PHYSICS (HONOURS)

SEMESTER-I

CC-1 : MATHEMATICAL PHYSICS-I
(Credits: Theory-04, Practicals-02)
Marks:100 (Theory:70, Practical: 30)
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. Constrained Maximization using Lagrange Multipliers. (4 Lectures)

Vector Calculus: Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields. (5 Lectures)

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. (7 Lectures)
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. (3 Lectures)

UNIT-III
Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates. (8 Lectures)

UNIT-IV
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). (13 Lectures)

Reference Books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013,7th Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning.
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press
- Mathematical Physics and Special Relativity-M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan) 2nd Edition 2009
- Mathematical Physics H. K. Dass, Dr. Rama Verma (S. Chand Higher Academics), 4th Edition 2011.
- Mathematical Physics C. Harper, (Prentice Hall India) 2006.
- Mathematical Physics-Goswami (Cengage Learning) 2014
- Mathematical Method for Physical Sciences- M. L. Boas (Wiley India) 2006

PHYSICS LAB-C:I
20 Classes (2 hrs. 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, under flow & over flow 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 looping statements) (If-statement. If-else Stateemnt. Nested if structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statement. 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 π

Referred Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw Hill Pub.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. 2007, Cambridge University Press.
- A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3 rd Edn., 2007, Wiley India Edition.
- Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to computational Physics, T. Pang, 2nd Edn., 2006,Cambridge Univ. Press.

SEMESTER-I

CC-2 : MECHANICS
(Credits: Theory-04, Practicals-02)
Marks:100 (Theory:70, Practical: 30)
Theory: 40 Classes (1 hr. duration)

UNIT-I

Rotational Dynamics: Centre of Mass and Laboratory frames. Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. (9 Lectures)

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. (3 Lectures)

UNIT-II

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

Fluid Motion: Kinematics of Moving Fluids: Poiseuilles Equation for Flow of a Liquid through a Capillary Tube. (3 Lectures)

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-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)

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Keplers Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts.(5 Lectures)

UNIT-IV

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. Energy-Momentum Four Vector. (9 Lectures)

Reference Books:

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole. (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 for scientists and Engineers with Modern Phys., J.W. Jewett, R.A.Serway, 2010, Cengage Learning
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
- Mechanics - J. C. Slater and N. H. Frank (McGraw-Hill)

PHYSICS LAB-C:II
20 Classes (2 hrs. 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
6. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuilles method).
7. To determine the Young's Modulus of a Wire by Optical Lever Method/Searle's method.
8. To determine the Modulus of Rigidity of a Wire by Maxwells needle/Dynamic Torsion.
9. To determine the elastic Constants of a wire by Searles method.
10. To determine the value of g using Bar Pendulum.
11. To determine the value of g using Katers Pendulum

Reference Books:

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.

SEMESTER-II

CC-3: ELECTRICITY AND MAGNETISM
(Credits: Theory-04, Practicals-02)
Marks:100 (Theory:70, Practical: 30)
Theory: 40 Classes (1 hr. 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)

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. (4 Lectures)

UNIT-II

Magnetic Field: Magnetic force between current elements and definition of Magnetic Field B. Biot-Savarts Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR. (10 Lectures)

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. (4 Lecturers)

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. (4 Lecturers)

Electromagnetic Induction: Faradays Law. Lenzs Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. (2 Lectures)

UNIT-IV

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. (5 Lectures)

Network theorems: Ideal Constant-voltage and Constant-current Sources. Network Theorems:
Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Growth & decay of currents in RC, RL, and LCR Series circuits for DC. (5 Lectures)

Reference Books:

- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
- Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.

PHYSICS LAB-C:III
20 Classes (2 hrs. duration)

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, 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 Fosters Bridge.
5. To compare capacitances using DeSautys bridge.
6. Measurement of field strength B and its variation in a solenoid/circular coil (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 Andersons 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
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleighs 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, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

SEMESTER-II

CC-4 : WAVES AND OPTICS
(Credits: Theory-04, Practicals-02)
Marks:100 (Theory:70, Practical: 30)
Theory: 40 Classes (1 hr. duration)

UNIT-I

Geometrical optics: Fermats principle, reflection and refraction at plane interface, Matrix formulation of geometrical Optics. Idea of dispersion. Application to thick lense, Ramsden and Huygens eyepiece.(5 Lecturers)

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygen's Principle. Temporal and Spatial Coherence. Division of amplitude and wave front. Youngs double slit experiment. Lloyds Mirror and Fresnels Biprism. Phase change on reflection: Stokes treatment. (5 Lecturers)

