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: 2024–28

GURU NANAK DEV UNIVERSITY AMRITSAR

(ii) Syllabi are subject to change at the discretion of the authority.
Please visit the University website from time to time.

Bachelor of Arts /Bachelor of Science/Honours Physics (CBGS)
(Under NEP 2020) *(Batch 2024-28) (Semester I-VIII)*
(Faculty of Sciences)

COURSE SCHEME

PHYSICS

FIRST SEMESTER		
Course Code	**Course Title**	**Credits L-T-P**
	Major Core Course	
	Electricity and Magnetism (Theory)	4-0-0
	Electricity & Magnetism Lab (Practical)	0-0-1

SECOND SEMESTER		
Course Code	**Course Title**	**Credits L-T-P**
	Major Core Course	
	Mechanics, Vibrations & Waves (Theory)	4-0-0
	Mechanics Lab (Practical)	0-0-1

THIRD SEMESTER		
Course Code	**Course Title**	**Credits L-T-P**
	Major Core Course	
	Statistical Physics & Thermodynamics (Theory)	4-0-0
	Optics Lab (Practical)	0-0-1

FOURTH SEMESTER		
Course Code	**Course Title**	**Credits L-T-P**
	Major Core Course	
	Quantum Physics (Theory)	4-0-0
	Thermal & Modern Physics Lab (Practical)	0-0-1

FIFTH SEMESTER		
Course Code	**Course Title**	**Credits L-T-P**
	Major Core Course	
	Solid State Physics & Electronics (Theory)	4-0-0
	Electronics Lab (Practical)	0-0-1
Summer Internship		
	Summer Internship (02 Weeks)	0-0-2
SIXTH SEMESTER		
Course Code	**Course Title**	**Credits L-T-P**
	Major Core Course	
	Nuclear Physics (Theory)	4-0-0
	Nuclear Physics & Materials Lab (Practical)	0-0-1

SEVENTH SEMESTER		
Course Code	**Course Title**	**Credits L-T-P**
	Major Core Course	
	Analog & Digital Electronics (Theory)	3-0-0
	Mathematical Physics (Theory)	3-0-0
	Classical Mechanics (Theory)	3-0-0
	Computational Techniques(Theory)	3-0-0
	Electronics Lab (Practical)	0-0-2
	Computer Lab (Practical)	0-0-2
Minor Course		
	Synthesis and Characterization of Materials (Theory)	4-0-0

EIGHTH SEMESTER		
Course Code	**Course Title**	**Credits L-T-P**
	Major Core Course	
	Quantum Mechanics-I (Theory)	3-0-0
	Electrodynamics-I (Theory)	3-0-0
	Atomic and Molecular Spectroscopy (Theory)	3-0-0
	Condensed Matter Physics-I (Theory)	3-0-0
	Condensed Matter Physics Lab (Practical)	0-0-2
	Spectroscopy Lab (Practical)	0-0-2

Minor Course		
	Fabrication of Electronic Devices (Theory)	4-0-0

*** Note : Students Opting for Physics subject in Bachelor of Arts/Bachelor of Science/Honours may choose any one of the following Skill Enhancement Course (SEC) in his/her degree Programme during Ist, IInd and IIIrd Year.**

SEC 1 : APPLIED OPTICS (THEORY)
SEC 2 :
SEC 3 : NANOSTRUCTURES, NANODEVICES & SPINTRONICS (THEORY)

Bachelor of Arts /Bachelor of Science/Honours Physics (CBGS)
(Under NEP 2020) *(Batch 2024-28) (Semester I-VIII)*
(Faculty of Sciences)

SEMESTER–I
PHYSICS
ELECTRICITY AND MAGNETISM
(THEORY)

Time: 3 Hrs. **Marks: 100**
Credit: 4
(4Hrs./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.

Bachelor of Arts /Bachelor of Science/Honours Physics (CBGS)
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SEMESTER–I

PHYSICS

ELECTRICITY AND MAGNETISM LAB

(PRACTICAL)

Time: 2 Hrs. | **Credit: 1**
(2 Hrs./week)
Marks: 25

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 experimentshould 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.

