STATE MODEL SYLLABUS FOR UNDER GRADUATE COURSE IN PHYSICS
(Bachelor of Science Examination)

UNDER CHOICE BASED CREDIT SYSTEM
## Course structure of UG Physics Honors

<table>
<thead>
<tr>
<th>SEMESTER</th>
<th>COURSE OPTED</th>
<th>COURSE NAME</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Ability Enhancement Compulsory</td>
<td>AECC-I</td>
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<td>4 Papers</td>
<td>Course-I</td>
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<tr>
<td>(400 Marks)</td>
<td>Core course-I</td>
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<td>Core Course-II Practical/Tutorial</td>
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<td>Generic Elective -1</td>
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<td>Ability Enhancement Compulsory</td>
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<td>Core course-IV</td>
<td>Waves and Optics</td>
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<td>Core course-VII</td>
<td>Analog Systems and Applications</td>
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<td>Core course-IX</td>
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<td>Core course-XI</td>
<td>Quantum Mechanics &amp; Applications</td>
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<td>Or Discipline Specific Elective-4</td>
<td>(Eligible Students may do a Project in DSE-IV)</td>
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<td>Total Credits</td>
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Generic Elective Papers (GE) (Minor-Physics) for other Departments/Disciplines: (Credit: 06 each)

Depending on their requirements, Universities may choose 2 (two) GE subjects with 2 papers from each subject or only one GE subject with 4 papers from it.

**Two papers GE subject will be:**

1. **GE-I** (Mechanics & Properties of matter, Oscillation & Waves, Thermal Physics, Electricity and Magnetism & Electronics) + Lab
2. **GE-II** (Optics, Special Theory of Relativity, Atomic Physics, Quantum Mechanics and Nuclear Physics)+ Lab

A student who chooses to read only Physics subject GE will take 4 DSC papers of the Pass Course as below

1. **GE-I** as **DSC-1** (Mechanics )+ Lab

2. **GE-II** as **DSC-2**, (Electricity, Magnetism & Emt) )+ Lab

3. **GE-III** as **DSC-3**, (Thermal Physics & Statistical Mechanics) )+ Lab

4. **GE-IV** as **DSC-4** (Waves And Optics )+ Lab

(GE-I same paper as DSC-1,GE-II same as DSC-2,GE-III same as DSC-3,GE-IV same as DSC-4)
PHYSICS

HONOURS PAPERS:
Core course – 14 papers
Discipline Specific Elective – 4 papers (out of the 5 papers suggested)
Generic Elective for Non Physics students – 4 papers. Incase University offers 2 subjects as GE, then papers 1 and 2 will be the GE paper.
Marks per paper –
For practical paper: Midterm : 15 marks, End term : 60 marks, Practical- 25 marks
For non practical paper: Midterm : 20 marks, End term : 80 marks
Total – 100 marks Credit per paper – 6
Teaching hours per paper –
Practical paper-40 hours theory classes + 20 hours Practical classes
Non Practical paper-50 hours theory classes + 10 hours tutorial

CORE PAPER-1

MATHEMATICAL PHYSICS-I

The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

UNIT-I

UNIT-II

**Calculus-II:** Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration, Constrained Maximization using Lagrange Multipliers,


UNIT-III

**Orthogonal Curvilinear Coordinates:** Orthogonal Curvilinear Coordinates, Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems, Comparison of velocity and accelerationincylindricalandsphericalcoordinatesystem

**Dirac Delta function and its properties:** Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular Function, Properties of Dirac delta function.

UNIT-IV

**Vector Differentiation:** Directional derivatives and normal derivative, Gradientofascalarfieldanditsgeometricalinterpretation,Divergenceandcurlof a vector field, Del and Laplacian operators, Vectoridentities

**Vector Integration:** Ordinary Integrals of Vectors, Multiple integrals, Jacobian, Notion of infinitesimal line, surface and volume elements, Line, surface and volume integrals of Vector fields, Flux of a vector field, Gauss’ divergence theorem, Green’s and Stokes Theorems and their applications (no rigorous proofs)

**TextBooks:**

2. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India)

**Reference books:**

1. Mathematical Physics C. Harper (Prentice Hall India)
3. Complex variables and applications, J. W. Brown and R.V.Churchill
   Mathematical Physics, Satya Prakash (SultanChand)
   Mathematical Physics and Special Relativity, M. Das, P.K. Jena and B.K.Dash (Srikrishna Prakashan)

**CORE PAPER I LAB:**

The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- Highlights the use of computational methods to solve physical problems
- The course will consist of lectures (both theory and practical) in the Lab
- Evaluation done not on the programming but on the basis of formulating the problem
- Aim at teaching students to construct the computational problem to be solved
- Students can use anyone operating system Linux or Microsoft Windows

**Introduction and Overview:** Computer architecture and organization, memory and Input/output devices.

**Basics of scientific computing:** Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow and overflow emphasize the importance of making equations in terms of dimensionless variables, iterative methods. Algorithm

**Errors and error Analysis:** Truncation and round off errors, Absolute and relative errors, Floating point computations. Systematic and Random Errors, Propagation of Errors, Normal Law of Errors, Standard and Probable Error.

**Review of C and C++ Programming:** Introduction to Programming, constants,
variables and Fundamentals data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (If Statement, IfelseStatement, NestedIfstructure, ElseIfStatement, Ternaryoperator, Goto Statement, Switch Statement, Unconditional and Conditional Looping, While Loop, Do-While Loop, FOR Loop, Break and Continue Statements, Nested Loops), Arrays (1D and 2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects

Programs: Sum and average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search

Random number generation: Area of circle, area of square, volume of sphere, value of $\pi$.

Reference Books:

CORE PAPER-II
MECHANICS

UNIT-I

**Rotational Dynamics:** Centre of Mass, Motion of CoM, Centre of Mass and Laboratory frames, Angular momentum of a particle and system of particles, Principle of conservation of angular momentum, Rotation about a fixed axis, Moment of Inertia, Perpendicular and Parallel Axis Theorems, Routh Rule, Calculation of moment of inertia for cylindrical and spherical bodies, Kinetic energy of rotation, Eulers Equations of Rigid Body motion, Motion involving both translation and rotation. Moment of Inertia of a Flywheel.

**Non-Inertial Systems:** Non-inertial frames and fictitious forces, Uniformly rotating frame, Laws of Physics in rotating coordinate systems, Centrifugal force, Coriolis force and its applications.

UNIT-II Elasticity: Relation between Elastic constants, Twisting torque on a Cylinder or Wire, Bending of beams, External bending moment, Flexural rigidity, Single and double cantilever

**Fluid Motion:** Kinematics of Moving Fluids: Poiseuilles Equation for Flow of a Liquid through a Capillary Tube, Surface tension, Gravity waves and ripple

**Viscosity:** Poiseuilles Equation for Flow of a Liquid with corrections.

UNIT-IV

**Oscillations:** Simple Harmonic Oscillations. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Equation of motion and solution, cases of oscillatory, critically damped and overdamped) Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor, Bar Pendulum, Katers Pendulum

**Special Theory of Relativity:** Michelson-Morley Experiment and its outcome, Postulates of Special Theory of Relativity, Lorentz Transformations, Simultaneity and order of events, Lorentz contraction, Time dilation, Relativistic transformation of velocity, Frequency and wave number, Relativistic addition of velocities, Variation of mass with velocity, Massless Particles, Mass-energy Equivalence, Relativistic Doppler effect, Relativistic Kinematics, Transformation of Energy and Momentum.

**Text Books:**
1. Mechanics, D.S. Mathur (S. Chand Publishing )
2. Introduction to Special Relativity, R. Resnick (John Wiley)

**Reference Books:**
1. Introduction to Mechanics Daniel Klapnner and Robert Kolenkow, Mcgraw-Hill.
2. Mechanics by K.R Simon
4. Physics, Resnick, Halliday and Walker (8/e.2008, Wiley)
CORE PAPER-II LAB
(minimum 5 experiments are to be done):

1. To study surface tension by capillary rise method
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuilles method).
6. To determine the Modulus of Rigidity of a Wire by Maxwellsneedle.
7. To determine the value of g using BarPendulum.
8. To determine the value of g using KatersPendulum

Reference Books:
1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, AsiaPublishing House
3. A Text Book of Practical Physics, I.Prakash and Ramakrishna, 11thEdn, 2011, Kitab Mahal

CORE PAPER-III
ELECTRICITY AND MAGNETISM

UNIT-I

Electric Field and Electric Potential

Electric field: Electric field lines, Electric flux, Gauss Law with applications to charge distributions with spherical, cylindrical and planar symmetry, Conservative nature of Electrostatic Field. Electrostatic Potential, Potential and Electric Field of a dipole, Force and Torque on a dipole, Potential calculation indifferentsimplecases,LaplacesandPoissonequations,TheUniquenessTheorem,
Method of Images and its application to (1) Plane Infinite Sheet and (2) Sphere.