UNIT-II

Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves. (5 Lectures)

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. (3 Lectures)

UNIT-III

Interference: Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newtons Rings: Measurement of wavelength and refractive index. (5 Lecturers)

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-IV

Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. (6 Lectures)

Fresnel Diffraction: Fresnels Assumptions. Fresnels Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnels Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire. (6 Lectures)

Reference Books:

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- Optics - Brijlal & Subramaniam- (S. Chand Publication) 2014.
- Geometrical and Physical Optics R.S. Longhurst, Orient Blackswan, 01-Jan-1986
- Vibrations and Waves - A. P. French, (CBS) Indian print 2003
- Optics, E. Hecht (Pearson India)

PHYSICS LAB-C:IV
20 Classes (2 hrs. duration)

1. To determine the frequency of an electric tuning fork by Meldes experiment and verify λ^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 / Cauchy's constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelsons interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newtons Rings.
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
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani.

SEMESTER-III

CC-5: MATHEMATICAL PHYSICS-II
(Credits: Theory-04, Practicals-02)
Marks:100 (Theory:70, Practical: 30)
Theory: 40 Classes (1 hr. 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
Fourier series: 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. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier series. Parseval Identity. (11 Lectures)

UNIT-II
Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance, Frobenius method and its applications to differential equations: Legendre & Hermite Differential Equations. Properties of Legendre & Hermite Polynomials: Ro-drigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Associated Legendre polynomials and spherical har-monics. (10 Lectures)

UNIT-III
Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). (5 Lectures)
Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. (4 Lectures)

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. Con-ducting and dielectric sphere in an external uniform electric field. Wave equation and its solution for vibrational modes of a stretched string. (10 Lectures)

Reference Books:

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.

- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
- Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books
- Mathematical Physics and Special Relativity {M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan) 2nd Edition 2009
- Mathematical Physics-H. K. Dass, Dr. Rama Verma (S. Chand Higher Academics) 6th Edition 2011.
- Mathematical Physics C. Harper, (Prentice Hall India) 2006.
- 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)
- Advanced Engineering Mathematics, E. Kreyszig (New Age Publication) 2011.

PHYSICS LAB-C:V
20 Classes (2 hrs. 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.

Topics	Description with Applications
Introduction to Numerical computation software Scilab	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 & logical operators, the while loop, for loop, details of loop operations, break & 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 deviation	Ohms law to calculate R, Hookes law to calculate spring constant
Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems.	Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)
Solution of ODE First order Differential equation Euler, modified Euler and Runge-Kutta second order methods Second order differential equation. Fixed difference method.	First order differential equation • Radioactive decay • Current in RC, LC circuits with DC source • Newtons law of cooling • Classical equations of motion 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 :

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J.20 Bence, 3rd ed., 2006, Cambridge University Press
2. Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
3. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
4. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scienti c and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernndez. 2014 Springer
5. Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
6. Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
7. Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

SEMESTER-III

CC-6: THERMAL PHYSICS
(Credits: Theory-04, Practicals-02)
Marks:100 (Theory:70, Practical: 30)
Theory: 40 Classes (1 hr. duration)

UNIT-I

Introduction to Thermodynamics: Recapitulation of Zeroth and First law of thermodynamics: Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnots Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics. 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. (5 Lectures)

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermody-namics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Principle of Increase of Entropy. TemperatureEntropy diagrams for Carnots Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. (6 Lectures)

UNIT-II

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibbs 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 (5 Lectures)

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwells Relations, Maxwells 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. (5 Lectures)

UNIT-III

Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Sterns Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. (5 Lectures)

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)

UNIT-IV

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrews Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waals Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joules Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling. (10 Lectures)

Reference Books:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
3. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
5. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
6. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford Uni-versity Press
7. Heat and Thermal Physics-Brijlal & Subramaiam (S.Chand Publication) 2014
8. Thermal Physics{ C. Kittel and H. Kroemer (McMillan Education India) 2010

PHYSICS LAB-C:VI
20 Classes (2hr duration)

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barnes constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searles Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstroms Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charltons 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 Caloriemeter.

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 & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.

