CORE COURSE (HONOURS IN PHYSICS)

Semester I

- Time – 3hrs
- F.M.: 100 [60(End sem)+15(Int)+25(Pr)]
- Credit- 6

PHYSICS-CC I: MATHEMATICAL PHYSICS-I (Credits: Theory-04, Practicals- 02)
Theory: 40 Classes (1 hr duration)

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
Calculus:
Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Calculus of variation: Euler equation, Constrained Maxima/ minima using Lagrange Multipliers.  

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-II
Orthogonal Curvilinear Coordinates:
Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. Comparison of velocity and acceleration in cylindrical and spherical coordinate system.

UNIT-III
Vector Calculus:

UNIT-IV
Vector Differentiation:

UNIT-V
Vector Integration:
Reference Books:
- Calculus of variations: Euler’s equation, Constrained Maxima/Minima using Langragian Multipliers
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press
- Mathematical Physics--Goswami (Cengage Learning) 2014
- Mathematical Method for Physical Sciences -- M. L. Boas (Wiley India) 2006

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PHYSICS LAB- CC - I LAB:
20 Classes (2 hr duration)

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 any one operating system Linux or Microsoft Windows
**Topics** | **Description with Applications**
--- | ---
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 & overflow emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.
Errors and error Analysis | Truncation and round off errors, Absolute and relative errors, Floating point computations.
Review of C & C++ Programming fundamentals | Introduction to Programming, constants, variables and 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 Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops), Arrays (1D & 2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects
Programs: | Sum & 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 \( \pi \).

**Referred Books:**
- An Introduction to computational Physics, T. Pang, 2nd Edn., 2006, Cambridge Univ. Press.
CORE COURSE (HONOURS IN PHYSICS)

Semester I

PHYSICS-CC II: MECHANICS
(Credits: Theory-04, Practicals-02) Theory: 40
Classes (1hr duration)

Time – 3hrs F.M.: 100 [60(End sem)+15(Int)+25(Pr)] Credit- 6

UNIT-I


UNIT-II
Elasticity: Relation between Elastic constants. Twisting torque on a Cylinder or Wire. (3 Lectures)

Fluid Motion: Kinematics of Moving Fluids: Poiseuille’s Equation for Flow of a Liquid through a Capillary Tube. (2 Lectures)

UNIT-III
Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. (3 Lectures)


UNIT-IV
Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. (5 Lectures)

UNIT-V
Reference Books:
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.

Additional Books for Reference
- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley

PHYSICS LAB-CC- II LAB
20 Classes (2hr duration)

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
- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, KitabMahal
CORE COURSE (HONOURS IN PHYSICS)

Semester II
Time – 3hrs       F.M.: 100 [60(End sem)+15(Int)+25(Pr)]            Credit- 6

PHYSICS-CC- III: ELECTRICITY AND MAGNETISM
(Credits: Theory-04, Practicals-02)
Theory: 40 Classes (1hr duration)

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. (3 Lectures)

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace’s and Poisson equations. the Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. (3 Lectures)

UNIT-II

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 \( \mathbf{D} \). Relations between \( \mathbf{E} \), \( \mathbf{P} \) and \( \mathbf{D} \). Gauss’ Law in dielectrics. (4 Lectures)

UNIT-III

UNIT-IV
Magnetic Properties of Matter: Magnetization vector \( \mathbf{M} \). Magnetic Intensity \( \mathbf{H} \). Magnetic Susceptibility and permeability. Relation between \( \mathbf{B} \), \( \mathbf{H} \), \( \mathbf{M} \). Ferromagnetism. \( \mathbf{B} \)-\( \mathbf{H} \) curve and hysteresis. (4 Lectures)

UNIT-V

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

(4 Lectures)

**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.

(4 Lectures)

**Reference Books:**
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.

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PHYSICS LAB-CC - III LAB

20 Classes (2hr duration)

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster’s Bridge.
5. To compare capacitances using De’Sauty’s bridge.
6. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson’s bridge.
10. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
11. To study the response curve of a parallel LCR circuit and determine its (a) Antiresonant frequency and (b) Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
14. To determine self-inductance of a coil by Rayleigh’s method.
15. To determine the mutual inductance of two coils by Absolute method.

**Reference Books**
- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, KitabMahal
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani
CORE COURSE (HONOURS IN PHYSICS)
Semester II

PHYSICS-CC - IV: WAVES AND OPTICS
(Credits: Theory-04, Practicals-02) Theory:
40 Classes (1hr duration)

Time – 3hrs       F.M.: 100 [60(End sem)+15(Int)+25(Pr)]       Credit- 6

UNIT-I


UNIT-II
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. (2 Lectures)

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front Huygens Principle. Temporal and Spatial Coherence.(3 Lectures)

UNIT-III

UNIT-IV
Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry -Perot interferometer. (5 Lectures)

UNIT-V

Fresnel Diffraction: Fresnel’s Assumptions. Fresnel’s Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel’s Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire. (7 Lectures)

Reference Books
PHYSICS LAB- CC- IV LAB
20 Classes (2hr duration)

