks is as follows :

(i)	One experiment	**10 Marks**
(ii)	Brief Theory	**5 Marks**
(iii)	Viva–Voce	**5 Marks**
(iv)	Record (Practical file)	**5 Marks**

II. There will be one sessions of 2 hours duration. The paper will have one session. Paper will consist of 8 experiments out of which an examinee will mark 6 experiments and one of these is to be allotted by the external examiner.

III. Number of candidates in a group for practical examination should not exceed 12.

IV. In a single group no experiment be allotted to more than three examinee in any group.

1. Measurement of reverse saturation current in p-n-junction diode at various temperatures and to find the approximate value of energy gap.
2. To draw forward and reverse bias characteristics of a p-n junction diode.
3. Study of a diode as a clipping element.
4. To measure the efficiency and ripple factors for (a) halfwave (b) full wave and (c) bridge rectifier circuits.
5. To draw the characteristics of a Zener diode.
6. To study characteristics of Common Base transistor.
7. To study characteristics of Common Emitter transistor.
8. To study the gain of an amplifier at different frequencies and to find Band width
9. To study the reduction in the ripple in the rectified output with RC, LC and л filters.
10. To study logic gates (OR, AND, NOT and NAND).

SEMESTER–V

PHYSICS

SUMMER INTERNSHIP

(02 WEEKS)

L-T-P
Credits : 0-0-2
Marks : 50

Instructions :-

1. One internship/Community Outreach of 2 credits in each 5th and 7th semester will be carried out in the related area of the particular programme.
2. The candidate will submit a brief report of the work done along with completion certificate duly signed on the letter head of the organization/institute where the internship/community outreach has been undertaken. The evaluation will be carried out by a panel of the concerned subject teachers as appointed by the principal of the college.
3. The submission and evaluation must be done before the end semester examinations.

SEMESTER–VI
PHYSICS
NUCLEAR PHYSICS
(THEORY)

Time: 3 Hrs. **L-T-P**
Credits : 4-0-0
Marks: 100
(4 Hrs./week)
Course Hrs : 60

Instructions for the Paper Setters:-

Eight questions of equal marks (specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Nuclear Properties: Constituents of nucleus, non-existence of electrons in nucleus, nuclear mass and binding energy, features of binding energy versus mass number curve, nucleus radius, angular momentum and parity, nuclear moments: magnetic dipole moment and electric quadrupole moment, properties of nuclear forces, Yukawa theory.

Lectures 15

SECTION-B

Radioactive Decays: Modes of decay of radioactive nuclides and decay Laws, radioactive series and displacement law, radioactive dating, Alpha decay: Gamow's theory of alpha decay, barrier penetration as applied to alpha decay, Geiger Nuttal law, Beta decays: β^- and electron capture decays, Neutrino hypothesis and its detection, parity violation in β decay, Gamma transitions: Excited levels, isomeric levels, Gamma transitions, internal conversion.

Lectures 15

SECTION-C

Accelerators, Nuclear reactions and Radiation detection: Linear accelerator, Cyclotron. Nuclear reactions, reaction cross- section, conservation laws, kinematics of nuclear reactions, Q value of a nuclear reaction and its physical significance. Geiger-Mueller counter, Scintillation counter, Semiconductor detectors.

Lectures 15

SECTION-D

Elementary Particles: Historical introduction, Classification of particles, fermions and bosons, particles and antiparticles, types of interactions: electromagnetic, weak, strong and gravitational interactions, Conservation laws and quantum numbers, Concepts of Isospin, Strangeness, Charge conjugation, Gell Mann method, Introduction to quarks and qualitative discussion of quark model.

Lectures 15

Books Suggested:-

1. Basic Ideas and Concepts in Nuclear Physics: K. Hyde
2. Introduction to Nuclear Physics: H.A. Enge
3. Nuclear Physics: I. Kaplan (Addison Wesley)
4. Nuclear and Particles: E. Segre
5. Atomic Nucleus, R. D. Evans
6. Introduction to Nuclear & Particle V.K. Mittal, R.C. Verma & S.C. Gupta P.H.I. (2009).