Bachelor of Arts /Bachelor of Science/Honours Physics (CBGS)
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SEMESTER–II
PHYSICS
MECHANICS, VIBRATIONS & WAVES
(THEORY)

Time: 3 Hrs. **Marks: 100**
Credit: 4
(4Hrs./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

Cartesian and spherical polar co–ordinate systems, area, volume, velocity and acceleration in these systems. Solid angle, relationship of conservation laws and symmetries of space and time.
Various forces in nature (Brief introduction)centre of mass, equivalent one-body problem, central forces, equation of motion under central force, equation of orbit and turning points. Kepler's Laws. Inertial frame of reference. Galilean transformation and invariance. Non-inertial frames, Coriolis force and its applications. Variation of acceleration due to gravity with latitude. Foucault pendulum, elastic collision in Lab and C.M. system, Rigid body motion; rotational motion, principal moments and axes, moments of Inertia, Euler's equations, precession and elementary gyroscope.

Lectures 15

SECTION-B

Newtonian relativity and Galilean transformations, attempts to locate the absolute frame of reference; Fizeau's experiment; Michelson-Morley experiment & ether drag hypothesis; Lorentz-Fitzgerald contraction; Einstein's basic postulates of relativity and geometric derivation of Lorentz transformations; length contraction; relativity of simultaneity; synchronization and time dilation; Einstein's velocity addition rule; transformation of acceleration; Aberration (relativistic) of star light and relativistic Doppler effect; variation of mass with velocity; mass-energy equivalence; relativistic formulae for momentum and energy; transformation of momentum, energy and force.

Lectures 15

SECTION-C

Simply harmonic motion, energy of an SHO. 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, Decay of free Vibrations due to damping. Differential equation of damped harmonic motion, types of motion, types of damping. Determination of damping coefficient logarithmic decrement, relaxation time and Q–Factor.

Lectures 15

SECTION-D

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. Coupled oscillators, Normal co–ordinates and normal modes of vibration. Inductive coupling of electrical oscillators.Types of waves, wave equation (transverse) and its solution, characteristic impedance of a string. Impedance matching. Reflection and transmission of waves at boundary. Reflection and transmission of energy. Reflected and transmitted energy coefficients. Standing waves on a string of fixed length. Energy of vibrating string. Wave and group velocity.

Lectures 15

Books Suggested:-

1. 1. Mechanics, Berkeley Vol.–I, C. Kittle.
2. Mechanics, H.S. Hans &S.P. Puri
3. Introduction to Relativity, Robert Resnick
4. Fundamentals of Vibrations and Waves: S.P. Puri.
5. Physics of Vibrations and Waves: H.J. Pain

SEMESTER–II

PHYSICS

MECHANICS LAB

(PRACTICAL)

Time: 2 Hrs. **Marks: 25**
Credit: 1
(2Hrs./week)

General Guidelines for Practical Examination:

I. The distribution of marks is as follows:

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

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.

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SEMESTER–III

PHYSICS

STATISTICAL PHYSICS & THERMODYNAMICS

(THEORY)

Time : 3 Hrs. **Marks: 100**
Credit: 4
(4Hrs./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)

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SEMESTER–III

PHYSICS

OPTICS LAB

(PRACTICAL)

Time : 2 Hrs. **Marks: 25**
Credit: 1
(2Hrs./week)

General Guidelines for Practical Examination:

I. The distribution of marks is as follows :

i)	One experiment	**10Marks**
ii)	Brief Theory	**5 Marks**
iii)	Viva–Voce	**5Marks**
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

(THEORY)

Time : 3 Hrs. **Marks: 100**
Credit: 4
(4Hrs./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.

Lectures 15

SECTION-B

Expectation value, probability current and conservation of probability. Admissibility conditions or wave function. Ehrenfest theorem, eigenfunction and eigenvalue. Operator formalism, orthogonal system, expansion in eigen functions, Hermitian operator, simultaneous eigen function, equation of motion.

Lectures 15

SECTION-C

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-D

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, Schrsodinger wave equation for spherically symmetric potential for hydrogen atom, wave function of H atom, solution of $R(r), \Theta(¯), \Phi(¤)$ equations.

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.

SEMESTER–IV

PHYSICS

THERMAL & MODERN PHYSICS LAB

(PRACTICAL)

Time : 2 Hrs. **Marks: 25**
Credit: 1
(2Hrs./week)

General Guidelines for Practical Examination:

I The distribution of marks is as follows:

One experiment	**10Marks**
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.

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SEMESTER–V

PHYSICS

SOLID STATE PHYSICS& ELECTRONICS

(THEORY)

Time : 3 Hrs. **Marks: 100**

Credit: 4

(4Hrs./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, 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, structure factor and atomic form factor.