SEMESTER-III

CC-7: DIGITAL SYSTEMS AND APPLICATIONS
(Credits: Theory-04, Practicals-02)
Marks:100 (Theory:70, Practical: 30)
Theory: 40 Classes (1 hr. duration)

UNIT-I

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary 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)

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. (5 Lectures)

UNIT-II

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. (3 Lectures)

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.(4 Lectures)

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

UNIT-III

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 lCs. (5 Lectures)

Introduction to CRO: Block Diagram of CRO. Electron Gun, Defection System and Time Base. Defection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. (5 Lectures)

UNIT-IV

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

1. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw Hill
2. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
5. Logic circuit design, Shimon P. Vingron, 2012, Springer.
6. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
7. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.
8. Concept of Electronics: D.C.Tayal (Himalay Publication) 2011.
9. Electronics-V. K. Meheta (S. Chand Publication),2013
10. The Art of Electronics, P. Horowitz and W. Hill, CUP.

PHYSICS PRACTICAL-C:VII
20 Classes (2 hrs. 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 astable multivibrator of given specifications using 555 Timer.
15. To design a monostable multivibrator of given specifications using 555 Timer.
16. Verification of Truth table OR, AND, NOT, NOR, NAND gates.

Reference Books:

1. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
3. Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
4. Microprocessor 8085:Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

SEMESTER-IV

CC-8 : MATHEMATICAL PHYSICS-III
(Credits: Theory-04, Practicals-02)
Marks:100 (Theory:70, Practical: 30)
Theory: 40 Classes (1 hr. 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

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. Cauchys theorem, Cauchys Integral formula. Simply and multiply connected. (10 Lectures)

UNIT-II

Integrals Transforms: Laurent and Taylors expansion. Residues and Residue Theorem. Application in solving Definite Integrals. 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.(10 Lectures)

UNIT-III

Integrals Transforms: Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transform (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.(10 Lectures)

UNIT-IV

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. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits. (10 Lectures)

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press

2. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
3. Advanced Engineering Mathematics, E. Kreyszig (New Age Publication) 2011.
4. Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
5. Complex Variables, A. S. Fokas & M. J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
6. Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
7. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett.
8. Mathematical Physics-H. K. Dass, Dr. Rama Verma (S. Chand Higher Academics) 6th Edition 2011.
9. Mathematical Physics C. Harper, (Prentice Hall India) 2006.
10. Mathematical Physics-Goswami (Cengage Learning) 2014
11. Mathematical Method for Physical Sciences - M. L. Boas (Wiley India) 2006
12. Introduction to the theory of functions of a complex variable- E.T.Copson (Oxford) Univ. Press, 1970

PHYSICS PRACTICAL-C:VIII
20 Classes (2 hrs. duration)

Scilab based simulations experiments based on Mathematical Physics problems like

1. Solve differential equations:
   (i) $\frac{dy}{dx} = e^{-x}$ with $y = 0$ for $x = 0$. (ii) $\frac{dy}{dx} + e^{-xy} = x^2$. (iii) $\frac{d^2y}{dt^2} + 2\frac{dy}{dt} = -y$.
   (iv) $\frac{d^2y}{dt^2} + e^{-t}\frac{dy}{dt} = -y$.
2. Dirac Delta Function: Evaluate $\frac{1}{\sqrt{2\pi\sigma^2}} \int e^{-(x-2)^2/2\sigma^2}(x+3)dx$ for $\sigma = 1, 0.1, 0.01$ and show it tends to 5.
3. Fourier Series: Program to $\sum_{n=1}^{\infty}(0.2)^n$.
   Evaluate the Fourier coefficients of a given periodic function (square wave)
4. Frobenius method and Special functions: $\int_{-1}^{1} P_n(\mu)P_m(\mu)\,d\mu = \delta_{n,m}$. Plot $P_n(x), J(x)$. 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 Bessels function at $N-$ 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:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
2. Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
3. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scienti c and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernndez. 2014 Springer ISBN: 978-3319067896
4. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
5. Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
6. Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing.

SEMESTER-IV

CC-9 : ELEMENTS OF MODERN PHYSICS
(Credits: Theory-04, Practicals-02)
Marks:100 (Theory:70, Practical: 30)
Theory: 40 Classes (1 hr. duration)

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. Atomic spectra, Line spectra of hydrogen atom, Ritz Rydberg combination principle. Alpha Particle Scattering, Rutherford Scattering Formula, Rutherford Model of atom and its limitations, Bohrs model of H atom, explanation of atomic spectra, correction for finite mass of the nucleus, Bohr correspondence principle, limitations of Bohr model, discrete energy exchange by atom, Frank Hertz Expt. Sommerfeld's Modification of Bohrs Theory. (11 Lectures)

UNIT-II

Wave Particle Duality: de Broglie hypothesis, Experimental conformation 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.

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. (11 Lectures)

UNIT-III

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 (8 Lectures)

UNIT-IV

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 defect, 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). (10 Lectures)

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
3. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
4. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
5. Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan
6. Modern Physics Bernstein, Fishbane and Gasiorowicz (Pearson India) 2010
7. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles R. Eisberg (Wiley India), 2012.