Electrostatic energy of system of charges, Electrostatic energy of a charged sphere, Conductors in an electrostatic field, Surface charge and force on a conductor.

UNIT-II


UNIT-III

**Dielectric Properties of Matter:** Electric Field in matter, Polarization, Polarization Charges, Electrical Susceptibility and Dielectric Constant, Capacitor (parallel plate, spherical, cylindrical) filled with dielectric, Displacement vector \( D \), Relations between \( E \), \( P \) and \( D \), Gauss Law in dielectrics. Magnetic Properties of Matter: Magnetization vector (M), Magnetic Intensity (H), Magnetic Susceptibility and permeability, Relation between B, H, M, Ferromagnetism, B-H curve and hysteresis.

**Electromagnetic Induction:** Faraday's Law, Lenz's Law, Self Inductance and Mutual Inductance, Reciprocity Theorem, Energy stored in a Magnetic Field, Introduction to Maxwell's Equations

UNIT-IV

**Electrical Circuits:** AC Circuits: Kirchhoffs laws for AC circuits, Complex Reactance and Impedance, Series LCR Circuit: (1) Resonance (2) Power Dissipation (3) Quality Factor, (4) Band Width, Parallel LCR Circuit.

**Network theorems:** Ideal Constant-voltage and Constant-current Sources,
Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem, Applications to DC circuits. Transient Currents Growth and decay of current in RC and LR circuits.

**Text Books:**

2. Foundations of Electromagnetic Theory-Ritz and Milford (Pearson)

**Reference Books:**

2. Electricity and Magnetism D. C. Tayal (Himalaya Publishing house)
3. Electricity, Magnetism and Electromagnetic Theory- S. Mahajan and Choudhury (Tata McGraw Hill)

**CORE PAPER-III**

LAB (minimum of 6 experiments are to be done)

Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (d) DC Current, (d) Capacitances, and (e) Checking electrical fuses.

1. To study the characteristics of a series RCCircuit.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Fosters Bridge. To compare capacitances using DeSautys bridge.
4. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
5. To verify the Thevenin and Norton theorems.
6. To determine self inductance of a coil by Andersons bridge.
7. To study response curve of a Series LCR circuit and determine its (a) Reso-
   nant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d)
   Band width.
8. To study the response curve of a parallel LCR circuit and determine its (a)
   Antiresonance frequency and (b) Quality factor Q.

Reference Books:
1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop,
   1971, Asia Publishing House
2. A Text Book of Practical Physics, I.Prakash and Ramakrishna, 11th
   Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn,
4. A Laboratory Manual of Physics for undergraduate classes,

CORE PAPER-IV: WAVES AND OPTICS

UNIT - I

Geometrical optics : Fermats principle, reflection and refraction at plane interface,
Matrix formulation of geometrical Optics, Cardinal points and Cardinal planes of an
optical system, Idea of dispersion, Application to thick Lens and thin Lens, Ramsden
and Huygens eyepiece. Wave Optics : Electromagnetic nature of light. Definition and
properties of wave front Huygens Principle. Temporal and Spatial Coherence.

UNIT - II

Wave Motion : Plane and Spherical Waves, Longitudinal and Transverse Waves,
Plane Progressive (Traveling) Waves, Wave Equation, Particle and Wave Velocities,
Differential Equation, Pressure of a Longitudinal Wave, Energy Trans- port, Intensity
of Wave. Superposition of two perpendicular Harmonic Oscillations : Graphical and
Analytical Methods, Lissajous Figures (1:1 and 1:2) and their uses, Superposition of N harmonic waves.

UNIT- III


UNIT - IV


TextBooks:
1. A textbook of Optics N. Subrahmanyam and Brij Lal (S. Chand Publishing)
2. Optics - Ajoy Ghatak (McGraw Hill)

Reference Books:
1. Optics - E. Hecht (Pearson)
2. Fundamental of Optics - F. A. Jenkins and H. E. White (McGraw Hill)
3. Geometrical and Physical Optics - R. S. Longhurst (Orient Blackswan)
5. Optics - P. K. Chakrabarty
7. The Physics of Waves and Oscillations - N.K. Bajaj (McGraw Hill)

**CORE PAPER-IV LAB**

(minimum 5 experiments are to be done)

1. To determine the frequency of an electric tuning fork by Meldes experiment and verify 2 T law.
2. To plot the I-D curve and to determine the refractive index of a prism.
3. To determine refractive index of the Material of a prism using sodium source.
4. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
5. To determine wavelength of sodium light using Newton's Rings.
6. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
7. To determine dispersive power and resolving power of a plane diffraction grating.

**Reference Books:**

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal

**CORE PAPER-V**

MATHEMATICAL PHYSICS-II
The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

UNIT-I

**Fourier Series-I**: Periodic functions, Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only), Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients, Complex representation of Fourier series, Expansion of functions with arbitrary period, Expansion of non-periodic functions over an interval, Even and odd functions and their Fourier expansions and Application, Summing of Infinite Series, Term-by-Term differentiation and integration of Fourier Series, Parseval Identity.

UNIT-II


UNIT-III

**Polynomials**: Simple recurrence relations of Legendre and Hermite Polynomials, Expansion of function in a series of Legendre Polynomials, Associated Legendre Differential Equation, Associated Legendre polynomials, Spherical Harmonics

**Some Special Integrals**: Beta and Gamma Functions and relation between them, Expression of Integrals in terms of Gamma Functions, Error Function (Probability Integral).

UNIT-IV

**Partial Differential Equations**: Solutions to partial differential equations using
separation of variables: Laplace’s Equation in problems of rectangular, cylindrical and spherical symmetry. Conducting and dielectric sphere in an external uniform electric field. Wave equation and its solution for vibrational modes of a stretched string

Text Books:
2. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India)

Reference Books:
1. Mathematical Physics and Special Relativity, M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan)
3. Mathematical Physics C. Harper (Prentice Hall India)
5. Complex variables and applications J.W. Brown and R.V. Churchill
6. Mathematical Physics, Satya Prakash (Sultan Chand)

CORE PAPER-VLAB
The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Topics
Introduction to Numerical computation software Scilab: Introduction to Scilab, Advantages and disadvantages, Scilab computation software Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2),
Branching Statements and program design, Relational and logical operators, the while loop, for loop, details of loop operations, break and continue statements, nested loops, logical arrays and vectorization (2) User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program(2).

**Curve fitting, Least square fit**
**Goodness of fit, standard constant Deviation:** Ohms law to calculate R, Hookes law to calculate spring constant

**Solution of Linear system of equations by Gauss elimination** Solution method and Gauss Seidal method. **Diagonalization matrices, Inverse of a matrix, Eigen vectors, problems:** Solution of mesh equations of electric circuits(3meshes), Solution of coupled spring mass systems(3masses)

**Solution of ODE**
**First order Differential equation Euler, modified Euler Runge-Kutta second methods**
Second order differential equation. **Fixed difference method:** First order differential equation

- Radioactive decay
- Current in RC, LC circuits with DC source
- Newton's law of cooling
- Classical equations of motion

**Second order Differential Equation**

- Harmonic oscillator (nofriction)
- Damped Harmonic oscillator
- Overdamped
- Criticaldamped
- Oscillatory
- Forced Harmonic oscillator
• Transient and Steady statesolution
• Apply above to LCR circuitsalso

**Reference Books:**

3. First course in complex analysis with applications, D. G. Zill and P. D. Shanahan, 1940, Jones and Bartlett
7. Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

**CORE PAPER-VI**

**THERMAL PHYSICS**

**UNIT-I**

**Introduction to Thermodynamics** Recapitulation of Zeroth and First law of thermodynamics,

**Second Law of Thermodynamics:** Reversible and Irreversible process with examples, Kelvin-Planck and Clausius Statements and their Equivalence, Carnots Theorem, Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

**Entropy:** Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy, Entropy of a perfect gas, Principle of

UNIT-II

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables,


Phase Transitions: First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations

Maxwells Thermodynamic Relations: Derivations and applications of Maxwells Relations, Maxwells Relations: (1) Clausius Clapeyron equation (2) Relation between \( C_p \) and \( C_v \) (3) \( TdS \) Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases (5) Energy equations (6) Change of Temperature during Adiabatic Process.

