Model Curriculum for Three/Four Year Degree Course
(With Multiple Entry /Exit Option)
Based on NEP-2020

Physics
(Single major and Two Minors)

(For Batch 2024-2027)

Sambalpur University
Jyoti Vihar, Sambalpur

Contents

UG Programme in Physics

Programme Outcomes:

The Undergraduate Programme in Physics is designed to result in:

PO1: Acquire adequate knowledge of the subject
PO2: Craft a foundation for higher learning
PO3: Be initiated into the basics of research
PO4: Imbibe sound moral and ethical values
PO5: Become conscious of environmental and societal responsibilities
PO6: Attain skills for communication and career
PO7: Learn to tolerate diverse ideas and different points of view
PO8: Become empowered to face the challenges of the changing universe

Course Outcomes

1: Understand the basic concepts of methodology of science and the fundamentals of mechanics, properties of matter and electrodynamics, Mathematical Physics.
2: Understand the theoretical basis of Mathematical Physics, quantum mechanics, relativistic physics, nuclear physics, optics, spectroscopy, solid state physics, astrophysics, statistical physics, photonics and thermodynamics
3: Understand and apply the concepts of electronics in the designing of different analog and digital circuits
4: Understand the basics of computer programming and numerical analysis
5: Apply and verify theoretical concepts through laboratory experiments

OUTLINE OF SYLLABUS

Physics

Three Year Degree Course with Single Major and Two Minors

Semester	Core-I	Core-II	Core-III	Multi-disciplinary	AEC	SEC	VAC	Community Engagement & Services / Field Work/ Internship	Total Minimum Credit
I	2X4=8 Mathematical Physics-1 Mechanics	1X4=4 Mechanics		1X3=3 Biophysics	1X4=4 Odia/Hindi/ Sanskrit/Urdu		1X3=3 Environmental Studies and Disaster Management		22
II	2X4=8 Electricity and Magnetism Mathematical-Physics-2		1X4=4 Electricity and Magnetism	1X3=3 Environmental Chemistry	1X4=4 English	1X3=3 Renewable Energy and Energy Harvesting			22
***Vocational Course 1: Fundamental of Horticulture (4 Credits)**									**44**
III	3X4=12 Waves and Optics Mathematical-Physics-3 Thermal Physics	1x4=4 Waves and Optics		1x3=3 Introduction to Spectroscopy			1x3=3 Nanomaterial and Nano technology		22
IV	3X4=12 .Analog System Basic Instrumentation Nuclear and Particle Physics		1x4=4 Analog System					1x4=4 (Field Work / Internship)	20
***Vocational Course 2: Nursery Management (4 Credits)**									**42**

V	3X4=12 .Digital System Quantum Mechanics and Applications Solid State Physics	1x4=4 Digital System				1x3=3 Applied Optics and Photonics	1x3=3 Basic Understanding of Molecular Dynamics		22
VI	2X4=8 Electromagnetic Theory Statistical Physics		1X4=4 Electromagnetic Theory			1X3=3 Corrosion and Prevention	1x3=3 Ethics & Values		18
									40
Total	15X4=60	3X4=12	3X4=12	3X3=9	2X4=8	3X3=9	4X3=12	1X4=4	**126**

In case a student opts for NCC and clears 'C' certificate additional 16 credits shall be awarded and total credit shall be 126+16 = 142 credits

***Vocational Course:**

After 2nd Semester: **Fundamental of Horticulture**

After 4th Semester: **Nursery Management**

(Students may choose vocational courses after 2nd Semester and 4 th Semester for Certificate Course or Diploma Course respectively with 4 credit each opt for exit. Student have to pay additional fees for the purpose as specified by the course provider.)

In case a student opts for NCC and clears 'C' certificate additional 16 credits shall be awarded and total credit shall be 126+16 = 142 credits

***Vocational Course:**

After 2nd Semester: **Fundamental of Horticulture**

After 4th Semester: **Nursery Management**

(Students may choose vocational courses after 2nd Semester and 4 th Semester for Certificate Course or Diploma Course respectively with 4 credit each opt for exit. Student have to pay additional fees for the purpose as specified by the course provider.)

Physics Basket (Core-I)

Semester	Four Year Hons. Without Research	Four Year Hons. With Research	Three Year Degree Course with single Major and Two Minor	Three Year Degree Course with Double Major	Three Year Degree Course with three Core without Major
I	1. (Mathematica Physics-1) 2. (Mechanics)	1. (Mathematical Physics-1) 2. (Mechanics)	1. (Mathematical Physics-1) 2. (Mechanics)	1. (Mathematic al Physics-1) 2. (Mechanics)	1. (Mathematical Physics- 1)
II	3. (Electricity and Magnetism) 4. (Mathematical-Physics-2)	3. (Electricity and Magnetism) 4. (Mathematical-Physics-2)	3. (Electricity and Magnetism) 4. (Mathematical-Physics-2)	3. (Electricity and Magnetism) 4. (Mathematical-Physics-2)	2. (Mechanics)
III	5. (Wave and Optics) 6. (Mathematical-Physics-3) 7. (Thermal Physics)	5. (Wave and Optics) 6. (Mathematical-Physics-3) 7. (Thermal Physics)	5. (Wave and Optics) 6. (Mathematical-Physics-3) 7. (Thermal Physics)	5. (Wave and Optics) 6. (Mathematical-Physics- 3) 7. (Thermal Physics)	3. Quantum Mechanics and aplications 4. Electricity and Magnetism
IV	8. (Analog System) 9. Basic Instrumentation 10. Nuclear and Particle Physics	8. (Analog System) 9. Basic Instrumentation 10. Nuclear and Particle Physics	8. (Analog System) 9. Basic Instrumentation 10. Nuclear and Particle Physics	8. (Analog System) 9. Basic Instrumentation 10. Nuclear and Particle Physics	5. Analog Electronics System
V	11. Digital System 12. Quantum Mechanics and Applications 13. Solid State Physics	11. Digital System 12. Quantum Mechanics and Applications 13. Solid State Physics	11. Digital System 12. Quantum Mechanics and Applications 13. Solid State Physics	11. Digital System 12. Quantum Mechanics and Applications 13. Solid State Physics	6. Wave and Optics
VI	14. Electro-Magnetic Theory 15. Statistical Physics	14. Electro-Magnetic Theory 15. Statistical Physics	14. Electro-Magnetic Theory 15. Statistical Physics	14. Electro-Magnetic Theory 15. Statistical Physics	7. Solid State Physics

VII	16. Mathematical Methods in Physics 17. Classical Mechanics 18. Quantum Mechanics 1 19. Computational Physics Lab	16.Classical Mechanics 17. Quantum Mechanics 1 18. Computational Physics Lab			
VIII	20. Classical Electrodynamics 21. Quantum Mechanics 2 22. Electronics 23. Optics and Modern Physics Lab	19. Classical Electrodynamics 20. Optics and Modern Physics Lab			
Total	23X4=92	20X4=80	15X4=60	15X4=60	7X4=28

Note:

One credit is equivalent to one hour of lecture or tutorials or two hours of practical work/field work per week in a semester. One Credit will be generally equivalent to 15 hours of instructions.

Each semester shall comprise of 15 weeks of academic activities with a minimum of 90 working days.

Credit for different classes			
Credit	**Theory**	**Tutorial**	**Practical/Field**
1	1 Hour	1 Hour	2 Hours

Evaluation:

Distribution of Marks in Semester End and Continuous Evaluation:

(Irrespective of credit in a course/Paper)

Course Type	Maximum Marks	Semester End Theory Marks	Continuous Evaluation Marks / Sessional	Mid Semester Theory Marks	Semester End and Practical Marks	Mid Semester Practical Marks
Without Practical	**100**	**60**	**20**	**20**	**----**	**----**
With Practical	**100**	**50**	**10**	**10**	**20**	**10**

Distribution of Sessional Marks:

Course Type	Maximum Marks	Mid Semester	Attendance		Surprise Test / Quiz	Assignment / Presentation
Without Practical	40	20	Above 95% -	5 Marks	10	05
With Practical	30	(Theory 10 + Practical 10) = 20	85%-94% -	4 Marks	05	Nil
			75%-84% -	3 Marks		

COURSE STRUCTURE OF UG PHYSICS (MAJOR) UNDER NEP-2020

Semester	Course Code	Course Name	Credit	Full Marks
I		Mathematical Physics-1	4	100
		Mechanics	4	100
II		Electricity and Magnetism	4	100
		Mathematical-Physics-2	4	100
III		Waves and Optics	4	100
		Mathematical- Physics-3	4	100
		Thermal Physics	4	100
IV		Analog System	4	100
		Basic Instrumentation	4	100
		Nuclear and Particle Physics	4	100
V		Digital System	4	100
		Quantum Mechanics and Applications	4	100
		Solid State Physics	4	100
VI		Electro- Magnetic Theory	4	100
		Statistical Physics	4	100
VII		Mathematical Methods in Physics	4	100
		Classical Mechanics	4	100
		Quantum Mechanics 1	4	100
		Computational Physics Lab	4	100
VIII		Classical Electrodynamics	4	100
		Quantum Mechanics 2	4	100
		Electronics	4	100
		Optics and Modern Physics Lab	4	100

COURSE STRUCTURE OF UG PSHYSICS CORE-II/CORE-III (MINOR) UNDER NEP-2020

(This is to be offered to students opting Physics as minor; for Odd semester, Core-II and for Even semester, Core-III)

Semester	Course Code	Course Name	Credit	Full Marks
I		Mechanics (Core-II)	4	100
II		Electricity and Magnetism (Core-III)	4	100
III		Waves and Optics (Core-II)	4	100
IV		Analog System (Core-III)	4	100
V		Digital System (Core-II)	4	100
VI		Electro- Magnetic Theory (Core-III)	4	100

MULTIDISCIPLINARY COURSES UNDER NEP-2020

Semester	Course Code	Course Name	Credit	Full Marks
I		Biophysics	3	100
II		Environmental Chemistry	3	100
III		Introduction to Spectroscopy	3	100

SKILL ENHANCEMENT COURSES (SEC) UNDER NEP-2020

Semester	Course Code	Course Name	Credit	Full Marks
II		Renewable Energy and Energy Harvesting	3	100
V		Applied Optics and Photonics	3	100
VI		Corrosion and Prevention	3	100

VALUE AIDED COURSES (VAC) UNDER NEP – 2020

Semester	Course Code	Course Name	Credit	Full Marks
I		Environmental Studies and Disaster Management (Compulsory)	3	100
III		Nanomaterial and Nano technology	3	100
V		Basic Understanding of Molecular Dynamics	3	100
VI		Ethics and Values	3	100

SUMMER VOCATIONAL COURSE UNDER NEP – 2020

Semester	Course Code	Course Name	Credit	Full Marks
II		Fundamental of Horticulture	4	100
IV		Nursery Management	4	100

SYLLABUS OF UG PHYSICS (MAJOR) UNDER NEP-2020
CORE COURSE - I

PAPER-I **SEMESTER – I**

MATHEMATICAL PHYSICS-I

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30hrs)

CO1 Basic understanding of Differential equations and their solutions, conceptual understanding of calculus.

CO2 Basic understanding of vector calculus and its differentiation.

CO3 Use of vector calculus to understand vector integration. Dirac delta function and its properties.

CO4 Understanding of orthogonal curvilinear coordinates and its application in vector differentiation.

CO5 To Understand the basic algorithm in application to functional algebra and error analysis.

UNIT-I

Calculus -I: Plotting of functions, Intuitive ideas of continuous, differentiable functions and plotting of curves, Approximation: Taylor and binomial series (statements only), First Order Differential Equations and Integrating Factor, Second Order Differential equations: Homogeneous Equations with constant coefficients, Wronskian and general solution, Statement of existence and Uniqueness Theorem for Initial Value Problems, Particular Integral.

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

UNIT-II

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

Vector Differentiation: Directional derivatives and normal derivative, Gradient of a scalar field and its geometrical interpretation, Divergence and curl of a vector field, Del and Laplacian operators, Vector identities.

UNIT-III

Vector Integration: Ordinary Integrals of Vectors, Multiple integrals, Jacobian, Notion of infitesimal line,surface and volume elements, Line, surface and volume integrals of Vector fields, Flux of a vector field,Gauss ' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs) **Dirac Delta function and its properties:** Definition of Dirac delta function. Representation as limitof a Gaussian function and rectangular function, Properties of Dirac delta function.

UNIT-IV

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

Text books:

1. Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, F. E. Harris (2013, 7th Edn.,Elsevier)
2. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India.

Reference books:

1. Mathematical Physics C. Harper (Prentice Hall India)
2. Complex Variable: Schaum's Outlines Series M. Spiegel (2nd Edition, Mc- Graw HillEducation)
3. Complex variables and applications, J. W. Brown and R.V. Churchill
4. Mathematical Physics, Satya Prakash (Sultan Chand)
5. Mathematical Physics, B. D. Gupta (4th edition, Vikas Publication)
6. Mathematical Physics and Special Relativity, M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan)
7. Mathematical Physics – H.K. Das, Dr. Rama Verma (S. Chand Publishing)
8. Mathematical Physics, B.S. Rajput, (Pragati Prakashan

CORE –I: PAPER-I

LAB: Credit-1

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

- Highlights the use of computational methods to solve physical problems

- Evaluation done not on the programming but on the basis of formulating the problem

- Aim at teaching students to construct the computational problem to be solved

- Students can use any one operating system Linux or Microsoft Windows.

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

devices. Basics of scientific computing: Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow and overflow emphasize the importance of making equations in terms of dimensionless variables, Iterative methods. Algorithm Errors and error Analysis: Truncation and round off errors, Absolute and relative errors, Floating point computations. Systematic and Random Errors, Propagation of Errors, Normal Law of Errors, Standard and Probable Error.

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

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

Random number generation: Area of circle, area of square, volume of sphere, value ofτ.

Reference Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt.Ltd.
2. Schaum's Outline of Programming with C++.J.Hubbard, 2000, Mc Graw–Hill Pub.
3. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn.2007, Cambridge University Press.
4. A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning.
5. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. , 2007 , Wiley India

Edition.

6. Numerical Methods for Scientists and Engineers, R.W. Hamming, 1973, Courier DoverPub.
7. An Introduction to computational Physics, T.Pang,2ndEdn., 2006,Cam- bridgeUn

PAPER-II **SEMESTER – I**

MECHANICS:

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30hrs)

CO-1 To Learn the basic concepts of Rigid body dynamics, Radius of Gyration, Moment of Inertia,Non-Inertial Systems

CO-2 To Understand the concept of Elasticity, Fluid motion and Types of Vibration

CO-3 To understand the concept of Newtonian theory through Gravitation, Central force motion, Keplar'slaws, GPS

CO-4 To learn the concept of Special theory of Relativity, Michelson- Morley experiment, Lorentz transformation, Relativistic Doppler effect.

CO-5 Apply the basic concepts of Mechanics in experiments.

UNIT-I

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

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

UNIT-II

Oscillations:

Damped oscillation. Equation of motion and solution (cases of oscillatory, critically damped and overdamped) Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor, Bar Pendulum, Katers Pendulum

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

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

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

UNIT-III

Gravitation and Central Force Motion: Law of gravitation, Gravitational potential energy, Inertial and gravitational mass, Potential and field due to spherical shell and solid sphere, Motion of a particle under a central force field, Two-body problem and its reduction to one-body problem and its solution, Differential Equation of motion with central force and its solution, The first Integrals (two), Concept of power Law Potentials, Kepler's Laws of Planetary motion, Satellites. Geosynchronous orbits, Weightlessness, Basic idea of global positioning system (GPS).