SEMESTER–VI

PHYSICS

NUCLEAR PHYSICS & MATERIALS LAB

(PRACTICAL)

Time: 2 Hrs. **L-T-P**
Credits : 0-0-1
Marks: 25
(2 Hrs./week)

General Guidelines for Practical Examination:

I. The distribution of marks is as follows :

i)	One experiment	**10 Marks**
ii)	Brief Theory	**5 Marks**
iii)	Viva–Voce	**5 Marks**
iv)	Record (Practical file)	**5 Marks**

II. There will be one sessions of 2 hours duration. The paper will have one session. Paper will consist of 8 experiments out of which an examinee will mark 6 experiments and one of these is to be allotted by the external examiner.

III. Number of candidates in a group for practical examination should not exceed 12.

IV. In a single group no experiment be allotted to more than three examinee in any group.

List of Experiments

1. To trace the B-H curves for different materials using CRO and find the magnetic parameters from these
2. To study the stabilization of output voltage of a power supply with Zener diode.
3. To draw output and mutual characteristics of an FET (Experiments) and determine its parameters.
4. To set up an oscillator and to study its output on CRO.
5. To draw the plateau of a GM counter and find its dead time.
6. To study the statistical fluctuations using GM counter.
7. To study the absorption of beta particles in aluminium using GM counter and determine the absorption coefficient of beta particles from it.
8. To study the characteristics of a thermistor and find its parameters.
9. To study the response of RC circuit to various input voltage (square, sine and triangular).

SEMESTER–VII
PHYSICS
ANALOG & DIGITAL ELECTRONICS
(THEORY)

Time : 3 Hrs. **L-T-P**
Credits : 4-0-0
Marks : 100
(4 Hrs. /week)
Course Hrs : 60

Instructions for the Paper Setters:
Eight questions of equal marks (specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Oscillators: Barkausen criterion of sustained oscillations, LC oscillator (tuned collector, tuned base Hartley), RC oscillators, phase shift and Wein bridge,
Electronic Devices: MOSFETs, construction and working of U.J.T. and SCR and their application in wave generation and power control, Multivibrators (astable, monostable and bistable)

Lectures 15

SECTION-B

Electronic Circuits: Differential amplifier, Operational amplifier (OP-AMP), OP-AMP as inverting and non-inverting, scalar, summer, integrator, differentiator. Schmitt trigger and logarithmic amplifier, Electronic analog computation circuits.

Lectures 15

SECTION-C

Digital Principles: Binary and Hexadecimal number system, Binary arithmetic, Logic gates, Boolean equation of logic circuits, Karnaugh map simplifications for digital circuit analysis, and design, Encoders & Decoders, Multiplexers and Demultiplexers, Parity generators and checkers, Adder-Subractor circuits.

Lectures 15

SECTION-D

Sequential Circuits: Flip Flops, Registers, Up/Down counters, D/A conversion using binary weighted resistor network, Ladder, D/A converter, A/D converter using counter, Successive approximation A/D converter.

Lectures 15

Books Suggested:
1. Electronic Devices and Circuits, Millman and Halkias-Tata McGraw Hill, 1983.
2. Digital Principles and Applications, A.P. Malvino and D.P. Leach-Tata Mc Graw Hill, New Delhi, 1986.
3. Digital Computer Electronics, A P Malvino-Tata McGraw Hill, New Delhi, 1986
4. Electronic Devices and Circuit Theory 10e, Robert L. Boylestad; Louis Nashelsky 2009

SEMESTER - VII
PHYSICS
MATHEMATICAL PHYSICS
(THEORY)

Time : 3 Hrs. **L-T-P**
Credits : 4-0-0
Marks : 100
(4 Hrs./week)
Course Hrs: 60

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Fourier Transformation: Fourier decomposition, Fourier series and convolution theorem. Fourier transformations and its applications to wave theory.

