COURSES OF STUDY

FOR

B.Sc. PHYSICS EXAMINATION

I Semester Examination November 2008
II Semester Examination April 2009
III Semester Examination November 2009
IV Semester Examination April 2010
V Semester Examination November 2010
VI Semester Examination April 2011

Syllabus applicable for the students seeking admission to the B.Sc. Physics Course in the academic year 2008-2009
Semester I  
Paper I  
PHY-101  
Mechanics

Credits assigned: 3  
Course duration: 45 hours  
M.M.:100  
(CA –30, SEE-70)

Objectives:  
To acquaint the students with the fundamental laws and principles involved in motion  
and to introduce some properties of matter like elasticity so that they develop abilities and  
skill that are relevant to the study and practice of Physics.

Unit I

Physical Laws and Frames of Reference:  
(10 periods)  
Inertial and non inertial frames, examples, Transformation of displacement, velocity and  
acceleration between different frames of reference involving translation in uniform  
motion, Galilean transformation and invariance of Newton’s laws, Transformation  
equations of displacement velocity and acceleration for rotating frames, Fictitious forces  
(Coriolis force and centrifugal force), effects of Centrifugal and Coriolis forces due to  
earth’s rotation, Focault’s pendulum.

Unit II

Centre of mass:  
(9 periods)  
Centre of mass of a two particle system, motion of centre of mass and reduced mass  
conservation of linear momentum, elastic and inelastic collision of two particles in  
laboratory and center of mass frames, motion of a system with varying mass, Angular  
momentum conservation with examples, charged particle scattering by nucleus.

Unit III

Motion under central forces:  
(8 periods)  
Motion under central forces, gravitational interaction, general solution under gravitational  
interaction, discussion of trajectories, cases of elliptical and circular orbits, Keplers laws.

Unit IV

Special theory of relativity:  
(9 periods)  
Postulates of special theory of relativity, Lorentz transformations, length  
contraction, Time dilation, transformation and addition of velocities, Relativistic  
Doppler’s effect, space- like space time interval, time-like space time interval.
Unit V

**Elastic Properties of Matter:** (9 periods)
Elastic constants: Young’s Modulus, Bulk Modulus, Modulus of Rigidity, Poisson’s ratio. Relations between the elastic constants, torsion of a cylinder.
Bending of beams: Bending moment, Cantilever, Potential energy and oscillation of a loaded cantilever, cantilever loaded at one end (i) when weight of beam is negligible (ii) When weight is considered, Beam supported at both ends and loaded in the middle, Experimental determination of elastic constants (Y, η, σ).

**Books Recommended:**
**Essential Readings:**

**Reference Books:**
Semester I  
Paper II  
PHY-102  
Electromagnetism

Credits assigned: 3  
Course duration: 45 hours  
M.M.: 100  
(CA-30, SEE-70)

Objectives: This course will acquaint the students with the scalar and vector fields, gradient, divergence, curl and their physical significance. Students will also learn about the fields produced by moving charges and magnetic fields in matter, electromagnetic induction, Maxwell’s equations and electromagnetic waves.

Unit I

Scalar and vector fields:  (8 periods)  
Partial derivatives, Gradient of a scalar function. Line integral of a vector field, Divergence and Curl of a vector field, Physical significance of divergence & curl and their expressions in Cartesian coordinates, Gauss divergence theorem, Stokes curl theorem, Laplacian operator, Poisson’s and Laplace’s equation.

Unit II

Dynamics of a charged particle  (9 periods)  
Magnetic forces, Invariance of charge, Electric field measured in different frames of reference, Field of a point charge moving with constant velocity, Interaction between a moving charge and other moving charges.

Unit III

Magnetostatics:  (10 periods)  
Ampere’s law in differential form, Magnetic Vector Potential, Poisson’s equation for vector potential, magnetic field due to a current carrying wire and deduction of Biot-Savart’s law. Electric current due to an orbiting electron, Bohr Magneton, Orbital gyro magnetic ratio, Electron spin and spin magnetic moment, magnetic susceptibility, magnetic field caused by magnetized matter, Magnetization current, Free current its H field.

Unit IV

Electrostatics and dielectrics:  (9 periods)  
Moments of a charge distribution, Atomic and molecular dipoles, Atomic Polarizability, Permanent dipole moment, Dielectrics, capacitor filled with dielectric, the potential and field due to a polarized sphere, dielectric sphere in a uniform electric field, The electric field of charge in dielectric medium and Gauss law, Relation between electric susceptibility and atomic polarizability, Polarization due to changing electric field. The bound charge current.
Unit V

Maxwell’s equations and electromagnetic waves: (9 periods)
Faraday’s laws of electromagnetic induction, its integral and differential form, Maxwell’s displacement current, Maxwell’s equations in differential and integral form, Poynting’s theorem, Wave equation, EM waves in a non-conducting dielectric medium, Plane monochromatic waves in a non-conducting medium, Energy flux in a plane electromagnetic wave, Radiation pressure.