UNIT-III

Kinetic Theory of Gases


Molecular Collisions: Mean Free Path, Collision Probability, Estimates of Mean Free Path,

Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.
UNIT-IV


Text Books:

1. Thermal Physics, A. B. Gupta (Books and allied Ltd)

Reference Books:

1. Theory and experiments on thermal Physics, P.K.Chakrabarty (New central book agency limited)
2. Thermodynamics, Kinetic Theory and Statistical Thermodynamics - Searsand Salinger (Narosa)

CORE PAPER-VI LAB

(minimum 5 experiments are to be done):
1. To determine Mechanical Equivalent of Heat, J, by Callender and Barnes constant flow method.
2. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charltons disc method.
3. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
4. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
5. To determine J by Caloriemeter
6. To determine the specific heat of liquid by the method of cooling
7. To determine the specific heat of solid by applying radiation of correction.

Reference Books:
1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I.Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal

CORE PAPER-VII
ANALOG SYSTEMS AND APPLICATIONS

UNIT-I

Semiconductor Diodes: P and N type semiconductors, energy level diagram, conductivity and Mobility, Concept of Drift velocity, PN junction fabrication (simple idea), Barrier formation in PN Junction Diode, Static and Dynamic Resistance, Current flow mechanism in Forward and Reverse Biased Diode, Drift velocity, derivation for Barrier Potential, Barrier Width and current Step Junction.

Two terminal device and their applications: (1) Rectifier Diode: Half-
UNIT II

**Bipolar Junction Transistors:** n-p-n and p-n-p transistors, Characteristics of CB, CE and CC Configurations, Current gains a and b, Relation between a and b, Load line analysis of Transistors, DC Load line and Q-point, Physical mechanism of current flow, Active, Cut-off and Saturation Regions.

**Transistors Biasing:** Transistor Biasing and Stabilization circuits, Fixed Bias and Voltage Divider Bias.

**Amplifiers:** Transistors as 2-port network h-parameter Equivalent Circuit, Analysis of a single stage CE amplifier using Hybrid Model, Input and Output impedance, Current, Voltage and Power Gains, Classification of class A, B and C amplifiers, Push-pull amplifier (class B).

UNIT-III

**Coupled Amplifier:** RC-coupled amplifier and its frequency response.


UNIT-IV

**Operational Amplifiers (Black Box approach):** Characteristics of an Ideal and Practical OP-AMP (IC741). Open-loop and Closed loop Gain. Frequency Response. CMRR, Slew Rate and concept of virtual ground.

**Application of Op-Amps:** (1) Inverting and non-inverting amplifiers (2) Adder (3) Subtractor (4) Differentiator, (5) Integrator (6) Log amplifier, (7) Zero
crossing detector (8) Wein bridge oscillator.

**Text Books:**

1. Foundations of Electronics-Raskhit and Chattopadhyay (New age International Publication)
2. Concept of Electronics- D.C.Tayal (HimalayPublication)

**Reference Books:**

1. Electronic devices and circuits R.L. Boylstad (Pearson India)
4. OP-Amps and Linear Integrated Circuit-R. A. Gayakwad (Prentice Hall)
5. Physics of Semiconductor devices, Donald A. Neamen (Prentice Hall)

**CORE PAPER-VII LAB**

*(minimum 5 experiments are to be done)*

1. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
2. Study of V-I and power curves of solar cells, and find maximum power point and efficiency.
3. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
4. To study the various biasing configurations of BJT for normal class A operation.
5. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
6. To design a Wien bridge oscillator for given frequency using an op-amp.
7. To design a phase shift oscillator for given specifications using BJT.
8. To study the Colpitt's oscillator.

Reference Books:

CORE PAPER-VIII
MATHEMATICAL PHYSICS-III

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

UNIT-I
Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation Euler's formula, De Moivre's theorem, Roots of complex Numbers, Functions of Complex Variables, Analyticity and Cauchy-Riemann Conditions, Examples of analytic functions, Singular functions: poles and branch points, order of singularity, branch cuts, Integration of a function of a complex variable, Cauchy's Inequality, Cauchy's Integral formula, Simply and multiply connected region, Laurent and Taylor's expansion, Residues and Residue Theorem, Application in solving Definite Integrals.

UNIT-II
Integral Transforms-I: Fourier Transforms: Fourier Integral theorem, Fourier Transform, Examples, Fourier Transform of trigonometric, Gaussian, finite wave train and other functions, Representation of Dirac delta function as a Fourier Integral, Fourier transform of derivatives, Inverse Fourier Transform.

UNIT-III

Integral Transforms-II: Convolution theorem, Properties of Fourier Transforms (translation, change of scale, complex conjugation), Three dimensional Fourier transforms with examples, Application of Fourier Transforms to Differential Equations: One dimensional Wave and Diffusion/Heatflow Equations.

UNIT-IV

Laplace Transforms: Laplace Transforms (LT) of Elementary functions.

Properties of Laplace Transforms: Change of Scale Theorem, Shifting Theorem, LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions, Inverse LT, Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

Text Books:
2. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India)

Reference Books:
   Mathematical Physics C. Harper (Prentice Hall India)
4. Complex variables and applications J.W.Brown and R.V.Churchill
5. Mathematical Physics, Satya Prakash (Sultan Chand)

**CORE PAPER-VIII LAB**

Scilab based simulations (XCos) experiments based on Mathematical Physics problems like

**PRACTICAL-C VIII LAB**

20 Classes (2hrs duration each)

Scilab based simulations (XCos) experiments based on Mathematical Physics problems like:

- Solve simple differential equations like:
  
  \[
  \frac{dy}{dx} = e^{-x} \quad \text{with } y(x=0) = 0
  \]
  
  \[
  \frac{dy}{dx} + e^{-x} = x^2 \quad \text{with } y(x=0) = 0
  \]
  
  \[
  \frac{d^2y}{dx^2} + 2\frac{dy}{dx} = -y \quad \text{with } y(x=0) = 0, \quad y'(x=0) = 1
  \]
  
  \[
  \frac{d^2y}{dx^2} + e^{-x}\frac{dy}{dx} = -y \quad \text{with } y(x=0) = 0, \quad y'(x=0) = 1
  \]

- Direct Delta Function
Evaluate \( \int_{-3}^{3} \frac{(x+3)}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-2)^2}{2\sigma^2}}, \) for \( \sigma = 0.1, 0.01, 0.001 \) and show that it tends to 5.

- **Fourier Series:**

Program to sum

Evaluate the Fourier coefficients of a given periodic function (square wave)

- **Frobenius method and Special functions:**

\[
\int_{-1}^{1} d\mu \ P_n(\mu) \ P_m(\mu) = \frac{2}{2n+1} \delta_{m,n}
\]

Plot \( P_n(x) \), Legendre polynomial of degree \( n \), and \( J_n(x) \), Bessel function of first kind.

Show recursion relation

- Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).

- Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.

- Evaluation of trigonometric functions e.g. \( \sin \theta \), Given Bessels function at \( N \) points find its value at an intermediate point.

Complex analysis: Calculate \( \int \frac{dx}{(x^2+2)} \) and check it with computer integration.

- Integral transform: FFT of \( e^{-x^2} \)

**Reference Books:**

CORE PAPER-IX

ELEMENTS OF MODERN PHYSICS

UNIT- I


Atomic Model: Bohrs Model of Hydrogen atom, explanation of atomic spec- tra, correction for finite mass of the nucleus, Bohr correspondence principle, limitations of Bohr model, discrete energy exchange by atom, Frank Hertz Experiment, Sommerfelds modification of BohrsTheory.

UNIT- II

Wave Packet: superposition of two waves, phase velocity and group velocity, wave packets, Gaussian Wave Packet, spatial distribution of wave packet, Localization of wavepacket in time, Time development of a wave packet, Wave Particle Duality, Complementarity.

Wave Particle Duality: de Broglie hypothesis, Experimental confirmation of matter wave, Davisson Germer Experiment, velocity of de Broglie wave, wave particle duality, Complementarity.