UNIT-IV

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

Text Books:

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

Reference Books:

1. Introduc tion to Mechanics Daniel Klapnner and Robert Kolenkow, McgrawHill.
2. Mechanics by K.R Simon
3. Mechanics, Berkeley Physics, vol. 1, C.Kittel, W. Knight, etal (Tata McGraw-Hill)
4. Physics, Resnick, Halliday and Walker (8/e.2008,Wiley)
5. Theoretical Mechanics-M.R. Spiegel (Tata McGrawHill).
6. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands (Pearson)
7. Mechanics-M.Das, P.K.Jena and R.N. Mishra (SrikrishnaPublications)
8. Classical Mechanics , Gupta Kumar & Sharama,(Pragati Prakashan)
9. Classical Mechanics, J.C.Upadhyaya, (Himalaya Publishing Home)

CORE –I: PAPER-II

LAB: Credit-1

(Minimum 4 experiments are to be done):

1. To study surface tension by capillary rise method.
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c)Modulus of rigidity.

4. To determine the Moment of Inertia of a Flywheel.
5. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuillesmethod).
6. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
7. To determine the value of g using Bar Pendulum.
8. To determine the value of g using Kater's Pendulum.

Reference Books:

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, AsiaPublishing House.
2. Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text ook of Practical Physics, I. Prakash and Ramakrishna, 11thEdn, 2011, Kitab Mahal

PAPER-III **SEMESTER – II**

ELECTRICITY AND MAGNETISM:

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30hrs)

CO-1 To understand the basic concepts of Electricity and Magnetism

CO-2 To Understand the various phenomena in Electricity and Magnetism

CO-3 To Understand Circuit analysis and network theorems

CO-4 To Explain the Dynamics of Charged Particles

CO-5 To Apply the acquired knowledge in Experiment.

UNIT-1

Electric Field and Electric Potential

Electric field: Electric field lines, Electric flux, Gauss Law with applications to charge distributions with spherical, cylindrical and planar symmetry, Conservative nature of Electrostatic Field. Electrostatic Potential, Potential and Electric Field of a dipole, Force and Torque on a dipole, Potential calculation in different simple cases, Laplace and Poisson equations, The Uniqueness Theorem, Method of Images and its application to (1) Plane Infinite Sheet and (2) Sphere. Electrostatic energy of system of charges, Electrostatic energy of a charged sphere, Conductors inan electrostatic Field, Surface charge and force on a conductor.

UNIT-II

Magnetic Field: Magnetic Force, Lorentz Force, Biot Savarts Law, Cur- rent Loop as a Magnetic Dipole and its Dipole Moment (analogy with Electric Dipole), Amperes Circuital Law and its application to (1) Solenoid (2) Toroid (3) Helmhotz coil, Properties of curl and divergence, Vector Potential, Ballistic Galvanometer: Torque on a current Loop, Current and Charge Sensitivity, Electromagnetic damping, Logarithmic damping, CDR.

UNIT-III

Dielectric Properties of Matter: Electric Field in matter, Polarization, Polarization Charges, Electrical Susceptibility and Dielectric Constant, Capacitor (parallel plate, spherical, cylindrical) filled with dielectric, Displacement vector D, Relations between E, P and D, Gauss Law in dielectrics. Magnetic Properties of Matter: Magnetization vector (M), Magnetic Intensity (H), Magnetic Susceptibility and permeability, Relation between B, H, M, Ferromagnetism, B-H curve and hysteresis. Electromagnetic Induction: Faradays Law, Lenz's Law, Self -Inductance and Mutual Inductance, Reciprocity Theorem, Energy stored in a Magnetic Field, Introduction to Maxwell's Equations.

UNIT-IV

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

Network theorems: Kirchoff's law for electrical circuits, Ideal Constant-voltageand Constant-current Sources.

Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem, Applications to DC circuits. Transient Currents Growth and decay of current in RC and LR circuits.

Text Books:

1. Introduction to Electrodynamics – D.J. Griffiths (Pearson, 4th edition, 2015)
2. Foundations of Electromagnetic Theory-Ritz and Milford (Pearson)

Reference Books:

1. Classical Electrodynamics, J. D. Jackson (Wiley).
2. Electricity and Magnetism D. C. Tayal (Himalaya Publishing house)
3. Electricity, Magnetism and Electromagnetic Theory- S. Mahajan and Choudhury (Tata McGraw Hill)
4. F eynman Lectures Vol.2, R. P. Feynman, R. B. Leighton, M. Sands
5. (Pearson)
6. Electricity and Magnetism, J. H. Fewkes and J. Yarwood. Vol. I (Oxford Univ. Press)
7. Classical Electromagnetism, H.C.Verma, Bharati Bhawan

CORE –I: PAPER-III

LAB: Credit-1

(Minimum 4 experiments are to be done):

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

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

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I.Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub

PAPER-IV SEMESTER – II

MATHEMATICAL PHYSICS-II:

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30h

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

CO-1: Conceptual understanding of Fourier series and its application in periodic function.
CO-2: Understanding the various special functions and its properties.
CO-3: Understanding various polynomials and special integrations.
CO-4: To learn the applications of partial differential equation.
CO-5: To apply the acquired knowledge to solve problems.

UNIT-I

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

UNIT-II

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance, Singularities of Bessel's and Laguerre Equations, Frobenius method and its applications to differential equations: Bessel, Legendre and Hermite Differential Equations, Legendre and Hermite Polynomials: Rodrigues Formula, G enerating Function, Orthogonality.

UNIT-III

Polynomials: Simple recurrence relations of Legendre and Hermite Polynomials, Expansion of function ina series of Legendre Polynomials, Associated Legendre Differential Equation, Associated Legendre polynomials, Spherical Harmonics. Spherical Bessel's Function (1st and 2^{nd} kind).

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

UNIT-IV

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

Text Books:

1. Mathematical Methods for Physicists, G.B.Arfken, H.J.Weber, F.E.Harris.(2013,7th Edn.,Elsevier)
2. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India)

Reference Books:

1. Mathematical Physics and Special Relativity, M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan)
2. Mathematical Physics–H. K. Dass, Dr. Rama Verma (S. Chand Publishing)
3. Mathematical Physics C. Harper (Prentice Hall India)
4. Complex Variable: Schaum's Outlines Series M. Spiegel (2nd Edition, McGraw Hill Education)
5. Complex variables and applications J.W.Brown and R.V.Churchill
6. Mathematical Physics, Satya Prakash (Sultan Chand)
7. Mathematical Physics B. D. Gupta (4th edition, Vikas Publication)
8. Mathematical Physics, B.S.Rajput, Pragati Prakashan

CORE –I: PAPER-IV

LAB: Credit-1

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of

lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Topics

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

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

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

Solution of ODE First order Differential equation Euler, modiftedEuler Runge-Kutta second methodsSecond order differential equation. Fixed difference method:

First order diferential equation

- Radioactivedecay
- Current in RC, LC circuits with DCsource
- Newtons law ofcooling
- Classical equations of motion

Second order Differential Equation

- Harmonic oscillator (no friction)
- Damped Harmonic oscillator
- Overdamped
- Critical damped
- Oscillatory

- Forced Harmonic oscillator
- Transient and Steady state solution
- Apply above to LCR circuits also

Reference Books:

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

PAPER-V **SEMESTER – III**

WAVE AND OPTICS:

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30h

CO-1 Basic understanding ofpropagation of light, its application and wave nature.

CO-2 To Understand the concepts of wave motion.

CO-3 To Understand the concepts of interference and its application.

CO-4 To Understand the concepts of diffraction and its application.

CO-5 To Apply the acquired knowledge of optics in Experiment

UNIT - I

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

UNIT - II

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

UNIT- III

Interference: Division of amplitude and wave front, Young's double slit experiment, Lloyds Mirror and Fresnels Bi-prism, Phase change on reflection: Stokes treatment, Interference in Thin Films: parallel and wedge-shaped films, Fringes of equal inclination (Haidinger Fringes), Fringes of equal thickness (Fizeau Fringes), Newton's Rings: Measurement of wavelength and refractive index. Interferometer : Michelson's Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of fringes, Fabry-Perot interferometer.

UNIT - IV

Fraunhoffer diffraction: Single slit, Circular aperture, Resolving Power of a telescope, Double slit, Multiple slits, Diffraction grating, Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions, Fresnel's Half-Period Zones for Plane Wave, Explanation of Rectilinear Propagation of Light, Theory of a Zone Plate: Multiple Foci of a Zone Plate, Fresnel's Integral, Fresnel diffraction pattern of a straight edge,as lit and a wire.

Text Books:

1. A text book of Optics N. Subhramanyam and BrijLal (S.Chand Publishing)
2. Optics - Ajoy Ghatak (McGraw Hill)

Reference Books:

1. Optics-E. Hecht(Pearson)
2. Fundamentals of Optics-F. A. Jenkins and H. E. White(McGraw-Hill)
3. Geometrical and Physical Optics R.S. Longhurst (Orient Blackswan)
4. The Physics of Vibrations and Waves- H. J .Pain(John Wiley)
5. Optics P. K. Chakraborty.
6. Principles of Optics-Max Born and Emil Wolf (Pergamon Press)
7. The Physics of Waves and Oscillations-N. K. Bajaj (Mc Graw Hill

CORE –I: PAPER-V

LAB: Credit-1

(Minimum 5 experiments are to be done)

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify 2-Tlaw.
2. To plot the I-D curve and to determine the refractive index of a prism
3. To determine refractive index of the Material of a prism using sodium source.
4. To determine the dispersive power and Cauchy constants of the material of a prism using mercurysource.
5. To determine wavelength of sodium light using Newton's Rings.
6. To determine wavelength of (1) Na source and (2) spectral lines of Hgsource using planediffraction grating.
7. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, AsiaPublishing House
2. A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Ed., 2011,Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4thEdition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985,Vani

PAPER-VI **SEMESTER – III**

MATHEMATICAL PHYSICS-III

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30h

CO-1 :Understanding and application of Complex function variables.

CO-2:Understanding the concept of Fourier Integral transform.

CO-3:To Understand the properties and application of Fourier integral transformation.

CO-4:To Understand the properties and application of Laplace integral transformation.

CO-5:To Apply the acquired knowledge to solve problems.

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

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

Text Books:

1. Mathematical Methods for Physicists, G.B.Arfken, H.J.Weber, F.E.Harris(2013, 7thEdn., Elsevier)
2. Advanced Engineering Mathematics, ErwinKreyszig (WileyIndia)

Reference Books:

1. Mathematical Physics and Special Relativity– M.Das, P.K.Jena and B.K. Dash(Srikrishna Prakashan)
2. Mathematical Physics–H. K. Dass, Dr. Rama Verma (S. Chand Publishing)
3. Mathematical Physics C. Harper (Prentice Hall India)
4. Complex• Variable: Schaum's Outlines Series M. Spiegel (2nd Edition , Mc-Graw HillEducation)
5. Complex variables and applications J.W.Brown and R.V.Churchill
6. Mathematical Physics, Satya Prakash (Sultan Chand)
7. Mathematical Physics B.D.Gupta (4thedition,VikasPublication)
8. Mathematical Physics B.S.Rajput, Pragati Prakashan
9. Mathematical physics-III,(University Physics), Dr. Ranjan Kumar Bhuyan, HimalayaPublishing House

CORE –I: PAPER-VI

LAB: Credit-1

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

. Solve simple differential equations like:

$\frac{dy}{dx} = e^{-x}$ with $y(x = 0) = 0$

$\frac{dy}{dx} + e^{-x} = x^2$ with $y(x = 0) = 0$

$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} = -y$ with $y(x = 0) = 0,\ y'(x = 0) = 1$

$\frac{d^2y}{dx^2} + e^{-x}\frac{dy}{dx} = -y$ with $y(x = 0) = 0,\ y'(x = 0) = 1$

Direct Delta Function:

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

Fourier Series:

Program to sum; evaluate the Fourier Coefficients of a given periodic function (Square Wave)

Frobenius Method and Special Functions:

$$\int_{-1}^{1} d\mu \; P_n\mu \, P_m\mu = \frac{2}{2n+1}\delta_{m,n}$$

Plot $P_n(x)$, Legendre polynomial of degree n, and $J_n(x)$, Bessel function of first kind.Show Recursion relation.

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

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

. Evaluation of trigonometric functions e.g. SinΘ, Given Bessel's function at N points, find its valueat an intermediate point.

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

. Integral transform: FFT of e^{-x}

Reference Books:

1. Mathematical Methods for Physics and Engineers, K. FRiley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press.
2. Mathematics for Physicists, P.Denneryand A.Krzywicki, 1967, Dover Publications.
3. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C.V. Fernndez. 2014 Springer ISBN: 978-3319067896
4. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
5. S ilab (AfreesoftwaretoMatlab): H.Ramchandran, A.S.Nair.2011 S.Chand And Company, Scilab Image Processing: Lambert M. Surhone. 2010 Betas cript Publishing.

PAPER-VII **SEMESTER – III**

THERMAL PHYSICS

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30h

CO-1:Basic understanding of thermodynamics and various thermal variables.

CO-2:Understanding various thermodynamics potential applications and their properties.

CO-3:To Understand the concepts of ideal gas and its thermal properties.

CO-4:To Understand the concepts of real gas and its thermal properties.

CO-5:To Apply the acquired knowledge of thermodynamics in Experiments

UNIT-I

Introduction to Thermodynamics Recapitulation of Zeroth and First law of thermodynamics, **Second Law of Thermodynamics:** Reversible and Irreversible process with examples, Kelvin-Planck and ClausiusStatements and their Equivalence, Carnot's Theorem, Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy, Entropy of a perfect gas, Principle of increase of Entropy, Entropy Changes in Reversible and Irreversible processes with examples, Entropy of the Principle of Increase of Entropy, Temperature Entropy diagrams for Carnot's Cycle, Third Law of Thermodynamics, Unattainability of Absolute Zero.

UNIT-II

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables. Internal Energy, Enthalpy, Helmholtz Free Energy, Gibbs Free Energy, Their Definitions, Properties and Applications, Surface Films and Variation of Surface Tension with Temperature, Magnetic Work, Cooling due to adiabatic demagnetization.

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

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

UNIT-III

Kinetic Theory of Gases

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

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

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

UNIT-IV

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation, The Virial Equation, Andrews Experiments on CO2 Gas. Critical Constants, Continuity of Liquid and Gaseous State. Vapour and Gas, Boyle Temperature, Van der Waals Equation of State for Real Gases, Values of Critical Constants, Law of Corresponding States, Comparison with Experimental Curves, P-V Diagrams, Joules Experiment, Free Adiabatic Expansion of a Perfect Gas, Joule- Thomson Porous Plug Experiment, Joule- Thomson Effect for Real and Van der Waal Gases, Temperature of Inversion, Joule-Thomson Cooling.

Text Books:

1. Thermal Physics, A. B. Gupta (Books and allied Ltd)
2. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman (McGraw- Hill)

Reference Books:

1. Theory and experiments on thermal Physics, P.K.Chakrabarty (New cen- tral book agency limited)
2. Thermodynamics, Kinetic Theory and Statistical Thermodynamics- Sears and Salinger (Narosa)
3. A Treatise on Heat- Meghnad Saha and B.N.Srivastava (The Indian Press) Heat, and thermodynamics and Statistical Physics, N.Subrahmanyam and Brij Lal (S.Chand Publishing)
4. Thermal and Statistical Physics M.Das, P.K. Jena, S. Mishra, R.N.Mishra (Shri Krishna Publication)
5. Heat, Thermodynamics and statistical physics, Brijlal, Subhramanyam andHemne, S.Chand Publication.

CORE –I: PAPER-VII

LAB: Credit-1

(Minimum 5 experiments are to be done)

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

Reference Books:

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I.Prakash and Ramakrishna, 11th Ed., 2011,Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4thEdition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

PAPER-VIII **SEMESTER – IV**

ANALOG SYSTEMS

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30h

CO-1:Basic understanding of semiconductor diodes, devices and their applications.

CO-2 :To Understand the basic concepts in transistors and amplifiers.

CO-3:To Understand the concept of coupled amplifier and its application in feedback circuit.

CO-4:To Understand the concepts of operational amplifier and its application.

CO-5:To Apply the acquired knowledge of electronic circuits in Experiments.