Books Recommended
Essential Readings:

References Books:
1. “Elements of Electromagnetics”, Mathew, N.D. Sadika, New Delhi, Oxford University Press.
NOTE - Students are expected to perform eight experiments in all taking four experiments from each section. One experiment from section A and one from section B will be set in the examination paper.

The duration of the Practical Examination shall be 5 hours.

The distribution of marks in the practical examination will be as follows:

1. Two experiments: 30 marks each.
2. Distribution of marks will be as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure /Formula/Theory</td>
<td>7</td>
</tr>
<tr>
<td>Observations/Calculations</td>
<td>16</td>
</tr>
<tr>
<td>Result / Result Analysis</td>
<td>5</td>
</tr>
<tr>
<td>Precautions</td>
<td>2</td>
</tr>
</tbody>
</table>

3. Viva-Voce : 10

Total : 70 marks
Semester I
Paper III
PHY-103
List of Experiments

Credits assigned: 3                                      Course duration: 60 hours
                                           M.M.:100
                                           (CA –30, SEE-70)

Section – A

1. To study the variation of charge and current with time in a R-C circuit for
different time constants using a DC source (charging and discharging
characteristics of a condenser).

2. To determine the specific resistance of the material of a resistance wire and to
determine the difference between two small resistances using Carey Foster’s
bridge.

3. To study the behavior of voltage and current in a LR circuit with AC power
source. Also to determine power factor, impedance and phase relations.

4. To study the behaviour of RC circuit with varying resistance and capacitance
using AC mains as a power source and also to determine the impedance and phase
relationship between voltage and current in the circuit.

5. To study the electromagnetic induction and to verify Faraday’s Law.

6. To study the characteristics of a junction diode.

Section – B

1. To determine Y, $\eta$ and $\sigma$ by Searl’s method.
2. To determine Young’s modulus by bending of beam.
3. To determine modulus of rigidity of a wire using Maxwell’s needle.
4. To determine the surface tension of given liquid at room temperature using
Jaeger’s method.
5. To convert Galvanometer into an ammeter of given range.
6. To convert Galvanometer into a Voltmeter of given range.
Semester II  
Paper I  
PHY-201  
Oscillation and Waves

Credits assigned: 3  
Course duration: 45 hours  
M.M.: 100  
(CA – 30, SEE-70)

Objectives:  
To familiarize the students with motion of different types of oscillators and also with wave motion in different medium. This will enable the students to develop abilities and skill to solve problems related to waves and oscillations.

Unit I

Simple harmonic and damped oscillator: (9 periods)  
Simple harmonic motion, Differential equation of simple harmonic motion, examples: mass on a spring, Torsional oscillator. LC Circuit, Potential energy curve and small oscillations in one dimensional potential well, Energy of oscillations, mass and two spring system, anharmonic oscillator.  
Damped harmonic oscillator, Mathematical formulation of damped harmonic oscillator, Energy of damped oscillator, Power dissipation, Relaxation time, Quality factor of damped harmonic oscillator, Electromagnetic oscillator: Moving coil galvanometer with small damping.

Unit II

Driven harmonic oscillator: (8 periods)  
Driven harmonic oscillator, Mathematical formulation of driven harmonic oscillator, Frequency response on amplitude and phase, Quality factor of driven oscillator, Resonance, Sharpness of resonance, Power absorption by forced oscillator, Series and parallel LCR circuit.

Unit III

Coupled oscillators: (10 periods)  
Equation of motion of two coupled simple harmonic oscillators, Normal modes, motion in mixed modes, dynamics of a linear chain of coupled oscillators with nearest neighbor interaction, Energy transfer between modes, Electrically coupled circuits (capacitive and inductive), Reflected impedance, effect of coupling and resistive load.
Unit IV

Lattice vibrations and Fourier analysis: (9 periods)
Equation of motion for one dimensional monatomic and diatomic lattice, acoustic and optical modes, dispersion relation, concept of group and phase velocities, Fourier Analysis of square, saw tooth and triangular wave forms.

Unit V

Wave motion: (9 periods)
Wave equation, Transverse waves in a string, Elastic waves in a solid rod, Pressure waves in a gas column, Plane electromagnetic waves, Energy and Momentum of EM waves, Radiation pressure, Radiation resistance of free space.

Books recommended:

Essential Readings:

Reference Books:
Semester II  
Paper II  
PHY-202  
Optics  

Credits assigned: 3  
Course duration: 45 hours  
M.M.:100  
(CA –30, SEE-70)

Objectives:  
This course familiarizes the students with the phenomenon of interference, diffraction, polarization, LASER and holography to enable them to acquire sufficient understanding and knowledge to recognize the usefulness of these phenomena in everyday life and also stimulate their interest in Physics.

