Bachelor of Science (Honours) Physics under CBCS

Programme Code: BSPHY

Programme Outcomes

At the completion of the programme, students will attain the ability to:

PO1: Acquire a fundamental/systematic and coherent understanding of the academic field of basic Physics in areas like Mechanics, Electricity and Magnetism, Waves and Optics, Thermal and Statistical Physics, Quantum Mechanics, Mathematical Physics and their applications to other core subjects in Physics.

PO2: Obtaina wide range and comprehensive experience in physics laboratory methods inexperiments related to mechanics, optics, thermal physics, electricity, magnetism,digital electronics, solid state physics and modern physics. Students shouldacquire the ability for systematic observations, use of scientific research instruments, analysis of observational data,making suitable error estimates andscientific report writing.

PO3: Acquire procedural knowledge that creates different types of professionals related to thedisciplinary/subject area of Physics, including professionals engaged in researchand development, teaching and government/public service;

PO4: Getknowledge and skills in areasrelated to their specialization area corresponding toelective subjects within the disciplinary/subject area of Physics and current andemerging developments in the field of Physics.

PO5: Demonstrate the ability to use skills in Physics and its related areas of technology for formulating and tackling Physics,-related problems and identifying and applying appropriate physical principles and methodologies to solve a wide range of problems associated with Physics.

PO6: Recognize the importance of mathematical modeling, simulation and computational methods, and the role of approximation and mathematical approaches to describing the physical world and beyond.

PO7: Plan and execute Physics-related experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate software

such as programming languages and purpose-written packages, and report accurately the findings of the experiment/investigations while relating the conclusions/ findings to relevant theories of Physics.

PO8: Demonstrate relevant generic skills and global competencies such as

i. problem-solving skills that are required to solve different types of Physics-related problems with well-defined solutions, and tackle open-ended problemsthat belong to the disciplinary area boundaries;
ii. investigative skills, including skills of independent investigation of Physics-related issues and problems;
iii. communication skills involving the ability to listen carefully, to read texts andresearch papers analytically and to present complex information in a concisemanner to different groups/audiences of technical or popular nature;
iv. analytical skills involving paying attention to detail and ability to constructlogical arguments using correct technical language related to Physics andability to translate them with popular language when needed;
v. ICT skills;
vi. personal skills such as the ability to work both independently and in a group.

PO9: Demonstrate professional behavior such as _

i. being objective, unbiased and truthful in all aspects of work and avoidingunethical, irrational behavior such as fabricating, falsifying or misrepresentingdata or committing plagiarism;
ii. the ability to identify the potential ethical issues in work-related situations;
iii. be committed to thefree development of scientific knowledge and appreciate itsuniversal appeal for the entire humanity;
iv. appreciation of intellectual property, environmental and sustainability issues;
v. promoting safe learning and working environment.

Programme Specific Outcomes

At the completion of the programme, students will attain the ability to:

PSO1: Develop strong competencies in Physics and its applications in a technology-rich, interactive environment.

PSO2: Link not only to the research in the area of theoretical but also to the area of experimental physics.

PSO3: Acquire skills in the research, analysis and interpretation of complex information.

PSO4: Get knowledge of the core physics at deeper levels and greater insight of the universe.

PSO5: Evolve as better human resource with a solid foundation in theoretical and experimental aspects in respective specializations as a preparation for career in academia and industry.

PSO6: Apply knowledge gained from this programme for employment in several sectors including Electronics, Manufacturing and Teaching industry.

Course Structure

Semester — I

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Introduction to Classical Mechanics- I(Th)	CC-1 (Th)	4-1-0	4	100
2	Introduction to Classical Mechanics- I(P)	CC-1 (P)	0-0-6	2	100
3	Mathematical Physics-I with Waves & Oscillation (Th)	CC-2 (Th)	4-1 -0	4	100
4	Mathematical Physics-I with Waves & Oscillation (P)	CC-2 (P)	0-0-6	2	100
5	English Communication	AECC- 1	2-l-0	2	100
6	Generic Elective- 1 (Th)	GE- 1 (Th)	4-1-0	4	100
7	Generic Elective- 1 (P)	GE- 1 (P)	0-0-6	2	100
Total credit - 20					

Semester — II

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Thermal Physics & Thermodynamics (Th)	CC-3 (Th)	4-1-0	4	100
2	Thermal Physics & Thermodynamics(P)	CC-3 (P)	0-0-6	2	100
3	Electricity & Magnetism (Th)	CC-4 (Th)	4-1 -0	4	100
4	Electricity & Magnetism(P)	CC-4 (P)	0-0-6	2	100
5	Environmental Science	AECC- 2	2-l-0	2	100
6	Generic Elective- 2 (Th)	GE- 2 (Th)	4-1-0	4	100
7	Generic Elective- 2 (P)	GE- 2 (P)	0-0-6	2	100
Total credit - 20					

Semester — III

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Mathematical Physics-II and Introduction to Computational Methods (Th)	CC-5 (Th)	4-1-0	4	100
2	Mathematical Physics-II and Introduction to Computational Methods (P)	CC-5 (P)	0-0-4	2	100
3	Electrodynamics & Electromagnetism (Th)	CC-6 (Th)	6-1-0	6	100
4	Optics (Th)	CC-7 (Th)	4-l -0	4	100
5	Optics (P)	CC-7 (P)	0-0-4	2	100
6	Skill Enhancement Course- 1	SEC- 1	2-0-0	2	100
7	Generic Elective-3 (Th)	GE- 3 (Th)	4-1-0	4	100
8	Generic Elective-3 (P)	GE- 3 (P)	0-0-4	2	100
Total credit - 26					

Semester — IV

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Elements of Modem Physics (Th)	CC-8 (Th)	6-1-0	6	100
2	Basic Electronics (Th)	CC-9(Th)	4-1-0	4	100
3	Basic Electronics(P)	CC-9(P)	0-0-4	2	100
4	Classical Mechanics-II & Special Theory of Relativity (Th)	CC-10 (Th)	4-1-0	4	100
5	Classical Mechanics-II & Special Theory of Relativity(P)	CC-10 (P)	0-0-4	2	100
6	Skill Enhancement Course- 2	SEC-2	2-0-0	2	100
7	Generic Elective-4 (Th)	GE-4(Th)	4-1-0	4	100
8	Generic Elective- 4 (P)	GE- 4(P)	0-0-4	2	100
Total credit - 26					

Semester — V

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Statistical Mechanics (Th)	CC-11(Th)	6-l-0	6	100
2	Quantum Mechanics & its Application (Th)	CC-12 (Th)	6-1-0	4	100
3	Discipline Specific Elective-1 (Th)	DSE-l (Th)	4-l-0	4	100
4	Discipline Specific Elective- l (P)	DSE-1(P)	0-0-4	2	100
5	Discipline Specific Elective-2 (Th)	DSE-2 (Th)	4-l-0	4	100
6	Discipline Specific Elective-2 (P)	DSE-2 (P)	0-0-4	2	100
Total credit - 22					

Semester — VI

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Atomic Spectroscopy& Physics of Nuclei (Th)	CC-13 (Th)	6-l -0	6	100
2	Solid State Physics (Th)	CC-14 (Th)	4-1-0	4	100
3	Solid State Physics (P)	CC-14 (P)	0-0-4	2	100
4	Discipline Specific Elective- 3 (Th)	DSE- 3 (Th)	4-1-0	4	100
5	Discipline Specific Elective- 3 (P)	DSE-3 (P)	0-0-4	2	100
6	Project/Dissertation/ Special camp to National Research Lab for Research Collaboration	DSE- 4	0-1-6	6	100
Total credit - 24					

***L/T/P: number of classes per week**

DSE/GE may either carry 6 credit, i.e., Theory (4 credit) + Practical (2 credit) format
Or
Consolidated (6 credit) for Theory only

Discipline Specific Elective Course (DSE):

Course name	L-T-P
1. Physics of Device and Instrument 2. Nuclear and Particle Physics 3. Physics of Molecules and Laser 4. Astronomy & Astrophysics 5.Experimental Techniques 6. Advanced Mathematical &Computational Physics 7. Communication System 8. Nano Materials and Applications 9. Earth Science 10. Biophysics 11. Plasma Physics l2. Dissertation/Project	

Generic Elective (GE):

For Physics Students		For Other Students	
Course name	**L-T-P**	**Course name**	**L-T-P**
1. Physical/Organic Chemistry 2. Mathematical Tools, Real analysis, Differential& Integral Calculus 3. Geology-Remote Sensing 4. Statistics- Data analysis, Linear Programming 5. Computer Programming language (C/Python) 6. Cyber Security 7. Forensic Science 8. Artificial Intelligence 9. Physical Geography		1. Electricity and Magnetism 2. Mathematical Physics 3. Waves and Optics 4. Mechanics and Mechanical system 5. Communication system 6. Elements of Modem Physics 7. Biophysics 8. Thermal Physics 9. Astronomy & Astrophysics 10. Earth Science 11. Electrical Circuits and Network skills	

Skill Enhancement courses (SEC):

1. Physics workshop
2. Computational Physics Skill
3. Electrical Circuits and Network skills
4. Basic Instrumentation Skill
5. Renewable Energy and Energy harvesting
6. Applied optics
7. Weather forecasting
8. Cyber Security
9. Intellectual property right
10. Yoga and Life Management
11. Introduction to MATLAB

SEMESTER – I

CC1: Introduction to Classical Mechanics-I

Course Outcomes

After the completion of the course, the students will be able to:

CO1: Know the difference between Newtonian mechanics and Analytic mechanics.
CO2: Solve the mechanics problems using Lagrangian formalism, a different method from Newtonian mechanics.
CO3: Understand the connection between classical mechanics and quantum mechanics from Hamiltonian formalism.
CO4: Understanding of basic concepts of special and general theory of relativity

CC1	**Introduction to Classical Mechanics–I (Theory: 4 Credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Rotating Frame of Reference** Inertial and non-inertial frames of reference, Earth as a frame, Centrifugal and Coriolis forces with their effects (variation in 'g', Deviation of a freely falling body, Geophysical effects), Foucault pendulum and Equation of trajectory of the bob, Direct proof of rotation of Earth, Relation between velocity and acceleration in two frames (operator equation).	15
2	**Mechanical Properties of Matter** Elastic constants, Relation connecting different elastic constants, Strain energy, Twisting couple on a hollow and a solid cylindrical wire, Strain energy in a twisted cylindrical wire, Torsional pendulum, Bending of beams, Bending moment, Theory of Cantilever, Depression of a beam supported at the ends and loaded at the center.	09
3	**Lagrangian Mechanics** Mechanics of a system of particles, Constraints (holonomic & non-holonomic), Generalized coordinates, D'Alembert's principle, Lagrange's equations of motion for holonomic system, Applications of Lagrange's equations	09
4	**Motion under Central Force** Two body central force problem, Reduction to the equivalent one body problem, Differential equation for the orbit and integrable power law potentials, Condition for stable circular orbit, Kepler problem, Laboratory and Centre of mass frames, Scattering problem- Differential scattering cross section, Rutherford scattering, Transformation of scattering problem to laboratory coordinates	15
	TOTAL	48

Suggested Readings :

1. H. Goldstein, C. P. Poole and J. F. Safko, Classical Mechanics, Addison-Wesley 2.N. C. Rana and P. S. Joag, Classical Mechanics, Tata McGraw-Hill.
2. D. S. Mathur, P. S. Hemne, Mechanics, S. Chand.
3. L. D. Landau and E. M. Lifshitz, Mechanics,Butterworth-Heinemann.
4. S. L. Gupta, V. Kumar and H. V. Sharma, Classical Mechanics, PragatiPrakashan.
5. R. D. Gregory, Classical Mechanics,Cambridge University Press.
6. R. Resnick, Introduction to Special Relativity, John Wiley and Sons.

CC1	Introduction to Classical Mechanics-I (Practical: 2 credits)

Practical

1. Measurement of length:To measure thickness, diameter, radius of curvature etc. Using slide calipers, screw gauge and spherometer
2. To find the moment of Inertia/ angular acceleration of a fly wheel.
3. To find acceleration due to gravity (g) in Lab using
   i. Bar Pendulum
   ii. Kater's Pendulum
4. To determine Moment of Inertia of a rectangular bar about an axis through Center of Gravity by the method of coincidence.
5. To find radius of Gyration (G) of object of different geometric shapes – Rectangular plate, Annular Disc, Circular Disc etc.
6. To find Young's Modulus of the material of a rectangular bar by bending
7. To find Moment of Inertia of an irregular body about an axis through its Center of Gravity with the help of torsional pendulum.
8. To determine Poisson's ratio for Rubber
9. To find Young's modulus, modulus of rigidity and Poisson's ratio for the material of the wire by Searle's method
10. To find the co-efficient of Viscosity uniform bore.
11. To study the flow of water through capillary as a function of pressure head.
12. To determine the co-efficient of viscosity of glycerin or castor oil by Stoke's method.
13. To verify (a) law of conservation of linear momentum and (b) law of conservation of kinetic energy in the case elastic collisions.
14. To calculate co-efficient of restitution using one dimensional collision apparatus of two hanging sphere.
15. To determine refractive index of material using – Travelling microscope (Glass/water cube) - Prism table (glass/water prism) and drawing bond.
16. To determine focus length of convex/ concave lens using U-V method.

Suggested Readings :

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.

CC2: Mathematical Physics-I with Waves & Oscillation

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Master the basic elements of complex mathematical analysis.
CO2: Solve differential equations that are common in physical sciences.
CO3: Apply group theory and integral transforms to solve mathematical problems of interest in Physics.
CO4: Understanding how to use special functions in various physics problems

CC2	Mathematical Physics -I with Waves & Oscillation (Theory: 4 credits)	
Unit	**Topics to be covered**	**No. of Lectures**
1	**First Order Differential Equations:** First order differential Equations: Variable separable, homogeneous, non-homogeneous, exact and inexact differential equations and Integrating Factors. Application to physics problems. **Second Order Differential Equations:** Homogeneous Equations with constant coefficients. Wronskian and general solution. Particular Integral with operator method, method of undetermined coefficients and method of variation of parameters.	10
2	**Vector Algebra:** Scalars and vectors, laws of vector algebra, scalar and vector product, triple scalar product, interpretation in terms of area and volume, triple cross product, product of four vectors. Scalar and vector fields. **Vector Differentiation:** Ordinary derivative of a vector, the vector differential operator∇. Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. **Computer fundamentals:** Introduction to computer, history of computers, generations of computers, types of computers and working principle, information processing, software and hardware, types of programming language, number system, assembler, compiler, interpreter, linker, loader (definition only), binary number interconversion, algorithm definition, flow chart.	15
3	**Oscillations:** Idea of SHM. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Compound pendulum. Damped oscillation. Forced oscillations: Transient and steady states, sharpness of resonance and Quality Factor. **Superposition of Collinear Harmonic oscillations**: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. **Superposition of two perpendicular Harmonic Oscillations**: Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequencies and their uses.	15
4	**Wave Motion:** Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave.	08
	TOTAL	48

Suggested Readings :

1. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India .
2. Advanced Mathematics for Engineers and Scientists: Schaum Outline Series, M. R Spiegel, McGraw Hill Education (2009).
3. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
4. Mathematical Methods for Physicists, Arfken, Weber and Harris, Elsevier
5. The Physics of Vibrations and Waves, H. J. Pain, john Wiley & Sons Ltd.
6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill
7. Waves and Oscillations, N Subrahmanyam, Brij Lal, Vikas Publishing House Pvt Ltd.

CC2	**Mathematical Physics - I with Waves & Oscillation (Practical: 2 credits)**

Part A:

To determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda^2 T$ law.
To determine frequency of tuning fork using a Sonometer.
To verify the laws of transverse vibration of stretched string using Sonometer.
To compare mass per unit length of two strings by Melde's experiment.
To determine the frequency of A.C. mains using a Sonometer and an electro-magnet.
To find the velocity of sound in the materials of given rod with a Kundt's tube.
To determine the velocity of ultrasonic waves in a given liquid (e.g. Kerosene oil).
Study of mixed modes of oscillations.

Part B: Introduction to programming in C/C++

Calculate the area of basic figures, square, triangle, rectangle.
Find the roots of a quadratic equation
To find the largest of three numbers
Find the sum and average of an array of numbers
Sorting of numbers in ascending and descending order

Scalar and vector product of two vectors

Suggested Readings :

1. Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3. Practical Physics, G. L. Squires, 2015, 4/e, Cambridge University Press.
4. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11/e, 2011, Kitab Mahal.

SEMESTER- II

CC3: Thermal Physics &Thermodynamics

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Comprehended the basic concepts of thermodynamics, the first and the second law of thermodynamics.

CO2: Understand the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations.

CO3: Learn about Maxwell's relations and use them for solving many problems in Thermodynamics.

CO4: Learn the basic aspects of kinetic theory of gases, Maxwell-Boltzmann distribution law, equitation of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion.

CC3	**Thermal Physics &Thermodynamics (Theory: 4 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Kinetic Theory of Gases** Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (no derivation). Molecular Collisions: Mean Free Path. Estimation of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian motion, Langevin and Einstein's theories and experimental determination of Avogadro's no., Rectilinear flow of heat in a metal rod, relation between thermal & electrical conductivities.	15
2	**Real Gases** Behavior of Real Gases and relation between different variables, Critical Constants. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Joule-Thomson Cooling.	09
3	**Zeroth and First Law of Thermodynamics** Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics and Concept of Temperature, Work, Heat, State Functions and path functions, First Law of Thermodynamics and its differential form, Internal Energy, Applications of First Law of	09

	thermodynamics-thin film, stretched wire, hydrostatics, etc., Specific heat General Relation between C_P and C_V.	
4	**Second Law of Thermodynamics** Principles of heat engines, Carnot engine, Carnot cycle, Principle of Refrigerator. Second Law of thermodynamics, Kelvin-Planck and Clausius Statements. Concept of Entropy, Clausius Inequality, Second Law in terms of Entropy, Temperature–Entropy diagrams. Third Law of thermodynamics, Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz & Gibb's Functions, Maxwell's Relations, Co-efficient of performance, Clausius-Clapeyron equation and phase transition (1^{st} and 2^{nd})	15
	TOTAL	48

Suggested Readings :

1. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
2. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
3. A Treatise on Heat, MeghnadSaha, and B.N. Srivastava, 1958, Indian Press
4. Classical and Quantum Thermal Physics, R. Prasad, 2016, Cambridge University Press
5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
6. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988,Narosa.
7. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, University Press.