Uncertainty Principle: Heisenberg Uncertainty Principle, Illustration of the Principle through thought Experiment of Gamma ray microscope and electron diffraction through a slit, Estimation of ground state energy of harmonic oscillator and hydrogen atom, non existence of electron in the nucleus, Uncertainty and complementarities.
UNIT- III

Nuclear Physics- I: Size and structure of atomic nucleus and its relation with atomic weight, Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle, Nature of the nuclear force, NZ graph, Liquid Drop model: semi empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.

UNIT- IV

Nuclear Physics- II: Radioactivity, stability of the nucleus, Law of radioactive decay, Mean life and Half life, Alpha decay, Beta decay-energy released, spectrum and Pauli's prediction of neutrino, Gamma ray emission energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus, Fission and fusion mass deficit, relativity and generation of energy, Fission—nature of fragments and emission of neutrons, Nuclear reactor: slow neutron interacting with Uranium 235, Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussion).

Text Books:
2. Modern Physics Murugeshan and Sivaprasad (S.Chand)

Reference Books:
2. Introduction to Quantum Theory, David Park (Dover Publications)
4. Modern Physics-Serway (CENGAGE Learnings)
5. Physics of Atoms and Molecules Bransden and Joachim (Pearson India)
7. Theoretical Nuclear Physics, J.M. Blatt and V.F. Weisskopf (Springer)

**CORE PAPER-IX LAB**

*(minimum 4 experiments are to be done):*

1. To show the tunneling effect in tunnel diode using I-V characteristics.
2. To determine the wavelength of laser source using diffraction of single slit.
3. To determine the wavelength of laser source using diffraction of double slits.
4. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating.
5. To determine the Planck's constant using LEDs of at least 4 different colours.
6. To determine the value of $e/m$ by (a) Magnetic focusing or (b) Bar magnet.
7. To setup the Millikan oil drop apparatus and determine the charge of an electron.

**Reference Books:**

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
3. A Text Book's Book of Practical Physics, I. Prakashand Ramakrishna, 11th Edn, 2011, Kitab Mahal

**CORE PAPER-X**

**DIGITAL SYSTEMS AND APPLICATIONS**

**UNIT-I**

**Integrated Circuits (Qualitative treatment only):** Active and Passive Components, Discrete components, Wafer Chip, Advantages and Drawbacks of ICs, Scale of Integration: SSI, MSI, LSI and VLSI (basic idea and definitions only), Classification of ICs, Examples of Linear and Digital ICs.
Digital Circuits: Difference between Analog and Digital Circuits, Binary Numbers, Decimal to Binary and Binary to Decimal Conversation, BCD, Octal and Hexadecimal numbers, AND, OR and NOT. Gates (realization using Diodes and Transistor), NAND and NOR Gates as Universal Gates, XOR and XNOR Gates and application as Parity Checkers.

UNIT-II

Boolean algebra: De Morgans Theorems: Boolean Laws, Simplification of Logic Circuit using Boolean Algebra, Fundamental Products, Idea of Minterms and Maxterms, Conversion of Truth Table into Equivalent Logic Circuit by

(1) Sum of Products Method and (2) Karnaugh Map.

Introduction to CRO: Block Diagram of CRO, Electron Gun, Deflection system and Time Base, Deflection Sensitivity,

Applications of CRO: (1) Study of Wave Form, (2) Measurement of Voltage, Current, Frequency and Phase Difference.

UNIT-III


Timers: IC 555: block diagram and application is Astable multivibrator and Monostable multivibrator.

UNIT-IV

Introduction to Computer Organization: Input/output Devices, Data storage (idea of RAM and ROM), Computer memory, Memory organization and addressing, Memory Interfacing, Memory Map.

Shift registers: Serial-in-serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out
and Parallel-in-Parallel-out. Shift Registers (only up to 4 bits)

**Counters (4 bits):** Ring Counter, Asynchronous counters, Decade Counter.

Synchronous Counter.

**Text Books:**
1. Digital Circuits and Logic Design: Samuel C. Lee (Prentice Hall)

**Reference Books:**
1. The Art of Electronics by Paul Horowitz and William Hill, Cambridge University
2. Electronics by Allan R. Hambley, Prentice Hall
3. Principles of Electronics V.K. Mehta and Rohit Mehta (S. Chand Publishing)
4. Digital Logic and Computer Design M. Morris Mano (Pearson)
5. Concepts of Electronics D.C. Tayal (Himalaya Publishing House)

**CORE PAPER–X LAB**

**(minimum 6 experiments are to be done):**

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO and to test a Diode and Transistor using a Millimeter.
2. To design a switch (NOT gate) using a transistor.
3. To verify and design AND, OR, NOT and XOR gates using NAND gates.
4. Half Adder, Full Adder and 4-bit binary Adder.
5. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
6. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
7. To design an astable multivibrator of given specifications using 555 Timer.
8. To design a monostable multivibrator of given specifications using 555 Timer.
Reference Books:

1. Basic Electronics: A Text Books lab manual, P.B. Zbar, A.P. Malvino,
   M.A. Miller, 1994, Mc-Graw Hill.

CORE PAPER-XI
QUANTUM MECHANICS AND APPLICATIONS

UNIT- I


UNIT-II


UNIT-III

Time Independent Schrödinger equation in one dimension (1d), 2d and 3d, Hamiltonian, stationary states and energy eigen values, expansion of an arbitrary
wave function as a linear combination of energy eigen functions, General solution of the time dependent Schrödinger equation in terms of linear combinations of stationary states. General Discussion of Bound states in an arbitrary potential: Continuity of wave function, Boundary condition and emergence of discrete energy levels, Application to one dimensional problem-Square well potential, Quantum mechanics of simple Harmonic Oscillator-Energy Levels and energy eigen functions, ground state, zero point energy and uncertainty principle, One dimensional infinitely rigid box energy eigen values and eigen functions, normalization, quantum dot as example, Quantum mechanical scattering and tunnelling in one dimension across a step potential and rectangular potential barrier.

UNIT-IV


Text Books:
1. Introduction to Quantum Theory, David Park (Dover Publications)
2. Introduction to Quantum Theory, D. J. Griffiths (Pearson)

Reference Books:
1. Quantum Mechanics, Theory and Applications, A. Ghatak and S. Lokanathan (McMillan India)
2. Quantum Mechanics, G. Aruldhas (Printice Hallof India)
3. Quantum Physics—S. Gasiorowicz (Wiley)
5. Quantum Mechanics - J.L. Powell and B. Craseman (Narosa)
6. Introduction to Quantum Mechanics M. Das and P. K. Jena (Shri Krishna Publication)

**CORE PAPER- XILAB**

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like (Use finite difference method, matrix method, ODE Solver method in all cases)

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:
\[
\frac{d^2y}{dr^2} = A(r)u(r), \quad A(r) = \frac{2m}{\hbar^2} [V(r) - E], \quad V(r) = -\frac{e^2}{r},
\]

where \( m \) is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is \( \sim -13.6 \text{eV} \). Take \( e = 3.795 \sqrt{(eV\text{Å})} \), \( \hbar c = 1973(eV\text{Å}) \) and \( m = 0.511 \times 10^6 eV/c^2 \)

2. Solve the s-wave radial Schrodinger equation for an atom:
\[
\frac{d^2y}{dr^2} = A(r)u(r), \quad A(r) = \frac{2m}{\hbar^2} [V(r) - E],
\]
where \( m \) is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential: \( V(r) = -\frac{e^2}{r} e^{-r/a} \)

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wave function. Take \( e = 3.795 \sqrt{(eV\text{Å})} \), \( \hbar c = 1973(eV\text{Å}) \) and \( m = 0.511 \times 10^6 eV/c^2 \), and \( a = 3\text{Å}, 5\text{Å}, 7\text{Å} \). The ground state energy is expected to be above -12 eV in all three cases.
3. Solve the s-wave radial Schrodinger equation for a particle of mass $m$: 
\[ \frac{d^2 y}{dr^2} = A(r)u(r), \quad A(r) = \frac{2m}{\hbar^2} [V(r) - E], \]

for the anharmonic oscillator potential: 
\[ V(r) = \frac{kr^2}{2} + \frac{br^3}{3}. \]

Find the ground state energy (in MeV) of the particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose 
\[ m = 940 \text{MeV}/c^2, \quad k = 100 \text{MeV}/fm^2, \quad b = 0, 10, 30 \text{MeV}/fm^3. \]
In these Units, $c = 197.3 \text{ MeV fm}$. [The ground state energy is expected to lie between 90 and 110 MeV for all three cases.]