1. To determine the frequency of an electric tuning fork by Melde’s experiment and verify $\lambda^2 - T$ law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster’s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson’s interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books
- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani
Theory: 40 Classes (1hr duration)

UNIT-I
Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to time, Gradient, Divergence and Curl. (2 Lectures)

Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. (2 Lectures)


UNIT-II
Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum. (3 Lectures)


UNIT-III

UNIT-IV
Elasticity: Hooke’s law - Stress-strain diagram - Elastic moduli - Relation between elastic constants - Poisson’s Ratio - Expression for Poisson’s ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion - Torsional pendulum - Determination of Rigidity modulus and moment of inertia - q, η and σ by Searle’s method. (8 Lectures)

UNIT-V

Note: Students are not familiar with vector calculus. Hence all examples involved differentiation either in one dimension or with respect to the radial coordinate

Reference Books:
• University Physics. F.W. Sears, M.W. Zemansky and H.D. Young, 13/e, 1986. Addison-Wesley
• Physics – Resnick, Halliday& Walker 9/e, 2010, Wiley
• University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
PHYSICS LAB: GE –I LAB:
MECHANICS 20 Classes (2hr duration)

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young’s Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell’s needle.
6. To determine the Elastic Constants of a Wire by Searle’s method.
7. To determine g by Bar Pendulum.
8. To determine g by Kater’s Pendulum.
9. To study the Motion of a Spring and calculate (a) Spring Constant, (b) g.

Reference Books:

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

PHY. DSC-I OF SEM-I IS SAME AS PHY.GE-I, OF SEM-I / III
PHYSICS- GE-II : ELECTRICITY , MAGNETISM AND EMT (Credits: Theory-04, Practicals-02)

Theory: 40 Classes (1hr duration)  
Time – 3hrs    F.M.: 100 [60(End sem)+15(Int)+25(Pr)]    Credit- 6

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). (4 Lectures)

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 (4 Lectures)

UNIT-II
Electrostatic Potential, Potential energy and Dielectrics
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. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric. (8 Lectures)

UNIT-III
Magnetism:

Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferromagnetic materials. (4 Lectures)

UNIT-IV

Growth and decay of currents in LR, LC and RC circuits. Reactance and impedance in AC circuits, Series and parallel LCR Circuits, Resonance and Band Width, Q-factor and Power factor. (4 Lectures)

UNIT-V
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. (8 Lectures)

Reference Books:
• Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education
PHY.

DSC-II OF SEM-II IS SAME AS PHY.GE-II OF SEM-II / IV

GE LAB: ELECTRICITY, MAGNETISM AND EMT
20 Classes (2hr duration)
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 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
- Advanced Practical Physics for students, B.L.Flint&H.T.Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I.Praaksh& Ramakrishna, 11th Ed.2011, KitabMahal
Semester III

PHYSICS-C V: MATHEMATICAL PHYSICS-II
(Credits: Theory-04, Practicals-02)
Theory: 40 Classes (1hr duration)
Time – 3 hrs. F.M. – 100 [ 60(Sem) +15 (Int.) + 25 (Pr.)] Credits: 04(Th.) +02(Pr.)
Lectures – 60 [ 40(Th.) + (Pr.)]

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
Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). (4 Lectures)

UNIT-III
UNIT-IV

Reference Books:
- Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books
- Mathematical Physics-Goswami (CENGAGE Learning) 2014
- Mathematical Method for Physical Sciences -- M. L. Boas (Wiley India) 2006
- Mathematics for Physicists, P. Dennery and A. Krzywicki Dover)

PHYSICS LAB-C V LAB
20 Classes (2hr duration)

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.

<table>
<thead>
<tr>
<th>Topics</th>
<th>Description with Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Numerical computation software Scilab</td>
<td>Introduction to Scilab, Advantages and disadvantages, 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 &amp; logical operators, the while loop, for loop, details of loop operations, break &amp; 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,</td>
</tr>
<tr>
<td>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).</td>
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<tr>
<td>Curve fitting, Least square fit, Goodness of fit, standard deviation</td>
<td>Ohms law to calculate R, Hooke’s law to calculate spring constant</td>
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<tr>
<td>Solution of Linear system of equations by Gauss elimination method and Gauss Seidal</td>
<td>Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)</td>
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</tbody>
</table>
method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems

<table>
<thead>
<tr>
<th>Solution of ODE</th>
<th>First order differential equation</th>
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</thead>
<tbody>
<tr>
<td>First order Differential equation</td>
<td>• Radioactive decay</td>
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<tr>
<td>Euler, modified Euler and Runge-Kutta second order methods</td>
<td>• Current in RC, LC circuits with DC source</td>
</tr>
<tr>
<td>Second order differential equation.</td>
<td>• Newton’s law of cooling</td>
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<tr>
<td>Fixed difference method</td>
<td>• Classical equations of motion</td>
</tr>
</tbody>
</table>

Second order Differential Equation

- Harmonic oscillator (no friction)
- Damped Harmonic oscillator
- Over damped
- Critical damped
- Oscillatory
- Forced Harmonic oscillator
- Transient and
- Steady state solution
- Apply above to LCR circuits also

Reference Books:

- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
- Scilab(A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand& Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing
PHYSICS-C VI: THERMAL PHYSICS  
(Credits: Theory-04, Practicals-02)  
Theory: 40 Classes (1hr duration)  
(Include related problems for each topic)  
Time – 3 hrs.  F.M. – 100 [ 60( Sem) +15 (Int.) + 25 (Pr.)]  Credits: -04(Th.) +02(Pr.)  
Lectures – 60 [ 40(Th.) + (Pr.)]  