CC3	**Thermal Physics & Thermodynamics (Practical: 2 credits)**

Practical

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 good conductor (Cu) by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of good conductor (Cu) by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlto'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 using a null method.
7. To determine Mechanical Equivalent of Heat, J, with the help of Joule's calorimeter.
8. To plot a graph between temperature and pressure at constant volume using Joly's apparatus and to find the coefficient of increase of pressure at constant volume.
9. To study the adiabatic expansion of a gas and hence to find the value of γ - the ratio of specific heat at constant pressure to specific heat at constant volume for air using Clement and Desorme's apparatus

Suggested Readings :

1. Advanced Practical Physics for students: B. L. Flint and H.T.Worsnop (Little Hampton Book)
2. A Text Book of Practical Physics :Indu Prakash& Ramakrishna(Kitab Mahal)
3. Advanced level Practical Physics: Nelkon and Ogborn (Heinemann Educational Publ.)

4. An Advanced Course in Practical Physics: D. Chattopadhyay& P. C. Rakshit, (New Central Book Agency)
5. Practical Physics: G.L. Squires (Cambridge University Press)
6. B.Sc. Practical Physics :C.L.Arora (S.Chand)

CC4: Electricity & Magnetism

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Apply Gauss's law of electrostatics to solve a variety of problems.

CO2: Articulate a knowledge of electriccurrent, resistance and capacitance in terms of electric field and electric potential.

CO3: Calculate the magnetic forces that act on moving charges and the magnetic fields due to currents (Biot- Savart and Ampere laws)

CC4	**Electricity & Magnetism (Theory: 4 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Electrostatics** Electric field, Electric field lines. Electric flux. Gauss's with applications to charge distributions with spherical, cylindrical and planar symmetry, Conservative nature of Electrostatic Field. Electrostatic Potential. Potential and Electric Field of a dipole. Force and Torque on a dipole in an electric field, Laplace's and Poisson equations. Relation between potential and electric field, The Uniqueness Theorem. Applications of Laplace's equations. Electrostatic potential energy of system of charges, Potential energy due to continuous charge distributions, Electrostatic potential energy of a charged sphere. Conductors in an electrostatic Field. Surface charge on a conductor. Capacitance of a system of charged conductors. Energy stored in a capacitor, Parallel-plate capacitor. Capacitance of an isolated conductor.	15
2	**Dielectric Properties of Matter** Electric Field in matter. Polarization, Polarization Charges. Surface charge and Bound charge, Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss's in dielectrics.	10
3	**Magnetism** Current loop as a magnetic dipole, Magnetization vector (**M**). Magnetic Intensity(**H**). Magnetic Susceptibility and permeability. Relation between **B**, **H**, **M**. Ferromagnetism. B- H curve and hysteresis. Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. 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.	15

	Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance and their determination for a solenoid, Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.	
4	**Electrical Circuits** AC Circuits: Kirchhoff‟s laws for AC circuits. Reactance and Complex Impedance. Series and parallel LCR Circuit: (1) Resonance, (2) Quality Factor, and (3) Band Width. Power in AC Circuits.	08
	TOTAL	48

Suggested Readings :

1. Fundamentals of Electricity and Magnetism, Arthur F. Kip, 2 nd Edn.1981, McGraw-Hill.
2. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
3. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
4. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
5. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
6. Electricity and Magnetism, J.H.Fewkes&J.Yarwood. Vol.I, 1991, Oxford Univ. Press.
7. Schaum's Outline of Electric Circuits, J. Edminister& M. Nahvi, 3rd Edn., 1995, McGraw Hill.

CC4	**Electricity & Magnetism** **(Practical: 2 credits)**

Practical :

1. Use of Multimeter for measuring (a) Resistance, (b) AC and DC Voltages, (c) DC Current, (d) Capacitance, 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) Anti-resonant frequency and (b) Quality factor Q.

Suggested Readings :

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. Engineering Practical Physics, S.PanigrahiandB.Mallick, 2015, Cengage Learning.

SEMESTER – III

CC5: Mathematical Physics-II and Introduction to Computational Methods

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Represent a periodic function by a sum of harmonics using Fourier series and their applications in physical problems such as vibrating strings etc.

CO2: Understand properties and applications of special functions like Legendre polynomials, Bessel functions and their differential equations and apply these to various physical problems such as in quantum mechanics.

CO3: Understand the basic concepts of complex analysis and integration.

CO4: In the laboratory course, the students will be able to design code and test simple programs in C++ in the process of solving various problems.

CC5	**Mathematical Physics-II and Introduction to Computational Methods (Theory: 4 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Vector Analysis in Curvilinear Coordinates and Tensors:** Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. Ordinary Integrals of Vectors, 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). Definition of Contravariant and covariant tensors, Symmetric and Anti-symmetric tensors with examples, elementary properties of tensors	10
2	**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, Bessel, Hermite and Laguerre Differential Equations.	15
3	**Partial Differential Equations:** Solutions to partial differential equations using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes.	13
4	**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. Cauchy's Inequality. Cauchy's Integral	10

	formula. Simply and multiply connected region. Integration of function of a complex variable.	
	TOTAL	48

Suggested Readings :

1. Vector Anyalysis, Murray R. Spiegel, Schaum's outlines
2. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J.Bence, 3 rd ed., 2006, Cambridge University Press
3. Advanced Engineering Mathematics, H. K. Dass, S. Chand & Co.
4. Advanced Differential Equations, M. D. Raisinghania, S. Chand Publications

CC5	**Mathematical Physics-II and Introduction to Computational Methods (Practical: 2 credits)**

Practical

1. **C & C++ Programming fundamentals and Programs:** 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 Statement. 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 Statements. Nested Loops), Arrays (1D & 2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects
2. Sum & average of a list of numbers,
3. Largest of a given list of numbers and its location in the list,
4. Sorting of numbers in ascending descending order,
5. **Random number generation :**Area of circle, area of square, volume of sphere, value of π
6. **Numerical differentiation** (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules): Given Position with equidistant time data to calculate velocity and acceleration and vice versa. Find the area of B-H Hysteresis loop

Suggested Readings :

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J.Bence, 3rd ed., 2006, Cambridge University Press
2. C++: The Complete Reference, Herbert Schildt, Indian Edition

CC6: Electrodynamics & Electromagnetism

Course Outcomes

After the completion of the course, the student will be able to understand:

CO1: Time-varying fields and Maxwell equations.

CO2: Various concepts of electromagnetic waves.

CO3: Radiation from localized time varying sources, and the charged particle dynamics.

CO4: The Concept of electromagnetic field energy density and boundary conditions

CC6	**Electrodynamics & Electromagnetism (Theory: 6 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	Maxwell Equations: Review of Maxwell' s equations. Displacement Current. Vector and Scalar Potentials. Wave Equations in free space. Plane waves in dielectric media. Boundary Conditions at Interface between Different Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.	14
2	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.	10
3	EM Wave Propagation 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. Metallic reflection (normal Incidence).	14
4	Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism.	10
5	**A. Wave Guides:** Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission. **B. Optical Fibres:** Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).	12
	TOTAL	60

Suggested Readings :

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 r
6. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
7. Electromagnetic Fields & Waves, P.Lorrain&D.Corson, 1970, W.H.Freeman& Co.
8. Electromagnetics, J .A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
9. Electromagnetic field theory fimdamentals, B. Guru and H. Hiziroglu, 2004,Cambridge University Press.

CC7: Optics

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Understand Interference as superposition of waves from coherent sources derived from same parent source.
CO2: Demonstrate basic concepts of Diffraction: Superposition of wavelets diffracted from aperture.
CO3: Understand Fraunhoffer and Fresnel Diffraction.
CO4: Gain experience of .using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment, Fresnel Biprism etc.

CC7	**Optics (Theory: 4 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Interference:** Superposition of waves, Conditions for interference, Two Beam Interference by Division of Wavefront (Fresnel's Biprism, Two Mirror arrangement, Lloyd's mirror) and by Division of Amplitude (Interference by thin film, Theory of Colours by thin film), Complex Representation and Intensity Distribution on reflection: Stoke's relations.	08
2	**Interferometer:** Michelson interferometer and its applications, Multiple beam interference in parallel film, Fabry-Perot interferometer, Coherence – Spatial and Temporal.	10
3	**Fraunhofer Diffraction:** Conditions for diffraction, Fraunhofer diffraction due to single, double and multiple slits, Plane transmission grating. **Fresnel diffraction:** Fresnel half- period zones, Zone plate, Huygens-Fresnel principle, Diffraction by a circular aperture, Diffraction by a straight edge, Resolving power of grating, telescope and microscope.	15
4	**Polarization and Double Refraction:** Polarized light and its mathematical representation, Production of polarized light by reflection, refraction and scattering, Polarization by double refraction, Nicol prism, Quarter wave plate, Half wave plate, Babinet's compensator, Production and analysis of circularly and elliptically polarized light, Optical activity and Fresnel's theory, Bi-quartzpolarimeter	15
	TOTAL	48

Suggested Readings :

1. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
2. Optics, (2017), 6th Edition, Ajoy Ghatak, McGraw-Hill Education, New Delhi
3. Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, S. Chand Publications

CC7	Optics (Practical: 2 credits)

Practical

1. To determine Magnifying Power of a telescope by the slit method using Microscope.
2. To find the height of an inaccessible object (altitude or angular diameter of the Sun) using Sextant.
3. To find angle of prism/ angle of minimum deviation and hence refractive index of material of prism using Spectrometer.
4. To find value of Cauchy's Constant A and B for the material of a given prism using a Mercury Vapour Lamp.
5. To determine Resolving Power of a prism.
6. To determine diameter of a thin wire by studying the diffraction (and interference) pattern.
7. To determine wavelength of sodium light using a plane diffraction grating.
8. To determine Resolving Power of a plane transmission grating.
9. To establish the dispersion relation for a plane transmission grating.
10. To verify Fresnel's Law of reflection and refraction by using a plane refracting surface.
11. Simple experiment demonstrating different applications of LASER and Optical Fibre.