Additional Books for Reference

8. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
9. Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
10. Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
11. Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
12. Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill
13. Modern Physics-Serway (CENGAGE Learnings) 2014
14. Modern Physics-Murugesan and Sivaprasad (S. Chand Higher Academics)
15. Physics of Atoms and Molecules Bransden (Pearson India) 2003

PHYSICS PRACTICAL-C:IX
20 Classes (2 hrs. duration)

Measurement of Plancks constant using black body radiation and photo-detector

1. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
2. To determine work function of material of lament of directly heated vacuumdiode.
3. To determine the Plancks constant using LEDs of at least 4 different colours.
4. To determine the wavelength of H-alpha emission line of Hydrogen atom.
5. To determine the ionization potential of mercury.
6. To determine the absorption lines in the rotational spectrum of Iodine vapour.
7. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
8. To setup the Millikan oil drop apparatus and determine the charge of an electron.
9. To show the tunneling effect in tunnel diode using I-V characteristics.
10. To determine the wavelength of laser source using diffraction of single slit.
11. To determine the wavelength of laser source using diffraction of double slits.
12. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011,Kitab Mahal

SEMESTER-IV

CC-10 : ANALOG SYSTEMS AND APPLICATIONS
(Credits: Theory-04, Practicals-02)
Marks:100 (Theory:70, Practical: 30)
Theory: 40 Classes (1 hr. duration)

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 for Step Junction. (5 Lectures)

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. (5 Lectures)

UNIT-II
Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Con gurations. Current gains and Relations between and . Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cuto and Saturation Regions. (5 Lectures)

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 amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. (5 Lectures)

UNIT-III
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. (2 Lectures)

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.(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. (5 Lectures)

Applications 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.(5 Lectures)

Reference Books:
1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
3. Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI Learning
4. Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

5. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
6. Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer
7. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
8. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India
9. Concept of Electronics: D.C.Tayal (Himalay Publication) 2011
10. Electronic devices :Circuits and Applications :W.D. Stanley Prentice Hall
11. Electronics- V. K. Meheta (S. Chand Publication)2013
12. Electronic Circuits :L.Schilling and Velove: 3rd Ed Mc Graw Hill
13. Electronics Raskhit & Chattopadhyay (New age International Publication)2011
14. Electricity and Electronic-D.C.Tayal (Himalaya Pub.)2011
15. Electronic devices and circuits R.L. Boylstad (Pearson India) 2009.

PHYSICS PRACTICAL-C:X
20 Classes (2 hrs. 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 di erential equation.

Reference Books:

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
2. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
3. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
4. Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson.

SEMESTER-V

CC-11 : QUANTUM MECHANICS AND APPLICATIONS
(Credits: Theory-04, Practicals-02)
Marks:100 (Theory:70, Practical: 30)
Theory: 40 Classes (1hr duration)

UNIT-I

Schrodinger equation & the operators: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Hermitian operator, Eigen values and Eigen functions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle. (8 Lectures)

UNIT-II

Time independent Schrodinger equation: 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 Schrodinger 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. (6 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 dot as ex-ample; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier. (14 Lectures)

UNIT-IV

Atoms in Electric & Magnetic Fields: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmors Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

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

Reference Books:

1. A Text book of Quantum Mechanics, P. M.Mathews and K.Venkatesan, 2nd Ed., 2010, Mc-Graw Hill
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. Quantum Mechanics, Leonard I. Schi , 3rd Edn. 2010, Tata McGraw Hill.
4. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
5. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
6. Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
7. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
8. Quantum Physics-S. Gasiorowicz (Wiley India) 2013
9. Quantum Mechanics -J.L. Powell and B. Craseman (Narosa) 1988
10. Introduction to Quantum Mechanics- M.Das, P.K.Jena,(SriKrishna Prakashan)
11. Basic Quantum Mechanics A.Ghatak (Mc Millan India) 2012
12. Introduction to Quantum Mechanics R. Dicke and J. Wittke
13. Quantum Mechanics- Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
14. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
15. Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer
16. Quantum Mechanics - F. Mandl (CBS) 2013
17. Cohen-Tannoudji, B Diu and F Lalo, Quantum Mechanics (2 vols) Wiley-VCH 1977

PHYSICS PRACTICAL-C:XI
20 Classes (2hr duration)