Coordinate Systems: Curvilinear coordinates, differential vector operators in curvilinear coordinates. Spherical and cylindrical coordinate systems. General coordinate transformation, **Tensors:** covariant, contravariant and mixed, Algebraic operations on tensors, Illustrative applications. **Lectures 15**

SECTION-B

Differential Equations: Second order differential equations. Frobenius method. Wronskian and a second solution, the Sturm Lioville problem. One dimensional Greens function.

Special functions: Gamma function. The exponential integral and related functions. Bessel functions of the first and second kind. Legendre polynomials, associated Legendre polynomials and spherical harmonics. Generating functions for Bessel, Legendre and associated Legendre polynomials. **Lectures 15**

SECTION-C

Complex Analysis: The Cauchy-Reimann conditions, Cauchy integral theorem, Cauchy integral formula. Taylor, and Lorent series, singularities and residues. Cauchy residue theorem. Calculation of real integrals.

Lectures 15

SECTION-D

Group Theory: Definition of a group, multiplication table, conjugate elements and classes of groups, direct product. Isomorphism, homomorphism, permutation group. Definitions of the three dimensional rotation group and SU(2).

Lectures 15

Suggested Books:

1. Mathematical Methods for Physicists: George Arfken-New York Academic Press, 1970.
2. Advanced Mathematical Methods for Engg. and Science Students: George Stephenson and P.M. Radmore-Cambridge University Press, 1990.
3. Applied Mathematics for Engineers & Physicists: L. A. Pipes and L. R. Harvil
4. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons

SEMESTER VII
PHYSICS
CLASSICAL MECHANICS
(THEORY)

Time : 3 Hrs. **L-T-P**
Credits : 4-0-0
Marks : 100
(4 Hrs./week)
Course Hrs: 60

Instructions for the Paper Setters:
Eight questions of equal marks (specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Lagrangian Mechanics: Newton's laws of motion, mechanics of a system of particles, constraints, D'Alembert's principle and Lagrange equations of motion. Velocity-dependent potentials and dissipation function. Some applications of Lagrangian formulation, Hamilton's principle, derivation of Lagrange equations from Hamilton's principle. Conservation theorems and symmetry properties.

Lectures 15

SECTION-B

Central Force Problem: Two body central force problem, reduction to equivalent one-body problem, equation of motion and first integrals, the equivalent one dimensional problem, and classification of orbits. The differential equation for the orbit and integrable power-law potential. The Kepler problem. Scattering in a central force.

Lectures 15

SECTION-C

Rigid Body Dynamics: The independent coordinates of a rigid body, orthogonal transformation, the Euler's angles. Eulers 's theorem on the motion of rigid body, finite and infinitesimal rotations, rate of change of a vector, angular momentum and kinetic energy about a point for a rigid body, the inertia tensor and moment of inertia, the eigen values of the inertia tensor and the principal axis transformation. Euler's equations of motion, torque free motion of a rigid body.

Lectures 15

SECTION-D

Canonical Transformations: Legendre transformation and Hamilton equations of motion, cyclic coordinates and conservation theorems, derivation of Hamiltons equations from a variational principle, the principle of least action. The equations of canonical transformation, examples of canonical transformations, Poisson brackets, equations of motion, infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation

Lectures 15

Suggested Books:

1. Classical Mechanics: Herbert Goldstein-Narosa Pub. House, New Delhi, 1970.
2. Mechanics : L.D. Landau-Pergamon Press, Oxford, 1982.
3. Classical Mechanics Rana and Joag-Tata McGraw Hill, New Delhi, 1995.

SEMESTER–VII
PHYSICS
COMPUTATIONAL TECHNIQUES
(THEORY)

Time : 3 Hrs. **L-T-P**
Credits : 4-0-0
Marks : 100
(4 Hrs./week)
Course Hrs: 60

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Introduction of MATLAB
Introduction: Basics of MATLAB, working with arrays, creating and printing plots, Interacting Computations: Matrices and Vectors, Matrices and Array Operations, built in functions, saving and loading data, plotting simple graphs Programming in MATLAB: Script files, function files, Compiled files, p-code, variables, loops, branches, and control flow, Input/Output, Advanced data objects, structures, cells.