Suggested Readings :

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.
5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press

SEMESTER – IV

CC08: Elements of Modern Physics

Course Outcomes

After the completion of the course, the student will be able to:

- **CO1:** Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics.
- **CO2:** Formulation of Schrodinger equation and the idea of probability interpretation associated with wave-functions.
- **CO3:** The spontaneous and stimulated emission of radiation, optical pumping and population inversion. Three level and four level lasers. Ruby laser and He-Ne laser in details. Basic lasing.
- **CO4:** The properties of nuclei like density, size, binding energy, nuclear forces and structure of atomic nucleus, liquid drop model and nuclear shell model and mass formula.

CC8	Elements of Modern Physics (Theory: 06 credits)	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Particle Properties of Radiations** Planck's quantum Hypothesis, Explanation of Photoelectric effect, Inadequacy of Wave theory and Need of Quantum theory of Light, Explanation of Blackbody' Radiation, Experiment Compton scattering and its Explanation, Pair Production and Amiihilation. **Wave Aspect of Particles** Idea De Broglie wavelength and matter waves, Davisson-Germer experiment for diffraction of electron, G.P. Thomson Experiment and Frish and Stem method on Diffraction of Helimn, Description of particles in terms of wave packets, Concept of Group and Phase velocities and relation between them.	10
2	**Wave-Particle Duality** Idea of Wave-particle duality, concept of wave amplitude and its relation with Probability of finding particles and expression for Wave functions, Heisenberg Uncertainty principle, Uncertainty relations involving canonical pair of variables and their Derivation from Wave Packets, Estimation of minimum energy for a confined particle using uncertainty principle, origin of natural width of emission lines, Uncertainty Principle and concept of Bohr Orbit.	10
3	Wave mechanical description of electron/material particles, the Schrodinger Wave equation, Two-slit interference experiment and Probability Density, Expectation value atom, Schrodinger equation for non-relativistic particles, Momentum and Energy operators. Time independent Schrodinger equation, Probability, probability current densities and Normalization of Wave functions in one dimension, Idea of energy eigenvalues and eigenfunctions.	10
4	**Atomic Structure** Various Atomic Models and their Shortcomings, Bohr's Atomic theoretical explanation of Hydrogen and Hydrogen-like Spectra, Comparison between H and He+ Spectra, Corrections for finite nuclear mass and corresponding variations in Rydberg Constant, Introduction to Sommerfeld Quantization Rule and Relativistic correction.	10
5	**Fundamental Properties of Nucleus** Size, constituent and structure of atomic nuclei and its relation with atomic weight, Idea of Isotope, Isobar, Isotope and Mirror nuclei , Mass defect and binding energy and Packing fraction with Binding Energy versus Mass number Curve. Stability of the nucleus and Nature of Nuclear force , Law of radioactive decay, Mean life and Half-life, successive nuclei transformation, Basic Idea of Alpha , Beta and Gamma decay, Idea of energy-momentum and parity conservation in nuclear decay process/reactions and the Q-value. Radiation Detector, Ionization Chamber, Geiger-Muller Counter, Neutron detection, Spark, Bubble, Cloud and Scintillation , Cherenkov and other chamber.	20
	TOTAL	60

Suggested Readings :

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Modern Physics by R ASerway, C J Moses and C A Moyer, 3rd edition, Thomson Brooks Cole, 2012.
3. Modern Physics for Scientists and Engineers by S T Thornton and A Rex, 4th edition, Cengage Learning, 2013.
4. Concepts of Nuclear Physics by B L Cohen, Tata McGraw Hill Publication, 1974.
5. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2ndEdn., 2002, Wiley.

CC9: Basic Electronics

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Fundamental designing concepts of different types of Logic Gates, Minimization techniques etc.

CO2: Designing of different types of the Digital circuits, and to give the computational details for Digital Circuits.

CO3: Characteristics of devices like PNP, and NPN junction diode and truth tables of different logic gates.

CO4: Basic elements rand to measure their values with multimeter and their 'characteristic study.

CC9	**Basic Electronics (Theory: 4 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Electronic instruments:** Block Diagram of CRO. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. Basic use of Multimeter, Function generator and regulated power supply, **Digital Circuits:** Difference between Analog and Digital Circuits. Binary Numbers, Decimal to Binary and Binary to Decimal Conversion. Binary arithmetic, BCD representation. Basic Gates, their realization using Diodes and Transistor; NAND and NOR as Universal Gates; XOR Gates; Their Truth Tables. **Boolean algebra:** Laws of Boolean Algebra, De Morgan's Theorems, Simplification of Logic Circuit using Boolean Algebra and Karnaugh Maps. Fundamental Products. Idea of Minterms and Maxterms, Don't care condition (φ).	12
2	**Combinational circuits:** Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors. **Sequential Circuits:** RS, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Race-around conditions in JK Flip-Flop and its avoidance.	12

	Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Address decoding, Memory Interfacing. Memory Map.	
3	**Semiconductor Diodes:** P and N type semiconductors. Energy Level Diagram. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Basic ideas of (1) LEDs, (2) Photodiode, (3) Zener Diode, (4) Solar Cell. **Electronic Devices and their Applications:** (1) Rectifier Diode: Half-wave Rectifiers. Full-wave Rectifiers (Centre-tapped and Bridge), Calculation of Ripple Factor and Rectification Efficiency, (2) Voltage Regulation using Zener Diode. Bipolar Junction transistors, **(**n-p-n and p-n-p), Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.	12
4	**Amplifiers:** Transistor Biasing circuits and Stability. 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. Class A, B & C Amplifiers (Classification only). **Feedback and Oscillation:** Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Wien Bridge oscillator, determination of Frequency. Hartley & Colpitts oscillators. **Operational Amplifiers and Applications (Black Box approach):** Characteristics of Ideal and Practical Op-Amps. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Voltage Comparator.	12
	TOTAL	48

Suggested Readings :

1. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw Hill
2. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
3. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
4. Electronic Principles. Albert P. Malvino
5. Electronic Devices and Circuit Theory. RobertL. Boylstead and Louis Nashley, Prentice Hallof India.
6. Principles of Electronics. V. K. Mehta and Rohit Mehta, S,Chand and Company.

CC9	Basic Electronics (Practical: 2 credits)

Practical

The student will develop an understanding of the basics of linear electronic circuits.

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. Half Adder and Half Subtractor.
6. To build a RS and D-type Flip-Flop using NAND gates and study timing diagram.
7. To study V-I characteristics of PN junction diode, and Light emitting diode.
8. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
9. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
10. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
11. To study the various biasing configurations of BJT for normal class A operation.
12. To design a CE transistor amplifier of a given DC gain and obtain its frequency response with and without bypass capacitor.
13. To design inverting amplifier using Op-amp (741) and study its frequency response
14. To add two dc voltages using Op-amp in inverting and non-inverting mode

Suggested Readings :

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, Boylestad&Nashelsky, 2009, Pearson.

CC10: Classical Mechanics - II & Special Theory of Relativity

Course Outcomes

After the completion of the course, the student will have to:

CO1: Understand the physical principle behind the derivation of Lagrange and Hamilton equations, and the advantages of these formulations.

CO2: Understand small amplitude oscillations.

CO3: Understand the intricacies of motion of particle in central force field. Critical thinking and problem-solving skills.

CO4: Recapitulate and learn the special theory of relativity extending to Four — vectors.

CC10	Classical Mechanics - II & Special Theory of Relativity (Theory: 4 credits)	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Rigid Body Motion** Rigid body, Eulerian angles, Kinematics of rotation, Euler's equations of motion, Motion of a symmetrical top	09
2	**Variational Principle and Hamiltonian formalism** Calculus of variation and its applications, Lagrange's equations of motion for non-holonomic system, Velocity-dependent potential, Cyclic coordinates, Symmetries and conservation laws, Legendre transformation, Hamilton's equations of motion and its applications, Principle of least action	15
3	**Canonical Transformation** Canonical transformation and its applications, Poisson Brackets, Jacobi identity, Hamilton-Jacobi equation, Action- angle variables, Theory of small oscillations	09
4	**Special Theory of Relativity** Galilean transformation, Michelson-Morley experiment, Postulates of special theory of relativity, Derivation of Lorentz transformation and physical significance of Lorentz invariance, Length contraction and time dilation, Concept of simultaneity, Relativistic velocity transformation relations, Variation of mass with velocity, Mass-energy relation, Concept of zero rest mass of photon, Relativistic relation between energy and momentum, Relativistic Doppler effect	15
	TOTAL	48

Suggested Readings :

1. H. Goldstein, C. P. Poole and]. F. Sako, Classical Mechanics, Addison-Wesley
2. N. C. Rana and P. S. Ioag, Classical Mechanics, Tata McGraw-Hill
3. L. D. Landau and E. M. Lifshitz, Mechanics, Butterworth-Heinemann
4. S. L. Gupta, V. Kumar and H. V. Sharma, Classical Mechanics, Pragati Prakashan
5. R. D. Gregory, Classical Mechanics, Cambridge University Press

CC10	Classical Mechanics -II & Special Theory of Relativity (Practical: 2 credits)

Practical :

To determine the value of g by dipping Metal ball using solenoid through a pair of photo gates.
To determine 'G' using torsion pendulum & verification of inverse.
To measure period of Oscillation of Pendulum by changing v.
To determine Moment as function of
(i) Distance between the Origin of G-ordinary and Point of action force.
(ii) Force (iii) the angle between the force and the position vector of point of application of force.
To calculate the moment of Inertia of different bodies.
To study liner the motion under low friction and on inclined plane.
To determine the characteristic frequencies of uncoupled spring.
To determine the spring constant of the Coupling Spring.
To determine the electric constants using methods :
(i) Searle's optical interference Newton's Ring
(ii) Cornc's Interference.
To determine elastic constant of Poly Crystalline Material by using Ultra sonic waves.
To study consecration of Momentum in
(i) 1- D
(ii) 2 - D Collisions
To determine the Surface Tension of Water by ring-pull out Method.
To determine the viscosity of Glycerin.
To investigate resonance in Forced Oscillation.
To investigate the damping effect of air, water, oil or glycerin on an oscillating spring.