Unit I

Geometrical Optics:  
(10 periods)
Fermat’s principle extremum path, Laws of reflection and refraction from Fermat’s principle, Refraction at a spherical surfaces (convex surface and concave surface) cardinal points ,construction of a image using cardinal points, Newton’s formula; Relationship between \( f_1 \) and \( f_2 \);Relationship between \( f_1 \), \( f_2 \), \( \mu_1 \) and \( \mu_2 \), Cardinal points of a coaxial system of two thin lens.

Unit II

Interference:  
(8 periods)
Young’s double slit experiment, types of interference: division of amplitude, division of wave front, Coherence: temporal and spatial coherence, Interference in thin films, colour in thin films, Newton’s rings, Determination of wavelength and refractive index of liquid by Newton’s rings, Michelson interferometer, Applications of Michelson interferometer: determination of wavelength, difference of wavelength and thickness of thin films.

Unit III

Diffraction:  
(9 periods)
Fresnel diffraction: Fresnel’s assumptions, Half period zones, Distinction between interference and diffraction, Difference between Fresnel and Fraunhoffer diffraction, , diffraction at a circular aperture, straight edge and thin slit, zone plate, difference between zone plate and a convex lens. 
Fraunhoffer diffraction: Diffraction at single slit, Intensity distribution in diffraction pattern due to a single slit, Diffraction at double slit, Diffraction at N slits( simple derivation), plane diffraction grating, dispersion by a grating, resolving power of a grating.
Unit IV

Polarization: (9 periods)
Plane electromagnetic waves. E and B of linearly, circularly, elliptically polarized electromagnetic waves.
Polarization by reflection, Huygens theory of double refraction, production and Analysis of plane, circularly and elliptically polarized light, Quarter and half wave plate.
Optical activity, specific rotation, Biquartz and half shade polarimeters.

Unit V

LASER and holography: (9 periods)
Difference between ordinary and LASER source, stimulated and spontaneous emission, Einstein A and B coefficients, Population inversion, Principle of laser action, Metastable states, Pumping, types of LASER, construction, working and energy levels schemes of He-Ne and Ruby laser, Applications of LASER.
Basic concepts of holography, construction of hologram and reconstruction of image, important features of hologram and uses of holography.

Books Recommended:

Essential Readings:

Reference Books:
NOTE - Students are expected to perform eight experiments in all taking four experiments from each section. One experiment from section A and one from section B will be set in the examination paper.

The duration of the Practical Examination shall be 5 hours.

The distribution of marks in the practical examination will be as follows:

1. Two experiments: 30 marks each.
2. Distribution of marks will be as follows:

   Figure /Formula/Theory : 7
   Observations/Calculations : 16
   Result /Result Analysis : 5
   Precautions : 2

3. Viva -Voce : 10

Total : 70 marks
Semester II
Paper III
PHY-203

List of Experiments

Credits assigned: 3          Course duration: 60 hours
                                      M.M.:100
                                      (CA –30, SEE-70)

Section – A

1. To determine wavelength of Sodium light by grating.
2. To determine wavelength of Sodium light by Fresnel’s Biprism.
3. To determine dispersive power of a prism using Mercury light.
4. Using Newton’s rings find out the wavelength of the given monochromatic, source.
5. Using Michelson’s interferometer, find out $\lambda$ and $\Delta\lambda$ for Sodium Light.
6. To determine Brewster’s angle and refractive index of glass by using spectrometer and Polaroids.

Section – B

1. To study damping of a compound pendulum and to determine the quality factor.
2. To study the charging of a condenser by unidirectional varying voltage pulses/alternating voltage pulses and then to integrate them.
4. To study the variation of magnetic field along the axis of a current carrying circular coil. Plot the necessary graph and hence determine the radius of circular coil.
5. To study resonance in a series L C R circuit and determine Q factor of the circuit.
6. To study the variation of reflection coefficient of nature of termination using torsional wave apparatus.
Objectives:
To acquaint the students with basic laws of thermodynamics and statistical physics, methods of producing low temperatures, Carnots engine so that they develop the scientific attitude to relate this knowledge to their daily life experiences.

Unit I

Basic Thermodynamics: (9 periods)
The Zeroth law, Various indicator diagrams(P-V diagram), First law of thermodynamics, Reversible and irreversible processes, Carnot’s engine, Carnot’s cycle and efficiency of Carnot’s engine, reversibility of Carnot’s engine, Carnot’s theorem. Second law of thermodynamics, (different statements and their equivalence) Entropy, Principle of increase of entropy, Thermodynamic scale of temperature, Thermodynamic scale as an absolute scale, Third law of thermodynamics.