Lectures 15

SECTION-B

Interpolation
Interpolation, Newton's formula for forward and backward interpolation, Divided differences, Symmetry of divided differences, Newton's general interpolation formula, Lagranges interpolation formula.

Lectures 15

SECTION-C

Numerical Differentiation and integration
Numerical integration, A general quadrature formula for equidistant ordinates, Simpson, Weddle and Trapezoidal rules, Monte- Carlo Method, Euler's method, Modified Euler's method, Runge-Kutta Method. **Lectures 15**

SECTION-D

Roots of Equation
Approximate values of roots, Bisection Method, Regula-Falsi Method, Newton-Raphson method, Bairstow method. Simultaneous Linear Algebraic Equations: Solution of Simultaneous Linear equations, Gauss elimination method, Gauss-Jordon method, Matrix inversion.

Lectures 15

Suggested Books:
1. Getting started with MATLAB- Rudra Pratap-Oxford University Press-2005.
2. A concise introduction to MATLAB- William J Palm III- McGraw Hill-2008.
3. James Scarborough- Numerical Mathematical Analysis (Oxford and IBH), 1966.
4. S.D. Conte- Elementary Numerical Analysis (McGraw Hill), 1965.
5. John. H. Mathews, Numerical Methods for Mathematics, Science and Engineering (Prentice Hall of India).

SEMESTER–VII

PHYSICS

ELECTRONICS LAB

(PRACTICAL)

Time : 2 Hrs. **L-T-P**
Credits : 0- 0-2
Max. Marks: 50
(4 Hrs./week)

1. Study of Op-Amps and their applications such as an amplifier (inverting, non-inverting), scalar, summer, differentiator and integrator.
2. Study of encoder, decoder circuit.
3. Study of arithmetic logic unit (ALU) circuit.
4. Study of shift registers.
5. Study of half and full adder circuits.
6. Study of A/D and D/A circuits.
7. Design and build analog circuits of DIAC on a breadboard and investigate their DC characteristics.
8. Design and build analog circuits of SCR on a breadboard and investigate their DC characteristics.
9. Design and build analog circuits of TRIAC on a breadboard and investigate their DC characteristics.
10. Design and build analog circuits of UJT on a breadboard and investigate their DC characteristics.
11. Design and build analog circuits of MOSFET on a breadboard and investigate their DC characteristics.
12. Design and build analog circuits of bi-stable, mono-stable and astable, multivibrators on a breadboard and investigate their characteristics.
13. Design and build logic gates using discrete elements and universal gates on a breadboard and investigate their characteristics.
14. Dismantling and assembly of above electronic apparatus (both working and non-working) to study their internal structure and identify faults.

SEMESTER–VII

PHYSICS

COMPUTER LAB

(PRACTICAL)

Time : 2 Hrs. | | |
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L-T-P
Credits: 0- 0-2
Max. Marks: 50
(4 Hrs./week)

Perform the following problems using any of one softwares : Fortran/Matlab/Python

1. Determination of Roots

a) Bisection Method

b) Newton Raphson Method

c) Secant Method

2. Integration

a) Trapezoidal rule

b) Simpson 1/3 and Simpson 3/8 rules

c) Gaussian Quadrature

3. Differential Equations

a) Euler's Method

b) Runge Kutta Method

4. Interpolation

a) Forward interpolation, Backward interpolation.

b) Lagrange's interpolation.

5. Applications

a) Chaotic Dynamics, logistic map

b) One dimensional Schrondinger Equation

c) Time period calculation for a potential

d) Luminous intensity of a perfectly black body vs. temperature

SEMESTER-VII

PHYSICS

(MINOR COURSE)

WAVES & VIBRATION

(THEORY)

Time: 3 hrs.