UNIT-I  
Introduction to Thermodynamics  
Recapitulation of Zeroth and First law of thermodynamics:  
Second Law of Thermodynamics: Reversible and Irreversible process with examples.  
& efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-  
Planck and Clausius Statements and their Equivalence. Carnot’s Theorem. Applications of  
Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to  
Perfect Gas Scale.  
(7 Lectures)  

UNIT-II  
Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of  
Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the  
Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot’s Cycle. Third Law  
of Thermodynamics. Unattainability of Absolute Zero.  
(7 Lectures)  

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables.  
Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb’s Free  
Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface  
Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and  
second order Phase Transitions with examples, Clausius-Clapeyron Equation and Ehrenfest  
equations  
(6 Lectures)  

UNIT-III  
Maxwell’s Thermodynamic Relations: Derivations and applications of Maxwell’s Relations,  
Maxwell’s Relations: (1) Clausius-Clapeyron equation, (2) Values of Cp-Cv, (3) Tds  
Equations,  
(4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change  
of Temperature during Adiabatic Process.  
(6 Lectures)  

Kinetic Theory of Gases  
Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal  
Gas and its Experimental Verification. Stern’s Experiment. Mean, RMS and Most Probable  
Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats  
of Gases.  
(4 Lectures)  

UNIT-IV  
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.  
(4 Lectures)  

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial  
and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal’s Equation of State for

(6 Lectures)

Reference Books:
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1958, Indian Press
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger, 1988, Narosa.
- Heat and Thermal Physics-Brijlal&Subramaian (S.Chand Publication) 2014
- Thermal Physics—C. Kittel and H. Kroemer (McMillan Education India) 2010

PHYSICS LAB- C VI LAB
20 Classes (2hr duration)
1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne’s constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle’s Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom’s Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton’s disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7. To calibrate a thermocouple to measure temperature in a specified Range using
   (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier
   and to determine Neutral Temperature.
8. To determine J by Calorimeter.

Reference Books
- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia
  Publishing House
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, KitabMahal

PHYSICS-C VII: DIGITAL SYSTEMS AND APPLICATIONS
(Credits: Theory-04, Practicals-02)
Theory: 40 Classes (1hr duration)
Time – 3 hrs. F.M. – 100 [ 60(Sem) +15(Int.) + 25(Pr.)] Credits: -04(Th.) +02(Pr.)
Lectures – 60 [ 40(Th.) + (Pr.)]

UNIT-I
**Integrated Circuits** (Qualitative treatment only): Active & 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. (3 Lectures)

**Digital Circuits:** Difference between Analog and Digital Circuits. Binary Numbers. Decimal toBinary and Binary to Decimal Conversion. 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. (5 Lectures)

**UNIT-II**


**UNIT-III**

**Introduction to CRO:** Block Diagram of CRO. Electron Gun, Deflection System and TimeBase. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. (3 Lectures)

**Timers:** IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. (3 Lectures)


**UNIT-IV**

**Data processing circuits:** Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. (4 Lectures)

**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). (2 Lectures)

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

**Reference Books:**

- Concept of Electronics: D.C. Tayal (Himalayan Publication) 2011
- Electronics - V. K. Mehta (S. Chand Publication) 2013
- The Art of Electronics, P. Horowitz and W. Hill, CUP
PHYSICS PRACTICAL-C VII LAB
20 Classes (2hr duration)

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To design an astablemultivibrator of given specifications using 555 Timer.
15. To design a monostablemultivibrator of given specifications using 555 Timer.

Reference Books:


Semester IV

PHYSICS-VIII: MATHEMATICAL PHYSICS-III
(Credits: Theory-04, Practicals-02)

Theory: 40 Classes (1hr duration)
Time – 3 hrs.    F.M. – 100 [ 60( Sem) +15 (Int.) + 25 (Pr.)]    Credits: -04(Th.) +02(Pr.)
Lectures – 60 [ 40(Th.) + (Pr.)]

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

Application in solving Definite Integrals.  

**UNIT-II**

Integrals Transforms:
Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.)  

10 Lectures.

**UNIT-III**

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT.  