SEMESTER-V

CC11: Statistical Mechanics

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Basic knowledge of thermodynamic systems.

CO2: Understand the basic idea about statistical distributions.

CO3: Impart the knowledge about the phase transitions and potentials.

CO4: Understand the applications of statistical laws

CC11	Statistical Mechanics (Theory: 6 credits)	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Introduction** Probability concepts and examples - random walk problem in one dimension mean values probability distribution for large N. Probability distribution of many variables. Macrostate and Microstate, Phase Space, Elementary Concept of Ensemble, Entropy and Thermodynamic Probability.	08
2	**Classical Statistics** Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, 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.	12
3	**Bose-Einstein Statistics** Bose-Einstein distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.	13
4	**Fermi-Dirac Statistics** Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.	13
5	**Theory of Radiation** Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Radiation Pressure. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe. Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.	14
	TOTAL	60

Suggested Readings :

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
2. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill.
3. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
4. An Introduction to Statistical Mechanics & Thermodynamics, R. H. Swendsen, 2012, Oxford Univ. Press
5. Introductory Statistical Mechanics, R. Bowley and M. Sanchez, 2nd Edn., 2007, Oxford Univ. Press
6. A treatise on Heat, M. N. Saha and B.N. Srivastava

CC12: Quantum Mechanics and its Applications

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Learn to represent quantum states by ket vectors, physical observables as operators and their time evolution.

CO2: Understand commutator brackets between observables and their properties.

CO3: Learn concept of system of identical non- interacting particles: dynamics of two level systems, qubits.

CO4: Understand the addition of orbital and spin angular momenta.

CC12	**Quantum Mechanics and its Applications** **Credits-06 (Theory)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Quantum Mechanics** Inadequacy of classical mechanics, Blackbody Radiation: Planck's concept, Planck's radiation formula; Quantum theory of light: Photo-electric effect and Compton scattering; De Broglie wavelength and matter waves; wave-particle duality, Heisenberg uncertainty principle and its applications.	10
2	**Formalism of Quantum Mechanics** State vector; Hilbert Space : Bra and Ket notation, Operators, Hermitian, Unitary, Commutator; Wave functions and its properties; Physical Interpretation of Wave Function; Probability and normalization, Postulates of Quantum Mechanics; Observables and operators, Expectation Values, Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum Wave Function of a Free Particle.	12
3	**Schrodinger equation and its application** Time, independent Schrodinger equation- Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wave function as a linear combination of energy eigenfunctions. Time dependent Schrodinger equation and dynamical evolution of a quantum state; 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.	14
4	**Infinite and Finite Square Well Potential, Tunneling & Harmonic Oscillator** Infinite-Finite one-dimensional problem-square well potential Tunnelling through Potential Step, Potential Barrier, Bound state solutions, Solution of simple harmonic oscillator- Energy levels and Eigen functions using Frobenious method, Hermite polynomials; Ground state, Zero point energy.	12
5	**Quantum Theory of Hydrogen Atom and Angular Momentum** Time independent Schrodinger equation in spherical polar coordinates; Separation of variables for second order partial differential equation; Angular	12

	momentum operator and quantum numbers; Radial Wave functions from Special function, Shapes of the probability densities for ground and first excited states, Concept of spin and Stern-Gerlach experiment. Rigid rotator	
	TOTAL	60

Suggested Readings :

1. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
2. Introduction to Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education
3. Quantum Mechanics: Concepts and Applications, NouredineZettili
4. Quantum Mechanics, Walter Greiner, 4thEdn., 2001, Springer
5. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
6. A Text book of Quantum Mechanics, P. M. Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill.
7. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002 Wiley.
8. Quantum Mechanics, Leonard I. Schifi 3rd Edn. 2010, Tata McGraw Hill.
9. Quantum Mechanics, G Aruldhas, 2nd Edn. 2002, PI-II Leamin of Inqia.
10. Quantum Mechanics: Foundations & Applications, Amo Boim, 3rd Edn., 1993, Springer
11. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

SEMESTER – VI

CC13: Atomic Spectroscopy & Physics of Nuclei

Course Outcomes

After the completion of the course, the student will be able to understand:

CO1: Atomic spectroscopy of one and two valance electron atoms.

CO2: The change in behavior of atoms in external applied electric and magnetic field.

CO3: Rotational, vibrational, electronic and Raman spectra of molecules.

CO4: Electron spin and nuclear magnetic resonance spectroscopy.

CC13	**Atomic Spectroscopy & Physics of Nuclei (Theory: 6 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**H-spectra** Fine structure of hydrogen spectra (H_α-line), Wilson-Sommerfeld quantization rule, Problems related to Bohr theory, Bohr-Sommerfeld theory and Ionization Potentials, Bohr-Sommerfeld (B-S) theoretical explanation of fine structure H-spectra, shortcomings of B-S theory, Stern-Gerlach Experiment to demonstrate the existence of electron spin, Difference between spectra of inner core electron (X-ray spectra) and optically active valence electron (UV-Visible and I.R. Spectra).	12
2	**Quantum mechanics of H-atom** Physical interpretation and properties of wave-function, Quantum mechanical treatment of one-electron atom system (Hydrogen atom).Solution of Schrodinger equation for Hydrogen atom using separation of variables, Associated Legendre Polynomial,Hypergeometric series, Recurrence Formula, Spherical Harmonics,Interpretation of quantum numbers and electron-probability density, Expectation value and parity of eigenfunctions.	14
3	**Concept of Vector Atom model** Orbital magnetic dipole moment, Behaviour of magnetic dipole in external magnetic field and Larmor Precession, Space quantization, electron spin, coupling of orbital and spin angular momentum, Spectroscopic term and their notations. Lamb Shift, Pauli's Exclusion Principle and wave function for identical particle system, Zeeman effect and Paschen Back effect.	10
4	**Spectra of 1 and 2 electron system (Alkali and Alkaline Earth Element)** Feature and explanation of Spectra of Alkali elements, Resonance lines and fine structure in Alkali spectra, Intensity ratio of Na- doublet lines, Interaction energy for L-S and J-J coupling for Alkaline Earth elements.	10
5	**Nuclear Models** Essence of Liquid drop model, Salient Features and Predictions of Shell model, Brief idea of Collective Model, Alpha particle model and Fermi gas model,	14

	Nuclear reaction and its types, Artificial Transmutation, Experimental determination of Q-value, Deuteron problem and its wavefunction, Central force and Non-Central force, Yukawa's model and π-meson.	
	TOTAL	60

Suggested Readings :

1. Modern Physics by R A Serway, C J Moses and C A Moyer, 3rd edition, Thomson Brooks Cole, 2012.
2. Concepts of Modern Physics by Arthur Beiser, McGraw Hill Education, 2009.
3. Concepts of Nuclear Physics by B L Cohen, Tata McGraw Hill Publication,1974.
4. Physics and Engineering of Radiation Detection by S N Ahmed, Academic Press Elsevier, 2007.

CC14: Solid State Physics

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Elucidate the concept of lattice, crystals and symmetry operations.

CO2: Understand the elementary lattice dynamics and its influence on the properties of materials.

CO3: Describe the main features of the physics of electrons in solids: origin of energy bands, and their influence electronic behavior.

CO4: Explain the origin of the dielectric properties exhibited by solids and the concept of polarizability.

CC14	**Solid State Physics (Theory: 4 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Crystal Structure:** Solids: Amorphous and Crystalline Materials. Lattice and Basis. Lattice Translation Vectors. Types of Lattices. Unit Cell. Miller Indices. Reciprocal Lattice. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law.	12
2	**A. Crystal Bonding:** Elementary idea of Bonding in Solids. Cohesive Energy of Ionic Crystals. Lennard Jones Potential. **(5 Lectures)** **B. Elementary Lattice Dynamics:** Lattice Vibrations and Phonons: Linear Monoatomic andDiatomic Chains. Acoustical and Optical Phonons.Dul0ng and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3— law.	12
3	**A. Free Electron Theory**: Theory of free electron gas, Fermi surface, Fermi Energy, Density of States. **(5 Lectures)** **B. Elementary Band Theory:** Bloch Theorem. Kronig-Penny Model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, Measurement of conductivity (Four Probe Method). Mobility. Hall Effect & Hall coefficient.	12

4	**A. Magnetic Properties of Matter:** Origin of magnetism. Langevin's theory of Diamagnetism and Paramagnetism. Ferromagnetism and Antiferromagnetism. Curie-Weiss law. Ferromagnetic Domains. **(5 Lectures)** **B.** Superconductivity: Critical Temperature. Critical Magnetic Field. Meissner effect. Type — Iand type — II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation). **(5 Lectures)** **C. Dielectric Properties of Materials:** Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius-Mossotti Equation.	12
	TOTAL	48

Suggested Readings :

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. Azaroff, 2004, Tata Me-Graw Hill.
4. Solid State Physics, N.W. Ashcrofi and N.D. Mermin, 1976, Cengage Learning.
5. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer.
6. Elementary Solid State Physics, l/e M. Ali Omar, 1999, Pearson India.
7. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

CC14	**Solid State Physics** **(Practical: 2 credits)**

Practical

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°C) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

Suggested Readings :

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. Azaroff, 2004, Tata Me-Graw Hill.