L-T-P
Credits : 3 -0 -0
M. Marks: 75
(3 hrs./week)
Course Hrs. : 45

Instructions for the Paper Setters:

Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION–A

Simple harmonic motion, Energy of a Simple harmonic oscillator, Compound pendulum, Torsional pendulum, Electrical Oscillations, Transverse vibrations of a mass on string, Superposition of two perpendicular SHMs having periods in the ratio 1:1 and 1:2.

10 Lectures

SECTION–B

Decay of free vibrations due to damping, Differential equation of damped Harmonic motion, Types of motion, Types of damping, Determination of damping co–efficient–Logarithmic decrement, Relaxation time and Q–Factor, Electromagnetic damping (Electrical oscillator, Eddy currents)

10 Lectures

SECTION–C

Differential equation for forced mechanical and electrical oscillators, Transient and steady state behaviour, Displacement and velocity variation with driving force frequency, Variation of phase with frequency, Resonance, Power supplied to an oscillator and its variation with frequency, Q–value and band width, Q–value as an amplification factor, Stiffness coupled oscillators, Normal co–ordinates and normal modes of vibration, Inductive coupling of electrical oscillators.

10 Lectures

SECTION–D

Types of waves, Wave equation (transverse) and its solution, Characteristic impedance of a string, Impedance matching, Reflection and Transmission of waves at a boundary, Reflection and transmission of energy, Reflected and transmitted energy coefficients, Doppler effect in sound, Sound waves in gases.

15 Lectures

Books Suggested:

1. Physics of Vibrations and Waves, H.J. Pain.
2. Fundamentals of Vibrations and Waves, S.P. Puri
3. EM waves and Radiating Systems by Edward C.Jordan and K.G Balmain.
4. Fields and Waves Electromagnetic by David.K.Cheng

SEMESTER - VIII

PHYSICS

QUANTUM MECHANICS - I

(THEORY)

Time : 3 Hrs. **L-T-P**
Credits : 4-0-0
Marks : 100
(4 Hrs./week)
Course Hrs: 60

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Basic Formulation and quantum Kinematics: Stern Gerlach experiment as a tool to introduce quantum ideas. Analogy of two level quantum system with polarisation states of light. Complex linear vector spaces, ket space, bra space and inner product, operators and properties of operators. Eigenkets of an observable, eigenkets as base kets, matrix representations. Measurement of observable, compatible vs. incompatible observable, commutators and uncertainty relations. Change of basis and unitary transformations. Diagonalisation of operators. Position, momentum and translation, momentum as a generator of translations, canonical commutation relations.

Lectures 15

SECTION-B

Quantum Dynamics: Wave functions as position representation of ket vectors. Momentum operator in position representation, momentum space wave function. Time evolution operator and Schrodinger equation, special role of the Hamiltonian operator, energy eigenkets, time dependence of expectation values, spin precession. Schrodinger vs. Heisenberg picture, unitary operators, state kets and observable in Schrodinger and Heisenberg pictures, Heisenberg equations of motion, Ehrenfest's theorem. **Lectures 15**

SECTION-C

One Dimensional Systems: Potential Step, potential barrier, potential well. Scattering vs. Bounds states. Simple harmonic oscillator, energy eigen states, wave functions and coherent states. **Lectures 15**

SECTION-D

Spherical Symmetric Systems and Angular momentum: Schrodinger equation for a spherically symmetric potential. Orbital angular momentum commutation relations. Eigenvalue problem for L^2, spherical harmonics. Three dimensional harmonic oscillator, three dimensional potential well and the hydrogen atom. Angular momentum algebra, commutation relations. Introduction to the concept of representation of the commutation relations in different dimensions. Eigen vectors and eigen functions of J^2 and J_z. Addition of angular momentum and Clebsch Gordan (C.G.) coefficients.