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 wavefunctions. Remember that the ground state energy of the hydrogen atom is -13.6 eV. Take e = 3.795 (eV)1/2, c = 1973 (eV) and m = 0.511x106 eV/c2.
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 signi cant digits. Also, plot the corresponding wavefunction. Take e = 3.795 (eV)1/2, m = 0.511x106 eV/c2, and a = 3 , 5 , 7 . In these units c = 1973 (eV). 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/c2, k = 100 MeV fm-2, b = 0, 10, 30 MeV fm-3In these units, c = 197.3 MeV fm. The ground state energy I 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 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 = 940x106eV/C2, D = 0.755501 eV, = 1.44, = 0.131349 Laboratory based experiments:
5. Study of Electron spin resonance- determine magnetic eld as a function of the resonance frequency.
6. Study of Zeeman effect: with external magnetic field; Hyper ne splitting
7. To show the tunneling effect in tunnel diode using I-V characteristics.
8. Quantum efficiency of CCDs

Reference Books:

1. Schaum's outline of Programming with C++. J.Hubbard, 2000,McGraw{Hill Publication
2. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rd Edn., 2007, Cambridge University Press.
3. An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press
4. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernndez.2014 Springer.
5. Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
6. Scilab Image Processing: L.M.Surhone.2010 Betascript Publishing ISBN:978-6133459274

SEMESTER-V

CC-12 : SOLID STATE PHYSICS
(Credits: Theory-04, Practicals-02)
Marks:100 (Theory:70, Practical: 30)
Theory: 40 Classes (1 hr. duration)

UNIT-I

Crystal Structure: Solids- Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis Central and Non-Central Elements. Unit Cell. Miller Indices. Types of Lattices, Reciprocal Lattice. Brillouin Zones. Diffraction of X-rays by Crystals. Braggs Law. Atomic and Geometrical Factor. (8 Lectures)

UNIT-II

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Di-atomic 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. T3 law (6 Lectures)

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of diaand Paramagnetic Domains. Curies law, Weisss Theory of Ferromagnetism and Ferromagnetic Domains. (6 Lectures)

UNIT-III

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. (4 Lectures)

Lasers: Einsteins 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. (4 Lectures)

UNIT-IV

Elementary band theory: Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Eeeect. Measurement of conductivity (04 probe method) & Hall coefficient. (8 Lectures)

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, Londons Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation).(4 Lectures)

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India
3. Introduction to Solids, Leonid V. Azaro , 2004, Tata Mc-Graw Hill

4. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
5. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
6. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
7. Solid State Physics, M.A. Wahab, 2011, Narosa Publications
8. Solid State Physics S. O. Pillai (New Age Publication)
9. Solid State Physics- R.K.Puri & V.K. Babbar (S.Chand Publication)2013
10. Lasers and Non linear Optics B.B.Laud-Wiley Eastern.
11. LASERS: Fundamentals and Applications Thyagarajan and Ghatak (McMillanIndia), 2012

PHYSICS PRACTICAL-CC-12
20 Classes (2 hrs. 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:

11. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
12. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
13. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
14. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

SEMESTER-VI

CC-13 : ELECTROMAGNETIC THEORY
(Credits: Theory-04, Practicals-02)
Marks:100 (Theory:70, Practical: 30)
Theory: 40 Classes (1 hr. duration)

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. (8 Lectures)

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.(8 Lectures)

UNIT-III

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

Optical Fibres: Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only). (12 Lectures)

UNIT-IV

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnels Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light.

Rotatory Polarization: Optical Rotation. Biots Laws for Rotatory Polarization. Fresnels Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnels theory. Specific rotation. Laurents half-shade polarimeter. (12 Lectures)

Reference Books:

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
2. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
3. Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
4. Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
5. Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
6. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
7. Electricity and Magnetism D C Tayal (Himalaya Publication)2014
8. Introduction to Electrodynamics-A.Z.Capri & P.V.Panat (Alpha Science) 2002
9. Optics E.Hecht, (Pearson India) (Additional Books for Reference)
10. Electromagnetic Fields & Waves, P.Lorrain & D.Corson,1970, W.H.Freeman & Co
11. Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
12. Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press
13. Electromagnetic Theory-A. Murthy (S. Chand Publication)2014
14. Classical Electrodynamics, J. D. Jackson (Wiley India)

PHYSICS PRACTICAL-C:XIII
20 Classes (2 hrs. 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 Babinets 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 Wollastons air-lm.
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 Stefans constant.
12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
4. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

SEMESTER-VI

CC-14 : STATISTICAL MECHANICS
(Credits: Theory-04, Practicals-02)
Marks:100 (Theory:70, Practical: 30)
Theory: 40 Classes (1 hr. duration)