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule: 
\[ \frac{d^2 y}{dr^2} = A(r)u(r), \quad A(r) = \frac{2m}{\hbar^2} [V(r) - E], \]

where $m$ is the reduced mass of the two-atom system for the Morse potential 
\[ V(r) = D(e^{-2\alpha r} - e^{-\alpha r}), \]

where $r = r - r_0$. Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave functions for the choices given below:

a) $m = 940 \times 10^6 \text{eV}/c^2, \quad D = 0.755501 \text{eV}, \quad \alpha = 1.44, \quad r_0 = 0.131349 \text{Å}$

b) $m = 940 \times 10^6 \text{eV}/c^2, \quad D = 0.755501 \text{eV}, \quad \alpha = 1.44, \quad r_0 = 0.131349 \text{Å}$

Laboratory based experiments:

1. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
2. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
3. To show the tunneling effect in tunnel diode using I-V characteristics.
4. Quantum efficiency of CCDs

Reference Books:

3. An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press
   ISBN:9786133459274

CORE PAPER-XII

SOLID STATE PHYSICS

UNIT-I


UNIT-II

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear, Monotomic and Diatomic Chains, Acoustical and Optical Phonons, Qualitative Description of the phonon spectrum in solids, Dulong and Petits Law, Einstein and Debye theories of specific heat of solids, $T^3$ Law

UNIT-III

**Dielectric Properties of Materials:** Polarization Local Electrical Field at an Atom, Depolarization Field, Electric Susceptibility, Polarizability, Clausius Mosotti Equation, Classical theory of Electronic Polarizability.

**Lasers:** Einstein's A and B coefficients, Metastable States, Spontaneous and Stimulated emissions, Optical Pumping and population Inversion, Three Level and Four Level Lasers, Ruby Laser and He-Ne Laser.

UNIT-IV

**Elementary band theory:** Kronig-Penny model of band Gap, Conductor, Semiconductor (P and N type) and insulator, Conductivity of Semiconductor, mobility, Hall Effect, Measurement of conductivity (04 problem method) and Hall Coefficient.

**Superconductivity:** Experimental Results, Critical Temperature, Critical magnetic field, Meissner effect, Type I and Type II Superconductors, London's Equation and Penetration Depth, Isotope effect, Idea of BCS theory (No derivation)

**Text Books:**
1. Introduction to Solid State Physics- Charles Kittel (Wiley India)
2. LASERS: Fundamentals and Applications- Thyagarajan and Ghatak (McMillan India)

**Reference Books:**
3. Solid State Physics S. O. Pillai (New Age Publication)
4. Lasers and Nonlinear Optics B. B. Laud (Wiley Eastern)
5. Elements of Solid State Physics- J.P. Srivastava (Prentice Hall of India)
**CORE PAPER-XII LAB**  
(minimum 4 experiments are to be done)

1. Measurement of susceptibility of paramagnetic solution (Quincks Tube-Method)
2. To measure the Magnetic susceptibility of Solids.
3. To measure the Dielectric Constant of a dielectric Material with frequency
4. To determine the Hall coefficient of a semiconductor sample.
5. To draw the BH curve of Fe using solenoid and to determine the energy loss from Hysteresis.
6. To measure the band gap of a given semiconductor by four-probe method.

**Reference Books:**

3. A Text Books Book of Practical Physics, I.Prakashand Ramakrishna, 11 Ed., 2011, Kitab Mahal

**CORE PAPER-XIII**

**ELECTROMAGNETIC THEORY**

**UNIT-I**

**Maxwell Equations:** Maxwells equations, Displacement Current, Vector and Scalar Potentials, Gauge Transformations: Lorentz and Coulomb Gauge, Boundary Conditions at Interface between Different Media, Wave Equations, Plane Waves in Dielectric Media, Poynting Theorem and Poynting Vector, Electromagnetic (EM) Energy Density, Physical Concept of Electromagnetic Field Energy Density

**UNIT-II**
EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance, Propagation through conducting media, relaxation time, skin depth, Electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.

UNIT-III

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media, Reflection and Refraction of plane waves at plane interface between two dielectric media, Laws of Reflection and Refraction, Fresnel’s Formulae for perpendicular and parallel polarization cases, Brewster’s law, Reflection and Transmission coefficients, Total internal reflection, evanescent waves, Metallic reflection (normal incidence)

UNIT IV

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization, Uniaxial and Biaxial Crystals, Light Propagation in Uniaxial Crystal, Double Refraction, Polarization by Double Refraction, Nicol Prism, Ordinary and extraordinary refractive indices, Production and detection of Plane, Circularly and Elliptically Polarized Light,


Rotatory Polarization: Optical Rotation, Biot’s Laws for Rotatory Polarization, Fresnel’s Theory of optical rotation, Calculation of angle of rotation, Experimental verification of Fresnel’s theory, Specific rotation, Laurent’s half-shade polarimeter.

Text Books:
1. Introduction to Electrodynamics, D.J. Griffiths (Pearson)
2. Principles of Optics - Max Born and E. Wolf

Reference Books:
1. Classical Electrodynamics by J.D. Jackson
2. Foundation of Electromagnetic Theory: Ritz and Milford (Pearson)
3. Electricity and Magnetism: D C Tayal (Himalaya Publication)
4. Optics: A.K. Ghatak
5. Electricity and Magnetism: Chattopadhyaya, Rakhit (New Central)

CORE PAPER XIII LAB

(minimum 4 experiments are to be done):
1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.
5. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
6. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
7. To verify the Stefan's law of radiation and to determine Stefan's constant.
8. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

Reference Books:
CORE PAPER-XIV

STATISTICAL MECHANICS

UNIT- I


UNIT- II


UNIT-III


UNIT-IV


Plancks Law of Black body Radiation: Experimental verification, Deduction of

Text Books:
1. Introduction to Statistical Physics by Kerson Huang (Wiley).
2. Statistical Physics, Berkeley Physics Course, F. Reif (Tata McGraw-Hill)

Reference Books:
1. Statistical Mechanics, B.K. Agarwal and Melvin Eisner (New Age International)
2. Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Francis W. Sears and Gerhard L. Salinger (Narosa)

CORE PAPER-XIV LAB
Use C/C++/Scilab for solving the problems based on Statistical Mechanics like
1. Plot Planck's law for Black Body radiation and compare it with Weins Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.
2. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases.
3. Plot Maxwell-Boltzmann distribution function versus temperature.
4. Plot Fermi-Dirac distribution function versus temperature.
5. Plot Bose-Einstein distribution function versus temperature.

Reference Books:


Discipline Specific Elective Paper-1

CLASSICAL DYNAMICS

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

UNIT-I


UNIT-II


UNIT-III

Special Theory of Relativity (Postulates of special theory of relativity), Lorentz transformations, Minkowski space, The invariant interval, light cone and world lines, space time diagrams, Time-dilation, length contraction and Twin paradox, Variation of mass with velocity mass energy relation.
UNIT- IV

Four Vectors: Space Like, Time-like and light-like. Four velocity and acceleration, Four momentum and energy-momentum relation. Doppler effects from a four vector perspective, Concept of four-force, Conservation of four momentum, Application to two-body decay of an unstable particle

Text Books:

1. Classical Mechanics, H. Goldstein, C.P. Poole, J.L. Safko (Pearson)

Reference Books:

1. Mechanics-D.S. Mathur (Sultan Chand)
4. Mathematical Physics with Classical Mechanics-Satya Prakash (Sultan Chand and sons)
5. Introduction to classical dynamics R.K. Takwale and S. Puranik (Tata McGraw Hill)
6. Classical Mechanics J.C. Upadhyay (Himalayan Publisher)
7. Classical Dynamics of particles and systems -S.T. Thorton and Marion (Cengage publication)
UNIT-I

**General properties of Nuclei:** Constituents of nucleus and their intrinsic properties, Quantitative facts about mass, radius, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excited states. **Radioactivity decays:** (a) Alpha decay: basics of alpha-decay processes, theory of alpha-emission, Gamow factor, Geiger Nuttall law (b) beta-decay: energy kinematics for beta-decay, positron emission, electron capture, neutrino hypothesis. (c) Elementary idea of Gamma decay.

UNIT-II

**Nuclear Models:** Liquid drop model approach, semi empirical mass formula and significance of its various terms, conditions of nuclear stability, two nucleon separation energies, evidence for nuclear shell structure, nuclear magic number, basic assumption of shell models.