Lectures 15

Suggested Books:

1. Modern Quantum Mechnics: J.J. Sakurai-Pearson Education Pvt. Ltd., New Delhi, 2002.
2. Quantum Mechanics :L I Schiff-Tokyo McGraw Hill, 1968.
3. Feynmann lectures in Physics Vol. III-Addison Wesly, 1975.
4. Quantum Mechanics :Powel and Craseman-Narosa Pub. New Delhi, 1961.
5. Quantum Mechanics : E. Merzbacher-John Wiley & Sons, New York, 1970.
6. Quantum Mechanics and Applications, A. K. Ghatak and S. Lokanathan, McMillan India

SEMESTER-VIII
PHYSICS
ELECTRODYNAMICS-I
(THEORY)

Time : 3 Hrs. **L-T-P**
Credits : 4-0-0
Marks : 100
(4 Hrs./week)
Course Hrs: 60

Instructions for the Paper Setters:

Eight questions of equal marks (specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Electrostatics: Coulomb's law, Guass's law, Poisson's equation, Laplace equation. Solution of boundary value problem: Green's function, method of images and calculation of Green's function for the image charge problem in the case of a sphere, Laplace equation, uniqueness theorem. Electrostatics of dielectric media, multipole expansion. Boundary value problems in dielectrics; molecular polarisability, electrostatic energy in dielectric media.

Lectures 15

SECTION-B

Magnetostatics: Biot and Savart's law. The differential equation of Magnetostatics and Ampere's law, vector potential and magnetic fields of a localised current distribution. Magnetic moment, force and torque on a magnetic dipole in an external field. Magnetic materials, Magnetisation and microscopic equations.

Lectures 15

SECTION-C

Time-varying fields: Time varying fields, Maxwell's equations, conservation laws: Faraday's law of induction, Energy in a magnetic field. Maxwell's displacement current, vector and scalar potential, Gauge transformations; Lorentz gauge and Coulomb gauge. Poynting theorem, conservation laws for a system of charged particles and electromagnetic field, continuity equation.

Lectures 15

SECTION-D

Electromagnetic Waves: Plane wave like solutions of the Maxwell equations. Polarisation, linear and circular polarisation. Superposition of waves in one dimension. Group velocity. Illustration of propagation of a pulse in dispersive medium. Reflection and refraction of electromagnetic waves at a plane surface between dielectrics. Polarisation by reflection and total internal reflection. Waves in conductive medium, Simple model for conductivity.

Lectures 15

Books Suggested:

1. Classical Electrodynamics - J.D. Jackson-John & Wiley Sons Pvt. Ltd. New York, 2004.
2. Introduction to Electrodynamics - D.J. Griffiths-Pearson Education Ltd., New Delhi, 1991.
3. Classical Electromagnetic Radiation - J.B. Marion-Academic Press, New Delhi, 1995.

SEMESTER - VIII
PHYSICS
ATOMIC AND MOLECULAR SPECTROSCOPY
(THEORY)

Time : 3 Hrs. **L-T-P**
Credits : 4-0-0
Marks : 100
(4 Hrs./week)
Course Hrs.: 60

Instructions for the Paper Setters:

Eight questions of equal marks (specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Spectra of one and two valance electron systems: Magnetic dipole moments; Larmor's theorem; Space quantization of orbital, spin and total angular momenta; Vector model for one and two valance electron atoms; Spin-orbit interaction and fine structure of hydrogen, Lamb shift, Spectroscopic terminology; Spectroscopic notations for L-S and J-J couplings; Spectra of alkali and alkaline earth metals; Interaction energy in L-S and J-J coupling for two electron systems; Selection and Intensity rules for doublets and triplets

Lectures 15

SECTION-B

Breadth of spectral line and effects of external fields: The Doppler effect; Natural breadth from classical theory; natural breadth and quantum mechanics; External effects like collision damping, asymmetry and pressure shift and stark broadening; The Zeeman Effect for two electron systems; Intensity rules for the Zeeman effect; The calculations of Zeeman patterns; Paschen-Back effect; LS coupling and Paschen –Back effect; Lande's factor in LS coupling; Stark effect

Lectures 15

SECTION-C

Microwave and Infra-Red Spectroscopy: Types of molecules, Rotational spectra of diatomic molecules as a rigid and non-rigid rotator, Intensity of rotational lines, Effect of isotopic substitution, Microwave spectrum of polyatomic molecules, The vibrating diatomic molecule as a simple harmonic and anharmonic oscillator, Diatomic vibrating rotator, The vibration-rotation spectrum of carbon monoxide, The interaction of rotation and vibrations, Outline of technique and instrumentation, Fourier transform spectroscopy.