UNIT-1

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

Two terminal device and their applications: (1) Rectifier Diode: Half-wave Rectifiers. center- tapped and bridge type Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, L and C Filters (2) Zener Diode and Voltage Regulation, Principle and structure of LEDS, Photo diode(3) Solar Cell.

UNIT II

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

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

Amplifiers: Transistors as 2-port network h-parameter Equivalent Circuit, Analysis of a single stage CE amplifier using Hybrid Model, Input and Output impedance, Current, Voltage and Power Gains.

UNIT-III

Classification of class A, B and C amplifiers, Push-pull amplifier (classB).

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

Feedback in Amplifiers: Effect of Positive and Negative Feedback on In- put Impedance, Output Impedance, Gain Stability, Distortion and Noise. Sinusoidal Oscillations: Barkhausens criterian for self- sustained oscillations. RC Phase shift oscillator, determination of Frequency, Hartley and Colpitts oscillators.

UNIT-IV

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

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

Text Books:

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

Reference Books:

1. Electronic devices and circuits R.L. Boylstad(PearsonIndia)
2. Electronic Principles- A.P.Malvino (Tata McGrawHill)
3. Principles of Electronics- V. K. Mehta and Rohit Mehta (S. Chand Pub- lication)
4. OP-Amps and Linear Integrated Circuit-R. A. Gayakwad (PrenticeHall)
5. Physics of Semiconductor devices, DonaldANeamen(PrenticeHall)
6. Analog System and Application: Gupta Kumar, Pragati Prakashan

CORE –I: PAPER-VIII

LAB: Credit-1

(Minimum 5 experiments are to be done)

1. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
2. Study of V-I and power curves of solar cells, and find maximum power point and efficiency.
3. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
4. T o study the various biasing configurations of BJT for normal class A operation.
5. T o study the frequency response of voltage gain of a RC-coupled transistor amplifier.
6. To design a Wien bridge oscillator for given frequency using a non-amp.
7. To design a phase shift oscillator of given specifications using BJT.
8. To study the Colpitt's oscillator.

Reference Books:

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

PAPER-IX SEMESTER – IV

BASIC INSTRUMENTATION

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30h

CO-1: Conceptual understanding of different measurement of electronic circuit with measuring devices.

CO-2: Basic understanding of CRO and its applications.

CO-3: Basic understanding of signal generators and its analysis

CO-4.: Basic understanding of digital instruments and their applications.

CO-5: To Apply the acquired knowledge of different electronic measurement-based instruments in Experiments

UNIT-I

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

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

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

AC milli voltmeter: Type of AC milli voltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac milli voltmeter, specifications and their significance.

UNIT-II

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

Applications of CRO: (1) Study of Wave Form, (2) Measurement of Volt- age, Current,

Frequency and Phase Difference.

Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

UNIT-III

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

UNIT-IV

Digital Instruments: Principle and working of digital meters, Comparison of analog and digital instruments, Characteristics of a digital meter, Working principles of digital voltmeter.

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

Text Books:

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

Reference Books:

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

CORE –I: PAPER-IX

LAB: Credit-1

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment.
4. Use of Digital multimeter/VTVM for measuring voltages.
5. Circuit tracing of Laboratory electronic equipment.
6. Winding a coil /transformer.
7. Study the layout of receiver circuit.

8. Trouble shooting a circuit.
9. Balancing of bridges.

Laboratory Exercises:

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

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter) More emphasis should be given on hands-on experiments.

Additional Reference Books for Practical papers:

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

PAPER-X **SEMESTER – IV**

NUCLEAR AND PARTICLE PHYSICS

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30h

CO-1: Understanding the properties of atoms in electric and magnetic field.

CO-2: Understanding the concept Nuclear physics.

CO-3: Conceptual understanding nuclear models and nuclear reactions.

CO-4: Conceptual understanding of particle physics.

CO-5: To Apply the acquired knowledge in conducting the experiments.

UNIT- I

Atoms in Electric and Magnetic Fields: Electron angular momentum. Space quantization, Electron Spin and Spin Angular Momentum, Larmor's Theorem, Spin Magnetic Moment, Stern Gerlach Experiment, Vector Atom Model, L-S and J-J coupling, Zeeman Effect, Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magnetron. Atoms in External Magnetic Fields: Normal and Anomalous Zeeman Effect, Paschen back and Stark-Effect (qualitative Discussion only).

UNIT- II

Nuclear Physics- : Nuclear composition, charge, size, shape, mass and density of the nucleus; Nuclear angular momentum; Nuclear magnetic dipole moment; Electric quadrupole moment; Mass defect; Packing fraction and Binding energy; Stability of nuclei (N vs Z curve), Binding e nergy curve. semi empirical mass formula; Nuclear Forces: General concept of nuclear force; Yukawa Meson field theory of nuclear forces; Properties of Nuclear forces.

Radioactive disintegration; Properties of alpha, beta, gamma rays; law of radioactive decay; successive radioactive decay; radioactive equilibrium; Radioisotopes; application of radioactivity(Agriculture, Medicinal, Industrial and Archaeological).

UNIT-III

Nuclear models: Liquid Drop model; Shell model; magic number in the nucleus; Alpha decay: Alpha particles spectra; Gamow's theory of Alpha decay; Beta decay: Shape of Beta ray spectrum; Explanation of Beta decay on the basis of Neutrino and Antineutrino hypothesis; Fermi theory of Beta decay; Selection rules; Gamma ray emission,

Nuclear reactions: Kinds of Nuclear reactions; Nuclear reaction kinematics; Q -value; Compound Nucleus and concept of direct reactions; Conservation laws; Nuclear reaction cross - sections. Nuclear energy: Nuclear Fission; Chain reaction and Critical Mass; Nuclear Reactors an d its basic components; Nuclear Fusion; Condition for the maintained Fusion reactions; Energy production in stars; Fusion reaction in Sun, Principle of atomic bomb and hydrogen bomb.

UNIT-IV

Particle Physics

Classification of particles-antiparticles and their interactions; Conservation laws; Charges; Isospin; Baryon number; Lepton number; Strangeness; Hyper charge; Parity; Charge

conjugation; CPT theorem; Conservation laws; Quark as the building blocks of Hadrons; Quark Model; Colour degree of freedom, Symmetry Classification of elementary particles; Higgs Boson Particle (God particle), elementary idea on Large Hadron collider (LHC), The future of universe, Dark matter and dark energy.

Text Books:

1. Concepts of Modern Physics Arthur Beiser (Mc Graw Hill)
2. Modern Physics Murugeshan and Sivaprasad (S.Chand)
3. Cohen B. L., "Concepts of Nuclear Physics", McGraw Hill Education.
4. Tayal D. C., "Nuclear Physics", Himalaya Publishing House.
5. Patel S. B., "Nuclear Physics: An Introduction", New Age International Publishers.
6. Singh Jahan, "Fundamental of Nuclear Physics", Pragati Publications

Reference Books:

1. Quantum Mechanics: Theory and Applications, A.K. Ghatakand S. Lokanathan, (Macmillan)
2. Introduction to Quantum Theory, David Park (DoverPublications)
3. Theory and Problems of Modern Physics ,Schaum's outline, R.Gautreau andW. Savin- (Tata McGraw-Hill)
4. Modern Physics-Serway (CENGAGE Learnings)
5. Physics of Atoms and Molecules Bransden and Joachim (Pearson India)
6. Atomic and Nuclear Physics-A.B.Gupta (NewCentral)
7. Theoretical Nuclear Physics , J.M.Blatt and V.F. Weisskopf (Springer)

CORE –I: PAPER-X

LAB: Credit-1

(Minimum 4 experiments are to be done)

1. Study of photoelectric effect.
2. Basics of GM counter characteristics and counting statistics.
3. Study of Gamma ray spectroscopy by SCA and MCA.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
6. To setup the Millikan oil drop apparatus and determine the charge of an electron.

Reference Books:

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

2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4thEdition, reprinted 1985, Heinemann Educational Publishers

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

PAPER-XI **SEMESTER – V**

DIGITAL SYSTEMS

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30h

CO-1: To Understand IC's and scales of Integration, Digital Circuits and their realization, Applications

CO-2: Build strong knowledge about Boolean Algebra, Truth tables, Equivalent Circuits, Theory and application of CRO.

CO-3: Gain a clear understanding of Data processing circuits, Arithmetic Circuits, different types of Timers: IC555

CO-4: To Explain the knowledge of computer organization, Shift registers and counters.

CO-5: To Apply the acquired knowledge to realize various types of circuits in experiment

UNIT-1

Integrated Circuits (Qualitative treatment only): Active and Passive Components, Discrete components, Wafer Chip, Advantages and Drawbacks of ICs, Scale of Integration: SSI, MSI, LSI and VLSI (basic idea and definitions only), Classification of ICs, Examples of Linear and Digital ICs.

Digital Circuits: Difference between Analog and Digital Circuits, Binary Numbers, Decimal to Binary and Binary to Decimal Conversation, BCD, Octal and Hexadecimal numbers, AND, OR and NOT. Gates (realization using Diodes and Transistor), NAND and NOR Gates as Universal Gates, XOR and XNOR Gates and application as Parity Checkers.

UNIT-II

Boolean algebra: De Morgan's Theorems: Boolean Laws, Simplification of Logic Circuit using Boolean Algebra, Fundamental Products, Idea of Minterms and Maxterms, Conversion of truth table into Karnaugh Map and SOP and POS simplification. Universal logic implementation (NAND & NOR).

UNIT-III

Data Processing Circuits: Basic Idea of Multiplexers, De-multiplexers, Decoders, Encoder
Arithmetic Circuits: Binary Addition. Binary Subtraction using 2s complement. Half and Full Adders. Half and Full Subtractors, 4 bit binary Adder/Subtractor.

Timers:IC555: block diagram and application is Astable multivibrator and Monostable multivibrator.

UNIT-IV

Introduction to Computer Organization: Input/output Devices, Data storage (idea of RAM andROM), Computer memory, Memory organization and addressing, Memory Interfacin g,

Memory Map.

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

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

Text Books:

1. Digital Circuits and Logic design: SamuelC. Lee(PrinticeHall)
2. Digital Principles and Applications- A.P. Malvino, D.P. Leach and Saha(Tata Mc Graw)

Reference Books:

1. The Art of Electronics by Paul Horowitz and Wilfield Hill, Cambridge University
2. Electronics by Allan R. Hambley ,Prentice Hall
3. Principles ofElectronics V.K.Mehta and Rohit Mehta (S.Chand publishing)
4. Digital Logic and Computer design M. Morris Mano (Pearson)
5. Conceptsof Electronics D.C.Tayal (Himalaya Publishing house)
6. Digital System and Application, Gupta Kumar, Pragati Prakashan

CORE –I: PAPER-XI
LAB: Credit-1

(Minimum 6 experiments are to be done)

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

Reference Books:

1. Basic Electronics: A Text Books lab manual, P.B. Zbar, A.P. Malvino, M.A.Miller, 1994, Mc-GrawHill.
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. Electronic Devices and circuit Theory, R.L.Boylestad and L.D.Nashelsky,2009,Pearson.

PAPER-XII SEMESTER – V

QUANTUM MECHANICS AND APPLICATIONS

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30h

CO-1: To understand Properties and physical interpretation of wave function and its application, knowledge in probability current density, significance of momentum space transformation and time dependent Schrödinger equation.
CO-2: To explain Time independent Schrödinger equation, Eigen value, Eigen function, generalized solutionof stationary states, knowledge in wave function and discrete energy level.
CO-3: Basic knowledge in quantum mechanical operators, Eigen value and Eigen function, Uncertaintyrelation and Gaussian wave packet.
CO-4: Acquire the knowledge in application of Schrödinger equation in different potential barriers, conceptof simple harmonic oscillator.
CO-5: Apply the acquired knowledge to solve various numerical problems .

UNIT- I

Schrodinger equation: Time dependent Schrodinger equation, Properties of Wave Function, Physical interpretation of wave function, Wave function of a free particle, Normalization, Probability current and probability current densities in three dimensions, Linearity and Superposition Principle, Wave Packet, Fourier Transform Theorem, Momentum space wave function and its significance, Representation of position vector in momentum space. Schrodinger equation in momentum space.

UNIT-II

Time Independent Schrodinger equation in 1-D, 2-D and 3-D, Hamiltonian, stationary states and energy Eigen values, expansion of an arbitrary wave function as a linear combination of energy Eigen functions, General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states. General Discussion of Bound states in an arbitrary potential: Continuity of wave function, Boundary condition and emergence of discrete energy levels.

UNIT-III

Operators: Operators, Commutator Algebra, Position, Momentum, Angular Momentum and Energy operators, Hermitian Operators, Expectation Value, Expectation values of position and momentum, Ehrenfest Theorem, Eigenvalues and Eigenfunctions of Hermitian Operator, Energy Eigen Spectrum, Degeneracy, Orthonormality of Eigen functions, Linear Dependance, Orthogonalisation, Uncertainty

Relation- Uncertainty product, minimum uncertainty wave packet- Gaussian Wave Packet.

UNIT-IV

Application to one dimensional problem- One dimensional infinitely rigid Box- Energy Eigen values and Eigen functions, normalization, quantum dot as an example, Quantum mechanical scattering and tunnelingin one dimension across a Potential Step and Rectangular Potential Barrier, Finite Square well potential, Quantum mechanics of simple Harmonic Oscillator-Energy Levels and Energy Eigen functions, ground state, zero point energy.

Text Books:

1. Introduction to Quantum Theory David Park (DoverPublications)
2. Introduction to Quantum Theory, D. J. Griffiths(Pearson)
3. Quantum Mechanics: Concepts and applications, N.Zettili, Wiley

Reference Books :

1. Quantum Mechanics, Theory and applications A.Ghatak andS.Lokanathan (McMillanIndia)
2. Quantum Mechanics- G. Aruldhas (Printice Hall of India)
1. Quantum Physics–S. Gasiorowicz (Wiley)
2. Quantum Mechanics- G.R. Chatwal and S.K. Anand
3. Quantum Mechanics -J.L. Powell and B. Craseman (Narosa)
4. Introduction to Quantum Mechanics M.Das and P.K.Jena (ShriKrishna Publication).
5.

CORE –I: PAPER-XII

LAB: Credit-1

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

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state ofthe Hydrogen atom:

$$\frac{d^2y}{dr^2} = A(r)\,u(r), A(r) = \frac{2m}{\hbar^2}\,[V(r) - E], V(r) = -\frac{e^2}{r}$$

Where, 'm' is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is

~ -13.6ev. Take e= 3.795 $\sqrt{(eV\text{Å})}$, ħc= 1973 (eVÅ) and m=0.511 × 10^6 eV/c^2.

2. Solve the S-Wave radial Schrodinger equation for an atom:

$$\frac{d^2y}{dr^2} = A(r)\,u(r), A(r) = \frac{2m}{\hbar^2}\,[V(r) - E],$$

Where, 'm' is the reduced mass of the system (Which can be chosen to be the mass of an electron), forthe screened coulomb potential: $v(r) = -\frac{e^2}{r}\,e^{-r/a}$

Find the energy (in eV) of the ground state of the atom to an accuracy of the significant digits. Also; plot the corresponding wave function. Take e= 3.795 (evÅ) , ħc= 1973(eVÅ) and m=0.511 $\times\ 10^6$ eV/c^2, and α =3Å, 5Å, 7Å. The ground state energy is expected to be above -12eV in all three cases.

3. Solve the S-Wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^2y}{dr^2} = A(r)\,u(r), A(r) = \frac{2m}{\hbar^2}\,[V(r) - E]$$

For the anharmonic Oscillator potential: $V(r) = \frac{kr^2}{2} + \frac{br^3}{3}$.

Find the ground state energy (in MeV) of the particle to an accuracy of three significant digits.Also, plot the corresponding wave function. Choose m=940MeV/C^2 , k= 100MeV/fm^2, b= (0, 10, 30) MeV/fm^3. In these units, c = 197.3 MeV fm. [The ground state energy is expected to lie between 90 and110 MeV for all three cases].