UNIT-III

**Detector for nuclear radiations:** Detector for nuclear radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of scintillation detectors and construction of photomultiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (Concept of charge carrier and mobility), neutron detector. **Particle Accelerators:** Van-de Graff generator (Tandem Accelerator), Linear accelerator, Cyclotron, Synchrotrons
UNIT-IV

**Particle Physics:** Particle interactions, basic features, types of particles and its families,

**Symmetries and conservation laws:** Energy and momentum, angular momentum, parity, baryon number, lepton number, isospin, strangeness and charm, Elementary ideas of quarks and gluons.

**Text Books:**
1. Introduction to Nuclear Physics By Roy and Nigam
2. Atomic and Nuclear Physics-N. Subramanyam, Brij Lal and Jivan Seshan (S. Chand Publishing)

**Reference Books:**
1. Introduction to Modern Physics-H.S. Mani and G.K. Mehta (Affiliated east and west)
2. Introductory Nuclear Physics-Kenneth S. Krane (Wiley India Pvt. Ltd)
3. Introduction to Elementary Particles-D. Griffith (John Wiley and Sons)

**Discipline Specific Elective Paper- II1**

**Nano Materials and Applications**

**UNIT-I**

**Nanoscale Systems:** Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, size effects in nano systems, Quantum confinement Applications of Schrodinger equation-infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructure and its consequences.
UNIT-II

Synthesis of Nanostructure Materials: Top down and bottom up approach, Photolithography, Ball milling, Gas phase condensation, Vacuum deposition, Physical vapour deposition (PVT): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition, Chemical vapour deposition (CVD), Sol-Gel Electrodeposition, Spray pyrolysis, Hydrothermal synthesis, Preparation through colloidal methods, MBE growth of quantum dots.

UNIT-III


UNIT-IV


Text Books:
2. Nano science and nano technology, K.K. Choudhury (Narosa)

Reference Books:
1. Nano Science and Nanotechnology, Sundar Singh (Pragati Prakashan)
2. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).

**Discipline Specific Elective Paper-1V**

**Project**

**OR**

**Basic Instrumentation**

**Basic Instrumentation**

**UNIT-I**

**Basic of Measurement:** Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects.

**Multimeter:** Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

**Electronic Voltmeter:** Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage measurement (block diagram only). Specifications of an electronic Voltmeter/Multimeter and their significance.

**AC millivoltmeter:** Type of AC millivoltmeters: Amplifier-rectifier, and rectifier-amplifier. Block diagram ac millivoltmeter, specifications and their significance.

**UNIT-II**

**Cathode Ray Oscilloscope:** Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only no mathematical treatment), brief discussion on screen phosphor, visual persistence and chemical composition. Time base operation, synchronization. Front panel controls.
Specifications of a CRO and their significance.

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

UNIT-III

Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators, pulse generator, and function generator, Brief idea for testing, specifications, Distortion factor meter, wave analysis.

UNIT-V


Digital Multimeter: Block diagram and working of a digital multimeter, Working principle of time interval, frequency and period measurement using universalcounter/frequency counter, time-base stability, accuracy and resolution.

The test of lab skills will be of the following test items:
1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges
**Laboratory Exercises:**

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and a high resistance.
2. To observe the limitations of a multimeter for measuring high-frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q-meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.

**Open Ended Experiments:**

1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

More emphasis should be given on hands-on experiments.

**Text Books:**

1. A Text Books book of electrical technology - B.L. Theraja (S.Chand Publishing)
2. Digital circuits and systems Venugopal (Tata McGraw Hill)

**Reference Books:**

1. Digital Electronics - Subrata Ghoshal (Cengage Learning)
2. Electronic Devices and circuits - S. Salivahanan and N. S. Kumar (Tata Mc-Graw Hill)
3. Electronic Devices - Thomas L. Floyd (Pearson)

**Additional Reference Books for Practical papers:**

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop (Asia Publishing House)
2. Practical Physics - B.B. Swain (Kitab Mahal)
3. Practical Physics - B. Ghosh (Vol. I and II)
4. A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal (Vani Publication)
5. B.Sc. Practical Physics - C.L. Arora (S. Chand Publishing)
GENERIC ELECTIVE (GE)

Generic Elective Paper I

(Mechanics and Properties of matter, Oscillation and Waves, Thermal Physics, Electricity and Magnetism and Electronics)

UNIT-I

Mechanics and Properties of Matter

Moment of Inertia Parallel axis and perpendicular axis theorem, M.I. of a Solid sphere and Solid cylinder, Gravitational potential and field due to a thin spherical shell and a solid sphere at external points and internal points, Relationamongelasticconstants,depressionatfreeendofalightcantilever,Surfacetension,pressure,differenceacrossacurvedmembrane,viscousflow,Poiseulles formula.

UNIT-II

Oscillation and Waves

Simple harmonic motion, damped harmonic motion, under damped, over damped and critically damped motion, Forced vibration, Resonance, Wave equation in a medium, Velocity of Longitudinal waves in an elastic medium and velocity of transverse wave in a stretched string, Composition of SHM, Lissajous figures for superposition of two orthogonal simple harmonic vibrations (a) with same frequency, (b) frequency with 2:1.

UNIT-III

Thermal Physics

Entropy, change in entropy in reversible and irreversible process, Carnot engine and its efficiency. Carnot Theorem, Second law of thermodynamics, Kelvin-Planck,
Clausius formula. Thermal conductivity, differential equation for heat flow in one dimension, Maxwell thermodynamic relation (statement only), Clausius Clapeyron equation, Black body radiation, Planck radiation formula (No derivation).

UNIT-IV

Electricity and Magnetism

Gauss law of electrostatics, use of Gauss law to compute electrostatic field due to a linear charge distribution, Magnetic induction B, Lorentz force law, Biot Savarts law, Magnetic induction due to long straight current carrying conductor, and in the axis of a current carrying circular coil, Amperes Circuital law, its differential form, The law of electromagnetic equations, its differential and integral form, Maxwell’s electro-magnetic equations and their physical significance, Growth and decay of currents in LR and RC circuits, time constant, alternating currents in RC, RL and LCR circuits, impedance, power factor, resonance.

P-type and N-type semiconductors, PN-Junction as rectifier, Half wave and Full wave rectifiers (Bridge type), efficiency, ripple factor, use of RC, LC, and filters, working of PNP and NPN transistors, transistor configurations in CE and CB circuits and relation between $\alpha$ and $\beta$. JFET, its operation and characteristics of V-I curve.

Text Books:

4. Electricity and magnetism- R. Murugesan (S. Chand Publishing)
5. Fundamentals of Electronics-Raskhit and Chattopadhyay (New age International Publication)

Reference Books:
3. Waves and Oscillations (2nd ed) N. Subramaniyam and Brij Lal (Vikas Publications)

**Generic Elective Paper I Lab-**

*(minimum 6 experiments are to be done)*

1. To determine the moment of inertia of a flywheel.
2. To determine the Youngs modulus Y of a wire by Searlsmethod.
3. To determine the modulus of rigidity of a wire by Maxwellssneedle/Torsion Pendulum (Dynamicmethod).
4. To determine g by barpendulum.
5. To determine the value of Y of a rubber by using travellingmicroscope.
6. To determine the Rigidity of modulus by staticmethod.
7. To determine the frequency of a telescope by usingSonometer.
8. Verification of Lawsof Vibrationof a string by using Sonometer.

**TEXT BOOKS:**

1. To compare capacitances using DeSautybridge.
2. To determine the Law of resistance by using Fosterbridge.
3. Compare the specific heat of two liquids by method of Cooling.

**Reference Books:**

1. Advanced Practical Physics for students, B.L.FlintandH.T.Worsnop, 1971, Asia PublishingHouse
2. A LaboratoryManualof Physicsfor UndergraduateClasses, D.P. Khandelwal (1985), VaniPublication
Generic Elective Paper -II

( Optics, Special Theory of Relativity, Atomic Physics, Quantum Mechanics and Nuclear Physics)

UNIT-I

Optics-I: Elementary ideas of monochromatic aberrations and their minimization, chromatic aberration, achromatic combination, Theory of formation of primary and secondary rainbow, condition of interference, coherent sources, Youngs double slit experiment, biprism and measurement of wave length of light of by it, color of thin films and Newtons rings, Fresnel and Fraunhoffer diffraction, diffraction by single slit plane transmissiongrating.

Optics-II: Electromagnetic nature of light, polarized and unpolarized light, polarization by reflection and refraction, Brewsters Law, Mauls Law, Double refraction, Ordinary and extraordinary rays.