Lectures 15

SECTION-D

Raman and Electronic Spectroscopy: Quantum and classical theories of Raman Effect, Pure rotational Raman spectra for linear and polyatomic molecules, Vibrational Raman spectra, Structure determination from Raman and infra-red spectroscopy, Electronic structure of diatomic molecule, Electronic spectra of diatomic molecules, Born Oppenheimer approximation- The Franck-Condon principle, Dissociation and pre-dissociation energy, The Fortrat diagram, example of spectrum of molecular hydrogen. **Lectures 15**

Books Suggested:

1. Introduction to Atomic Spectra: H.E. White, McGraw Hill
2. Fundamentals of Molecular spectroscopy: C.B. Banwell-Tata McGraw Hill, 1986.
3. Spectroscopy Vol. I, II & III: Walker & Straughen
4. Introduction to Molecular Spectroscopy: G.M. Barrow-Tokyo McGraw Hill, 1962.
5. Spectra of Diatomic Molecules: G. Herzberg-New York, 1944.
6. Molecular Spectroscopy: Jeanne L McHale, Prentice Hall, 1999.
7. Molecular Spectroscopy: J.M.Brown, Oxford University Press, 1998.
8. Spectra of Atoms and Molecules: P.F. Bermath-New York, Oxford University Press, 1995.
9. Modern Spectroscopy: J.M. Holias

SEMESTER - VIII
PHYSICS
CONDENSED MATTER PHYSICS-I
(THEORY)

Time : 3 Hrs. **L-T-P**
Credits : 4-0-0
Marks :100
(4 Hrs./week)
Course Hrs.: 60

Instructions for the Paper Setters:
Eight questions of equal marks (specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Lattice vibrations, Specific Heat and Elastic Constants:
Lattice vibrations, Concepts of phonons, Scattering of photons by phonons, Vibration and mono-atomic, linear chains, Lattice specific heat of solids, Einstein model of the lattice Specific heat, Density of modes of vibration, Debye model of Lattice specific heat, Born cut-off procedure, Specific heat of metals. Elastic strain and stress components, Elastic compliance and stiffness constants, Elastic constants of cubic crystals, Elastic waves in cubic crystals.

Lectures 15

SECTION-B

Defects and Diffusion in Solids:
Point defects: Impurities, Vacancies-Schottky and Frankel vacancies, Diffusion, Fick’s law, Self diffusion in metals, Color centers and coloration of crystals, F-centres, V-centres, Line defects, Edge and screw dislocations, Burgers vectors, Stress field of dislocations, Grain boundaries, Low angle grain boundaries, dislocation densities, Dislocation multiplication and slips, dislocation and crystal growth.

Lectures 15

SECTION-C

Band Theory & Electrical Conductivity of Solids:
Band Theory: Kronig-Penney model, Effective Mass, Distinction between metals, insulators and semiconductos, Electrical conductivity of metals, Drift velocity and relaxation time, The Boltzmann transport equation, The Sommerfield theory of conductivity, Mean free path in metals, Qualitative discussion of the features of the resistivity, Mathiessen's rule. Thermal conductivity of metals, Wiedemann-Franz law.

Lectures 15

SECTION-D

Dielectrics and Ferro Electrics:
Macroscopic field, The local field, Lorentz field, The Clausius-Mossotti relations, Different contribution to polarization: dipolar, electronic and ionic polarizabilities, Ferroelectric crystals: Classifications and their general properties, Structure and properties of $BaTiO_3$, The dipole theory of ferroelectricity, objection against dipole theory, Thermodynamics of ferroelectric transitions.