Discipline Specific Elective (DSE)

DSE1: Physics of Devices And Instruments

Course Outcomes

After the completion of the course, the student will be able to:

COl: Understand principle of "working and industrial applications of various transducers like Electrical, Thermal and Mechanical systems commonly used to measure Temperature and Position in industry.
CO2: Develop an understanding of construction and working of different measuring instruments.

DSE1	**Physics of Devices And Instruments (Theory: 4 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Devices:** Metal-semiconductor Junction. Characteristic and small signal equivalent circuits of BJT and JFET. Metal oxide semiconductor (MOS) device. Enhancement and Depletion Modes in MOSFETS, Enhancement type MOSFETS, CMOS. UJT and SCR: Construction, working and characteristics, Charge coupled devices. **Circuit simulation software:** Familiarity with Pspice/Orcad/Kicad software, simulation of simple diode rectification, BJT CE amplifier, Series LCR circuit.	15
2	**Power supply and Filters:** Block Diagram of a Transistor based Power supply with Short circuit protection, Qualitative idea of C and L Filters. 78XX and79XX series IC Regulators, Line and load regulation, Low Pass, High Pass, Band Pass and band Reject Filters, First order Passive Filters (RC filters in L, T and Pi configurations).	09
3	**Multivibrators:**Astable and Monostable Multivibrators using transistors. Phase Locked Loop (PLL): Basic Principles, XOR based Phase detector, Voltage Controlled Oscillator (Basics, varactor). Loop Filter– Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046). **Electronic and analytical instruments:** Block Diagram and basic features of CRO and DSO. Basic ideas of some analytical instruments (construction and working): UV and Visible spectrophotometer, analytical balance, LCR meter, PID controlled furnace, X-ray Diffractometer.	15
4	**Digital Data Communication Standards:** Serial Communications: RS232, Handshaking, Implementation of RS232 on PC. Universal Serial Bus (USB), Types and elements of USB transfers. Devices (Basic idea of UART). Parallel Communications: General Purpose Interface Bus (GPIB), Handshaking and interface management, Basic idea of sending data through a COM port. **Data Communication systems:** Introduction to communication systems: Block diagram of Analog and digital communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator.	09

	Demodulation of AM wave using Diode Detector. Basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK.	
	TOTAL	48

Suggested Readings :

1. Physics of Semiconductor Devices, S.M. Sze & K.K. Nag, 3rd Ed.2008, John Wiley & Sons
2. Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.
3. Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd
4. Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
5. Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
6. Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.
7. PC based instrumentation; Concepts & Practice, N. Mathivanan, 2007, Prentice-Hall of India

DSE1	**Physics of Devices And Instruments (Practical: 2 credits)**

Practical

1. To design the active Low pass and High pass filters of given specification.
2. To design the active filter (wide band pass and band reject) of given specification.
3. To study the output and transfer characteristics of a JFET.
4. To design a common source JFET Amplifier and study its frequency response.
5. To study the output characteristics of a MOSFET.
6. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
7. To design an Astable multivibrator of given specifications using transistor.
8. Glow an LED via USB port of PC.

SPICE / MULTISIM/eSim simulations for electrical networks and electronic circuits

1. To obtain characteristics of a PN junction diode
2. Design the inverting and non-inverting amplifier using an Op-Amp of given gain
3. Design a BJT common emitter amplifier and study its gain and frequency response.
4. Design a series LCR circuit and measure its resonant frequency.

Suggested Readings :

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A.Miller,1994, Mc-Graw Hill
2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
3. Electronics : Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
4. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4thedn., 2000, Prentice Hall
5. Introduction to PSPICE using ORCAD for circuits & Electronics, M.H. Rashid, 2003, PHI Learning
6. PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

DSE2: Nuclear and Particle Physics

Course Outcomes

After the completion of the course, the student will be able to:

CO1: To be able to understand the basic properties of nuclei as well as knowledge of experimental determination of the same, the concept of binding energy, its various dependent parameters, N-Z curves and their significance
CO2: To appreciate the formulations and contrasts between different nuclear models such as Liquid drop model, Fermi gas model and Shell Model and evidences in support.
CO3: Knowledge of radioactivity and-decay laws. A detailed analysis, comparison and energy kinematics of alpha, beta and gamma decays.
CO4: Familiarization with different types of nuclear reactions, Q- values, compound and direct reactions.

DSE2	**Nuclear and Particle Physics (Theory: 6 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**General Properties of Nuclei:** Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density, matter density (experimental determination of each), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/Z plot, angular momentum, parity, magnetic moment, electric moments	10
2	**Nuclear Models:** Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, nucleon separation energies(up to two nucleons), Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure and the basic assumption of shell model	10
3	**Radioactivity decay:** Decay rate and equilibrium (Secular and Transient) (a) Alpha decay: basics of a-decay processes, theory of or-emission, Gamow factor, Geiger Nuttall law, a-decay spectroscopy, decay Chains. (b) B -decay: energy kinematics for [3 -decay, B-spectrum, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission from the excited state of the nucleus& kinematics, internal conversion.	10
4	**Nuclear Reactions:** Types of Reactions, units of related physical quantities, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering)	10
5	**Detector for Nuclear Radiations and particle accelerators:** Gas detectors: estimation of electric field, mobility of particle for ionization chamber and GM Counter **(4 Lectures)** Linear accelerator, Cyclotron, Synchrotrons (Principal, construction, working, advantages and disadvantages) **(6 Lectures)** **Particle physics:** Particle interactions (concept of different types of forces); basic features, types of particles and its families, Conservation Laws (energy and	20

	momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness), concept of quark model, color quantum number and gluons	
	TOTAL	60

Suggested Readings :

1. Basic Ideas and concepts in Nuclear Physics: An introductory Approach by K Heyde, Third edition, IOP Publication, 1999.
2. Nuclear Physics by S. N. Ghoshal, First edition, S. Chand Publication, 2010.
3. Concepts of Nuclear Physics by Bemard L Cohen, Tata McGraw Hill Publication, 1974.
4. Introductory Nuclear Physics by Kenneth S, Krane, Wiley-India Publication, 2008
5. Nuclear Physics : principles and applications by Jolm Lilley, Wiley Publication, 2006.
6. Physics and Engineering of Radiation Detection by Syed Naeem Ahmed, Academic Press Elsevier, 2007.
7. Radiation detection and measurement, G.F. Knoll, John Wiley & Sons, 2010.
8. Technique for Nuclear and Particle Physics experiments by William R Leo, Springer, 1994.
9. Introduction to Modem Physics by Mani & Mehta, Affiliated East-West Press, 1990.
10. Introduction to elementary particles by David J Griffiths, Wiley, 2008.
11. Modem Physics by Serway, Moses and Moyer, CENGAGE LEARNING, 2012.
12. Concepts of Modern Physics by Arthur Beiser, McGraw Hill Education, 2009.

DSE3: Physics of Molecules and Laser

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Obtain a deeper understanding of molecular binding and spectroscopic techniques.
CO2: Understand the working principles of different type of LASER and their applications in day to day life.

DSE3	**Physics of Molecules and Laser (Theory: 6 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	Basic Theory of LASER: Energy levels and process of Absorption and Emission Einstein's Predication. Difference between spontaneous and stimulated emission important features of stimulated emission Einstein's A and B Co-efficient and light Amplification condition for large stimulated emission, population inversion and pumping method and schemes (two level, three level and four level): Amplifier and Optical Resonator with threshold condition for LASING.	12
2	Application of LASERs in holography-concept of temporal and spatial coherence, principle and method of generation and viewing of hologram, types of holograms. Application in consumer electronic industry (Barcode reader and elements), in communication-basic principle and element of optical fiber communication. Numerical aperture of fiber optics cables. In medical science, LASER diagnostics, LASER in ophthalmology and LASIK, LASER-surgery and LASER in Dermatology.	14

3	Concept of molecule, basic idea of molecular bonding-Ionic and covalent and molecular formation, Morse potential energy curve, Molecule as oscillator, Concept of dissociation, wave function of H_2^+ (Hydrogenmolecular ion) - different approaches like valence bond, Linear Combination of Atomic Orbitals (L.C.A.O.) treatments.	10
4	Hamiltonian of molecule as a system, Separation of electronic and nuclear motion (born-oppenheimer approximation), Types of molecular energy states- vibrational, rotational and electronic, Types of molecular spectra-UV, IR, Raman; flame spectroscopy and flame photometry, X-Ray and Mossbauer spectroscopy.	12
5	Different Molecular spectroscopic techniques as a Tool- atomic absorption spectroscopy, Emission spectroscopy, Molecular Luminescence, Photo and Opto-acoustic spectroscopy (PAS/OAS), Nuclear Magnetic Resonance (NMR), Nuclear Quadrupole Resonance (NQR), Electron Spin Resonance (ESR) and Electron diffraction spectroscopy.	12
	TOTAL	60

Suggested Readings :

1. Atoms Molecules and Photons, W Demtröder , Springer (2010) 2/e
2. Atoms and Quanta, Haken and Wolf, Springer (2010) 2/e
3. Physics of Atoms and Molecules B H Bransden and C J Joachain, Pearson International (2011) 2/e
4. Quantum Mechanics (Non-relativistic Theory) L D Landau and E M Lifshitz, Course on Theoretical Physics Vol 3, Pergamon Press/Butterworth Heinemann
5. Molecular Quantum Mechanics Atkins and Friedman, Oxford Press 4/e

DSE4: Astronomy & Astrophysics

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Different types of telescopes, diurnal and yearly motion of astronomical objects, and astronomical coordinate systems and their transformations.
CO2: Brightness scale for stars, types of stars, their structure and evolution on HR diagram.
CO3: Components of Solar System and its evolution.
CO4:The large scale structure of the Universe and its history.
CO5: Distribution of chemical compounds in the interstellar medium and astrophysical conditions necessary for the emergence and existence of life.