8 Lectures

**UNIT-IV**


8 Lectures

**Reference Books:**

  Tata McGraw-Hill
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett.
- Mathematical Physics-Goswami (Cengage Learning) 2014
- Mathematical Method for Physical Sciences -- M. L. Boas (Wiley India) 2006

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**PHYSICS PRACTICAL-C VIII LAB**

20 Classes (2hr duration)

Scilab based simulations experiments based on Mathematical Physics problems like

1. Solved differential equations:
   \[
   \frac{dy}{dx} = e^{-x} \quad \text{with} \quad y = 0 \quad \text{for} \quad x = 0 \\
   \frac{dy}{dx} + e^{-x} y = x \\
   \frac{d^2y}{dt^2} + 2 \frac{dy}{dt} = -y \frac{d^2y}{dt^2} \\
   + e^{-t} \frac{dy}{dt} = -y
   \]
2. Dirac Delta Function:
Evaluate \( \frac{1}{\sqrt{2\pi\sigma^2}} \int e^{-\frac{(x-2)^2}{2\sigma^2}} (x + 3) \, dx \) for \( \sigma = 1, 0.1, 0.01 \) and show it tends to 5

3. Fourier Series:
Program to sum \( \sum_{n=1}^{\infty} (0.2)^n \)
Evaluate the Fourier coefficients of a given periodic function (square wave)

4. Frobenius method and Special functions:
\[
\int_{-1}^{1} p_n(\mu) d\mu = \delta_n, m
\]
Plot \( P_n(x), J_\nu(x) \)
Show recursion relation

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

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

7. Evaluation of trigonometric functions e.g. \( \sin \theta \), Given Bessel’s function at \( \mathbb{N} \) points find its value at an intermediate point. Complex analysis: Integrate \( 1/(x^2 + 2) \) numerically and check with computer integration.

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

**Reference Books:**
- Scilab(A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand& Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

**PHYSICS-C IX: ELEMENTS OF MODERN PHYSICS**
(Credits: Theory-04, Practicals-02)
Theory: 40 Classes (1hr duration)
Time – 3 hrs. F.M. – 100 [ 60( Sem) +15 (Int.) + 25 (Pr.)] Credits: -04(Th.) +02(Pr.)
Lectures – 60 [ 40(Th.) + (Pr.)]

**UNIT-I**
Atomic Spectra and Models
Inadequacy of classical physics, Brief Review of Black body Radiation, Photoelectric effect, Compton effect, dual nature of radiation, wave nature of particles.

3 Lectures

Wave Particle Duality
de Broglie hypothesis, Experimental confirmation of matter wave, Davisson Germer Experiment, velocity of de Broglie wave, wave particle duality, Complementarity. Superposition of two
waves, phase velocity and group velocity, wave packets, Gaussian Wave Packet, spatial distribution of wave packet, Localization of wave packet in time.

**UNIT-II**

(10 Lectures)

**UNIT-III**
Time development of a wave Packet; Wave Particle Duality, Complementarity. Heisenberg Uncertainty Principle, Illustration of the Principle through thought Experiments 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.

(8 Lectures)

**UNIT-IV**
Nuclear Physics
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 nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.

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 neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).

(14 Lectures)

**Reference Books:**
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Modern Physics – Bernstein, Fishbane and Gasiorowicz (Pearson India) 2010
- Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles -- R. Eisberg (Wiley India) 2012

**Additional Books for Reference**
- Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rdEdn., Institute of Physics Pub.
- Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill
- Modern Physics-Serway (CENGAGE Learnings) 2014
- Modern Physics ---Murugesan and Sivaprasad---(S. Chand Higher Academics)
- Physics of Atoms and Molecules – Bransden (Pearson India) 2003
PHYSICS PRACTICAL-C IX LAB
20 Classes (2hr duration)
1. Measurement of Planck’s constant using black body radiation and photo-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the 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 ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.
11. To determine the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source using diffraction of double slits.
13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating

Reference Books
• Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
• A Text Book of Practical Physics, I.Praaksh & Ramakrishna, 11th Edn, 2011, Kitab Mahal

PHYSICS-C X: ANALOG SYSTEMS AND APPLICATIONS
(Credits: Theory-04, Practicals-02)
Theory: 40 Classes (1hr duration)
Time – 3 hrs.  F.M. – 100 [ 60( Sem) +15 (Int.) + 25 (Pr.)]  Credits: -04(Th.) +02(Pr.)
Lectures – 60 [ 40(Th.) + (Pr.)]

Unit-I

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers. Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell. (4 Lectures)

Unit-II

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE

Unit-II
Coupled Amplifier: RC-coupled amplifier and its frequency response. (4 Lectures)

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. (4 Lectures)


Unit-IV
Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. (4 Lectures)


Reference Books:
• Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
• Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India
• Concept of Electronics: D.C. Tayal (Himalay Publication) 2011
• Electronic devices : Circuits and Applications : W.D. Stanley Prentice Hall
• Electronics- V. K. Mehta (S. Chand Publication) 2013
• Electronic Circuits : L. Schilling and Velove: 3rd Ed, McGraw Hill
• Electronics–Raskhit & Chattopadhyay (New age International Publication) 2011
• Electricity and Electronic-D.C. Tayal (Himalya Pub.) 2011
• Electronic devices and circuits – R.L. Boylstad (Pearson India) 2009

PHYSICS PRACTICAL-C X LAB 20
Classes (2hr duration)
1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To study the various biasing configurations of BJT for normal class A operation.
6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for given frequency using an op-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To study the Colpitt’s oscillator.
11. To design a digital to analog converter (DAC) of given specifications.
12. To study the analog to digital convertor (ADC) IC.
13. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
14. To design inverting amplifier using Op-amp (741,351) and study its frequency response
15. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response
16. To study the zero-crossing detector and comparator
17. To add two dc voltages using Op-amp in inverting and non-inverting mode
18. To design a precision Differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of an op-amp as an Integrator.
20. To investigate the use of an op-amp as a Differentiator.
21. To design a circuit to simulate the solution of a 1st/2nd order differential equation.