UNIT-I

Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Microcanonical, Canonical and grand canonical ensemble. Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression. (12 Lectures)

UNIT-II

Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.(8 Lectures)

UNIT-III

Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchho s law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wiens Displacement law. Wiens Distribution Law. Sahas Ionization Formula. Rayleigh-Jeans Law. Ul-traviolet Catastrophe. Plancks Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wiens Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wiens Displacement law from Plancks law.(12 Lectures)

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, degenarate Fermigas, Density of States, Fermi energy.(8 Lectures)

Reference Books:

1. Statistical Mechanics-R.K.Pathria & Paul D. Beale (Academic Press) 3rd Edition (2011)
2. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
3. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer

6. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press.
7. An introduction to Equilibrium Statistical Mechanics: Palash Das (I.K.International Publica-tion) 2012
8. Statistical Physics - F. Mandl (CBS) 2012
9. Statistical Physics of Particles-M. Kardar (CUP 2007)

PHYSICS PRACTICAL-C:XIV
20 Classes (2 hrs. duration)

Use C/C++/Scilab for solving the problems based on Statistical Mechanics like

1. Plot Plancks 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:

1. Elementary Numerical Analysis, K.E.Atkinson, 3 r d Edn. 2007, Wiley India Edition
2. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
3. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
5. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernndez. 2014 Springer ISBN: 978-3319067896
6. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
7. Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

SKILL ENHANCEMENT COURSE

SEMESTER-IV

SEC-2 : RENEWABLE ENERGY & ENERGY HARVESTING
(Credits: 06 – Max Marks : 100)

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 O shore 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. **Ocean Energy:** Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. Geothermal Energy: Geothermal Resources, Geothermal Technologies. **Hydro Energy:** Hydropower resources, hydropower technologies, environmental impact of hydro power sources. (10 Lectures)

Unit-III

Piezo-electric energy harvesting : Introduction, Physics and characteristics of piezo-electric effect, materials and mathematical description of piezo-electricity, pieze-electric parameters and modeling, piezo-electric generators, piezo-electric energy harvesting applications, human power. (8 Lecturers)

Unit-IV

Electro-magnetic energy harvesting : Linear generators, physics & Mathematical models, recent applications. (4 Lecturers)

Carbon Captured technologies, cell, batteries, power consumption (2 Lecturers)

Environmental issues and renewable sources of energy and sustainability (2 lecturers)

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.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, Renewable Energy, Power for a sustainable future, 2004, Oxford University Press, in association with The Open University.
5. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
7. http://en.wikipedia.org/wiki/Renewable energy.

DISCIPLINE SPECIFIC ELECTIVE (DSE)

(4 papers including the Project)
DSE-1 to DSE-4 (6 Credits each)

SEMESTER-V

DSE-1 : CLASSICAL DYNAMICS

(Credits: Theory-05, Tutorial-01)
Theory: 50 Classes (1 hr. duration) No Practical

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, Lagrangian and Euler-Lagrange equations. Applications to simple systems such as coupled oscillators. 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. (25 Lectures)

UNIT-II

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 & twin paradox. 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. (25 Lectures)

Reference Books:

1. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
2. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
3. Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
4. Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press
5. Classical Mechanics-J. C.Upadhyay (Himalaya Publication) 2014
6. Classical Dynamics of Particles and Systems S. T. Thornton (Cengage Learning) 2012
7. Introduction to Classical Mechanics-R. K. Takwale, S.Puranik-(Tata Mc Graw Hill)
8. Classical Mechanics-M. Das, P.K.Jena, M. Bhuyan, R.N.Mishra (Srikrishna Prakashan)

SEMESTER-V

DSE-2 : NUCLEAR & PARTICLE PHYSICS
(Credits: Theory-05, Tutorials-01)
Theory: 50 Classes (1 hr. duration) No Practical

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 moments, nuclear excites 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,

Radioactivity decay: (a) α- 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, (25 Lectures)

UNIT-II

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 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 Graaffgenerator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

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. (25 Lectures)

Reference Books:

1. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
2. Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
3. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
4. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
5. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
6. Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991)
7. Atomic and Nuclear Physics -A. B. Gupta, Dipak Ghosh. (Books and Allied Publishers)
8. Physics of Atoms and Molecules Bransden (Pearson India) 2003
9. Subatomic Physics - Henley and Gracia (World Scientific) 2012
10. Introduction to Nuclear and Particle Physics-A.Das and T.Ferbel (World Scientific)
11. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).