UNIT-II Atomic Physics

Inadequacy of classical physics, brief outline of Rayleigh Jeans theory and Plancks quantum theory of radiation, particle nature of electromagnetic radiation photo electric effect, Compton effect, dual nature of radiation, wave nature of particles, de-Broglie hypothesis, matter wave, wave-particle duality, Davisson-Germerexperiment.


UNIT-III

Quantum Mechanics: Heisenbergs Uncertainty relation, Time dependent Schrodingers wave equation in one dimension and three dimensions, The physical interpretation of the wave function, Probability density and probability current
density, Equation of continuity, Normalization of the Wave function, Expectation value of an observable, Ehrenfests theorem. Time independent Schrodinger's wave equation in one dimension particle in a box, energy eigen values and eigenfunctions.

UNIT-IV

**Nuclear Physics**: Properties of the nucleus Charge, Size, Spin, Magnetic Moment, Mass, Mass defect, Binding energy, Packing fraction, Nuclear force and its characteristics features, Radioactive decay laws, average life, half life, nuclear fission, nuclear fusion, Linear accelerators, and cyclotron.

**Relativity**: Galilean transformation, Newtonian relativity and its limitation, MichelsonMorley experiment and its consequence, postulates of special theory of relativity. Lorentz transformation, length contraction, time dilation, relativistic mass and momentum, mass energy relation.

**Text Books**:  
1. University Physics, H. D. Young, R. A. Freedman(Person)  
2. Fundamentals of Physics, Resnick, Halliday, Walker(WIley)

**Reference Books**:
2. Introduction to Special Relativity-R. Resnick (JohnWiley)  
4. Modern Physics H.S. Mani and G.K.Mehta

**Generic Elective Paper II LAB**  
*(minimum 6 experiments are to be done):*

1. Determination of E.C.E. of a Copper by taking 3 readings.  
2. Determination of Refractive index of the material of a prism using Sodium light.  
3. To determine the wavelength of light using planediffraction grating.
4. To determine the wavelength of light using Newton's ring.

5. Determination of refractive index of (a) glass and (b) liquid by using travelling microscope.

6. To plot the I-D curve and to determine the refractive index of a prism.

7. Determination of radius of curvature of a convex/concave mirror by using Kohlrausch's method.

8. To determine the magnifying power of a given telescope.

9. To obtain the static characteristics of a P-N-P/N-P-N transistor/Triode Valve.

10. To determine the reduction factor of a tangent Galvanometer.

11. To study the Variation of magnetic field along the axis of a circular coil carrying current.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House


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<td>Mechanics</td>
<td>04</td>
<td>75</td>
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<td>Thermal Physics &amp; Statistical</td>
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<td>V</td>
<td>DSE-I</td>
<td>Digital and Analog Circuits &amp;</td>
<td>04</td>
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Discipline Specific Core – 4 papers  
Discipline Specific Elective – 2 papers  
Marks per paper –  
Practical paper: Midterm : 15 marks, End term : 60 marks, Practical: 25 marks  
For non practical paper: Mid term : 20 marks, End term : 80 marks  
Total – 100 marks Credit per paper – 6  
Teaching hours per paper –  
Practical papers:40 hours + 20 hours practical  
Non practical papers:50 hours + 10 hours tutorial

Discipline Specific Core Paper 1  
MECHANICS

UNIT-I


Non Inertial frames and fictitious Forces: Uniformly Rotating frame, laws of Physics in rotating Coordinate system, centrifugal Forces, Coriolis force and its applications.

UNIT-II

Gravitation: Newton’s Law of gravitation. Gravitational field Intensity and Potential,
Central Force:


UNIT-III

Elasticity: Relation between Elastic constants. Torsion of a right circularcylinder, torsionalwire, Bending of Beams, External Bending Moment, flexuralrigidity, singleCantilever, double cantilever(weightless cantilever, and with its own weight)

Fluid Properties:

Surface Tension- Express Pressure across a curved membrane, S.T., Quincke’s drop, gravity waves and ripple,


Unit-IV

Oscillations: Simple Harmonic Oscillations. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Equation of motion and solution, cases of oscillatory, critically damped and overdamped) Forced oscillations: Transient and steady states;

Resonance, sharpness of resonance; power dissipation and Quality Factor. Bar Pendulum, Kater’s Pendulum. Composition of two SHMs propagating perpendicularly to each other(with frequency in the ratio 1:1,2:1) Lissajous figures

Text Books:

1. Mechanics, D.S. Mathur (S. Chand Publishing )
2. Introduction to Special Relativity-R. Resnick (John Wiley)
Reference Books:

1. Mechanics, Berkeley Physics, vol.1, C.Kittel, W. Knight, etal (Tata McGraw-Hill)

Discipline Specific Core Paper I LAB

(minimum 6 experiments are to be done)

1. To study the random error in observations.
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of Rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine g and velocity for a freely falling body using Digital Timing Technique.
7. To determine the Young's Modulus of a Wire by Optical Lever Method.
8. To determine the Modulus of Rigidity of a Wire by Maxwell’s needle.
9. To determine the elastic Constants of a wire by Searle’s method.
10. To determine the value of g using Bar Pendulum.
11. To determine the value of g using Kater’s Pendulum.

Reference Books

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, AsiaPublishing House
Discipline Specific Core Paper-11

ELECTRICITY, MAGNETISM AND EMT

UNIT-I

Vector Analysis: Scalar and Vector product, gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential.

UNIT-II


UNIT-III

Magnetism:


**UNIT-IV**

**Maxwell’s equations and Electromagnetic wave propagation:** Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

**Text:**

1. Introduction to Electricity and Magnetism – D.C.Tayal (Himalaya Publishing house)

**Reference:**

1. Electricity, Magnetism & Electromagnetic Theory- S. Mahajan and Choudhury ( Tata McGraw Hill)
4. Foundations of Electromagnetic Theory-Ritz and Milford (Pearson)

**Discipline Specific Core Paper 11 LAB**

(minimum 6 experiments are to be done)

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer:
   (i) Measurement of charge and current sensitivity
   (ii) Measurement of CDR
(iii) Determine a high resistance by Leakage Method
(iv) To determine Self Inductance of a Coil by Rayleigh’s Method.
3. To compare capacitances using De’Sauty’s bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx)
5. To study the Characteristics of a Series RC Circuit.
6. To study a series LCR circuit LCR circuit and determine its (a) Resonant frequency, (b) Quality factor
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q
8. To determine a Low Resistance by Carey Foster’s Bridge.
9. To verify the Thevenin and Norton theorems
10. To verify the Superposition, and Maximum Power Transfer Theorems

Reference Books

3. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed.2011, Kitab Mahal

Discipline Specific Core Paper III

THERMAL PHYSICS AND STATISTICAL MECHANICS

UNIT-I

Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

**Thermodynamical Potentials:** Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell’s relations and applications - Joule-Thomson Effect, Clausius-Clapeyron Equation, Expression for \((CP – CV)\), \(CP/CV\), \(TdTs\) equations.

**UNIT-II**

**Kinetic Theory of Gases:** Derivation of Maxwell’s law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

**UNIT-III**

**Theory of Radiation:** Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck’s law, Deduction of Wien’s distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien’s displacement law from Planck’s law.

**UNIT-IV**


**Text:**

1. Thermal Physics, A. B. Gupta (Books and allied Ltd)
2. Theory and experiments on thermal Physics, P.K. Chakrabarty (New central book agency limited)
Reference:

3. Thermal Physics, S. Garg, R. Bansal and Ghosh-(Tata McGraw-Hill)
4. Thermodynamics, Kinetic Theory & Statistical Thermodynamics- Sears & Salinger (Narosa)
5. A Treatise on Heat- Meghnad Saha and B.N.Srivastava (The Indian Press)
6. Heat, Thermodynamics and Statistical Physics-- N.Subrahmanyam and Brij Lal (S.Chand Publishing)

**Discipline Specific Core Paper 1II LAB**

*(minimum 6 experiments are to be done)*

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne’s constant flow method.
3. To determine Stefan’s Constant.
4. To determine the coefficient of thermal conductivity of Cu by Searle’s Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom’s Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton’s disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system.
Reference Books:


Discipline Specific Core Paper IV

WAVES AND OPTICS

UNIT-I

**Geometrical optics:** Fermat’s principle, reflection and refraction at plane interface, Matrix formulation of geometrical Optics. Idea of dispersion.