Lectures 15

Books Suggested:

1. Solid State Physics: A.J. Dekker-Prentice Hall, 1965.
2. An Introduction to Solid State Physics: C. Kittle-Wiley, 1997
3. Elementary Solid State Physics-Omar, Addison Welly, 1975.
4. Principles of Solid State Physics: R.A. Levey-Academic Press, 1968
5. Introduction of Solid State Physics: N. Ashroft and D. Mermin

SEMESTER - VIII
PHYSICS
CONDENSED MATTER PHYSICS LAB
(PRACTICAL)

Time : 2 Hrs. **L-T-P**
Credits : 0-0-2
Marks : 50
(4 Hrs./week)

1. To determine Hall coefficient by Hall Effect.
2. To determine the band gap of a semiconductor using p-n junction diode..
3. To determine the magnetic susceptibility of a material using Quink's method.
4. To determine the g-factor using ESR spectrometer.
5. To determine the energy gap and resistivity of the semiconductor using four probe method.
6. To trace hysteresis loop and calculate retentivity, coerc ivity and saturation magnetization.
7. To determine dielectric constant.
8. To study the series and parallel characteristics of a photovoltaic cell.
9. To study the spectral characteristics of a photovoltaic cell.

SEMESTER - VIII

PHYSICS

SPECTROSCOPY LAB

(PRACTICAL)

Time : 2 Hrs.

L-T-P
Credits : 0-0-2
Marks : 50
(4 Hrs./week)

1. To find the wavelength of monochromatic light using Febry Perot interferometer.
2. To find the wavelength of sodium light using Michelson interferometer.
3. To calibrate the constant deviation spectrometer with white light and to find the wavelength of unknown monochromatic light.
4. To find the grating element of the given grating using He-Ne laser light.
5. To find the wavelength of He-Ne laser using Vernier calipers.
6. To verify the existance of Bohr's energy levels with Frank-Hertz experiment.
7. To determine the charge to mass ratio (e/m) of an electron with normal Zeeman Effect
8. To determine the velocity of ultrasonic waves in a liquid using ultrasonic interferometer

SEMESTER-VIII
PHYSICS
(MINOR COURSE)
FABRICATION OF ELECTRONIC DEVICES
(THEORY)

Time: 3 Hrs. **L-T-P**
Credits : 3 -0 -0
Max. Marks : 75
Course Hrs. :45

Instructions for the Paper Setters:
Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Crystal growth: Czochralski and Bridgman techniques, Float Zone growth, Distribution coefficients, Zone refining, Wafer preparation and specifications. Epitaxy: Importance of lattice matching in epitaxy, CVD of Si, Thermodynamics of vapour phase growth, defects in epitaxial growth, MBE technology.

Lectures 10

SECTION-B

Diffusion: Fick's diffusion equation in one dimension, Atomistic models of diffusion, analytic solution of Fick's law for different cases. Diffusivities of common dopants in Si and SiO_2. Diffusion enhancements and retardation, Thermal Oxidation: Deal-Grove model of oxidation. Effects of dopants during oxidation, oxidation induced defects, Ion Implantation: channeling and projected range of ions, implantation damage, Rapid Thermal Annealing (RTA).

Lectures 15

SECTION-C

Metallization applications: Gates and interconnections, Metallization choices, metals, alloys and silicides, deposition techniques, metallization problems, step coverage, electro migration, Etching: Dry and wet chemical etching, Reactive Plasma Etching, Ion enhanced etching and ion induced etching.

Lectures 10

SECTION-D

Optical lithography: photoresists, Contact and proximity printers, projection printers, Mask alignment, X-ray and electron beam lithography, Fundamental considerations for IC processing: Building individual layers, Junction and Trench isolation of devices.

Lectures 10

Books Suggested:

1. The Science and Engineering of Microelectronics Fabrication - SA Campbell - Oxford University Press–1996
2. VLSI Technology - SM Sze - - McGraw Hill International Editions –1988