SEMESTER-VI

DSE-3 : BIO-PHYSICS
(Credits: Theory-05, Tutorials-01)
Theory: 50 Classes (1 hr. duration)

UNIT-I

Building Blocks & Structure of Living State: Atoms and ions, molecules essential forblife, what is life. Living state interactions: Forces and molecular bonds, electric & thermal interactions, electric dipoles, casimir interactions, domains of physics in biology.

Heat Transfer in bio-materials: Heat Transfer Mechanism, The Heat equation, Joule heating of tissue.

Living State Thermodynamics: Thermodynamic equilibrium, first law of thermodynamics and conservation of energy. Entropy and second law of thermodynamics, Physics of many particle systems, Two state systems, continuous energy distribution, Composite systems, Casimir contribution of free energy, Protein folding and unfolding. (25 Lectures)

UNIT-II

Open systems and chemical thermodynamics: Enthalpy, Gibbs Free Energy and chemical potential, activation energy and rate constants, enzymatic reactions, ATP hydrolysis & synthesis, Entropy of mixing, The grand canonical ensemble, Hemoglobin.

Diffusion and transport: Maxwell-Boltzmann statistics, Ficks law of diffusion, sedimentation of Cell Cultures, diffusion in a centrifuge, diffusion in an electric field, Lateral diffusion in membranes, Navier stokes equation, low Reynolds Number Transport, Active and passive membrane transport.

Fluids: Laminar and turbulent fluid flow, Bernoullis equation, equation of continuity, venture effect, Fluid dynamics of circulatory systems, capillary action.

Bio-energetics and Molecular motors: Kinesins, Dyneins, and microtubule dynamics, Brownian motion, ATP synthesis in Mitochondria, Photosynthesis in Chloroplasts, Light absorption in biomolecules, vibrational spectra of bio-biomolecules. (25 Lectures)

Reference Books:

1. Introductory Biophysics, J. Claycomb, JQP Tran, Jones & Bartelett Publishers
2. Aspects of Biophysics, Hughe S W, John Willy and Sons.
3. Essentials of Biophysics by P Narayanan, New Age International.
4. Molecular Biophysics- P.K.Banarjee (S. Chand Publication), 2014.
5. Essentials of Biophysics : P. Narayanan, (New Age International, New Delhi), 2005 .
6. Biophysics: An introduction : Rodney Cotterill, John Wiley and Sons Ltd, 2002.
7. Biophysics- Dr.G.R.Chatwal (Himalaya Pub.),2011.

SEMESTER-VI

DSE-4 : PROJECT WORK
(Credits: 06) (Compulsory)

GENERIC ELECTIVE (GE) (Minor-Physics)

SEMESTER-I & III

GE:I-MECHANICS & PROPERTIES OF MATTER, OSCILLATION & WAVES, THERMAL PHYSICS, ELECTRICITY, MAGNETISM & ELECTRONICS
(Credits: Theory - 04, Practicals 02)
Theory: 40 classes (1 hr. duration each)-Full Marks: 70

UNIT-I: Mechanics & 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. Relation among elastic constants, depression at free end of a light cantilever. Surface tension, pressure difference across a curved membrane, viscous flow, Poiseulles formula. (8 classes) 14 Marks

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.(8 classes) 14 Marks

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).(8 classes) 14 Marks

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. Maxwells 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.(8 classes) 14 Marks

UNIT-V: Electronics
Extrinsic and intrinsic semiconductors, 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 α and β JFET, its operation and characteristics of V-I curve.(8 classes) 14 Marks

Reference Books:

1. Properties of Matter D.S. Mathur (S. Chand Publication).
2. Heat and Thermodynamics A.B. Gupta & H.B. Ray (New Central Book Agency).
3. Sound M. Ghosh (S. Chand Publication).
4. Introduction to Electrodynamics D.I. Gri th (Prentice Hall of India).
5. Foundations of Electronics Chattopadhyaya and Rakshit.
6. Physics of Degree students Vol.I M. Das, P.K. Jena, M. Bhuyan, D.K. Rout (Srikrishna Prakashan).
7. Physics of Degree students Vol.I M. Das, P.K. Jena, M. Bhuyan, and others (Srikrishna Prakashan).
8. University Physics Sears, Zemansky, H.D. Young (Addison Wesely).

GE:I LAB.