Unit II

Thermodynamic Relations: (9 periods)
Maxwell’s thermodynamic relations, Triple point, Clausius Clapyron latent heat equation, Effect of pressure on boiling point of liquids, Helmholtz free energy, Enthalpy, Gibbs function, Internal energy, Thermodynamic potentials, Deduction of Maxwell’s relations from thermodynamic potentials.

Unit III

Production of low temperatures: (8 periods)
Joule Thomson expansion and JT coefficient for ideal as well as Vander Waals gas, Porous plug experiment, Temperature of inversion, Regenerative cooling, cooling by adiabatic expansion and demagnetization, liquid He, He I and He II, Peculiar properties of He II, Nernst heat theorem.

Unit IV

Distribution of molecular velocities: (9 periods)
Distribution law of molecular velocities, Most probable, Average and RMS velocities, energy distribution function, Experimental verification of Maxwell velocity distribution, Principle of equipartition of energy.
Mean free path and collision cross section, distribution of mean free path, Transport of mass, momentum and energy and their interrelationship, (coefficient of viscosity ,thermal conductivity & diffusion)

Unit V

Classical Statistics :
Phase space, micro and macro states, Thermodynamic probability, relation between entropy and thermodynamic probability, Monatomic ideal gas, Barometric equation, specific heat capacity of diatomic gas and specific heat of solids.

Quantum Statistics:

Books Recommended:

Essential Readings:

Reference Books:
Objectives: This course aims to develop the fundamental knowledge of electronics by learning various topics viz. circuit analysis, network theorems, P-N diode equation, rectifiers, filters, transistors and transistor amplifiers and their analysis. Students will also learn feedback amplifiers, logic gates and fabrication of IC’s

Unit I
Basic Circuit Analysis: (10 periods)
Open and short circuits, Impedance, Admittance and Hybrid parameters of any four terminal network, Kirchoff’s laws, Mesh and Node analysis.

Various Circuit theorems:
Superposition theorem, Thevenin’s theorem, Norton’s theorem, Maximum power transformer theorem, Miller’s theorem and Reciprocity theorem.

Unit II
Semi conductor diode and rectification: (9 periods)
p-n junction diodes, I-V characteristics, diode as a rectifier, half-wave, full-wave and bridge rectifiers: calculations of ripple factor, efficiency and regulation.

Filters: Series inductor, shunt capacitor, L-section and π section filters.
Voltage regulation: Zener diode, breakdown voltage (avalanche and zener effect), voltage regulation and voltage stabilization, voltage multipliers.

Unit III
BJT and amplifiers: (9 periods)
Basic construction of pnp and npn transistors and their operation, Input and output characteristics of CB, CC and CE configurations, active, saturation and cut-off regions, Load line and Q-point, Two-port analysis of a transistor using h-parameters, Analysis of CB, CE and CC amplifier for current gain, voltage gain, input and output impedances using h-parameters, Gain-frequency response of an amplifier.

Unit IV
Feed-back amplifier: (8 periods)
Concept of feed-back, positive and negative feedback, voltage and current feedback circuits (series and parallel circuits).
Advantages of negative feedback: Stabilization of gain, effect on input and output impedances, reduction of non-linear distortion, effect on gain-frequency response.

Oscillators: Barkhausen criterion, RC oscillators, Colpitt’s oscillator, Hartley oscillator, crystal oscillators and its advantages.
Unit V

**Digital Electronics:** (9 periods)
Transistors as a switch, Logic fundamentals: AND, OR, NOT, NAND, NOR, XOR gates.
Boolean algebra, De Morgan’s theorem, positive and negative logic, Logic gates circuit realization using DTL and TTL logic, Simplification of Boolean expressions.

**Integrated Circuit Technology:**
Integrated circuit vs. discrete components, Integrated circuit processing, Oxidation, diffusion, photolithography, epitaxy, chemical vapour deposition, Bipolar transistor fabrication.

**Books recommended:**

**Essential Readings:**

**References:**
Semester III  
Paper III  
PHY-303  
PHYSICS PRACTICAL

NOTE - Students are expected to perform eight experiments in all taking four experiments from each section. One experiment from section A and one from section B will be set in the examination paper.

The duration of the Practical Examination shall be 5 hours.