Reference Books:

Skills Enhancement Course (SEC)

SEC II– (Semester-IV)

Time - 2 hrs. F.M. - 50 [ 40 (Sem.) + 10 (Int./Pr./Viva) ] Credit - 2

3. RENEWABLE ENERGY AND ENERGY HARVESTING
(Credits: 02)
Theory: 20 Classes (1hr duration)

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.(10 Lectures)

Unit-II


Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. (10 Lectures)

Reference Books:
• Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
• Solar energy - M P Agarwal - S Chand and Co. Ltd.
• Dr. P Jayakumar, Solar Energy: Resource Assessment Handbook, 2009
• J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
• http://en.wikipedia.org/wiki/Renewable_energy

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Semester III

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PHYSICS-DSC-III - 1C: THERMAL PHYSICS AND STATISTICAL MECHANICS

(Credits: Theory-04, Practicals-02)
Theory: 40 Classes (1hr duration)
Time – 3 hrs. F.M. – 100 [ 60 (Sem) +15 (Int.) + 25 (Pr.)] Credits: -04(Th.) +02(Pr.)
Lectures – 60 [ 40(Th.) + (Pr.)]

UNIT-I

UNIT-II
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, TdS equations. (10 Lectures)

UNIT-III
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. (10 Lectures)

UNIT-IV
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. (6 Lectures)


**Reference Books:**
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears and G.L. Salinger. 1988, Narosa
  • Thermal and Statistical Physics ---M. Das , P. K. Jena and others (Sri Krishna Prakashan)
  • Heat and Thermal Physics-Brijlal&Subramaiam (S.Chand Publication) 2014
  • Thermal Physics-- C. Kittel and H. Kroemer (McMillan Education India) 2010
  • Thermodynamics & Statistical Physics-J.K.Sharma, K.K.Sarkar (Himalaya Pub.)2014

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**PHYSICS-DSC 1C LAB: THERMAL PHYSICS AND STATISTICAL MECHANICS**

20 Classes (2hr duration)
- To determine Mechanical Equivalent of Heat, J, by Callender and Barne’s constant flow method.
- Measurement of Planck’s constant using black body radiation.
- To determine Stefan’s Constant.
- To determine the coefficient of thermal conductivity of Cu by Searle’s Apparatus.
- To determine the Coefficient of Thermal Conductivity of Cu by Angstrom’s Method.
- To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton’s disc method.
- To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
- To study the variation of thermo emf across two junctions of a thermocouple with temperature.
- To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
- To calibrate Resistance Temperature Device (RTD) using Null Method/Off- Balance Bridge

**Reference Books:**
- Advanced Practical Physics for students, B.L.Flint&H.T.Worsnop, 1971, Asia Publishing House.
- A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal, 1985, Vani Publicatio

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**Semester IV**

**PHYSICS-DSC-IV - 1D: WAVES AND OPTICS (Credits: Theory-04, Practicals-02) Theory: 40 Classes (1hr duration)**

Time – 3 hrs.   F.M. – 100 [ 60( Sem) +15 (Int.) + 25 (Pr.)]   Credits: -04(Th.) +02(Pr.)

Lectures – 60 [ 40(Th.) + (Pr.)]
UNIT-I

**Fluids:** Surface Tension: Synclastic and anticlastic surface - Excess of pressure - Application of spherical and cylindrical drops and bubbles - Variation of surface tension with temperature - Jaeger’s method. Viscosity - Rate flow of liquid in a capillary tube - Poiseuille’s formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of liquid with temperature - lubrication. *(6 Lectures)*

**Sound:** Simple harmonic motion - forced vibrations and resonance - Fourier’s Theorem - Application of saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine’s formula - measurement of reverberation time - Acoustic aspects of halls and auditoria. *(6 Lectures)*

UNIT-II

**Superposition of Two Perpendicular Harmonic Oscillations:** Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses. *(2 Lectures)*

**Waves Motion- General:** Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity. *(2 Lectures)*

**Wave Optics:** Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. *(2 Lectures)*

UNIT-III

**Interference:** Interference: Division of amplitude and division of wavefront. Young’s Double Slit experiment. Lloyd’s Mirror and Fresnel’s Biprism. Phase change on reflection: Stokes’ treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton’s Rings: measurement of wavelength and refractive index. *(10 Lectures)*

**Michelson’s Interferometer:** (1) Idea of form of fringes (no theory needed), (2) Determination of wavelength, (3) Wavelength difference, (4) Refractive index, and (5) Visibility of fringes. *(2 Lectures)*

UNIT-II

**Diffraction:** Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. *(7 Lectures)*

**Polarization:** Transverse nature of light waves. Plane polarized light—production and analysis, half wave plate, quarter wave plate, Circular and elliptical polarization. *(3 Lectures)*

Reference Books:

- Principles of Optics, B.K. Mathur, 1995, Gopal Printing
- University Physics, F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison-Wesley

PHYSICS-DSC 1D LAB: WAVES AND OPTICS

20 Classes (2 hr duration)

- To investigate the motion of coupled oscillators
- To determine the Frequency of an Electrically Maintained Tuning Fork by
Melde’s Experiment and to verify $\lambda - T$ Law.