20 classes (2 hours duration each)-Full Marks: 30

1. Measurement of length (or diameter) using Vernier calipers, Screw gauge and travelling micro-scope.
2. To determine the moment of inertia of a y wheel.
3. To determine the Youngs modulus Y of a wire by Searls method.
4. To determine the modulus of rigidity of a wire by Maxwells needle/Torsion Pendulum (Dynamic method).
5. To determine g by bar pendulum.
6. To determine the elastic constants of a wire by Searls method.
7. To determine the value of Y of a rubber by using travelling microscope.
8. To determine the Rigidity of modulus by static method.
9. To determine the frequency of a telescope by using Sonometer.
10. Verification of Laws of Vibration of a string by using Sonometer.
11. To compare capacitances using DeSauty bridge.
12. To determine the Law of resistance by using Foster bridge.
13. To determine the Mechanical equivalent of heat J by Callender and Barnes constants flow method.
14. To determine the J by Joules Calorimeter.
15. To determine the coefficient of viscosity of water by Capillary flow method (Poiseilles method).
16. Compare the specific heat of two liquids by method of Cooling.

Reference Books:

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House B.B. Swain.
2. A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal (1985), Vani Publication.
3. A Text book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition (2011), Kitab Mahal, New Delhi.

SEMESTER-II & IV

GE-II: OPTICS, SPECIAL THEORY OF RELATIVITY, ATOMIC PHYSICS, QUANTUM MECHANICS & NUCLEAR PHYSICS

(Credits: Theory - 04, Practicals 02)
Theory: 40 classes (1hr duration each)-Full Marks: 70

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. Colour of thin lms and Newtons rings. Fresnel and Fraunhoffer diffraction, diffraction by Single slit Plane transmission grating.(8 classes) 14 Marks

UNIT-II: Optics-II and Relativity
Electromagnetic nature of light, polarized and unpolarized light, polarization by reflection and re-fraction. Brewsters Law, Malus Law, Double refraction. Ordinary and extraordinary rays.
Galilean transformation, Newtonian relativity and its limitation, Michelson Morley experiment and its consequence, postulates of special theory of relativity. Lorentz transformation, length contraction, time dilation, relativistic mass and momentum, mass energy relation.(8 classes) 14 Marks

UNIT-III: 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-Germer experiment.

Bohrs theory of Hydrogen atom, explanation of Hydrogen Spectra correction for finite mass of the nucleus. Bohrs correspondence principle, limitations of Bohrs theory. Discrete energy, exchange by atom Frank Hertz experiment.(8 classes) 14 Marks

UNIT-IV: 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 Schrodingers wave equation in one dimension particle in a box, energy eigen values and eigen functions.(8 classes) 14 Marks

UNIT-V: 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 ssion, nuclear fusion, Linear accelerators, and cyclotron.(8 classes) 14 Marks

Reference Books:

1. Principles of Optics A.B. Gupta.
2. Fundamentals of Optics Jenkins and White.
3. Relativity R. Resnick.
4. Modern Physics H.S. Mani and G.K. Meheta.
5. Quantum Mechanics J.L. Powel and B. Craseman.
6. Atomic and Nuclear Physics Gupta and Ghosh (Books and allied).
7. Physics of Degree students Vol. III M. Das, P.K. Jena and others (Srikrishna Prakashan).
8. Physics of Degree students Vol. IV M. Das, P.K. Jena and others (Srikrishna Prakashan).
9. Concept of Modern Physics Arthur Beiser (Mc-graw Hill) (2009).
10. University Physics Sears, Zemansky, H.D. Young (Addison Wesely).

GE : II LAB.

20 classes (2 hours duration each)-Full Marks: 30

1. Determination of Horizontal component of Earths magnetic field and magnetic moment of a bar magnet using deflection and oscillation magnetometer.
2. Determination of E.C.E. of a Copper by taking 3 readings.
3. Familiarization with Schuster focusing and determination of angle of prism.
4. Determination of Refractive index of the material of a prism using Sodium light.
5. To determine the wavelength of light using plane diffraction grating.
6. To determine the wavelength of light using Newtons ring.
7. Determination of refractive index of (a) glass and (b) liquid by using travelling microscope.
8. Determination of radius of curvature of a convex/concave mirror by using Kohlrauschs method.
9. To determine the magnifying power of a given telescope.
10. Verification of inverse square law of magnetism by using a deflection magnetometer.
11. To draw the static characteristics of a P-N junction diode.
12. Obtain the static characteristics of a P-N-P / N-P-N transistor / Triode Valve.
13. To determine the reduction factor of a tangent Galvanometer.
14. Variation of magnetic field along the axis of a circular coil carrying current.
15. To study the characteristics of a series RC circuit.

Reference Books:

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
2. A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal (1985), Vani Publication.
3. A Text book of Practical Physics, Indu Prakash And Ramakrishna, 11th Edition (2011), Kitab Mahal, New Delhi.