The distribution of marks in the practical examination will be as follows:

1. Two experiments: 30 marks each.
2. Distribution of marks will be as follows:

   Figure /Formula/Theory : 7
   Observations/Calculations : 16
   Result /Result Analysis : 5
   Precautions : 2

3. Viva - Voce : 10

Total : 70 marks
Semester III
Paper III
PHY-303
List of Experiments

Credits assigned: 3
Course duration: 60 hours
M.M.:100
(CA –30, SEE-70)

Section – A

1. Using platinum resistance thermometer, find the melting pint of a given substance.

2. To determine thermal conductivity of a bad conductor by Lee’s method.

3. To determine ‘J’ by Calender and Barne’s method.

4. Determine the thermodynamic constant \( \frac{C_p}{C_v} \) using Clement’s and Desorm’s method.

5. Study of variation of total thermal radiation with temperature.

6. To plot thermo emf versus temperature graph for Cu-Fe thermo couple and to determine temperature of a hot source (use sand bath).

Section – B

1. To study the variation of power transfer to different loads by a D. C. source and to verify maximum power transfer theorem.

2. Study of half wave rectification using single diode and application of L & \( \pi \) section filters.

3. To study characteristics of a given transition PNP/NPN (CE, CB & CC configuration).

4. Study of single stage transistor audio amplifier (variation of Gain with Frequency).

5. To verify laws and network theorems in D C circuits.

6. Using discrete components, study OR, NOT, AND logic gates.
SEMESTER IV
PAPER I
PHY-401
MATHEMATICAL PHYSICS AND NUMERICAL METHODS

Credits assigned: 3

Course duration: 45 hours
M.M.: 100
(CA-30, SEE-70)

Objectives: The objectives of this paper are to acquaint the students with different types of coordinate systems, tensors, four vectors etc. The students will also learn the Fourier analysis and various numerical methods.

UNIT I

Orthogonal curvilinear coordinate system:

Orthogonal curvilinear coordinate system, scale factors, Expressions for gradient, divergence and curl and their application to Cartesian, Circular Cylindrical and Spherical polar coordinate systems.

Tensors:
Coordinate transformations, Transformation of covariant, contra variant and mixed tensors. Addition, subtraction, outer product, contraction and inner product of tensors, Quotient law, Symmetric and antisymmetric tensors, Metric tensor. Dirac delta function and its properties.

UNIT II

Four vectors:

Four vector formulation, four velocity vector, energy-momentum four vector, relativistic equation of motion; invariance of rest mass, orthogonality of four force and four velocity, Lorentz force as an example of four force, transformation of four frequency vector, longitudinal and transverse Doppler’s effect.

UNIT III

Boundary value problems:

Techniques of separation of variables and its application to the following boundary value problems (i) Laplace’s equation in three dimensional Cartesian coordinate system – line charge between two earthed parallel plates, (ii) Helmholtz equation in circular cylindrical coordinates-Cylindrical resonant cavity, (iii) Wave equation in spherical polar coordinates-the vibrations of a circular membrane, (iv) Diffusion equation in two dimensional Cartesian coordinate system-heat conduction in a thin rectangular plate.
UNIT IV

Fourier Series and Integrals: (8 periods)
Introduction, Fourier series and coefficients, functions with point of discontinuity, arbitrary period, even and odd functions, half range expansion, Parseval’s theorem.

UNIT V

Numerical Methods: (10 periods)

Books Recommended:

Essential Readings:


References:

Semester IV  
Paper II  
PHY-402  
Condensed Matter Physics and Devices

Credits assigned: 03  
Course duration: 45 hours  
M.M.: 100  
(CA –30, SEE-70)

Objectives:
To familiarize the students with the basics of condensed matter physics which form the basic for further studies in condensed matter physics. The students get acquainted with the crystal structure, properties of solids, superconductivity and magnetism which strengthens the theoretical base for research in contemporary fields of condensed matter physics like imperfect solids and nano particle physics..

Unit I  
(9 periods)

Crystal structure: Symmetry elements in crystal, Unit cell, Wigner Seitz cell, fundamental lattice system and types, Miller indices, crystal structures of simple cubic, FCC, BCC, HCP, diamond. 
Crystal Diffraction: Bragg’s law, X-ray and neutron diffraction, Rotating crystal method, laue Method and Powder method.

Unit II  
(9 periods)

Band theory of solids: Formation of bands, distinction between metals, insulators and semiconductors, periodic potential of a solid, wave function in a periodic lattice and Bloch theorem, Kroning and Penny model. Physical origin of reduced mass (effective mass),negative effective mass and holes.

Unit III  
(9 periods)


Superconductivity: Zero resistivity, Critical temperature, critical magnetic field, Meissner effect, Type I and type II superconductors, BCS theory (Basic idea),High Tc superconductors.
Unit IV (9 periods)

**Magnetic Properties:** Classification of magnetic material, Diamagnetism, Paramagnetism due to free ions and conduction electrons, Curie’s law, ferromagnetism Nature and Origin of Weiss molecular field. Domains, hysteresis loop, outline of antiferromagnetism and ferrimagnetisms, ferrites.