Solve the S-Wave radial Schrodinger equation for the vibrations of hydrogen molecule:

$$\frac{d^2y}{dr^2} = A(r)\,u(r), A(r) = \frac{2m}{\hbar^2}\,[V(r) - E]$$

Where, 'm' is the reduced mas of the two-atom system for the Morse potential

$v(r) = D(e^{-2\alpha r} - e^{-\alpha r}$)

Where r = r-r0 .

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significantdigits. Also plot the corresponding wave functions for the choices given below:

m = 940x10^6 ev/c^2, D = 0.755501ev, α = 1.44, r_0 = 0.131349Åm = 940x106ev/c^2, D = 0.755501ev, α = 1.44, r_0 = 0.131349Å

Laboratory based experiments:

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

Reference Books:

1. Schaum's outline of Programming with C++.J. Hubbard, 2000, McGraw–Hill Publication
2. Numerical Recipes in C: The Art of Scientific Computing, W.H. Press etal., 3rd Edn.,

2007, Cambridge University Press.
3. An introduction to computational Physics, T.Pang, 2nd Edn.,2006,Cam- bridge Univ. Press
4. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C.V. Fernndez.2014 Springer.
5. Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand and Co.
6. Scilab Image Processing: L.M.Surhone.2010 Beta script Publishing ISBN:9786133459274

PAPER-XIII SEMESTER – V

SOLID STATE PHYSICS

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30h)

CO-1: To understand the Concept of crystal structure and properties, X-ray Diffraction, Bragg's and Laue's condition.

CO-2: Conceptual understanding of Lattice vibration, Einstein and Debye specific heat theories of solids,knowledge in Band theory, Kroning-Penny model and Hall Effect.

CO-3: Understanding the Concept in magnetic and dielectric properties of materials.

CO-4: Basic knowledge on LASER and its generation, types. Conceptual understanding of superconductivity and its type, London's Equation, Penetration Depth and BCS theory.

CO-5: To Apply the acquired knowledge in experiments.

UNIT-I

Crystal Structure: Solids, Amorphous and Crystalline Materials, Lattice translation Vectors, Lattice witha Basis. Central and Non-Central Elements. Unit Cell, Miller Indices, Types of Lattices, Reciprocal Lattice, Brillouin zones, Diffraction of X- rays by crystals, Bragg's Law, Laue's Condition, Atomic and Geometrical Factor.

UNIT-II

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

Elementary band theory: Kroning-Penny model of band Gap, Conductor, Semiconductor (P and N type) and insulator, Conductivity of Semiconductor, mobility, Hall Effect, Measurement of conductivity (four probe method) and Hall Co- efficient.

UNIT-III

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferro- magnetic Materials, Classical Langevins theory of dia and Paramagnetic Domains, Curies law, Weiss Theory of Ferromagnetism and Ferromagnetic Domains, Discussion of B- H Curve, Hysteresis and Energy Loss.

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

UNIT-IV

Lasers: Einsteins A and B co-efficientnts, Metastable States, Spontaneous and Stimulated emissions, Optical Pumping and population Inversion, Three Level and Four Level Lasers, Ruby Laser and He-Ne Laser.

Superconductivity: ExperimentalResults, CriticalTemperature, Critical magnetic field, Meissner effect, Type-I and Type-II Superconductors, London's Equation and Penetration Depth, Isotope effect, Idea of BCS theory (No derivation).

Text Books:

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

Reference Books:

1. Solid State Physics-N.W.Ashcroft and N.D.Mermin (Cengage)
2. Solid State Physics- R.K.Puri and V.K. Babbar (S.Chand Publication)
3. Solid State Physics S. O. Pillai (New Age Publication)
4. Lasers and Non-linear Optics B.B.Laud (Wile yEastern)
5. Elements of Solid State Physics-J.P. Srivastava (Prentice Hall of India)
6. Elementary Solid State Physic s-Ali Omar (Addison Wiley)
7. Solid State Physics, Gupta and Kumar, Pragati Prakashan.

CORE –I: PAPER-XIII
LAB: Credit-1

(Minimum 4 experiments are to be done)

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube- Method)
2. To measure the Magnetic susceptibility of Solids.

3. To measure the Dielectric Constant of a dielectric Materials with frequency
4. To determine the Hall coefficient of a semiconductor sample.
5. To draw the BH curve of Fe using solenoid and to determine the energy loss from Hysteresis
6. To measure the band gap of a given semiconductor by four-probe method.

Reference Books:

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

PAPER-XIV **SEMESTER – VI**

ELECTROMAGNETIC THEORY

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30h

CO-1: Physical significance of Maxwell Equation and its application to free space, Lorentz and Coulomb gauge transformation, poynting theorem, concept of energy density.

CO-2: Analysis of Maxwell's equations in different media and Physical significance ofrelaxation time, skin depth, Electrical conductivity of ionized gases, plasma frequency.

CO-3: Basic understanding of polarization of EM wave, and different types of crystals, Phase Retardation Plates and Rotatory Polarization.

CO-4: Conceptual understanding of EMW application in bounded media, plane interface,dielectric media, Brewster's law, TIR, Evanescent wave, metallic reflection.

CO-5 :To Apply the acquired knowledge for visualize basic concept of phenomenon of lightin various experiments

UNIT-I

Maxwell Equations: Maxwells equations, Displacement Current, Vector and Scalar Potentials, Gauge Transformations: Lorentz and Coulomb Gauge, Wave Equations, Plane Waves in free space and characteristics, Poynting Theorem and Poynting Vector, Electromagnetic (EM) Energy Density, Physical Concept of Electromagnetic Field Energy Density.

UNIT-II

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

UNIT-III

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization, uniaxial and biaxial crystals, light propagation in uniaxial crystal, double refr action, polarization by double refraction, Nicol Prism, Ordinary and extraordinary refractive indices, Production and detection of Plane, Circularly and Elliptically polarized light,

Phase Retardation Plates: Quarter-Wave and Half- Wave Plates. Babinets Compensator and its Uses, Analysis of Polarized Light.

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

UNIT IV

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

Text Books:

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

Reference Books :

1. Classical Electrodynamics by J.D.Jackson.
2. Foundation of electromagnetic theory: Ritz and Milford(Pearson).
3. Electricity and Magnetism : D C Tayal (Himalaya Publication)
4. Optics: A. K. Ghatak
5. Electricity and Magnetism : Chattopadhyaya, Rakhit (NewCentral)
6. Electromagnetic Theory, Gupta and Kumar, Pragati Prakashan

CORE –I: PAPER-XIV

LAB: Credit-1

Minimum 4 experiments are to be done):

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

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn,

4Th Edition, reprinted 1985, Heinemann Educational Publishers

3. A Text Books Book of Practical Physics, I.Prakashand Ramakrishna, 11 Ed., 2011, KitabMahal Electromagnetic Field Theory for Engineers and Physicists, G. Lehner, 2010,Springer

PAPER-XV SEMESTER – VI

STATISTICAL MECHANICS

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30h)

CO-1: Understanding the concept of ensembles and its partition function, phase space andthermodynamic relations, MB distribution law.

CO-2: Conceptual understanding of addition of entropy, Sackur Tetrode equation, Law ofequipartition of Energy and its application.

CO-3: Basic postulates and different distribution of Fermi and Dirac particles and B-E condensation.

CO-4: Basic knowledge in thermal and Black body radiation, Concept of different laws of radiation and their experimental verification.

CO-5: Apply the acquired knowledge for analyze the laws radiation and different distribution functions using computational analysis.

UNIT- I

Classical Statistics-I: Macro state and Microstate, Elementary Concept of Ensemble, Micro canonical, Canonical and Grand Canonical ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function.

UNIT- II

Classical Statistics-II : 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.

UNIT- III

Quantum Statistics: Identical particles, macro states and microstates, Fermions and Bosons, Bose Einstein distribution function and Fermi- Dirac distribution function. Bose- Einstein Condensation, Bose deviation from Planck's law, Effect of temperature on Fermi-Dirac distribution function, degenerate Fermi gas, Density of States Fermi energy.

UNIT-IV

Radiation: Properties of Thermal Radiation, Blackbody Radiation, Pure Temperature dependence, Kirchhoff's law, Stefan Boltzmann law: Thermodynamic proof, Radiation Pressure, Wein's Displacement law, Wien's distribution Law, Saha's Ionization Formula, Rayleigh Jeans Law, Ultra Violet catastrophe.

Planck's Law of Black body Radiation: Experimental verification, Deduction of (1) Wien's Distribution Law, (2) Rayleigh Jean's Law, (3) Stefan Boltzmann Law, (4) Wein's Displacement Law from Planck's Law.

Text Books:

1. Introduction to Statistical Physics by Kerson Huang(Wiley).
2. Statistical Physics, Berkeley Physics Course, F.Reif (TataMcGraw-Hill)

Reference Books:

1. Statistical Mechanics, B.K. Agarwal and Melvin Eisner (New Age Inter- national)
2. Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Francis W.Sears and Gerhard L.Salinger (Narosa)
3. Statistical Mechanics: R.K. Pathria and Paul D. Beale (AcademicP ress)
4. Statistical Mechanics: Sharma and Satyal, Kalyani Publishing
5. Basic Statistical Mechanics, Gupta and Kumar, Pragati Prakashan

CORE –I: PAPER-XV

LAB: Credit-1

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

1. Plot Planck's law for Black Body radiation and compare it with Wein's.
2. Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.
3. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c)Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases
4. Plot Maxwell-Boltzmann distribution function versus temperature.
5. Plot Fermi-Dirac distribution function versus temperature.
6. Plot Bose-Einstein distribution function versus temperature.

Reference Books:

1. Elementary Numerical Analysis, K.E. Atkinson, 3rdEdn. 2007, Wiley India Edition
2. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
3. Thermodynamic, Kinetic Theory and Statistical Thermodynamics, Fran- cis .Searsand GerhardL. Salinger, 1986, Narosa.
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
5. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. VandeWouwer, P. Saucez, C.V. Fernndez. 2014 Springer ISBN: 978-3319067896
6. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
7. Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978613345927

CORE COURSE-II

(Other than Physics Core-I students)

Minor (Paper-I) **SEMESTER- I**

MECHANICS:

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30hrs)

CO-1 To Learn the basic concepts of Rigid body dynamics, Radius of Gyration, Moment of Inertia,Non-Inertial Systems

CO-2 To Understand the concept of Elasticity, Fluid motion and Types of Vibration

CO-3 To understand the concept of Newtonian theory through Gravitation, Central force motion, Keplar'slaws, GPS

CO-4 To learn the concept of Special theory of Relativity, Michelson- Morley experiment, Lorentz transformation, Relativistic Doppler effect.

CO-5 Apply the basic concepts of Mechanics in experiments.

UNIT-I

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

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

UNIT-II

Oscillations:

Damped oscillation. Equation of motion and solution (cases of oscillatory, critically damped and overdamped) Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor, Bar Pendulum, Katers Pendulum

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

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

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

UNIT-III

Gravitation and Central Force Motion: Law of gravitation, Gravitational potential energy, Inertial and gravitational mass, Potential and field due to spherical shell and solid sphere, Motion of a particle under a central force field, Two-body problem and its reduction to one-body problem and its solution, Differential Equation of motion with central force and its solution, The first Integrals (two), Concept of power Law Potentials, Kepler's Laws of Planetary motion, Satellites. Geosynchronous orbits, Weightlessness, Basic idea of global positioning system (GPS).

UNIT-IV

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

Text Books:

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

Reference Books:

1. Introduc tion to Mechanics Daniel Klapnner and Robert Kolenkow, McgrawHill.
2. Mechanics by K.R Simon
3. Mechanics, Berkeley Physics, vol. 1, C.Kittel, W. Knight, etal (Tata McGraw-Hill)
4. Physics, Resnick, Halliday and Walker (8/e.2008,Wiley)
5. Theoretical Mechanics-M.R. Spiegel (Tata McGrawHill).
6. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands (Pearson)
7. Mechanics-M.Das, P.K.Jena and R.N. Mishra (SrikrishnaPublications)
8. Classical Mechanics , Gupta Kumar & Sharama,(Pragati Prakashan)
9. Classical Mechanics, J.C.Upadhyaya, (Himalaya Publishing Home)

Minor: PAPER-I

LAB: Credit-1

(Minimum 4 experiments are to be done):

1. To study surface tension by capillary rise method.
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c)Modulus of

rigidity.

4. To determine the Moment of Inertia of a Flywheel.
5. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuillesmethod).
6. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
7. To determine the value of g using Bar Pendulum.
8. To determine the value of g using Kater's Pendulum.

Reference Books:

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition,reprinted 1985, Heinemann Educational Publishers.
3. A Text ook of Practical Physics, I. Prakash and Ramakrishna, 11thEdn, 2011,Kitab Mahal

Minor (Paper-II) SEMESTER- III

WAVES AND OPTICS: Credit-3

CO-1: Basic understanding ofpropagation of light, its application and wave nature.

CO-2: To Understand the concepts of wave motion.

CO-3: To Understand the concepts of interference and its application.

CO-4: To Understand the concepts of diffraction and its application.

CO-5: To Apply the acquired knowledge of optics in Experiment

UNIT – I

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

UNIT - II

Wave Motion: Plane and Spherical Waves, Longitudinal and Transverse Waves, Plane Progressive (Traveling) Waves, Wave Equation, Particle and Wave Velocities, Differential Equation, Pressure of a Longitudinal Wave, Energy Trans- port, Intensity of Wave. Superposition of two perpendicular

Harmonic Oscillations: Graphical and Analytical Methods, Lissajous Figures (1:1 and 1:2) and their uses, Superposition of Harmonic waves.

UNlT- III

Interference: Division of amplitude and wave front, Young's double slit experiment, Lloyds Mirror and Fresnels Bi-prism, Phase change on reflection: Stokes treatment, Interference in Thin Films: parallel and wedge-shaped films, Fringes of equal inclination (Haidinger Fringes), Fringes of equal thickness (Fizeau Fringes), Newton's Rings: Measurement of wavelength and refractive index. Interferometer : Michelson's Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of fringes, Fabry-Perot interferometer.

UNlT – IV

Fraunhoffer diffraction: Single slit, Circular aperture, Resolving Power of a telescope, Double slit, Multiple slits, Diffraction grating, Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions, Fresnel's Half-Period Zones for Plane Wave, Explanation of Rectilinear Propagation of Light, Theory of a Zone Plate: Multiple Foci of a Zone Plate, Fresnel's Integral, Fresnel diffraction pattern of a straight edge,as lit and a wire.

Text Books:

1. A text book of Optics N. Subhramanyam and BrijLal (S.Chand Publishing)
2. Optics - Ajoy Ghatak (McGraw Hill)

Reference Books:

1. Optics-E. Hecht(Pearson)
2. Fundamentals of Optics-F. A. Jenkins and H. E. White(McGraw-Hill)
3. Geometrical and Physical Optics R.S. Longhurst (Orient Blackswan)
4. The Physics of Vibrations and Waves- H. J .Pain(John Wiley)
5. Optics P. K. Chakraborty.
6. Principles of Optics-Max Born and Emil Wolf (Pergamon Press)
7. The Physics of Waves and Oscillations-N. K. Bajaj (Mc Graw Hill)

Minor: PAPER-II

LAB: Credit-1

(Minimum 5 experiments are to be done)

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify 2-Tlaw.
2. To plot the I-D curve and to determine the refractive index of a prism
3. To determine refractive index of the Material of a prism using sodium source.
4. To determine the dispersive power and Cauchy constants of the material of a prism using mercurysource.
5. To determine wavelength of sodium light using Newton's Rings.
6. To determine wavelength of (1) Na source and (2) spectral lines of Hgsource using planediffraction grating.
7. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, AsiaPublishing House
2. A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Ed., 2011,Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4thEdition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985,Vani

Minor (Paper-III) **SEMESTER- V**

DIGITAL SYSTEM: Credit-3

CO-1: To Understand IC's and scales of Integration, Digital Circuits and their realization, Applications

CO-2: Build strong knowledge about Boolean Algebra, Truth tables, Equivalent Circuits, Theory and application of CRO.