DSE4	**Astronomy & Astrophysics (Theory: 6 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Astronomical Scales:** Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature, Basic	15

	Parameters of Stars: Determination of Distance by Parallax Method; Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus; Determination of Temperature and Radius of a star; Determination of Masses from Binary orbits; Stellar Spectral Classification, Hertzsprung-Russell Diagram. **Astronomical techniques:** Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes).	
2	**The sun:** Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity, The solar family, Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets. Stellar spectra and classification Structure (Atomic Spectra Revisited, Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification)	10
3	**Stellar Structure:** Hydrostatic Equilibrium of a Star, Some Insight into a Star: Virial Theorem, Sources of Stellar Energy, Modes of Energy Transport, Simple Stellar Model, Polytropic Stellar Model. Star formation: Basic composition of Interstellar medium, Interstellar Gas, Interstellar Dust, Formation of Protostar, Jeans criterion, Fragmentation of collapsing clouds, From protostar to Pre-Main Sequence, Hayashi Line.	10
4	**The milky way:** Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way (Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms), Stars and Star Clusters of the Milky Way	10
5	**Cosmology:** Cosmic Distance Ladder, Distance Measurement using Cepheid Variables, Hubble's Law (Distance- Velocity Relation), Clusters of Galaxies (Virial theorem and Dark Matter), Friedmann Equation and its Solutions, Early Universe and Nucleosynthesis, Cosmic Background Radiation	15
	TOTAL	60

Suggested Readings :

1. An Introduction to the Theory of Stellar Structure and Evolution, Dina Prialnik
2. Introduction to Cosmology, Andrew Liddle
3. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.
4. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory
5. The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University Science Books.
6. Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer
7. K.S. Krishnasamy, 'Astro Physics a modern perspective,' Reprint, New Age International (p) Ltd, New Delhi,2002.
8. BaidyanathBasu, 'An introduction to Astro physics', Second printing, Prentice -Hall of India Private limited, New Delhi,2001.
9. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B.Bhatia, Narosa Publication.

DSE5: Experimental Techniques

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Handle the various experimental techniques and electronic devices.
CO2: Understand how to formulate the research problems.

DSE5	**Experimental Techniques (Theory: 4 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Basic Laboratory tools** Vernier'sCallipers, screw gauge, spherometer, thermometer (mercury and electronic), galvanometer, voltmeter and ammeter, spectrometer, optical bench, pressure measurement instruments.	08
2	**Basic Electronics** Semiconductor devices (diodes, junctions, transistors, field effect transistors, UJT : device structure, working, device characteristics, applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). Digital multimeter, function generator and measurement with oscilloscope.	10
3	**Electronic measurement** Transducers (sensors and actuators), Signals and Signal processing, Operational amplifiers and their application in signal processing. Digital techniques and applications (registers, counters, comparators and similar circuits). A/D and D/A converters Voltage regulator IC series 78XX and 79XX. Simple regulated power supply using these, Data logger and Data acquisition systems (Basic ideas).	15
4	**Basics of research** Steps in research: Problem selection, Literature survey- available sources, Research Design, Instrumental measurement, report writing and publication. Measurement process and Calibration, Data and information, Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting, Binomial, Poisson and Gaussian distributions and their relevance in statistical data interpretation. Simple Data analysis using spreadsheet (e.g. Microsoft Excel)	15
	TOTAL	48

Suggested Readings :

1. Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
2. Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
3. Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.

DSE5	**Experimental Techniques (Practical: 2 credits)**

Practical

1. Familiarization with Vernier Callipers, Screw gauge and spherometer
2. Familiarization with spectrometer and optical bench and their applications
3. Use of digital multimeter for measurement of voltage, current and resistance & testing diode.
4. Use of CRO for observing different waveforms (generated by function generator and measuring voltage and signal frequency).
5. Analysis of Data generated by advanced laboratory equipment along with error analysis.

Reference Books:

1. Prayogik Bhautiki- Singh and Sinha
2. Basic electronics – a text lab manual by Zbar and Malvino.
3. Research Methodology – C. R. Kothari
4. Introduction to PSPICE using ORCAD for circuits & Electronics, M.H. Rashid, 2003, PHI Learning
5. PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

DSE6: Advanced Mathematical & Computational Physics

Course Outcomes

After the completion of the course, the student will be able to:

CO1:Obtain a deeper understanding of linear algebra and linear transformation.
CO2: Learn numerical techniques of differentiation and integration along interpolation techniques.

DSE-06	**Advanced Mathematical & Computational Physics (Theory: 6 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Linear Algebra:Vector Spaces:** Vector Spaces over Fields of Real and Complexnumbers. Examples. Vector space of functions. Linear independence of vectors. Basisand dimension of a vector space. Change of basis. Subspace. Isomorphisms. Innerproduct and Norm. Inner product of functions: the weight function. Triangle and Cauchy Schwartz Inequalities.	12
2	**Linear Transformations:** Introduction. Identity and inverse. Singular and non-Singulartransformations. Representation of linear transformations by matrices. Similaritytransformation. Linear operators. Differential operators as linear operators on vectorspace. Commutator of operators. Orthogonal and unitary operators and theirmatrix representations. Adjoint of a linear operator. Hermitian operators and their matrixrepresentation. Eigenvalues and eigenvectors of linear operators. Properties of eigenvalues andeigenvectors of Hermitian and unitary operators	12
3	**Tensors:**	12

	Tensors as multilinear transformations (functionals) on vectors. Examples: Moment of Inertia, dielectric susceptibility. Components of a tensor in basis. Symmetric and antisymmetric tensors. The completely antisymmetric tensor. Non-orthonormal andreciprocal bases. Summation convention. Inner product of vectors and the metric tensor.Coordinate systems and coordinate basis vectors. Reciprocal coordinate basis.Components of metric in a coordinate basis and association with infinitesimal distance.	
4	**Numerical Differentiation:** Taylor Series method; Generalized numerical differentiation: truncation errors. Roots of Linear, Non-linear Algebraic and Transcendental equations: Newton-Raphson method; convergence of solutions. **Numerical Integration:** Newton-cotes formulae: Trapezoidal rule, Simpson's 1/3 rule, error estimates in Trapezoidal rule and Simpson 1/3 rule using Richardson deferred limitapproach; Gauss-Legendre quadrature method; Monte Carlo (mean sampling) method for single, double and triple integrals. **Curve Fitting:** Principle of least square; Linear regression; Polynomial regression; Exponential and Geometric regression.	12
5	**Interpolation:** Finite differences; Interpolation with equally spaced points; Gregory - Newton's Interpolation formula for forward and backward interpolation; Interpolation with unequally spaced points: Lagrangian interpolation, Solution of Simultaneous Linear Equations: Gaussian elimination method, Pivioting; Gauss-Jordan elimination method; Matrix inversion. Eigen values and Eigen vectors: Jacobi's method for symmetric matrix. **Numerical Solution of First Order Differential Equations:** First order Taylor Series method; Euler's method; Runge-Kutta methods; Predictor corrector method; Elementary ideas of solutions of partial differential equations, Numerical Solutions of Second Order Differential Equation: Initial and boundary value problems: shooting methods.	12
	TOTAL	60

Suggested Readings :

1. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications
2. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris,l970, Elsevier.
3. Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.
4. Linear Algebra, W. Cheney, E.W. Cheney & D.R. Kincaid, 2012, Jones & Bartlett Learning.
5. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
6. Mathematical Methods for Physics & Engineers, K.F. Riley, M.P. Hobson, S.J. Bence,3rd Ed., 2006, Cambridge University Press
7. Gerald, Applied Numerical Analysis, Pearson.
8. Landau and Binder, A Guide to Monte Carlo Simulations in Statistical Physics, Cambridge University Press.
9. Teukolsky, Vetterling and F Iannery, Numerical Recipes, Cambridge University Press
10. W. H. Press, B.P. F lamiery, S.A. Teukolsky and W.T. Vetterling, Numerical Recipes: The Art of Scientific Computing, Cambridge University Press.
11. H. M. Antia, Numerical Methods for Scientists and Engineers, Hindustan Book Agency.
12. D. W. Heermann, Computer Simulation Methods in Theoretical Physics, Springer.
13. H. Gould and J. Tobochnik, An Introduction to Computer Simulation Methods, Addison Wesley.
14. J. M. Thijssen, Computational Physics, Cambridge University Press.

DSE7: Communication System

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Learn the concept of different types of signals and their modulation used in transmission.
CO2: Understand about techniques used in computer networking.
CO3: Understand the basic principle of optical fiber and its application in communication.