Unit V (9 periods)

**Solid State Devices:** Light emitting diode, Solar cell, SCR.

**Operational amplifier:** Differential amplifiers, differential gain and CMRR, inverting and non-inverting configurations Applications of op-amp: adder, subtractor, differentiator and integrator.

**Field affect Transistor (FET):** Classification of various types of FET, constructional details of FET, drain characteristics and baising of FET, operating regions, pinch-off voltage, idea of metal oxide semiconductor field effect transistor (MOSFET).

Books Recommended:

**Essential Readings:**

**Reference Books:**
1. “Solid state physics”, A.J Dekker ,Macmilan India Ltd.
Semester IV  
Paper III  
PHY-403  
PHYSICS PRACTICAL

Section A

Students are expected to perform five experiments in all from which they will have to perform one experiment in the semester end exam.

The distribution of marks in the practical examination will be as follows:

1. One experiment : 30 marks.

   Distribution of marks will be as follows:

   - Figure / Formula/Theory : 7
   - Observation / Calculation : 16
   - Result /Result Analysis : 5
   - Precautions : 2

2. Viva –Voce : 5 marks

   Total : 35 marks

Section B

Project : 35 marks

Distribution of marks will be as follows:

- Seminar presentation : 15
- Write up : 10
- Viva –voce : 10
Semester IV  
Paper III  
PHY-403  

List of Experiments  

Credits assigned: 3  
Course duration: 60 hours  
M.M.:100  
(CA –30, SEE-70)  

Section – A  

1. To determine band gap using a junction diode.  
2. To study the Zener regulated power supply with different loads.  
3. To study the characteristics of FET.  
4. Study of the temperature dependence of resistance of a semiconductor (four probe method) and to determine its band gap.  
5. To study FET as an amplifier.  
6. To study a voltage multiplier circuit to generate high voltage DC from AC.  

Section – B  

1. Project  

Details of Project  

Students of semester IV are required to choose a topic for the project from a list approved by the department. They are required to perform a new experiment or carry out studies for writing a review article on a subject. At the end of the semester, a project report shall be submitted by each student. This project will be assigned to them in the beginning of the IV semester.  

Evaluation of Project:  

A mid term evaluation of the project will be made along with the second CA test. This will carry 30 % of the total marks assigned for the project. At the end of the semester, the student shall be examined on the basis of project report submitted by her by a panel of external and internal examiners. The external appointed for the practical exam shall also evaluate the project along with the internal project supervisors. The evaluation of project will be based on presentation / viva-voce.  

Total duration of practical exam and project evaluation shall be 5 hours.
Objectives: This paper aims to develop the basic knowledge of quantum mechanics and its application to various problems. It also deals with the techniques of wave mechanics like Schrödinger equation and its solution, angular momentum and spin.

Unit I

(9 periods)

Introduction to Wave mechanics:
Duality of radiation and matter, De broglie’s hypothesis, justification for the relation, Experimental confirmation of $\lambda = h/p$ (Davission and Germer experiment).
Uncertainty principle relating to position and momentum, relating to energy and time, its applications to various quantum mechanical problems such as:

(i) Non-existence of electrons in nucleus
(ii) Ground state energy of H-atom
(iii) Ground state energy of Harmonic oscillator
(iv) Natural width of spectral line

Schrödinger equation:
Wave function and its interpretation, Schrödinger time dependent and time independent one-dimensional equation, three-dimensional Schrödinger wave equation, probability current density, physical meaning of $\psi$, conditions to be satisfied by $\psi$.

Unit II

Operator formulation in Quantum mechanics: (9 periods)
Operators, algebra of operators, commutative property, linear operators, Commutator operator, eigen values and eigen functions, operators for momentum, K.E., Hamiltonian, total energy and angular momentum, Fundamental postulates of Q.M.
Hermitian operators, orthonormality, degeneracy, Commutation relations, Ehrenfest’s theorem, Bohr’s principle of complementarity, principle of superposition.
Unit III

Simple solutions of Schrödinger equation: (8 periods)
Boundary and continuity conditions on the wave function. Particle in one dimensional box, eigen function and eigen values, discrete energy levels, generalization to 3-D and degeneracy of levels

Boundary value problems:
Step potential, Penetration through rectangular barrier, calculation of reflection and transmission coefficients. Quantum mechanical tunneling. Square well potential problem, reflection and transmission coefficient and resonant scattering.

Unit IV

Simple harmonic oscillator (1-D Case): Schrödinger equation and its solutions, eigen function, energy eigen values. Zero point energy, parity, symmetric and anti-symmetric wave functions with graphical representation.
Rigid rotator: Schrodinger equation and its solution.