- To study Lissajous Figures
- Familiarization with Schuster’s focussing; determination of angle of prism.
- To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille’s method).
- To determine the Refractive Index of the Material of a Prism using Sodium Light.
- To determine Dispersive Power of the Material of a Prism using Mercury Light
- To determine the value of Cauchy Constants.
- To determine the Resolving Power of a Prism.
- To determine wavelength of sodium light using Fresnel Biprism.
- To determine wavelength of sodium light using Newton’s Rings.
- To determine the wavelength of Laser light using Diffraction of Single Slit.
- To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Grating
- To determine the Resolving Power of a Plane Diffraction Grating.
- To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.

**Reference Books:**

Semester V

PHYSICS-C XI: QUANTUM MECHANICS AND APPLICATIONS (Credits: Theory-04, Practicals-02)
Theory: 40 Classes (1hr duration)

Unit-I

UNIT-II
Time independent Schroedinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wave function as a linear combination of energy eigen functions; General solution of the time dependent Schroedinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle. (8 Lectures)

Unit-III
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 & uncertainty principle. One dimensional infinitely rigid box-energy eigen values and eigen functions, normalization, Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier. (12 Lectures)

Unit-IV
Atoms in External Magnetic Fields: Normal and Anomalous Zeeman Effect. Paschen-Back and Stark Effect (Qualitative Discussion only). (12 Lectures)

Reference Books:
• A Text book of Quantum Mechanics, P. M.Mathews and K.Venkatesan, 2nd Ed.,
Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom: Here, 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 \( \approx -13.6 \) eV. Take \( e = 3.795 \) (eVÅ)\(^{1/2} \), \( \hbar c = 1973 \) (eVÅ) and \( m = 0.511 \times 10^6 \) eV/c\(^2 \).

2. Solve the s-wave radial Schrodinger equation for an atom: 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. 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 \( e = 3.795 \) (eVÅ)\(^{1/2} \), \( m = 0.511 \times 10^6 \) eV/c\(^2 \), and \( a = 3, 5, 7 \) Å. In these units \( \hbar c = 1973 \) (eVÅ). 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: For the anharmonic oscillator potential for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose \( m = 940 \) MeV/c^2, \( k = 100 \) MeV fm\(^{-2} \), \( b = 0, 10, 30 \) MeV fm\(^{-3} \) in these units, \( \chi = 197.3 \) 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: Where \( \mu \) is the reduced mass of the two-atom system for the Morse potential Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function. Take: \( m = 940 \times 10^6 \) eV/C\(^2 \), \( D = 0.755501 \) eV, \( a = 1.44 \), \( r_0 = 0.131349 \) Å

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
7. To show the tunnelling effect in tunnel diode using I-V characteristics.
8. Quantum efficiency of CCDs

Reference Books:
• Schaum's outline of Programming with C++. J.Hubbard, 2000,McGraw-- Hill Publication
• An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press

PHYSICS-C XII: SOLID STATE PHYSICS
(Credits: Theory-04, Practicals-02)
Theory: 40 Classes (1hr duration)

Unit-I

UNIT-II

Unit-III

Unit-IV
Meissner effect. Type I and type II Superconductors, London’s Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation)  

(4 Lectures)

Reference Books:
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics – S. O. Pillai (New Age Publication)
- LASERS: Fundamentals and Applications – Thyagarajan and Ghatak (McMillanIndia) 2012

PHYSICS PRACTICAL-C XII LAB

20 Classes (2 hr duration)
1. Measurement of susceptibility of paramagnetic solution (Quinck’s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 oC) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

Reference Books
- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, KitabMahal
CLASSICAL DYNAMICS (DSC-1)(Compulsory) (SEMESTER –V)
(Credits: Theory-04, Practical-02)
Theory: 40 Classes (1hr duration)

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
Classical Mechanics of Point Particles: Generalised coordinates and velocities, Hamilton's Principle, Derivation of Lagrangian and Euler-Lagrange equations, Applications to simple systems such as coupled oscillators. (10 Lectures)

Unit-II
Canonical momenta & Hamiltonian, Hamilton's equations of motion, Applications: Hamiltonian for a harmonic oscillator, particle in a central force field, Motion of charged particles in external electric and magnetic fields. (10 Lectures)

Unit-III

Unit-IV
Four-vectors: space-like, time-like & light-like. Four velocity and acceleration, Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler Effect from a four vector perspective, Concept of four force, Conservation of four-momentum, Relativistic kinematics, Application to two-body decay of an unstable particle. (12 Lectures)

Reference Books:
• Classical Mechanics-J. C.Upadhyay( Himalaya Publication) 2014
• Classical Dynamics of Particles and Systems – S. T. Thornton (Cengage Learning) 2012
• Classical Mechanics-M. Das, P.K.Jena, M. Bhuyan, R.N.Mishra (SrikrishnaPrakashan)
PHYSICS PRACTICAL-DSC-1 LAB 20
Classes (2hr duration)
Use C/C++/Scilab for solving the problems based on Classical dynamics and Relativity like

1. Solve coupled oscillators and harmonic oscillators with suitable examples.
2. Solve the equation of a motion a particle moving under central force field.
3. Analyze the motion of charged particles in an external electric/magnetic field.
4. Calculation of speed of aircraft from the stand point of length contraction.
5. Calculation of Time loss of an atomic clock.
6. Develop a code for relativistic Doppler Effect in twin paradox.
7. Calculation of relativistic mass of a moving particle.
8. Determination of ratio of rest mass and relativistic mass of a moving particle.