CO-3: Gain a clear understanding of Data processing circuits, Arithmetic Circuits, different types of Timers: IC555

CO-4: To Explain the knowledge of computer organization, Shift registers and counters.

CO-5: To Apply the acquired knowledge to realize various types of circuits in experiment

UNIT-1

Integrated Circuits (Qualitative treatment only): Active and Passive Components, Discrete components, Wafer Chip, Advantages and Drawbacks of ICs, Scale of Integration: SSI, MSI, LSI and VLSI (basic idea and definitions only), Classification of ICs, Examples of Linear and Digital ICs.

Digital Circuits: Difference between Analog and Digital Circuits, Binary Numbers, Decimal to Binary and Binary to Decimal Conversation, BCD, Octal and Hexadecimal numbers, AND, OR and NOT. Gates (realization using Diodes and Transistor), NAND and NOR Gates as Universal Gates, XOR and XNOR Gates and application as Parity Checkers.

UNIT-II

Boolean algebra: De Morgan's Theorems: Boolean Laws, Simplification of Logic Circuit using Boolean Algebra, Fundamental Products, Idea of Minterms and Maxterms, Conversion of truth table into Karnaugh Map and SOP and POS simplification. Universal logic implementation (NAND & NOR).

UNIT-III

Data Processing Circuits: Basic Idea of Multiplexers, De-multiplexers, Decoders, Encoders.

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2s complement. Half and Full Adders. Half and Full Subtractors, 4 bit binary Adder/Subtractor.

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

UNIT-IV

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

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

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

Text Books:

1. Digital Circuits and Logic design: SamuelC. Lee(PrinticeHall)
2. Digital Principles and Applications -A.P. Malvino, D.P. Leach and Saha (Tata Mc Graw)

Reference Books *:*

1. The Art of Electronics by Paul Horowitzand Wilfield Hill, Cambridge University
2. Electronics by Allan R. Hambley Prentice Hall
3. Principles of Electronics V.K.Mehta and Rohit Mehta (S.Chand Publishing)
4. Digital Logic and Computer design M. Morris Mano (Pearson)
5. Conceptsof Electronics D.C.Tayal (Himalaya Publishing house)
6. Digital System and Application, Gupta Kumar, Pragati Prakashan

Minor: PAPER-III

LAB: Credit-1

(Minimum 6 experiments are to be done)

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

Reference Books:

1. Basic Electronics: A Text Books lab manual, P.B. Zbar, A.P. Malvino, M.A.Miller, 1994, Mc-GrawHill.
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. Electronic Devices and circuit Theory, R.L.Boylestad and L.D.Nashelsky,2009,Pearson

CORE COURSE-III

(Other than Physics Core-I students)

Minor (Paper-I) **SEMESTER- II**

ELECTRICITY AND MAGNETISM:

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30hrs)

CO-1 To understand the basic concepts of Electricity and Magnetism

CO-2 To Understand the various phenomena in Electricity and Magnetism

CO-3 To Understand Circuit analysis and network theorems

CO-4 To Explain the Dynamics of Charged Particles

CO-5 To Apply the acquired knowledge in Experiment.

UNIT-1

Electric Field and Electric Potential

Electric field: Electric field lines, Electric flux, Gauss Law with applications to charge distributions with spherical, cylindrical and planar symmetry, Conservative nature of Electrostatic Field. Electrostatic Potential, Potential and Electric Field of a dipole, Force and Torque on a dipole, Potential calculation in different simple cases, Laplace and Poisson equations, The Uniqueness Theorem, Method of Images and itsapplication to (1) Plane Infinite Sheet and (2) Sphere. Electrostatic energy of system of charges, Electrostatic energy of a charged sphere, Conductors inan electrostatic Field, Surface charge and force on a conductor.

UNIT-II

Magnetic Field: Magnetic Force, Lorentz Force, Biot Savarts Law, Cur- rent Loop as a Magnetic Dipole and its Dipole Moment (analogy with Electric Dipole), Amperes Circuital Law and its application to (1) Solenoid (2) Toroid (3) Helmhotz coil, Properties of curl and divergence, Vector Potential, Ballistic Galvanometer: Torque on a current Loop, Current and Charge Sensitivity, Electromagnetic damping, Logarithmic damping, CDR.

UNIT-III

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

Induction: Faradays Law, Lenz's Law, Self -Inductance and Mutual Inductance, Reciprocity Theorem, Energy stored in a Magnetic Field, Introduction to Maxwell's Equations.

UNIT-IV

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

Network theorems: Kirchoff's law for electrical circuits, Ideal Constant-voltageand Constant-current Sources.

Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem, Applications to DC circuits. Transient Currents Growth and decay of current in RC and LR circuits.

Text Books:

1. Introduction to Electrodynamics – D.J. Griffiths (Pearson, 4th edition, 2015)
2. Foundations of Electromagnetic Theory-Ritz and Milford (Pearson)

Reference Books:

1. Classical Electrodynamics, J. D. Jackson (Wiley).
2. Electricity and Magnetism D. C. Tayal (Himalaya Publishing house)
3. Electricity, Magnetism and Electromagnetic Theory- S. Mahajan and Choudhury(Tata McGraw Hill)
4. F eynman Lectures Vol. 2, R. P. Feynman, R. B. Leighton, M. Sands
5. (Pearson)
6. Electricity and Magnetism, J. H. Fewkes and J. Yarwood. Vol. I (Oxford Univ.Press)
7. Classical Electromagnetism, H.C.Verma, Bharati Bhawan

Minor: PAPER-I

LAB: Credit-1

(Minimum 4 experiments are to be done):

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

1. To study the characteristics of a series RC Circuit.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Fosters Bridge.
4. To compare capacitances using DeSauty's bridge.

5. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
6. To verify the Thevenin and Norton theorems.
7. To determine self-inductance of a coil by Andersons bridge.
8. To study response curve of a Series LCR circuit and determine its (a) Reso- nant frequency, (b) Impedanceat resonance, (c) Quality factor Q, and (d) Band width.
9. To study the response curve of a parallel LCR circuit and determine its (a)
10. Anti-resonance frequency and (b) Quality factor Q.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I.Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub

Minor (Paper-II) SEMESTER- IV

ANALOG SYSTEMS: Credits-3

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30hrs)

CO-1: Basic understanding of semiconductor diodes, devices and their applications.
CO-2 : To Understand the basic concepts in transistors and amplifiers.
CO-3: To Understand the concept of coupled amplifier and its application in feedback circuit.
CO-4: To Understand the concepts of operational amplifier and its application.
CO-5: To Apply the acquired knowledge of electronic circuits in Experiments.

UNIT-1

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

Two terminal device and their applications: (1) Rectifier Diode: Half-wave Rectifiers. center-tapped and bridge type Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, L and C Filters (2) Zener Diode and Voltage Regulation, Principle and structure of LEDS,

(3) Photo diode (3) Solar Cell.

UNIT II

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

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

Amplifiers: Transistors as 2-port network h-parameter Equivalent Circuit, Analysis of a single stage CE amplifier using Hybrid Model, Input and Output impedance, Current, Voltage and Power Gains.

UNIT-III

Classification of class A, B and C amplifiers, Push-pull amplifier (classB).

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

Feedback in Amplifiers: Effect of Positive and Negative Feedback on In- put Impedance, Output Impedance, Gain Stability, Distortion and Noise. Sinusoidal Oscillations: Barkhausens criterian for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency, Hartley and Colpitts oscillators.

UNIT-IV

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

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

Text Books:

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

Reference Books:

1. Electronic devices and circuits R.L.Boylstad(PearsonIndia)
2. Electronic Principles- A.P.Malvino (Tata McGrawHill)
3. Principles of Electronics- V. K. Mehta and Rohit Mehta (S. Chand Pub- lication)
4. OP-Amps and Linear Integrated Circuit-R. A. Gayakwad (PrenticeHall)
5. Physics of Semiconductor devices, DonaldANeamen(PrenticeHall)
6. Analog System and Application: Gupta Kumar, Pragati Prakashan

Minor: PAPER-II

LAB: Credit-1

(Minimum 5 experiments are to be done)

1. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
2. Study of V-I and power curves of solar cells, and find maximum power point and efficiency.
3. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
4. T o study the various biasing configurations of BJT for normal class A operation.
5. T o study the frequency response of voltage gain of a RC-coupled transistoramplifier.
6. To design a Wien bridge oscillator for given frequency using a non-amp.
7. To design a phase shift oscillator of given specifications using BJT.
8. To study the Colpitt's oscillator.

Reference Books:

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

Minor (Paper-III) **SEMESTER- VI**

ELECTROMAGNETIC THEORY: Credit-3

(4 Credit, Theory: 45hrs, 1 Credit, Practical: 30hrs)

CO-1: Physical significance of Maxwell Equation and its application to free space, Lorentz and Coulomb gauge transformation, poynting theorem, concept of energy density.

CO-2: Analysis of Maxwell's equations in different media and Physical significance ofrelaxation time, skin depth, Electrical conductivity of ionized gases, plasma frequency.

CO-3: Basic understanding of polarization of EM wave, and different types of crystals, Phase Retardation Plates and Rotatory Polarization.

CO-4: Conceptual understanding of EMW application in bounded media, plane interface,dielectric media, Brewster's law, TIR, Evanescent wave, metallic reflection.

CO-5 :To Apply the acquired knowledge for visualize basic concept of phenomenon of lightin various experiments

UNIT-1

Maxwell Equations: Maxwells equations, Displacement Current, Vector and Scalar Potentials, Gauge Transformations: Lorentz and Coulomb Gauge, Wave Equations, Plane Waves in free space and characteristics, Poynting Theorem and Poynting Vector, Electromagnetic (EM) Energy Density, Physical Concept of Electromagnetic Field Energy Density.

UNIT-II

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

UNIT-III

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization, uniaxial and biaxial crystals, light propagation in uniaxial crystal, double refr action, polarization by double refraction, Nicol Prism, Ordinary and extraordinary refractive indices, Production and detection of Plane, Circularly and Elliptically polarized light,

Phase Retardation Plates: Quarter-Wave and Half- Wave Plates. Babinets Compensator and its Uses, Analysis of Polarized Light.

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

UNIT IV

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

Text Books:

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

Reference Books :

1. Classical Electrodynamics by J.D.Jackson.
2. Foundation of electromagnetic theory: Ritz and Milford(Pearson).
3. Electricity and Magnetism : D C Tayal (Himalaya Publication)
4. Optics: A. K. Ghatak
5. Electricity and Magnetism : Chattopadhyaya, Rakhit (NewCentral)
6. Electromagnetic Theory, Gupta and Kumar, Pragati Prakashan

Minor: PAPER-III

LAB: Credit-1

(Minimum 5 experiments are to be done)

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

Reference Books:

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

MULTIDISCIPLINARY COURSES UNDER NEP 2020

SEM-I: BIO PHYSICS

(Theory: 3 Credit)

CO-1: Basic fundamentals of living organism and its interactions in domains of Physics in biology
CO-2: Understating of heat transfer in biomaterials and its mechanism
CO-3: Diversifying of thermal, statistical physics in biological domain.
CO-4 : Understating fluid mechanisms in living organism in the domain of Physics

UNIT- I

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

UNIT -II

Heat Transfer in biomaterials: Heat Transfer Mechanism, The Heat equation, Joule heating of tissue. Living State Thermodynamics: Thermodynamic equilibrium, first law of thermodynamics and conservation of energy. Entropy and second law of thermodynamics, Physics of many particle systems, Two state systems, continuous energy distribution, Composite systems, Casimir contribution of free energy, Protein folding and unfolding.

UNIT -III

Open systems and chemical thermodynamics: Enthalpy, Gibbs Free Energy and chemical potential, activation energy and rate constants, enzymatic reactions, ATP hydrolysis & synthesis, Entropy of mixing, The grand canonical ensemble, Hemoglobin. Diffusion and transport Maxwell-Boltzmann statistics, Fick's law of diffusion, sedimentation of Cell Cultures, diffusion in a centrifuge, diffusion in an electric field, Lateral diffusion in membranes, Navier stokes equation, low Reynold's Number Transport, Active and passive membrane transport.

UNIT -IV

Fluids: Laminar and turbulent fluid flow, Bernoulli's equation, equation of continuity,venture effect, Fluid dynamics of circulatory systems, capillary action. Bioenergetics and Molecular motors: Kinesins, Dyneins, and microtubule dynamics, Brownian motion, ATP synthesis in Mitochondria, Photosynthesis in Chloroplasts, Light absorption in biomolecules, vibrational spectra of bio-biomolecules.

Reference Books:

1. Introductory Biophysics, J. Claycomb, JQP Tran, Jones & Bartelett Publishers
2. Aspects of Biophysics, Hughe S W, John Willy and Sons.
3. Essentials of Biophysics by P Narayanan, New Age International

SEM-II: ENVIRONMENTAL CHEMISTRY

(Theory: 3 Credit)

Course Objectives:

The objectives of a course in environmental chemistry typically aim to provide students with a deep understanding of the chemical processes occurring in the environment and their impacts on ecosystems, human health, and the planet as a whole with a comprehensive understanding of the components and processes of environmental systems, including the atmosphere, hydrosphere, lithosphere, and biosphere, and their interactions. Investigation of the chemical composition of environmental compartments, including the atmosphere (air pollutants), hydrosphere (water pollutants), and lithosphere (soil pollutants), and the sources, fate, and transport of pollutants in these compartments. To examine the chemical properties and toxicological effects of environmental pollutants on ecosystems and human health, including acute and chronic toxicity, bioaccumulation, biomagnification, and risk assessment.

Course outcomes:

- Gain a comprehensive understanding of the chemical processes occurring in the environment, including the sources, fate, and transport of pollutants
- Develop analytical skills in environmental chemistry, and apply a range of analytical techniques for the detection, and characterization of environmental pollutants.
- Aware of global environmental issues and challenges such as climate change, pollution, biodiversity loss, and resource depletion.
- Apply the principles of environmental chemistry for mitigating environmental pollution, promoting environmental conservation, and contributing to the development of environmentally friendly technologies and policies.

UNIT I

Environment Introduction, Composition of atmosphere, vertical temperature, heat budget of the earth atmospheric system, vertical stability atmosphere, Biogeochemical Cycles of C, N, P, S and O. Biodistribution of elements. Hydrosphere Chemical composition of water bodies- takes, streams, rivers and wet lands etc. Hydrological cycle. Aquatic pollution-inorganic, organic, pesticide agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters-dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and mocro-organisms. Water quality standards, Analytical methods for measuring BOD, DO, COD, F, oils, metals (As, Cd, Cr, Hg, Pb, Se etc) residual chloride and chlorine demand. Purification and treatment of water.

UNIT II

Soils composition, micro and macro nutrients, pollution-fertilizers, pesticides, plastics and metals, waste treatment Atmosphere Chemical composition of atmosphere-particles, ions and radicals and their formation. Chemical and photochemical reactions in atmosphere, smog formation, oxides of N,

C, S, O and their effect, pollution by chemicals, petroleum, minerals, chlorofluorohydrocarbons. Greenhouse effect, acid rain, air pollution controls and their chemistry. Analytical methods for measuring air pollutants. Continuous monitoring instruments.

UNIT III

Industrial Pollution Cement, Sugar, distillery, drug, paper and pulp, thermal power plants, nuclear power plants, metallurgy. Polymers, drugs etc. Radionuclide analysis. Disposal of wastes and their management.

UNIT IV

Environmental Toxicology, Chemical solutions to environmental problems, biodegradability, principles of decomposition.

Text Books

1. *Environmental Chemistry, A. K. De, Wiley Eastern*
2. *Environmental Chemistry, S.E. Manahan, Lewis Publishers*
3. *Environmental Chemistry with Green Chemistry, A. K. Das, Books & Allied (P) Ltd., Kolkata, 1st Edn, 2010*
4.