Lectures 15

SECTION–B

Lattice vibrations, concepts of phonons, scattering of photons by phonons, vibration and mono-atomic, linear chains, density of modes, Einstein and Debye models of specific heat. Free electron model of metals, Free electron, Fermi gas and Fermi energy, band Theory: Kronig-Penney model, metals and insulators, qualitative discussion of the following: conductivity and its variation with temperature in semiconductors, Fermi levels in intrinsic and extrinsic semiconductors, band gap in semiconductors.

Lectures 15

SECTION-C

Concepts of current and voltage sources, p-n junction, 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). Basic concepts of Boolean algebra, AND OR NOT and NAND Gates.Junction transistor : structure and working relation between different currents in transistors, sign conventions, amplifying action, different configurations of a transistor and their comparison, CB and CE characteristics, structure and characteristics of JEFT, transistor biasing and stabilization of operating point.

Lectures 15

SECTION-D

Working of CE amplifier, amplifier analysis using h-parameters, equivalent circuits, determination of current gain, power gain, input impedance, FET amplifier and its voltage gain, feedback in amplifiers, different types, voltage gain, advantage of negative feedback, emitter follower as negative feedback circuit. Barkausen criterion of sustained oscillations, LC oscillator (tuned collector, tuned base Hartley), RC oscillators, phase shift and Wein bridge.

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. **Marks: 25**
Credit: 1
(2Hrs./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)

Credit: 2

- Students will undergo training / Internship for a period of 2 weeks in academic institutes/ industries.

SEMESTER–VI
PHYSICS
NUCLEAR PHYSICS
(THEORY)

Time : 3 Hrs. **Marks: 100**
Credit: 4
(4Hrs./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 quadruple 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, constituents of Cosmic rays, Alpha decay: Gamow's theory of alpha decay, barrier penetration as applied to alpha decay, Geiger Nuttal law, Beta decays: $\beta^{-,}$ 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

Nuclear Reactions: Types of nuclear reactions, reactions cross section, conservation laws, Kinematics of nuclear reaction, examples of nuclear reactions, Q-value and its physical significance, compound nucleus, level width.

Lectures 15

SECTION-D

Nuclear Models: Liquid drop model, semi-empirical mass formula, condition of stability, evidence for nuclear magic numbers, Shell Model, energy level scheme, angular momenta of nuclear ground states, parity and magnetic moment of nuclear ground states.

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. Nuclei and Particles: E. Segre
5. Atomic Nucleus, R. D. Evans

SEMESTER–VI

PHYSICS

NUCLEAR PHYSICS & MATERIALS LAB

(PRACTICAL)

Time : 2 Hrs. **Marks: 25**
Credit: 1
(2Hrs./week)

General Guidelines for Practical Examination:

I. The distribution of marks is as follows :
   i) One experiment **10Marks**
   ii) Brief Theory **5 Marks**
   iii) Viva–Voce **5 Marks**
   iv) Record (Practical file) **5Marks**

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. **Marks: 75**
Credit: 3
(3Hrs./week)
Course Hrs: 45

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

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 10

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 10

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 10

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. **Marks: 75**
Credit: 3
(3Hrs./week)
Course Hrs: 45

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 10**

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 10

SECTION-D

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

Lectures 10

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. **Marks: 75**
Credit: 3
(3Hrs./week)
Course Hrs: 45

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, Hamiltons 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 10

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 10

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 10

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. **Marks: 75**
Credit: 3
(3Hrs./week)
Course Hrs: 45

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 10

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 10**

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 10

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. **Max. Marks: 50**
Credits: 2
(4Hrs./week)

1. To Study the D C characteristics and applications of DIAC.
2. To study the D C characteristics and applications of SCR.
3. To study the D C characteristics and applications of TRIAC.
4. Investigation of the D C characteristics and applications of UJT.
5. Investigation of the D C characteristics of MOSFET.
6. Study of bi-stable, mono-stable and astable, multivibrators.
7. Study of Op-Amps and their applications such as an amplifier (inverting, non-inverting), scalar, summer, differentiator and integrator.
8. Study of logic gates using discrete elements and universal gates.
9. Study of encoder, decoder circuit.
10. Study of arithmetic logic unit (ALU) circuit.
11. Study of shift registers.
12. Study of half and full adder circuits.
13. Study of A/D and D/A circuits.