Laboratory Based Experiments:

1. To determine the rigidity modulus by static method.
2. To determine the rigidity modulus by dynamic method.
3. To determine the Young’s Modulus by Double Cantiliver.
4. Verification of Stoke’s law
5. To determine the velocity of sound at 0°C

Reference Books:
• Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
• A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, KitabMahal
• Scilab by example: M. Affouf. 2012. ISBN: 978-1479203444
Nuclear and Particle Physics: (DSC-2) (Compulsory)(SEMESTER –V)
(Credits: Theory-04, Practical-02)
Theory: 40 Classes (1hr duration)

Unit-I
General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, 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 multiple moments, nuclear excite states.
Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model. (12 Lectures)

Unit-II
Radioactivity decay: (a) Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Elementary idea of Gamma decay.
Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value. (08 Lectures)

Unit-III
Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors, construction of photo-multiplier 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. (12 Lectures)

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. Elementary ideas on quarks and color hypothesis. (08 Lectures)

Reference Books:
• Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
• Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
• Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
• Atomic and Nuclear Physics -A. B. Gupta, DipakGhosh. (Books and Allied Publishers)
• Physics of Atoms and Molecules – Bransden (Pearson India) 2003
• Subatomic Physics - Henley and Gracia (World Scientific) 2012
• Introduction to Nuclear and Particle Physics-A.Das and T.Ferbel (World Scientific)
• Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
PHYSICS PRACTICAL-DSC-2 LAB 20
Classes (2hr duration)
Use C/C++/Scilab for solving the problems based on Nuclear and Particle Physics like

1. Develop a code for estimation of nuclear type from its radius.
2. Develop a code to estimate the density of nuclear matter.
3. Calculate the binding energy of alpha particle and express in MeV and joule.
4. Calculate the binding energy of Fe-56.
5. Determine the most stable isotopes of A=75.
6. Calculate the height of barrier faced by alpha particle of Ra-226.
7. Develop a code to calculate the Q-value of a given reaction.
8. Develop a code to calculate the K.E of protons in Van de Graff accelerator.
9. Develop a code to calculate the electric field at the surface of wire of the G. M. Counter.
10. Develop a code to calculate the thickness of the depletion layer of Silicon detector and amplitude of voltage pulse.

Reference Books:
- Introduction to Nuclear and Particle Physics: V. K. Mittle, R. C. Verma, S. C. Gupta

SEMESTER-V

PHYSICS: DSE-1-P-1: DIGITAL AND ANALOG CIRCUITS AND
INSTRUMENTATION
(Credits: Theory-04, Practicals-02)
Theory: 40 Lectures

UNIT-I:
Digital Circuits
Difference between analog and Digital Circuits, Binary Numbers, Decimal to Binary and Binary to Decimal Conversion, AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates, XOR and XNOR Gates, De Morgan's Theorems, Boolean Laws, Simplification of Logic Circuit using Boolean Algebra, Fundamental Products, Minterms and Maxterms, Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. (10 Lectures)

UNIT-II:
Semiconductor Devices:
Semiconductor Diodes: p and n type semiconductors, Barrier Formation in PN Junction Diode, Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode, PN junction and its characteristics, Static and Dynamic Resistance, Principle and structure of (1) LEDs (2) Photodiode (3) Solar Cell. (8 Lectures)

UNIT-III:
Transistors & Amplifiers:

UNIT-IV:
Operational Amplifiers (Black Box approach):

Instrumentations:
Introduction to CRO: Block Diagram of CRO. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. Power Supply: Half-wave Rectifiers, Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, Basic idea about capacitor filter, Zener Diode and Voltage Regulation. (4 Lectures)

Reference Books:
• Electronic devices and circuits, S. Salivahanan and N.Suresh Kumar, 2012, Tata Mc-Graw Hill.
• Modern Electronic Instrumentation & Measurement Tech.,Helfrick&Cooper,1990,
PRACTICALS: DSE-1-P-1 LAB: DIGITAL AND ANALOG CIRCUITS AND INSTRUMENTS
20 Lectures : 2 credits
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:
provide them with exposure and hands-on learning wherever possible. Each unit must have 50% subjective and 50% objective questions.

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.

(10 Lectures)

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.