References Books

1. *Environmental Chemistry, S.E. Manahan, Lewis Publishers*
2. *Environmental Chemistry with Green Chemistry, A. K. Das, Books & Allied (P) Ltd., Kolkata, 1st Edn, 2010*
3. *Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication*
4. *Erach Bharucha. Textbook of Environmental Studies, Universities Press, 2005*

SEM-III: INTRODUCTION TO SPECTROSCOPY

(Theory: 3 Credit)

CO-1: Basic understanding of atomic models and its spectroscopy nature

CO-2: Conceptual understanding of Spectra of Alkali elements

CO-3: Understating the basic of X-ray and its applications

CO-4 : Understating molecular spectroscopy

UNIT- I :

Vector Atomic Model: Inadequacies of Bohr and Bohr-Sommerfeld atomic models w.r.t. spectrum of Hydrogen atom (fine structure of H-alpha line). Modification is due to the finite mass of the nucleus and the Deuteron spectrum. Vector atomic model (Stern-Gerlach experiment included) and physical & geometrical interpretations of various quantum numbers for single & many valence electron systems. LS & JJ couplings, spectroscopic notation for energy states, selection rules for transition of electrons and intensity rules for spectral lines. Fine structure of H- alpha line based on vector atomic model.

UNIT-II:

Spectra of Alkali & Alkaline Elements: Spectra of alkali elements: Screening constants for s, p, d& amp; f orbitals; sharp, principle, diffuse & amp; fundamental Series; doublet structure of spectra and fine structure of Sodium D line. Spectra of alkaline elements: Singlet and triplet structure of spectra.

UNIT-III:

X-rays & X-Ray Spectra: Nature & production, Continuous X-ray spectrum & Duane-Hunt' s law, Characteristic X-ray spectrum & Mosley's law, Fine structure of Characteristic X-ray spectrum, and X-ray absorption spectrum.

UNIT-IV:

Molecular Spectra: Discrete set of a molecule's electronic, vibrational and rotational energies. Quantization of vibrational energies, transition rules and pure vibrational spectra. Quantization of rotational energies, transition rules, pure rotational spectra and determination of inter nuclear distance. Basics of UV Visible & photoluminescence spectroscopy

Reference Books:

1. H.E. White, "Introduction to Atomic Spectra", McGraw Hill, 1934 8.
2. C.N. Banwell, E.M. McCash, "Fundamentals of Molecular Spectroscopy", McGrawHill, 2017, 4e 9.
3. R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. ChandPublishing, 2019, 18e 10.
4. S.L. Gupta, V. Kumar, R.C. Sharma, "Elements of Spectroscopy", Pragati Prakashan, Meerut, 2015, 27

SKILL ENHANCEMENT COURSES (SEC) UNDER NEP-2020

SEC-I

SEM-II RENEWABLE ENERGY AND ENERGY HARVESTING: 3-Credit

CO-1: Basic understanding of alternative sources of energy.
CO-2: Conceptual understanding and importance of solar cell , characterization
CO-3: Understating the energy harvesting and its applications using wind and piezoelectric material
CO-4: Understating the electromagnetic energy harvesting and its applications

UNIT-I

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

UNIT-II

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

UNIT-III

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

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power.

UNIT-IV

Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications 42 Carbon captured technologies,cell, batteries, power consumption Environmental issues and Renewable sources of energy, sustainability.

Reference Books:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, OxfordUniversity Press, in association with The Open University.
5. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
7. http://en.wikipedia.org/wiki/Renewable_energy

SEC-II

SEM-V APPLIED OPTICS AND PHOTONICS: : 3-Credit

CO-1: Basic understanding of different sources and detectors, principles.

CO-2: Conceptual understanding of frequency filtering and its application.

CO-3: Basic concept of holography, and its application in microscopy and interferometry.

CO-4: Basic knowledge in Optical fiber, and its principle and application in sensors.

CO-5: Apply the acquired knowledge in Experiments

UNIT-I

Sources and Detectors: Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, lightamplification, Characterization of laser beam, He-Ne laser, Semiconductor Lasers.

Unit-II

Fourier Optics and Electron Microscopy: Concept of spatial Frequency Filtering, Fourier Transforming property of a thin lens. Electron Microscope, Working Principle, Types of electron microscope: TEM, SEM(BASICS),Applications of electron microscope, Advantages and limitations of electron microscope

Unit-III

Holography: Basic principle and theory: coherence, resolution, Types of holograms, white light reflectionhologram, application of holography in microscopy, interferometry.

Unit-IV

Photonics: Fiber Optics Optical fibers and their properties, Principal of light propagation through a fiber, The numerical aperture, Attenuation in optical fiber and attenuation limit, Single mode and multimode fibers, Fiber optic sensors.

LAB: Credit-1

1. Experiment on Lasers:

To find the width of the wire or width of the slit using diffraction pattern obtained by aHe-Ne or solid state laser.

2. Experiments on Semiconductor Sources and Detectors

a. V-I characteristics of LED

b. Photovoltaic Cell

3. Experiments on Holography and interferometry.

a. Constructing a Michelson interferometer or a Fabry Perot interferometer.

b. Constructing a Mach-Zender interferometer.

4. Experiments on Photonics: Fiber Optics

a. To measure the numerical aperture of an optical fiber.

b. To study the variation of the bending loss in a multimode fiber.

c. To determine the power loss at a splice between two multimode fiber

Reference Books:

1. Fundamental of Optics, F.A. Jenkins &H.E. White , 1981, Tata McGraw hill.
2. Laser Fundamentals and Applications, K.Thyagarajan and A.K.Ghatak, 2010-Tata McGraw hill .
3. Fiber Optics through experiment , A.K.Ghatak, Bishnu P. Pal, M.R. Shenoy , Sunil K. Khijwania, 2009,vira Book.
4. Fiber optics and optoelectronics, R.P. Khare, Oxford university.

e.https://www.wikilectures.eu/w/Electron_microscopy/principle

SEC-III

SEM-VI CORROSION AND PREVENTION: 3-Credit

(Syllabus not provided)

Detailed syllabus to be taken from other HEIs and will be provide in due course of time.

VALUE AIDED COURSES (VAC) UNDER NEP-2020

ENVIRONMENTAL STUDIES

&

DISASTER MANAGEMENT

SEMESTER-1

(FOR UNDER GRADUATE COURSES ARTS, SCIENCE AND COMMERCE)

FULL MARK-100 (3-Credit)

UNIT I

Multidisciplinary nature of environmental studies **(12 Period)**

Definition, scope and importanceNeed for public awareness

Environmental Pollution Definition, Cause, effects and control measures of:- Air pollution,

Water pollution, Soil pollution, Marine pollution, Noise pollution, Radiation pollution

UNIT II

Natural Resources: (12 Period)

Renewable and non-renewable resources:

Natural resources and associated problems.

a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
b) Water resources : Use and over-utilization of surface and ground water,floods, drought, conflicts over water, dams-benefits and problems.
c) Mineral resources : Use and exploitation, environmental effects of extractingand using mineral resources, case studies.
d) Food resources : World food problems, changes caused by agriculture and Overgrazing, effects of modern agriculture, fertilizer-pesticide problems, waterlogging,salinity, case studies.
e) Energy resources : Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.

Biodiversity:-

Introduction-Definition; Biogeographically classification of India

India as a mega diversity nation. Hot sports of biodiversity, Threats to biodiversity. Endangeredand endemic species of India. Conservation of biodiversity. In Situ and Ex-so conservation ofbiodiversity

UNIT III

Disaster Management (12 Period)

1. **Disaster Management:** Types of disasters (natural and Man-made) and their causes and effect)
2. **Vulnerability Assessment and Risk analysis:** Vulnerability to various disasters (Flood, Cyclone, Earthquake, Heat waves, Desertification and Lighting)
3. **Institutional Framework:** Institutional arrangements for disaster management (National Disaster Management Authority (NDMA), State Disaster Management Authority

(SDMA), Disaster Management Act, 2005, District Disaster Management Authority (DDMA), National Disaster Response Force (NDRF) and Odisha Disaster Rapid Action Force (ODRAF)

4. **Preparedness measures:** Disaster Management cycle, Early Warning System, Pre-Disaster and Post-Disaster Preparedness, strengthening of SDMA and DDMA, CommunityPreparedness for flood cyclone, heat waves, fire safety, lightening and snake biting. Stakeholders participation, Corporate Social Responsibility (CSR)

5. **Survival Skills:** Survival skills adopted during and after disaster (Flood, Fire, Earthquake, Cyclone and Lightening), Disaster Management Act-2005, Compensation and Insurance

UNIT IV

Social Issues and the Environment (9 Period)

A.

a) Environmental Ethics: Issues and possible solutions.

b) Climate change, global warming, acid rain, ozone layer depletion, nuclearaccidents and holocaust. Case studies

c) Environment Protection Act

d) Air (Preservation Control of Pollution) Act

e) Water (Preservation Control of Pollution) Act

f) Wildlife Protection Act

g) Forest Conservation Act

h) Solid waste management Cause, effect and Control Measure of Urban and Industrial waste (Role of each individual in conservation of Natural resources and prevention of pollution)

B. Human Population and the Environment

Population Ecology: Individuals, species, population, community Human population growth, population control method Urbanisation and its effect on society

UNIT V

Field work (15 Periods of 30 hrs)

- Visit to an area to document environmental assets: river/forest/flora/fauna, etc.
- Visit to a local polluted site- Urban/Rural/Industrial/Agricultural
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems-pond, river, Delhi Ridge ,etc.

NANO MATERIAL AND NANO TECHNOLOGY

(Theory: 3 Credit)

SEMESTER-1II

CO-1: Basic understanding of nanostructured shape, application of Schrodingerequation in nanostructured

CO-2 : Understanding of nanomaterial synthesis

CO-3 : Understanding of nanomaterials different Characterization

CO-4 : Understating of different optical properties of nanomaterials

CO-5:Apply the above concepts in Experiments

UNIT- 1

NANOSCALE SYSTEMS:

Length scales in physics, Nanostructures: 1D, 2D and 3Dnanostructures (nano dots, thin films, nanowires, nano rods), 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. (10 Lectures)

UNIT-II

SYNTHESIS OF NANOSTRUCTURE MATERIALS: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots. (8 Lectures)

UNIT-III

CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy. Scanning lectron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning TunnelingMicroscopy. (8 Lectures)

UNIT-IV

OPTICAL PROPERTIES: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostrctures and nanostructures. (14 Lectures)

Reference books:

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. Banerjee, 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).

LABORATORY: 1 credit

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticles.
3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4. XRD pattern of nanomaterials and estimation of particle size.5. To study the effect of size on color of nanomaterials.
6. Growth of quantum dots by thermal evaporation.
7. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.

BASIC UNDERSTANDING OF MOLECULAR DYNAMICS: 3-Credit

SEMESTER-V

(Syllabus not provided)

Detailed syllabus to be taken from other HEIs and will be provide in due course of time.

ETHICS AND VALUES 3-Credit

SEMESTER-VI

COURSE OUTCOME

- Development of a good human being and a responsible citizen
- Developing a sense of right and wrong leading to ethically correct behavior
- Inculcating a positive attitude and healthy work culture
- To equip the students to prepare themselves national and state level civil service and othercompetitive examination.

COURSE CONTENTS

UNIT-I- ETHICS AND HUMAN INTERFACE **[5 Hours]**

Learning Outcome-

- ✓ *Understand the basic concept of ethics and its relevance in life*

- Ethics and Human Interface: Essence, Determinants and consequence of ethics and human action.
- Dimensions of Ethics in private and public relationship
- Human Values: Tolerance, Compassion, Rationality, Objectivity, Scientific Attitude Integrity, Respecting conscience and Empathy etc.
- Mahatma Gandhi and Ethical Practices: Non-Violence, Truth, Non-hatred and love for all, concern for the poorest, objective Nationalism

Subject Teacher: Philosophy/Political Science or Any other Teacher.

UNIT-II- ETHICS AND MAJOR RELIGIONS AND CIVILIZATIONS [7 hours]

Learning Outcome-

- ✓ *Be familiar with ethical principles and values promoted by major religious traditionsand civilization*
- Hinduism- Dharma and Mokhya (out of 4 goals of life Dharma, Artha, Kama and Mokhya), Concept of Purusartha, Nisakama Karma(work without attachment to results), Concept of Basudev Kutumba and Peace (Whole world including all animals, plants, inanimate beings and human form one world)
- Ten Commandments: (Christianity and Judaism Tradition)
- Islamic Ethics: Justice, Goodness, Kindness, Forgiveness, Honesty, Purity and Piety
- Egyptian- Justice, Honesty, Fairness, Mercy, Kindness and Generosity
- Mesopotian-Non-indulgence in lying, stealing, defrauding, maliciousness, adultery, coveting possession of others, unworthy ambition, misdemeanors and injurious teaching.
- Buddhism-Arya Astangika Marg: Right View, Thought, Speed, Action, Livelihood, Efforts, Attention and Concentration.
- Jainism-Right faith, knowledge and conduct(Triralna)
- Chinese-Confucianism- Respect for Autonomy, Beneficence, non-maleficence and justice. Taoism: No killing, No stealing, No sexual misconduct, No false Speech and No taking of intoxicants.

Subject Teacher: History/Philosophy/Political Science or Any other Teacher.

UNIT-III- CONSTITUTIONAL VALUES, GOOD CITIZENSHIP, PATRIOTISM AND VOLUNTEERISM [10 Hours]

Learning Outcome-

- ✓ *Students Learns about constitutional values of India, Civic Sense and good Citizenship (both National and International) Patriotism and need for Volunteerism*

- Salient Values of Indian Constitution: Sovereign, Socialist, Secular, Democratic, Republic, Justice, Liberty, Equality and Fraternity
- Patriotic values and ingredients of National Building, Examples of great Patriots, Rani Laxmi Bai, Bhagat Singh, Mangal Pandey, Birsa Munda, Laxman Naik, Subhas Chandra Bose and Khudiram Bose.
- Law abiding citizenship
- Concept of Global citizenship in contemporary world
- Volunteerism- concept and facts of Volunteerism, building a better society through Volunteerism, Blood Donation, Social work, Helping the Aged, Promotion of Green Practices and Environment protection.

Subject Teacher: History/Philosophy/Political Science or Any other Teacher.

UNIT-IV- WORK ETHICS [6 hours]

Learning Outcome-

- ✓ *Understand the concept of work ethics, ethics in work place and ethical practices to be adopted by various professionals*
- The concept of professionalism.
- Professional ethics at work place
- Core values needed for all professionals. Reliability, Dedication, Discipline, Productivity, Co-operation, Integrity, Responsibility, Efficiency, Professionalism, Honesty, Purity and Time Management, Accountability, Respect Diversity, Gender Sensitivity, Respect for others, Cleanliness, Rational Thinking, Scientific Attitude, Clarity in Thinking . Diligence, cleanliness and Environment Consciousness.
- Codes of conduct for Students (both in College and Hostels), Teachers, Business professional, Doctors, Lawyers, Scientist, Accountants, IT professionals and Journalist.
- Practical ethics in day-to-day life.

Subject Teacher: Commerce/Philosophy/Education/History/ or Any other Teacher.

UNIT-V-ETHICS AND SCIENCE AND TECHNOLOGY [7 Hours]

Learning Outcome-

- ✓ *Understand how Science is related to ethics and values has ethical implications.*
- Ethics of Science and Technology. Are science and Technology ethically neutral? Are Science and Technology Value Free?
- Ethics of scientific Research ,Innovation and Technology
- Ethics of Social Media, Modern Gadgets

- AI and Ethics

Subject Teacher: Philosophy or Any Science Teacher

UNIT-VI- ETHICS AND VULNERABLE SECTIONS OF SOCIETY [10 hours]

Learning Outcome-

- ✓ *Understand how various vulnerable sections of our society are treated unequallyand what needs to be done to address their inequality*
- ✓ *Understand dimensions of substance abuse*

1. **Women and family-**Gendered practices in the family, marriages (dowry, child marriage, women's consent).