Unit V

Angular Momentum
Introduction: orbital angular momentum, Operators for its Cartesian components, commutation relations, mutual as well as with $L^2$, $L^+$ and $L^-$ operators, their interpretation as step operators, eigen values of $L_z$. Total angular momentum operators, commutation relations obeyed by the components of generalized momentum operator. Commutation relation of $J_z$ with $J_+$ and $J_-$, $J_+$ and $J_-$, commutation relation of $J^2$ with $J_+$ and $J_-$.

Books Recommended:
Essential readings:

References:
5. “Perspectives of Modern physics”, A. Beiser, Mc Graw Hill.
Semester V
Paper II
PHY-502
Nuclear and Particle Physics

Credits assigned: 3
Course duration: 45 hours
M.M.:100
(CA -30, SEE-70)

Objectives:
To give the students insight into the fundamentals of nuclear and particle physics.

Unit I
(9 periods)

Nuclear Properties: Rutherford’s theory of $\alpha$ particle scattering, Basic properties: charge, mass, size, spin, magnetic moment, electric quadrupole moment, Parity. Binding energy per nucleon and its observed variation with mass number of the nucleus. Semi empirical mass formula – coulomb energy, volume energy, surface energy, other corrections, explanation of binding energy curve, Liquid drop model, Nuclear forces and their properties, Theory of nuclear forces.

Unit II
(9 periods)

Nuclear Fission: Energy release in fission, Theory of nuclear fission and liquid drop model, Barrier penetration – Theory of spontaneous fission, Nuclear chain reaction, condition of controlled chain reaction, Principle of nuclear reactors, classification of reactors.

Nuclear Fusion: Energy release in fusion, fusion reactions in stars: carbon and pp cycle.

Unit III
(10 periods)

Particle Physics: Classification of elementary particles, properties of particles. Fundamental interactions, Conservation laws: Energy, momentum, angular momentum, charge, lepton number, Baryon number, isospin, strangeness, Invariance under charge, parity, C.P., time and C.P.T., (Qualitative discussion).
Cosmic rays: Properties of cosmic rays, properties of secondary radiation, electronic showers, geomagnetic effects, cosmic ray stars, the origin of cosmic rays.

Unit IV
(9 periods)

Accelerators: Need for accelerators, Ion sources, Van De graff generator, Drift tube, linear accelerator, Wave guide accelerator, cyclotron, synchrocyclotron, electron synchrotron, proton synchrotron.
Unit V

(8 periods)

**Detectors**: Ionization chamber, Proportional Counter, Geiger Muller Counter, Scintillation counter, Cloud chamber, Bubble chamber, Spark chamber, Solid state detectors.

**Nuclear mass spectroscopy**: Basic components of mass spectroscope.

**Books Recommended:**

**Essential Readings:**


**Reference books:**

NOTE - Students are expected to perform eight experiments in all taking four experiments from each section. One experiment from section A and one from section B will be set in the examination paper.

The duration of the Practical Examination shall be 5 hours.

The distribution of marks in the practical examination will be as follows:

1. Two experiments: 30 marks each.
2. Distribution of marks will be as follows:

   - Figure /Formula/Theory : 7
   - Observations/Calculations : 16
   - Result /Result Analysis : 5
   - Precautions : 2

3. Viva -Voce : 10

   Total : 70 marks
Semester V  
Paper III  
PHY-503  
List of Experiments  

Credits assigned: 3                                        Course duration: 45 hours  
M.M.:100  
( CA –30, SEE-70 )

Section A

1. Determination of Stefan’s constant.
2. Determination of Planck’s constant using a Photocell.
3. Determination of Planck’s constant using a solar cell.
4. Study of power supply using two diodes/bridge rectifier with various filter circuits.
5. To perform various logic functions using NOR and NAND gates, i.e., OR, NOT, AND, NOR, NAND, X-OR gates.
6. To measure CMRR and input bias current and offset current using OP-AMP.

Section B

1. Study of characteristics of GM counter and verification of inverse square law for same strength of a radioactive source.
2. Study of absorption of $\beta$-rays in Aluminum foil using GM counter and to determine its absorption coefficient.
3. Determine ballistic constant of a ballistic galvanometer.
4. To determine self-inductance of a given coil by Anderson’s bridge using AC.
5. To study Hall effect and to determine Hall coefficient.
6. Application of operational amplifier as (a) inverting amplifier and (b) non inverting amplifier
Objective: This course aims to introduce various types of spectra for hydrogen, alkali and alkaline earth atoms. It also gives an introduction to X-ray spectra. Techniques of Molecular spectroscopy are also discussed in this paper, which include IR and Raman spectra.

Unit I

Introduction to Atomic Spectra

Types of spectra, spectrum of Hydrogen atom, spectral lines, the spinning electron, space quantization, quantum numbers and their physical interpretation, quantum numbers for complete atom, magnetic moments of an atom and Landes ‘g’ factor, Larmor’s theorem, Stern and Gerlach experiment, fine structure of the Hydrogen lines, spectral terms and their notation.