SEMESTER–VII

PHYSICS

COMPUTER LAB

PRACTICAL

Time : 2 Hrs. **Max. Marks: 50**
Credits: 2
(4Hrs./week)

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

1. Determination of Roots

a) Bisection Method
b) NewtonRaphson 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) RungeKutta 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)

SYNTHESIS AND CHARACTERIZATION OF MATERIALS (THEORY)

Time: 3hrs **M. Marks: 100**
Credit: 4
(4hrs/week)
Course Hrs: 60

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

SECTION-A

Single crystal growth: Czochlralski, Bridgmann and float zone methods, Preparation of bulk polycrystalline materials by solid state reaction, sintering, calcination and annealing. Glass synthesisby melt-quenching, Preparation of nanomaterials by Inert gas condensation, Ball Milling, Thin film deposition by evaporation, sputtering, Molecular beam epitaxy, Chemical vapour deposition method, Electro deposition. **Lectures 15**

SECTION-B

Metal nanocrystals by reduction, Solvothermal synthesis, Nanocrystals of semiconductors and othermaterials by arrested precipitation, Thermolysis routes, Sonochemical routes, Liquid-liquid interface,Hybrid methods, Solvated metal atom dispersion, Post-synthetic size-selective processing. Sol-gel,Micelles and microemulsions, Cluster compounds. **Lectures 15**

SECTION-C

X-ray and neutron diffraction, Atomic Force Microscopy, Scanning Electron Microscopy,Transmission Electron Microcopy,Scanning Tunneling Microscope, Optical transmission and
metallurgical microscope; their description, operational principle and application for analysis of materials, UV-VIS-IR Spectrophotometers, Principle of operation and application for band gap measurements, Raman spectroscopy, Magnetic measurements, electrical conductivity measurementby two probe, four probe and Van-der-Pauw methods.

Lectures 15

SECTION-D

AFM based nanolithography and nanomanipulation, electron beam lithography and SEM based nanolithography and nanomanipulation, Ion beam lithography, oxidation and metallization. Mask andits application. Deep UV lithography, X-ray based lithography. Fabrication of nanostructures.

Lectures 15

Suggested Books:

1. Thin film phenomena, K.L. Chopra-McGraw-HillInc. 1969.
2. Vacuum Technology, A. Roth-Elsevier Science, 2012.
3. Material Science of Thin Films, Milton Ohring, Academic Press, 2001.
4. Thin Films fundamentals: A. Goswami-New age International, 2007.
5. Introduction to Nanotechnology: Charles P. Poole Jr. and Franks J. Qwens –John and Wiley & Sons, 2003.
6. Solid State Physics: J.P. Srivastava-Prentice Hall, 2007.
7. Nanotubes and Nanowires: CNR Rao and A Govindaraj –Royal Society of Chemistry, 2005.
8. The Science and Engineering of Microelectronics Fabrication - SA Campbell-Oxford University Press–1996
9. VLSI Technology - SM Size - - McGraw Hill International Editions –1988

SEMESTER - VIII
PHYSICS
QUANTUM MECHANICS - I
(THEORY)

Time: 3 Hrs. **Max. Marks: 75**
Credits: 3
(3Hrs./week)
Course Hrs: 45

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 Educaton 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. **Max. Marks: 75**
Credits: 3
(3Hrs./week)
Course Hrs: 45

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 10

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 10

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 10

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. **Max. Marks: 75**
Credits: 3
(3Hrs./week)
Course Hrs: 45

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

Lectures15

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

Lectures10

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.

Lectures10

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 10**

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. **Max. Marks: 75**
Credits: 3
(3Hrs./week)
Course Hrs: 45

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 Specific Heat and Elastic Constants:
Different theories of 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 10

SECTION-C

Conductivity of metals and ionic crystals:
Electrical conductivity of metals, Drift velocity and relaxation time, The Boltzmann transport equation, The Sommer field 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. Hydration energy of ions, Activation energy for formation of defects in ionic crystals, Ionic conductivity in pure alkali halides. **Lectures 10**

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 10

Books Suggested:

1. SolidState Physics: A.J. Dekker-Prentice Hall, 1965.
2. An Introduction to SolidState 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. **Max. Marks: 50**
Credits:2
(4Hrs./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, coercivity 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. **Max. Marks: 50**
Credits:2
(4Hrs./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. **M. Marks: 100**
Credit: 4
Course Hrs:60

Instructions for the Paper Setters: Eight questions of equal marks areto be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (notexceeding four). Candidates are required to attempt five questions, selecting at least one questionfrom each Section. The fifth question may be attempted from any Section.

SECTION-A

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

Lectures 15

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 SiO2. 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 andsilicides, deposition techniques, metallization problems, step coverage, electromigration, Etching: Dry and wet chemical etching, Reactive Plasma Etching, Ion enhanced etching and ion induced etching.

Lectures 15

SECTION-D

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

Lectures 15

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