   Women and work- women's work at home and at work place, pay gap, gendered roles, harassment at work place and working women and role conflict.

   Women and Society- Gender sensitive language, property right, marriage-divorce/Separationand women's right; violence against women

2. **Issues Relating to Children:** Nutrition and health , Child Exploitation: Child labour ,trafficking, sexual exploitation

3. **Issues Relating to Elderly Persons :** Abuse of Elders, Financial insecurity, Loneliness and Social insecurity, Health Care Issues, Needs for a happy and Dignified Ageing

4. **Issues Relating to persons with disability:** Rights of PWD, affirmative action, prevention of discrimination, providing equal opportunity, various scheme for empoweringPWD and social justice for PWD.

5. **Issues Relating to Third Gender:** Understanding LGBTQ, Social justice for them, Removal of discrimination, Affirmative action and Acceptance of diversity of gender.

   Subject Teacher: Sociology/political Science /Anthropology or Any Science Teacher

Sample Questions-

1. Birsa Munda belongs to which state of India? [1 mark]
2. Recall at least 4 constitutional values from the preamble to India constitution. [2 marks]
3. Explain utility of being Punctual. [5 marks]
4. Explain the ethical principles a scientist should follow. [8 marks]
5. **Course material:** To be developed by OSHEC and DDCE, Utkal University. Video Lectureswill be also prepared by OSHEC and VTP, Utkal University. There shall be no internal examination for this course. The Term End Examination shall be conducted by the respectiveUniversities. Student would engage in self-study and colleges shall conduct at least 4 doubt clearing session for each unit by engaging subject teachers as indicated above. The Principal may assign responsibility to any teacher.

FOUR YEAR HONS. WITHOUT RESEARCH

PAPER-XVI SEMESTER – VII

MATHEMATICAL METHODS IN PHYSICS

(Theory : 4 Credits)

CO1: Understanding of Complex Variables and Contour Integration: Gain a comprehensive understanding of complex variables and contour integration techniques, including their applications in mathematical analysis and physics.

CO2: Learning Tensors for Physics: Acquire knowledge and proficiency in working with tensors, a fundamental mathematical tool in physics used to describe physical quantities and their transformations.

CO3: Understanding Group Theory: Develop a deep understanding of group theory and its role in physics, including applications in symmetry analysis and quantum mechanics.

CO4: .Learning Special Functions for Applications in Physical Problems: Master specialized functions commonly used in physics to solve complex problems, enhancing problem-solving skills and expanding mathematical techniques.

UNIT-I

Complex Variables: Analytic functions, Contour integrals, Cauchy's integral theorem, Laurent's series,singular points, residues and the Residue Theorem, Evaluation of real definite and indefiniteintegrals by contour integration, indented semi-circular contour, evaluation of single and multi- valued functions, branch points and branch cuts, Contour integration involving branch point.

UNIT-II

Tensors: Introduction, Types of tensor, Invariant tensor, epsilon tensor, Pseudo tensor, the algebra of tensor, Quotient law, Metric Tensor, Covariant derivative of tensor, Fundamental Tensor, Cartesian tensor, Christoffel symbol.

UNIT-III

Group Theory: Definitions of groups, subgroups and classes, Isomorphism, Homomorphism, Cayley's theorem, Group representations, Orthogonality theorem, characters, Orthogonality relation for group character, Character table, Preliminary idea about infinite group, calculation of generator, Calculation of generator associated with S.U. (2) and SO(3) group,

UNIT-IV

Special Functions: Legendre Polynomials, generating functions, Recurrence formulae, Orthogonality properties of Legendre's polynomial of 1st kind, Bessel generating function, Bessel function of 1st and 2nd Kind, Recurrence formulae, Orthogonality properties of Bessel's polynomials, Spherical Bessel functions, Fourier and Laplace transformation.

Text books:

1. Mathematical Methods of Physics by Mathews and Walker (W. A. Benjamin Inc.)
2. Matrices and Tensors in physics by A. W. Joshi (New Age International Publisher)
3. Mathematical Methods in the physical Science by Mary L. Boas (Wiley- India)

Reference Books:

1. Mathematical Methods for Physicist by G. Arfken and H. Weber, Academic Press(Elsevier)
2. Elements of Group Theory by A. W. Joshi (New Age International Publisher)
3. Mathematical Physics by H. K.Das and Dr. R. Verma (S. Chand & Company L.T.D.)
4. Mathematical Physics by P. K. Chattopadhyaya (New Age International)

PAPER-XVII SEMESTER – VII

CLASSICAL MECHANICS

(Theory : 4 Credits)

CO1: Enhance comprehension of rigid body kinematics.
CO2: Master the Hamiltonian formalism.
CO3: Deepen understanding of canonical transformations in various physical scenarios.
CO4: Grasp concepts related to small oscillations.

UNIT-I

KINEMATICS OF RIGID BODY MOTION:

Independent coordinates of a rigid body, Orthogonal transformations, Eulerian angles, infinitesimal rotations, rate of change of vector, Coriolis force, angular momentum and kinetic energy of motion about a point, inertial tensor and the moment of inertia, Eigen values of Inertial tensor and the principal axis transformation, methods of solving rigid body problems and Euler's equations of motion, torque free motion of a rigid body. Heavy symmetrical top with one point fixed.

UNIT-II

HAMILTONIAN FORMULATION: Calculus of Variations and Euler-Lagrange's Equation, Brachistochrone Problem, Hamilton's Principle, Extension of Hamilton's Principle to Nonholonomic Systems, Legendre Transformation and the Hamilton Equations of Motion, Physical Significance of Hamiltonian, Derivation of Hamilton's Equations of Motion from a Variational Principle, Routh's Procedure, Principle of Least Action

UNIT-III

CANONICAL TRANSFORMATIONS: Canonical Transformation, Types of Generating Function, conditions for canonical transformation, Integral Invariance of Poincare, Poisson Bracket, Poisson's Theorem, Lagrange Bracket, Poisson and Lagrange Brackets as Canonical Invariant, Infinitesimal Canonical transformation and Conservation Theorems, Liouville's Theorem Hamilton Jacobi Theory: Hamilton-Jacobi Equation for Hamilton's Principal Function, Harmonic Oscillator and Kepler problem by Hamilton-Jacobi Method, Action-Angle Variables for completely Separable System, Kepler Problem in action-angle variables.

UNIT-IV

SMALL OSCILLATION: Problem of Small Oscillations, Example of linear triatomic molecule and two coupled Oscillator, General Theory of Small Oscillations, Normal Coordinates and Normal Modes of Vibration.

Test Books:

1. Classical Mechanics- by H. Goldstein (Addison-Wesley)

Reference books:

2. Classical Mechanics by S. N. Biswas, Books and Allied Publisher Ltd.
3. Classical Mechanics by J.C. Upadhay, Himalaya Publishing House.
4. Classical Mechanics by Landau and Liftshitz (Butter Worth)

PAPER-XVIII SEMESTER – VII

QUANTUM MECHANICS-1

(Theory : 4 Credits)

CO 1: To comprehend the postulates and general formalism of quantum mechanics.
CO2: To acquire knowledge of quantum dynamics.
CO3: To grasp the concepts of rotational and orbital angular momentum.
CO4: To understand spin angular momentum, addition of spin, and Clebsch-GordanCoefficient

UNIT-I

GENERAL PRINCIPLES OF QUANTUM MECHANICS:

Postulates of Quantum Mechanics and meaning of measurement, Operators and their expectationvalues, .Dirac Notations,Linear vector space, Ket and Bra vectors, Scalar product of vectors and their properties, Dirac delta function, linear operators, Adjoint operators, Unitary Operators, Expectation values of dynamical variables and physical interpretation of Hermitian operators, Eigen values and eigen vectors, orthonormality of eigen vectors, probability interpretation, Degeneracy, Schmidt method of orthogonalization, Expansion theorem, Completeness and closure properties of the basis set, Coordinate and momentum representations, compatible an Incompatible observables, Commutator algebra, uncertainty relation as a consequence of non- commutability, minimum uncertainty wave packet, Representations of Ket and Bra vectors and operators in matrix form, Unitary transformation of basis vectors and operators.

UNIT-II

QUANTUM DYNAMICS:

Time evolution of quantum states, Time evolution operator and its properties, Schrödinger, Heisenberg and Interaction picture, Equations of motion, Operator method solution of Harmonic oscillator problem,

Matrix representation and time evolution of creation and annihilation operator.

UNIT-III

ROTATION AND ORBITAL ANGULAR MOMENTUM

Rotation Matrix, Orbital angular momentum operators as generators of rotation, Lx, Ly, Lz and L2and their Commutation relations, Raising and Lowering operators (L+ and L-), Lx, Ly, Lz and L2 in Spherical Polar coordinates, Eigen values and Eigen functions of Lz and L2 (operatormethod), Matrix representation of Lx, Ly, Lz and L2.

UNIT-IV

SPIN ANGULAR MOMENTUM:

Spin ½ particles, Pauli spin matrices and their properties, Eigen values and Eigen functions, Spinand rotations. Total angular momentum: Total angular momentum J, Eigen value problem of Jz and J^2 , Angular momentum matrices, Addition of angular momentum and C. G. coefficients forthe states with (i) $j_1 = ½$ and $j_2 = ½$ (ii) $j_1 = 1$ and $j2 = ½$.

Text books:

1. " Quantum Mechanics: Concepts and Applications" by NouredineZettile John Wileyandsons.

Reference Books:

1. "Quantum Mechanics",L.I. Schiff L.I 3rd Ed, McGraw Hill Book Co.
2. “Quantum Mechanics”E. Merzbacher , 2ndEd., John Wiley &Sons.
3. "Quantum Physics", S.Gasiorowicz John Wiley.
4. "A TextBook ofQuantum Mechanics"by P.M.Mathews . andVenkatesan , TataMcGraw Hill.
5. Introduction to Quantum Mechanics, by D.J.Griffiths ,2nd edition ,PearsonPublications.
6. Lectures on Quantum Mechanics , Ashok Das , University ofRochester,USA(second edition;Hindustan Book Agency

PAPER-XIX **SEMESTER – VII**

LABORATORY: COMPUTATIONAL PHYSICS *(4 Credits)*

The main goal of this laboratory is to utilize programming languages such as C/C++, Fortran, Matlab, and Scilab to tackle straightforward problems in the fields of classical mechanics, quantum mechanics, and statistical mechanics.

1. Introduction to the programming language (e.g. C /C++/ Fortran/ Matlab/Scilab). The introduction is accompanied by examples in thefollowing general areas. (a) Sorting Algorithms -- selection sort, Quick sort etc.(b) Solution of equation -- Newton's method, Secant method etc. (c) Simplenumerical integratons -- Trapezoidal rule, simpson 1/3 rule .
2. Classical mechanics (2nd order ODE, initial value problems). Euler method, Modified-Euler (predictor-corrector) method, Runge-Kutta method, Leapfrog method, Verlet method, Velocity Verlet method, each with and without velocity dependent drag terms, harmonic oscillator with damping ,forced one, realistic projectile motion with air drag, realistic planetary orbit calculation.
3. Quantum Mechanics (2nd order ODE, boundary value and eigenvalue problems). Shooting method and Numerov's method, examples of bound states calculation for 1D wells, quantum harmonic oscillators. Eigenvalue problem in matrix form (finite dimensional basis), and exact (Lanczos) diagonalization, Variational calculation with orthogonal basis states. Time-dependent Schrodinger equation, wave equation.
4. Statistical Mechanics (Stochastic and Monte Carlo Methods). Uniform random number generation, Random walk and diffusion, Monte Carlo Integration -- advantage in higher dimension, error analysis. Importance sampling and detailed balance. Generation of random numbers from a Gaussian distribution-- Box Miller method, using central limit theorem, Sampling points from arbitrary distributions --Metropolis sampling and examples.

Reference Textbooks:

1. Computational Physics, N. J. Giordano and H. Nakanishi, Pearson PrenticeHall (2006)
2. Introduction to Computational Physics, Pao Tang, Cambridge University Press.
3. Computational Physics, S. E. Koonin and D. C. Meredith, Addison-Wesley PublishingCompany.
4. Computational Physics, J. M. Thijssen, Cambridge University Press

PAPER-XX **SEMESTER – VIII**

CLASSICAL ELECTRODYNAMICS

(Theory : 4 Credits)

CO 1: To understand the covariance formulation of electrodynamics through topics such as Lorentz transformations, Scalars, Vectors, Tensors, and the Inhomogeneous Wave Equation.

CO2: To explore the concepts of Lienard-Wiechert potential and the field of a uniformly moving electron, as well as the propagation of electromagnetic waves in rectangular waveguides.

CO3: To learn about radiation from accelerated charges.

CO4: To comprehend radiation, scattering, and dispersion phenomena in the context of electrodynamics.

UNIT 1

a. Covariant formulation of electrodynamics:

Lorentz transformation; Scalars, vectors and Tensors; Maxwells equations and equations of continuity in terms of Aμ and Jμ; Electromagnetic field tensor and its dual; Covariant form of Maxwell"s equations; Lagrangian for a charged particle in presence of external electromagnetic field and Maxwell's equation as Euler-Lagrange equations.

b. The Inhomogeneous Wave equation:

UNIT –II

a. Lienard-Wiechart potential and Field of a uniformly moving electron: Lienard- Wiechart potential, Fields of a charge in uniform motion, Direct solution of the wave equation, Convection potential, Virtual photon concept.

b. Wave guides, Propagation of electromagnetic waves in rectangular wave guides**.**

Wave equations for potentials, solution by Fourier analysis, Radiation field, Radiation energy, Hertz potential, Computation of radiation fields by Hertz method, electric dipole radiation, multipole-radiation.

UNIT –III

Radiation from Accelerated Charges: Radiation from an accelerated charge, Fields of an accelerated charge radiation at low velocity, Case of velocity parallel to acceleration, radiation from circular orbits, Radiation with no restrictions on the acceleration or velocity, Classical cross section for bremsstrahlung in a Coulomb field, Cherenkov radiation.

UNIT –IV

Radiation, scattering and dispersion:

Radiative damping of a charged harmonic oscillator, forced vibrations, scattering by an individual free electron, scattering by a bound electron, absorption of radiation by an oscillator, equilibrium between an oscillator and a radiation field, effect of a volume distribution of scatters, scattering from a volume distribution, Rayleigh scattering, the dispersion relation.

Text Book:

1. "Classical Electricity and Magnetism" by Wolfgang K.H.Panofsky and Melba Philips, Second Edition.

Reference books:

1. "Classical Electrodynamics", Jakson J D, John Wiley.
2. 'Introduction to Electrodynamics", Griffiths DJ, Prentice Hall.

PAPER-XXI SEMESTER – VIII

QUANTUM MECHANICS-II

(Theory : 4 Credits)

CO1: Master the principles of solving motion in a spherically symmetric field.
CO 2: Acquire proficiency in utilizing approximate methods.
CO3: Comprehend advanced techniques like the Variational method, W. K. B. method, andTime-dependent perturbation theory.
CO4: Gain insight into Time-dependent perturbation theory and the scattering of identicalparticles.

UNIT 1

Motion in a spherically symmetric field:

The hydrogen atom, Reduction to equivalent one body problem, radial equation, Energy eigenvalues and eigen functions, Degeneracy, Radial probability distribution, free-particle problem, Expression of plane waves in terms of spherical waves. Bound states of a 3-D square well.

UNIT 1I

Approximate methods:

stationary perturbation theory, Rayleigh Schrodinger method for non-degenerate case, first and second order perturbation, an harmonic oscillator, general theory for the degenerate case, removal of degeneracy, linear Stark effect, normal Zeeman effect**.**

UNIT 1II

Variational method: Ground State, First Excited State and Second Excited State of H- atomOne-Dimensional Harmonic Oscillator, and He-atom.