DSE-07	**Communication System (Theory: 6 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Introduction to Analogue and Digital transmission system** Type of signal: Analog and Digital, Basic Model for transportation of information by electrical means and limitation of physics pairs/Underground cable, concept of carrier system and need for modulation (AM, FM, and PM), need for digitalization, principle and techniques of Modulation/Multiplexing.	11
2	**Broad Band Communication** Free space/ Line of sight propagation, Effect of Ground/ nature of Earth surface / Atmosphere on transmission, antennas and Associated equipment terminal transmitter and received, Satellite communication-Geosynchronous Orbit, Frequency of Operation,Introduction to Optical Fiber communication-Advantages, structure, type and characteristics of optical fiber, light source – LED and LASERs, photo detectors PIN, APD.	12
3	**Pulse Modulation** Different type of modulation- Pulse amplitude (PM), Pulse Duration/Width (PDM or PWM), Pulse Position (PPM), Pulse Frequency (PFM), Time Division (TDM), Sampling Method and theorem, Quantizing, Encoding of signal, A-D conversion Line Coding (NRZ and RZ binary, Bipolar, HDB_3, CMI, 5B6B.	11
4	**Computer Network** Uses of network, Network hardware for different type of network (Local Area, Metropolitan Area, wide area, wireless and internet), Network software (Protocol Hierarchies, Design issues for the Layers, Interface and Services, Relationship of Services to Protocol), Reference models and example network, Physical Layers(Theoretical Basis for data communication and different transmission media, Network security and application, Electronic Mail, WWW, multimedia)	14
5	**Optical Fiber** Basic principle involved in optical fiber technology, physical nature of optical fiber, fiber classification, Numerical Aperture, Optical Fiber bundles and cables, Fiber Optical Communication System, Dielectric Wave guide and optical fiber, Type of Fiber.	12
	TOTAL	60

Suggested Readings :

1. Electronic Communications, D. Roddy and J. Coolen, Pearson EducationIndia.
2. Advanced Electronics Communication Systems- Tomasi, 6thEdn. PrenticeHall.
3. Electronic Communication systems, G. Kennedy, 3rd Edn., 1999, Tata McGrawHill.
4. Principles of Electronic communication systems – Frenzel, 3rd edition, McGrawHill.
5. Computer Networks, Andrew S. Tanenbaum, PHI Publication.

DSE8: Nano Materials and Applications

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Get basic knowledge of nanoscience and nanotechnology, the basic idea about the nano structure.
CO2: Impart the knowledge about the properties and characteristics techniques of nano materials.

DSE8	**Nano Materials and Applications (Theory: 6 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**NANOSCALE SYSTEMS:** Length scales in physics, Nanostructures: ID, 2D and 3Dnanostructures (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.	14
2	**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.	14
3	**CHARACTERIZATION:** X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.	10
4	**APPLICATIONS-1:** Applications of nanoparticles, quantum dots, nanowires and thinfilms for photonic devices (LED, solar cells). Single electron devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage.	12
5	**APPLICATIONS-2:** Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).	10
	TOTAL	60

Suggested Readings :

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Baneijee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
6. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004)

DSE9: Earth Science

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Get basic knowledge of Earth, its structure and environment.
CO2: Understand various dynamical processes happening on the Earth.

DSE9	**Earth Science (Theory: 5 credits + Tutorial: 1 credit)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	**The Earth and the Universe:** (a) Origin of universe, creation of elements and earth, A Holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography. Introduction to various branches of Earth Sciences. ' (b) The Milky Way galaxy, solar system, Earth's orbit and spin, the Moon's orbit and spin. The terrestrial and Iovian planets. Meteorites & Asteroids. Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age. Particle fluxes incident on the Earth Cosmic Raysand the Magnetosphere.	16
2	**Structure:** (a) The Solid Earth: Mass, dimensions, shape and topography, geothermal energy, magnetic field. Hydrological Cycle, Seismic waves and the Earth's interior. (b) The Hydrosphere: The Oceans. depth, volume, chemical composition. Surface and Ground water reservoirs. Structure of (c) The Atmosphere: Structure of atmosphere (variation of temperature, density and composition with altitude), clouds. (d) The Cryosphere: Polar caps and ice sheets. Mountain glaciers. (e) Biosphere: Plants and Animals, Marine and land ecology.	16
3	**Dynamical Processes:** (a) The Solid Earth, Layering of the Earth. Convection in Earth's core and production of its magnetic field. Introduction to geophysical methods of earth investigations. Concept of plate tectonics, sea-floor spreading and continental drift. Geodynamic elements of Earth: Mid Oceanic Ridges, trenches, transform faults and island arcs. Origin of	12

	oceans, continents, mountains and rift valleys, Earthquake and earthquake belts. Volcanoes: types, products and distribution. (b) The Atmosphere: Atmospheric circulation. Weather and climatic changes. Earth's heat budget. Cyclones. Climate: Earth's temperature and greenhouse effect, Paleoclimate and recent climate changes. The Indian monsoon system. Water cycle, Carbon cycle, Nitrogen cycle, Phosphorous cycle, The role of cycles in maintaining a steady state.	
4	**Evolution:** Nature of stratigraphic records, Standard stratigraphic geological time scale. Introduction to the geology and geomorphology of Indian subcontinent. Time line of major Geological and Biological events. Origin of life on Earth. Role of the biosphere in shaping the environment. Projected Future of evolution of the Earth and solar system.	08
5	**Disturbing the Earth - Contemporary dilemmas:** Human population growth. Green house gas emissions in atmosphere, Ground water pollution, air pollution. Fresh water depletion. Chemical effluents, nuclear waste. Biodiversity loss. Deforestation. Robustness and fragility of ecosystems.	08
	TOTAL	60

Suggested Readings :

1. Planetary Surface Processes, H. Jay Melosh, Cambridge University Press, 2011.
2. Consider a Spherical Cow: A course in environmental problem solving, John Harte. University Science Books
3. Holme's Principles of Physical Geology. 1992. Chapman 8: Hall.
4. Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.

DSE10: Biophysics

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Obtain the knowledge of living cell.
CO2: Understand thermodynamics and interaction involved in biomaterials.

DSE10	**Biophysics (Theory:6 credits)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	Building Blocks & Structure of Living State: Atoms and ions, molecules essential for life, what is life. Living state interactions: Forces and molecular bonds, electric and thermal interactions, electric diploes, Casimir interactions, domains of physics in biology.	12
2	Heat Transfer in biomaterials: Heat Transfer Mechanism, The Heat Equation, Joule heating of tissue, Living State Thermodynamics: Thermodynamics equilibrium, first law of thermodynamics and	12

	consignation of energy, Entropy and second law of thermodynamics, Casimir contribution of free energy, Protein folding and unfolding.	
3	Open systems and chemical thermodynamics: Enthalpy, Gibbs Free energy and chemical potential, activation energy and rate constants, enzymatic reactions, ATP hydrolysis and synthesis, Entropy of mixing, The Grand Canonical ensemble, Hemoglobin.	12
4	Diffusion and Transport: Maxwell-Boltzmann statistics, Fick's law of diffusion, sedimentation of Cell Cultures, diffusion in a centrifuge, diffusion in an electric filed. Lateral diffusion in membranes, Navier stokes equation, low Reynold's number Transport, active and passive transport.	12
5	Bioenergetics and Molecular motors: Kinesins, Dyneins, and microtubule dynamics, Brownian motion, ATP synthesis in Mitochondria, Photosynthesis in Chloroplasts, Light absorptions in biomolecules vibrational spectra of bio-biomolecules.	12
	TOTAL	60

Suggested Readings :

1. Principles of Biochemistry by A.L. Lehninger, D.L. Nelson and M.M. Cox, CBS Publishers, New Delhi, 1993.
2. Biochemistry by L. Stryer, W.H. Freeman and Co., Newyork, 1997.
3. Biophysics by VasanthaPattabhi and N. Gautham, Narosa Publishing House, New Delhi, 2002.
4. Introductory Biophysics, J. Claycomb, JQP Tran, Jones &Bartelett Publishers.
5. Aspects of Biophysics, Hughe S W, John Willey and Sons.
6. Essentials of Biophysics by P Narayanan, New Age international.

DSE11: Plasma Physics

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Obtain the understanding of fundamentals of plasma physics.
CO2: Understand the application of plasma in various fields of physics.

DSE11	**Plasma Physics** **(Theory: 5 credits + Tutorial: 1 credit)**	
Unit	**Topics to be covered**	**No. of Lectures**
1	The fourth state of matter, collective behavior, charge neutrality concept of plasma temperature, classification of Plasma, Debye shielding, Debye length, plasma frequency, plasma parameters and criteria for plasma state.	12
2	Single particle dynamics, charged particle motion in electric field, magnetic field and in combined electric and magnetic field, Basics of E x B drift, Drift of guiding centre, gradient drift, curvature drift and magnetic mirror.	12

3	Elementary concepts of plasma kinetic theory, space and velocity distribution function, the Boltzmann equation, Equations of kinetic theory, Derivation of fluid equations by taking different moments.	12
4	Magnetohydrodynamics (MHD) equations and their derivation, ideal MHD, magnetic Reynold's number, frozen-in condition, conservation of magnetic topology, MHD waves: magnetosonic waves, Alfven waves.	12
5	Saha's theory of thermal ionization, Controlled thermonuclear fusion, Tokamak, MHD Generator, Industrial applications of plasma, Application in space science.	12
	TOTAL	60

Suggested Readings :

1. Introduction to Plasma Physics and Controlled Fusion, Francis, F. Chen, Plenum Press, 1984
2. Fundamental of Plasma Physics, J, A. Bittencourt, Springer-Verlag New York Inc., 2004
3. The Fourth State of Matter- Introduction to Plasma Science, S. Eliezer and Y. Eliezer, IoP Publishing Ltd., 2001.
4. Elementary Plasma Physics, L. A. Arzimovich, Blaisdell Publishing Company, 1965
5. Plasmas- The Fourth State of Matter, D. A. Frank- Kamenetskii, Macmillan Press, 1972.