Cardinal Points and cardinal planes of an optical system, location of cardinal points and cardinal planes of (1) thick lens (2) thin lens and (3) coaxial combination of two thin lenses using matrix formulation.


UNIT-II


UNIT-III

Interference-I: Division of amplitude and wavefront. Young’s double slit experiment. Lloyd’s Mirror and Fresnel’s Biprism. Phase change on reflection: Stokes’ treatment

Interference-II:


UNIT-IV


Text:

2. Optics - Ajoy Ghatak (McGraw Hill)

Reference:

1. Optics-E.Hecht (Pearson)
3. Geometrical and Physical Optics – R.S. Longhurst (Orient Blackswan)
5. Optics – B.K.Mathur

Discipline Specific Core Paper 1V LAB

(minimum 6 experiments are to be done)

1. To investigate the motion of coupled oscillators
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde’s Experiment and to verify $\lambda^2 - T$ Law.
3. To study Lissajous Figures
4. Familiarization with Schuster’s focussing; determination of angle of prism.
5. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille’s method).
6. To determine the Refractive Index of the Material of a Prism using Sodium Light.
7. To determine Dispersive Power of the Material of a Prism using Mercury Light
8. To determine the value of Cauchy Constants.
10. To determine wavelength of sodium light using Fresnel Biprism.
12. To determine the wavelength of Laser light using Diffraction of Single Slit.
13. To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Grating
15. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits
Reference Books:

UNIT-1:
Digital Circuits

UNIT-II
Semiconductor Devices and Amplifiers:

UNIT-III
BJT and Amplifiers
Oscillators: Hartley and Colpitt’s Oscillator

UNIT-IV:
Operational Amplifiers (Black Box approach):
Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop & Closed-loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and Non-inverting

**Instrumentations:**
Introduction to CRO: Block Diagram of CRO. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

**Text:**

1. Electronics: Fundamentals and applications – D. Chattopadhyay and P.C.Rakshit (New Age international)

**Reference :**

3. Digital Logic and Computer design – M. Morris Mano (Pearson)
4. Text book of Electronics – B. B. Swain (Kitab Mahal)
5. Concepts of Electronics – D.C.Tayal (Himalaya Publishing house)

**Discipline Specific Elective Paper –I LAB**

**DIGITAL AND ANALOG CIRCUITS AND INSTRUMENTS**

*(minimum 6 experiments are to be done)*

1. To measure (a) Voltage, and (b) Frequency of a periodic waveform using a CRO
2. To verify and design AND, OR, NOT and XOR gates using NAND gates.
3. To minimize a given logic circuit.
4. Half adder, Full adder and 4-bit Binary Adder.
5. Adder-Subtractor using Full Adder I.C.
6. To design an astable multivibrator of given specifications using 555 Timer.
7. To design a monostable multivibrator of given specifications using 555 Timer.
8. To study IV characteristics of PN diode, Zener and Light emitting diode
9. To study the characteristics of a Transistor in CE configuration.
10. To design a CE amplifier of a given gain (mid-gain) using voltage divider bias.
11. To design an inverting amplifier of given gain using Op-amp 741 and study its frequency response.
12. To design a non-inverting amplifier of given gain using Op-amp 741 and study its Frequency Response.
13. To study a precision Differential Amplifier of given I/O specification using Opamp.
14. To investigate the use of an op-amp as a Differentiator
15. To design a Wien Bridge Oscillator using an op-amp.

Reference Books:


Discipline Specific Elective Paper II

ELEMENTS OF MODERN PHYSICS

UNIT-I
Planck’s quantum, Planck’s constant and Compton scattering. De Broglie experiment.
light as a collection of photons; Photoelectric effect, wavelength and matter waves; Davisson-Germer Experiment

Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra.
UNIT-II
Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.
Two slit interference experiment with photons, atoms & particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wavefunction, probabilities and normalization; Probability and probability current densities in one dimension.

UNIT-III
One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier.

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy

UNIT-IV
Radioactivity: stability of nucleus; Law of radioactive decay; Mean life and half-life; α decay; β decay - energy released, spectrum and Pauli’s prediction of neutrino; γ-ray emission.

Fission and fusion - mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions.

Text:

2. Modern Physics – Murugeshan and Sivaprasad (S.Chand)

Reference:

2. Introduction to Quantum Mechanics, David J. Griffith (Pearson)
4. Modern Physics-Serway (CENGAGE Learnings)
5. Physics of Atoms and Molecules – Bransden (Pearson India)
6. Quantum Mechanics– Satya Prakash (Pragati Prakashan)
DSE II LAB: ELEMENTS OF MODERN PHYSICS

(minimum 6 experiments are to be done)

1. To determine value of Boltzmann constant using V-I characteristic of PN diode.
2. To determine work function of material of filament of directly heated vacuum diode.
3. To determine the ionization potential of mercury.
4. To determine value of Planck’s constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the absorption lines in the rotational spectrum of Iodine vapour.
7. To study the diffraction patterns of single and double slits using laser and measure its intensity variation using Photosensor & compare with incoherent source – Na.
8. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
9. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
10. To setup the Millikan oil drop apparatus and determine the charge of an electron.

Reference Books:

3. 1985, Heinemann Educational Publishers
SKILL ENHANCEMENT COMPULSORY COURSES (SECC)

Optional for SECC II paper

Skill Enhancement Compulsory Courses (SECC Option-I)

APPLIED OPTICS

The quest to understand the 'nature of light' is a favourite inquiry of mankind since ancient times. By the advent of lasers, holography, and optical fibres in twentieth century the optics now-a-days finds application in several branches of science and engineering. This paper provides the conceptual understanding of these branches of modern optics to the students.

Theory includes only qualitative explanation. Minimum three experiments should be performed covering minimum three sections.

Unit-I

(i) Photo-sources and Detectors

Lasers: an introduction, Planck’s radiation law (qualitative idea), Energy levels, Absorption process, Spontaneous and stimulated emission processes, Theory of laser action, Population of energy levels, Einstein’s coefficients and optical amplification, properties of laser beam, Ruby laser, He-Ne laser, and semiconductor lasers; Light Emitting Diode (LED) and photo-detectors.

(ii) Elementary ideas of Fourier Optics

Concept of Spatial frequency filtering, Fourier transforming property of a thin lens.

Unit-II

Holography

Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition.
Photonics: Fibre Optics

(ii) Photonics: Fibre Optics

Optical fibres: Introduction and historical remarks, Total Internal Reflection, Basic characteristics of the optical fibre: Principle of light propagation through a fibre, the coherent bundle, The numerical aperture, Attenuation in optical fibre and attenuation limit; Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating.

Skill Enhancement Compulsory Courses (SECC Option-I) LAB

Minimum three experiments should be performed covering minimum two sections.

Experiments on Lasers:

1. To determine the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.
2. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
3. To find the polarization angle of laser light using polarizer and analyzer
4. To determine the wavelength and angular spread of laser light by using plane diffraction grating.

Experiments on Semiconductor Sources and Detectors:

1. V-I characteristics of LED
2. Study the characteristics of solid state laser
3. Study the characteristics of LDR
5. Characteristics of IR sensor

Experiments on Fibre Optics

1. To measure the numerical aperture of an optical fibre
2. To measure the near field intensity profile of a fibre and study its refractive index profile
**Reference Books:**


**Skill Enhancement Compulsory Courses (SECC Option-II)**

**RENEWABLE ENERGY AND ENERGY HARVESTING**

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible

**Unit-I**

**Fossil fuels and Alternate Sources of energy:** Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

**Solar energy:** Solar energy, its importance, storage of solar energy, solar pond, non plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

**Unit-II**

**Wind Energy harvesting:** Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.


**Hydro Energy**: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

**Skill Enhancement Compulsory Courses (SECC Option-II)-LAB**

**Demonstrations and Experiments**

1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into volta geusing thermoelectric modules.

**Reference Books:**

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
Faculty Training to be imparted in the following Topics

Computational Physics Lab—C, C++,

Scilab Programming for Core I,C-V,C-VIII,C-XI and C-XIII Practicals.


3. Quantum Mechanics Problem Solving

4. Solid State Physics- Elementary Band Theory and Superconductivity

5. Statistical Mechanics.-Quantum Distribution


ESSENTIAL LABORATORY EQUIPMENT RECOMMENDED:

Every college must have CRO, Function generator, Laser and Logic Gate packages.