W. K. B. method: Connection formulas, Bohr-Sommerfeld quantization rule, Harmonic oscillator and cold emission Time-dependent perturbation theory:
Transition probability, constant and harmonic perturbation, Fermi Golden rule

UNIT 1V

Scattering amplitude and scattering cross section:

Born approximation, application to Coulomb and screened Coulomb potentials. Partial waveanalysis for scattering, optical theorem, scattering from a hard sphere, resonant scattering from a square well potential. Identical particles, Symmetric and antisymmetric wave function, Scattering of identical particles.

Text Book:

1. " Quantum Mechanics: Concepts and Applications" by Nouredine Zettile John Wiley and sons.

Reference Books:

1. "Quantum Mechanics", L.I. Schiff 3rdEd, McGraw Hill Book Co.
2. “Quantum Mechanics” E. Merzbacher , 2ndEd., John Wiley &Sons.
3. "Quantum Physics", S.Gasiorowicz John Wiley.
4. "A Text Book of Quantum Mechanics" by P.M. Mathews . and Venkatesan , Tata McGraw Hill.
5. Introduction to Quantum Mechanics, by D.J. Griffiths ,2nd edition,Pearson Publications.

PAPER-XXII SEMESTER – VIII

ELECTRONICS

(Theory : 4 Credits)

CO1: Enhance understanding of Network Analysis, Bipolar Junction Transistors, and Operational Amplifiers.
CO2: Acquire knowledge of Oscillator circuits and their functionality.
CO3: Master the concepts of Digital Circuits and their applications.
CO4: Comprehend the operation and usage of Optoelectronic Devices in electronic systems.

UNIT 1

Network Analysis: Superposition principle Thevenin and Norton Theorems, BJT, FET,MOSFET: characteristic, biasing-parameter analysis Feedback Circuits. Operational Amplifiers: The differential amplifier, D.C. and A.C. signal analysis, integral amplifier, rejection of common mode signals, CMMR, The operational amplifier, input and output impedances, Application of operational Amplifiers unit gain buffer, summing, integrating amplifier, Comparator, Operational amplifier as a differentiato**r.**

UNIT 1I

Oscillator circuits: Feedback criteria for oscillation, Nyquist criterion, Phase shift, Wien-Bridge oscillator, Crystal controlled oscillator

UNIT 1II

Digital Circuits: Logic fundamentals, Booleantheorem, logicgates: AND, OR, NOT, NOR,NANDXOR, and EXNOR.RTL, DTL and TTL logic, Flip-flop, RS-and JK-Flip flop, A/D and D/A Convertors

UNIT 1V

Optoelectrics Device:

Principle of optical sources, Source material, Choice of materials, Internal and external quantum efficiency of L.E.D., Structures, Types of L.E.D.: Surface emitting L.E.D., Edge emitting L.E.D., Modulation capability, emission pattern, power bandwidth product, laser Diode Modes, Threshold condition, resonant frequency, Laser Diode Structure, Brief description of principle of optical detectors, Photomultipliers P.I.N. and A.P.D. configuration, Solar Cell.

Text Book:

1. " Electronic fundamental and application by J.D. Ryder, PHI, Learning Pvt Ltd.
2. Electronics: Circuits and Analysis, D.C.Dubey, Alpha Science
3. R.P.Khare, Fiber Optics and Optoelectronics, Oxford University Press

Reference Books:

1. " Foundation of electronics – Chattopadhyay, Rakshit, Saha and Purkait , New age International publisher
2. Electronics principles-Albert Malvino, Tata Mc Graw-Hill Edition
3. Modern Digital Electronics-R.P Jain, Tata Mc Graw-Hill Edition

PAPER-XXIII SEMESTER – VIII

LABORATORY: OPTICS AND MODERN PHYSICS *(4 Credits)*

The main objectives of this laboratory course are:

1. To apply the principles of optics, electronics, and modern physics in conducting experiments.
2. To gain a better understanding of theoretical principles through hands-on experimentation.

N.B: Following is the list of some experiment however, the college can add any otherexperiments as per the convince.

Optics &Modern Physics:

1. Determination of Boltzmann constant using V-I characteristics of PN diode.
2. Determination of Planck's constant using LEDs at least four colors.
3. Determination of e/m by Bar magnet/magnetic focus sung
4. Study of photo-electric effect.
5. Study of diffraction pattern of single and double slits using laser source and determination of its wavelength.
6. Study the electrical resistance as a function of temperature.
7. Experiments with Michelson interferometer: Determination of A and α Thickness of

mica sheet

8. Fabry Perot interferometer Polarization Experiments Babinetcompensator Edsar-Butlerbands Quarter wave plate Mallus Law Study of elliptical polarized light
9. Constant Deviation Spectrography Calibration Zeeman effect
10. Babinet Quartz Spectrography
11. Any other suitable experiments
12. Any other experiments that may be set up from time to time.

Reference Books:

1. Elements of Modern Physics: Laboratory (BPHEL-142, Prepared by: Ignou: school of science (https://egyankosh.ac.in)
2. Modern Physics Lab (PHYS 340) Prepared by: Purdue University, (https://www.physics.putrdue.edu)

FOUR YEAR HONS. WITH RESEARCH

PAPER-XVI SEMESTER – VII

CLASSICAL MECHANICS

(Theory : 4 Credits)

CO1: Enhance comprehension of rigid body kinematics.

CO2: Master the Hamiltonian formalism.

CO3: Deepen understanding of canonical transformations in various physical scenarios.

CO4: Grasp concepts related to small oscillations.

UNIT-I

KINEMATICS OF RIGID BODY MOTION:

Independent coordinates of a rigid body, Orthogonal transformations, Eulerian angles, infinitesimal rotations, rate of change of vector, Coriolis force, angular momentum and kinetic energy of motion about a point, inertial tensor and the moment of inertia, Eigen values of Inertial tensor and the principal axis transformation, methods of solving rigid body problems and Euler's equations of motion, torque free motion of a rigid body. Heavy symmetrical top with one point fixed.

UNIT-II

HAMILTONIAN FORMULATION: Calculus of Variations and Euler-Lagrange's Equation, Brachistochrone Problem, Hamilton's Principle, Extension of Hamilton's Principle to Nonholonomic Systems, Legendre Transformation and the Hamilton Equations of Motion, Physical Significance of Hamiltonian, Derivation of Hamilton's Equations of Motion from a Variational Principle, Routh's Procedure, Principle of Least Action

UNIT-III

CANONICAL TRANSFORMATIONS: Canonical Transformation, Types of Generating Function, conditions for canonical transformation, Integral Invariance of Poincare, Poisson Bracket, Poisson's Theorem, Lagrange Bracket, Poisson and Lagrange Brackets as Canonical Invariant, Infinitesimal Canonical transformation and Conservation Theorems, Liouville's Theorem Hamilton Jacobi Theory: Hamilton-Jacobi Equation for Hamilton's Principal Function, Harmonic Oscillator and Kepler problem by Hamilton-Jacobi Method, Action-Angle Variables for completely Separable System, Kepler Problem in action-angle variables.

UNIT-IV

SMALL OSCILLATION: Problem of Small Oscillations, Example of linear triatomic molecule and two coupled Oscillator, General Theory of Small Oscillations, Normal Coordinates and Normal Modes of Vibration.

Test Books:

1. Classical Mechanics- by H. Goldstein (Addison-Wesley)

Reference books:

1. Classical Mechanics by S. N. Biswas, Books and Allied Publisher Ltd.
2. Classical Mechanics by J.C. Upadhay, Himalaya Publishing House.
3. Classical Mechanics by Landau and Liftshitz (Butter Worth)

PAPER-XVII SEMESTER – VII

QUANTUM MECHANICS-1

(Theory : 4 Credits)

CO 1: To comprehend the postulates and general formalism of quantum mechanics.
CO2: To acquire knowledge of quantum dynamics.
CO3: To grasp the concepts of rotational and orbital angular momentum.
CO4: To understand spin angular momentum, addition of spin, and Clebsch-GordanCoefficient

UNIT-I

GENERAL PRINCIPLES OF QUANTUM MECHANICS:

Postulates of Quantum Mechanics and meaning of measurement, Operators and their expectationvalues, .Dirac Notations,Linear vector space, Ket and Bra vectors, Scalar product of vectors and their properties, Dirac delta function, linear operators, Adjoint operators, Unitary Operators, Expectation values of dynamical variables and physical interpretation of Hermitian operators, Eigen values and eigen vectors, orthonormality of eigen vectors, probability interpretation, Degeneracy, Schmidt method of orthogonalization, Expansion theorem, Completeness and closure properties of the basis set, Coordinate and momentum representations, compatible an Incompatible observables, Commutator algebra, uncertainty relation as a consequence of non- commutability, minimum uncertainty wave packet, Representations of Ket and Bra vectors and operators in matrix form, Unitary transformation of basis vectors and operators.

UNIT-II

QUANTUM DYNAMICS:

Time evolution of quantum states, Time evolution operator and its properties, Schrödinger, Heisenberg and Interaction picture, Equations of motion, Operator method solution of Harmonic oscillator problem, Matrix representation and time evolution of creation and annihilation operator.

UNIT-III

ROTATION AND ORBITAL ANGULAR MOMENTUM

Rotation Matrix, Orbital angular momentum operators as generators of rotation, Lx, Ly, Lz and L2and their Commutation relations, Raising and Lowering operators (L+ and L-), Lx, Ly, Lz and L2 in Spherical Polar coordinates, Eigen values and Eigen functions of Lz and L2 (operatormethod), Matrix representation of Lx, Ly, Lz and L2.

UNIT-IV

SPIN ANGULAR MOMENTUM:

Spin ½ particles, Pauli spin matrices and their properties, Eigen values and Eigen functions, Spinand rotations. Total angular momentum: Total angular momentum J, Eigen value problem of Jz and J^2 , Angular momentum matrices, Addition of angular momentum and C. G. coefficients forthe states with (i) j_1 = ½ and j_2 = ½ (ii) j_1 = 1 and j2 = ½.

Text books:

1. " Quantum Mechanics: Concepts and Applications" by NouredineZettile John Wileyandsons.

Reference Books:

1. "Quantum Mechanics",L.I. Schiff L.I 3rd Ed, McGraw Hill Book Co.
2. "Quantum Mechanics"E. Merzbacher , 2ndEd., John Wiley &Sons.
3. "Quantum Physics", S.Gasiorowicz John Wiley.
4. "A TextBook ofQuantum Mechanics"by P.M.Mathews . andVenkatesan , TataMcGraw Hill.
5. Introduction to Quantum Mechanics, by D.J.Griffiths ,2nd edition ,PearsonPublications.
6. Lectures on Quantum Mechanics , Ashok Das , University ofRochester,USA(second edition;Hindustan Book Agency

PAPER-XVIII SEMESTER – VII

LABORATORY: COMPUTATIONAL PHYSICS *(4 Credits)*

The main goal of this laboratory is to utilize programming languages such as C/C++, Fortran, Matlab, and Scilab to tackle straightforward problems in the fields of classical mechanics, quantum mechanics, and statistical mechanics.

1. Introduction to the programming language (e.g. C /C++/ Fortran/ Matlab/Scilab). The introduction is accompanied by examples in thefollowing general areas. (a) Sorting Algorithms -- selection sort, Quick sort etc.(b) Solution of equation -- Newton's method, Secant method etc. (c) Simplenumerical integratons -- Trapezoidal rule, simpson 1/3 rule .
2. Classical mechanics (2nd order ODE, initial value problems). Euler method, Modified-Euler (predictor-corrector) method, Runge-Kutta method, Leapfrog method, Verlet method, Velocity Verlet method, each with and without velocity dependent drag terms, harmonic oscillator with damping ,forced one, realistic projectile motion with air drag, realistic planetary orbit calculation.
3. Quantum Mechanics (2nd order ODE, boundary value and eigenvalue problems). Shooting method and Numerov's method, examples of bound states calculation for 1D wells, quantum harmonic oscillators. Eigenvalue problem in matrix form (finite dimensional basis), and exact (Lanczos) diagonalization, Variational calculation with orthogonal basis states. Time-dependent

Schrodinger equation, wave equation.

4. Statistical Mechanics (Stochastic and Monte Carlo Methods). Uniform random number generation, Random walk and diffusion, Monte Carlo Integration -- advantage in higher dimension, error analysis. Importance sampling and detailed balance. Generation of random numbers from a Gaussian distribution-- Box Miller method, using central limit theorem, Sampling points from arbitrary distributions --Metropolis sampling and examples.

Reference Textbooks:

1. Computational Physics, N. J. Giordano and H. Nakanishi, Pearson PrenticeHall (2006)
2. Introduction to Computational Physics, Pao Tang, Cambridge University Press.
3. Computational Physics, S. E. Koonin and D. C. Meredith, Addison-Wesley PublishingCompany.
4. Computational Physics, J. M. Thijssen, Cambridge University Press

PAPER-XIX **SEMESTER – VIII**

CLASSICAL ELECTRODYNAMICS

(Theory : 4 Credits)

CO 1: To understand the covariance formulation of electrodynamics through topics such as Lorentz transformations, Scalars, Vectors, Tensors, and the Inhomogeneous Wave Equation.

CO2: To explore the concepts of Lienard-Wiechert potential and the field of a uniformly moving electron, as well as the propagation of electromagnetic waves in rectangular waveguides.

CO3: To learn about radiation from accelerated charges.

CO4: To comprehend radiation, scattering, and dispersion phenomena in the context of electrodynamics.

UNIT 1

a. Covariant formulation of electrodynamics:

Lorentz transformation; Scalars, vectors and Tensors; Maxwells equations and equations of continuity in terms of Aμ and Jμ; Electromagnetic field tensor and its dual; Covariant form of Maxwell"s equations; Lagrangian for a charged particle in presence of external electromagnetic field and Maxwell's equation as Euler-Lagrange equations.

b. The Inhomogeneous Wave equation:

UNIT –II

a. Lienard-Wiechart potential and Field of a uniformly moving electron: Lienard- Wiechart potential, Fields of a charge in uniform motion, Direct solution of the wave equation, Convectionpotential, Virtual photon concept.

b. Wave guides, Propagation of electromagnetic waves in rectangular wave guides**.**

Wave equations for potentials, solution by Fourier analysis, Radiation field, Radiation energy, Hertz potential, Computation of radiation fields by Hertz method, electric dipole radiation, multipole-radiation.

UNIT –III

Radiation from Accelerated Charges: Radiation from an accelerated charge, Fields of an accelerated charge radiation at low velocity, Case of velocity parallel to acceleration, radiation from circular orbits, Radiation with no restrictions on the acceleration or velocity, Classical cross section for bremsstrahlung in a Coulomb field, Cherenkov radiation.

UNIT –IV

Radiation, scattering and dispersion:

Radiative damping of a charged harmonic oscillator, forced vibrations, scattering by an individual free electron, scattering by a bound electron, absorption of radiation by an oscillator, equilibrium between an oscillator and a radiation field, effect of a volume distribution of scatters, scattering from a volume distribution, Rayleigh scattering, the dispersion relation.

Text Book:

1. "Classical Electricity and Magnetism" by Wolfgang K.H.Panofsky and Melba Philips, Second Edition.

Reference books:

1. "Classical Electrodynamics", Jakson J D, John Wiley.
2. 'Introduction to Electrodynamics", Griffiths DJ, Prentice Hall.

PAPER-XX SEMESTER – VIII

LABORATORY: OPTICS AND MODERN PHYSICS *(4 Credits)*

The main objectives of this laboratory course are:

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2. To gain a better understanding of theoretical principles through hands-on experimentation.

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6. Study the electrical resistance as a function of temperature.
7. Experiments with Michelson interferometer: Determination of A and α Thickness of mica sheet
8. Fabry Perot interferometer Polarization Experiments Babinetcompensator Edsar-Butlerbands Quarter wave plate Mallus Law Study of elliptical polarized light
9. Constant Deviation Spectrography Calibration Zeeman effect
10. Babinet Quartz Spectrography
11. Any other suitable experiments
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