Unit II

Spectra of alkali and alkaline atoms


Unit III

X-ray spectra

Continuous x-ray spectrum, characteristic emission and absorption spectrum and their explanation, energy levels, Moseley’s law, combination principle, fine structure of x-ray lines, fluorescence yield and Auger effect, soft x-ray emission and structure of absorption edges.
Unit IV

Infra red spectroscopy (vibrational and rotational spectra) (9 periods)
Salient features of vibrational rotational spectra, vibrating diatomic molecules as a harmonic oscillator, fine structure of vibrational rotational bands, interaction of vibrational and rotational energies, experimental arrangements for studying IR spectra.

Unit V

Raman Spectra (10 periods)
Raman effect and its salient features, Observation of Raman spectra, classical theory of Raman effect, quantum theory of Raman effect, probability of energy transition in Raman effect, vibrational Raman spectra, Pure rotational Raman spectra, structure determination from Raman and infra red spectroscopy.

Books Recommended

Essentials Readings


References

Objectives:
Information Communications Technology - or technologies (ICT) is an umbrella term that includes all technologies for the communication of information. This course gives a brief idea of the technology of wireless communication and networks. The objective of this course is to provide a comprehensive technical survey of wireless communication, fundamentals, wireless networks and wireless applications.

Unit I
Introduction and Transmission Fundamentals: (9 periods)
Transmission Fundamentals: Signals for conveying information: Time domain concepts, Frequency domain concepts, Relationship between data rate and bandwidth.
Analog and Digital data transmission: Analog and digital data, analog and digital signaling, Analog and digital transmission.
Channel Capacity: Nyquist bandwidth, Shannon capacity formula.
Transmission Media: Terrestrial microwaves, Satellite microwaves, Broadcast radio, Infrared.

Unit II
Communication Networks and Protocols: (9 periods)
Communication Networks: LANs, MANs and WANs, Switching Techniques, Circuit Switching, Packet Switching: Basic operation, Packet size.

Unit III
Antennas and Propagation: (9 periods)
Antennas: Radiation patterns, Antenna types, Antenna Gain.
Line of Sight Transmission: Attenuation, Free Space loss, Noise, The expression $E_b / N_0$,
Atmospheric absorption, Multipath, Refraction.
Unit IV

Satellite Communication: (9 periods)
Satellite parameters and configurations: Satellite Orbits, GEO, LEO, MEO satellites, frequency bands, transmission impairments, satellite network configurations, Capacity allocation – Frequency division: Frequency division multiplexing, Frequency division multiple access (FAMA, DAMA); Capacity Allocation: Time division

Unit V

Cellular Wireless Networks: (9 periods)
Principles of Cellular networks: Cellular network organization, operation of cellular systems, mobile radio propagation effects, power control; First generation analog: spectral allocation, operation, AMPS control channels.
Second generation TDMA: Time division multiple access, Mobile wireless TDMA design considerations, Global system for mobile communications, GSM network architecture.
Second generation CDMA: CDMA, Mobile wireless CDMA design considerations.
Introduction to third generation systems.

Books Recommended:

Essential Readings:


Reference Books:

3. “Wireless Communication”, Reppaport, Pearson Education
NOTE - Students are expected to perform eight experiments in all taking four experiments from each section. One experiment from section A and one from section B will be set in the examination paper.

The duration of the Practical Examination shall be 5 hours.

The distribution of marks in the practical examination will be as follows:

1. Two experiments: 30 marks each.
2. Distribution of marks will be as follows:
   
<table>
<thead>
<tr>
<th>Figure /Formula/Theory</th>
<th>Observations/Calculations</th>
<th>Result /Result Analysis</th>
<th>Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>: 7</td>
<td>: 16</td>
<td>: 5</td>
<td>: 2</td>
</tr>
</tbody>
</table>

3. Viva -Voce : 10

Total : 70 marks
Semester VI  
Paper III  
PHY-603  
List of Experiments

Credits assigned: 3                                       Course duration: 45 hours
                                M.M.:100
                                (CA –30, SEE-70)

Section A

1. Study of Iodine Spectrum with the help of a grating, spectrometer and ordinary bulb.

2. To determine the specific rotation of sugar by polarimeter.

3. To verify Malus cosine law with the help of a photo-voltaic cell.

4. To determine curie temperature of monel alloy.

5. Measurement of capacitance by De-Sauty bridge.


Section B


2. Study of L-C Transmission Line.
   a) At definite frequency
   b) At variable frequency

3. To study amplitude modulation and demodulation and measure modulation index.

2. To study single side band AM using balanced modulator.

3. Study the frequency response of a transistor wide band amplifier with and without feedback. Also obtain input and output impedance of the amplifier.

4. To determine the recovery time of a diode.

***