**Geothermal Energy:** Geothermal Resources, Geothermal Technologies.

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

(10 Lectures)

**Reference Books:**
- Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
- Solar energy - M P Agarwal - S Chand and Co. Ltd.
- J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

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Semester VI

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PHYSICS-C XIII: ELECTROMAGNETIC THEORY
(Credits: Theory-04, Practicals-02)
Theory: 40 Classes (1hr duration)

Unit-I

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. (08 Lectures)

Unit-III

Unit-IV

Reference Books:
• Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
• Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
• Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
• Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
• Electricity and Magnetism ---D C Tayal (Himalaya Publication) 2014
• Introduction to Electrodynamics-A.Z.Capri&P.V.Panat (Alpha Science) 2002
• Optics E.Hecht, (Pearson India)

Additional Books for Reference
• Electromagnetic Theory-A. Murthy (S. Chand Publication) 2014
• Classical Electrodynamics, J. D. Jackson (Wiley India)

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PHYSICS PRACTICAL-C XIII LAB
20 Classes (2hr duration)

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 study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves.
7. To study Polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston’s air-film.
9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
11. To verify the Stefan’s law of radiation and to determine Stefan’s constant.
12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

Reference Books
• Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
• A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, KitabMahal
• Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

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PHYSICS-C XIV: STATISTICAL MECHANICS
(Credits: Theory-04, Practicals-02)
Theory: 40 Classes (1hr duration)
Unit-I

Unit-II

Unit-III

Unit-IV
Quantum Statistics: Identical particles, macrostates and micro states, Fermions and Bosons, Bose Einstein distribution function and Fermi-Dirac Distribution function, Bose Einstein Condensation, Bose deviation from Planck’s law, Effect of temperature on F-D distribution function, degenerate Fermi gas, Density of States, Fermi energy. (10 Lectures)

Reference Books:
• Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
• Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
• Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
• An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press.
• Statistical Physics -- F. Mandl (CBS) 2012
• Statistical Physics of Particles-M. Kardar (CUP 2007)

PHYSICS PRACTICAL-C XIV LAB 20
Classes (2hr duration)
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 Wein’s 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:**
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. 2007, Wiley India Edition
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer

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**Nano Materials and Applications:** (DSC-3) (Compulsory) (SEMESTER –VI)
(Credits: Theory-04, Practical-02)
Theory: 40 Classes (1hr duration)

**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 nanostructures and its consequences.  

**Unit-II**

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

**Unit-III**


**Unit-IV**


**Reference books:**
1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
7. Nanotechnology- RakeshRathi (S Chand & Company, New Delhi)

PHYSICS PRACTICAL-DSC-3 LAB 20
Classes (2hr duration)
Use C/C++/Scilab for solving the problems based on Material Science like

1. What is the degree of polymerization $n$ of the average polyethylene molecule?
2. Calculate the density of MgO.
3. Calculate the number of C and H atoms in the polyethylene unit cell.
4. What is the angle between 110 and 111 direction in the cubic system?
5. Find the equilibrium concentration of vacancies in metals at given temperature.

Laboratory Based Experiments:

1. Nano material Sample Preparation.
2. Characterization of sample by using X-ray diffraction software.

Reference Books:
- Introduction to Material Science for Engineers: J.F. Shackelford

Project (Credits: 06) (DSC-4)(Compulsory)(SEMESTER –VI)
Dissertation: 60 Marks
Presentation: 25 Marks
Viva-voce: 15 Marks

Projects submitted by the student are to be evaluated by the Internal Examiner and External Examiner appointed by University. Students should opt for Supervision of Dissertation from the internal faculties of his own college/Institution. The Supervisor in consultation with the concerned Head of the Department should decide the topic. The presentation should be open to all faculties as well as graduate students.
SEMESTER-VI

PHYSICS: DSE-1-P-2: ELEMENTS OF MODERN PHYSICS
(Credits: Theory-04, Practicals-02)
Theory: 40 Classes (1hr duration)

UNIT-I
Blackbody radiation and Planck’s and Law, Photoelectric effect and Compton scattering, De-Broglie wavelength and matter waves, Davission-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.  

(10 Lectures)

UNIT-II
Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle, Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty.  

(4 Lectures)
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 wave
function, probabilities and normalization; Probability density and probability current density 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.  

UNIT-IV
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.  

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.  

Reference Books:
• Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson,2009, PHI Learning
• Six Ideas that Shaped Physics:Particle Behave like Waves, Thomas A. Moore, 2003, McGraw Hill
• Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Cengage Learning

PHYSICS- DSE-1-P-2 LAB: ELEMENTS OF MODERN PHYSICS 20 Classes (2hr duration)
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:
• Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
• A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab
BASIC INSTRUMENTATION SKILLS (PHYSICS:SEC-4)  
(SEMESTER-VI)  
(Credits: 02)  
Theory: 20 Classes (1hr duration)

This course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics. Each unit must have 50% theoretical and 50% practical based questions.

Unit-I  

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 millivolmeters: Amplifier-rectifier, and rectifier-amplifier. Block diagram ac millivoltmeter, specifications and their significance.

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 & 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.

(10 Lectures)

Unit-II
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.


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

(10 Lectures)

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 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)

**Reference Books:**
- A text book in Electrical Technology - B L Theraja - S Chand and Co.
- Performance and design of AC machines - M G Say ELBS Edn.
- Electronic Devices and circuits, S. Salivahanan& N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India