COURSES OF STUDIES

PHYSICS SYLLABUS FOR B.Sc. DEGREE UNDER SEMESTER SYSTEM

UNDER CHOICE BASED CREDIT SYSTEM

SCHOOL OF PHYSICS
GANGADHAR MEHER UNIVERSITY
AMRUTA VIHAR, SAMBALPUR-768004, ODISHA

13th March 2023

VISION

To take the leadership in setting the standard of Physics Education in terms of Teaching and Research in the State and in the Country that will have a transformative impact on society through continual innovation in education, research and creativity.

MISSION

M1 - To make quality education accessible to students.
M2- To maintain high academic standards in teaching and research consistent with global scenario.
M2 - To encourage and facilitate faculty, researchers and students to work synergistically.
M3 - To establish collaboration with other academic and research institutes.

PROGRAMME OUTCOMES

(Chosen from the allowed list as set by UGC)

PO-1: Disciplinary Knowledge: Demonstrate comprehensive knowledge and skills of the disciplines that constitute a programme of study.

PO2-: Communication Skill: Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.

PO-3: Critical Thinking: Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.

PO-4: Problem solving: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.

PO-5: Research related skills: Demonstrate a sense of inquiry and capability for asking relevant questions; ability to recognize cause-and effect relationships, define problems, formulate and test hypotheses, analyze, interpret and draw conclusions from data; plan, execute and report the results of an investigation.

PO-6: Scientific reasoning: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.

PO-7: Multicultural competencies: Possess knowledge of the values and beliefs of multiple
culture and a global perspective; capacity to work effectively in multiple socio-cultural context and interact respectfully with diverse social groups

Po-8: Information/digital literacy: Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.

PROGRAMME OBJECTIVES
(Set by School of Physics)

- Apply theoretical and Experimental knowledge in Physics to solve various problems in physical sciences.
- Develop abilities and skills that encourage research and development activities and are useful in everyday life.
- Impart quality education in physics to students through well designed courses of fundamental interest and of technological importance.
- Develop the skill to plan, execute and report the result of extended experimental and theoretical Physics.

PROGRAMME SPECIFIC OUTCOMES
(Set by School of Physics)

PSO-1: Demonstrate the critical knowledge in Physical Sciences.
PSO-2: Apply theoretical Knowledge of Physics to solve various practical problems.
PSO-3: Interpret various Mathematical techniques and Mathematical models of physical behavior to apply in various ICT based techniques.
PSO-4: Learn to design and conduct an experiment and understand the basic physics behind it.
PSO-5: Develop the proficiency in the handling of laboratory instruments.
PSO-6: Enhance Intellectual, Computational, Experimental and Analytical skills of Physical Science.
PSO-7: Develop aptitude of doing research through undertaking small projects and research centre visit.

Matching

Matching Percentage	Level Indicator
> 70	3
= 60 %	2
< 50%	1

MISSION TO PO MAPPING

	PO-1	PO-2	PO-3	PO-4	PO-5	PO6	PO-7	PO-8
M1	3	3	3	3	3	3	2	3
M2	3	2	3	3	3	2	3	2
M3	3	2	2	3	2	2	2	2
M4	1	2	1	3	1	1	1	2

PSO TO PO MAPPING

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
PSO1	3	3	2	3	3	3
PSO2	1	3	3	2	3	3
PSO3	3	2	2	2	2	3
PSO4	1	2	3	3	3	2
PSO5	2	3	3	2	3	2
PSO6	1	2	2	3	1	1

A Brief Overview of Syllabus

FIRST SEMESTER			
Course No.	**Name of Course**	**Marks**	**Credit**
GE-I (Theory + Practical)	Mechanics	15+25+60	6
CC-I (Theory + Practical)	Mathematical Physics-I	15+25+60	6
CC-II (Theory + Practical)	Mechanics	15+25+60	6
AECC-1	Environmental Studies	20 + 80	4
EV-1 (Ethics and Values)	Issues related to Women	25	1
SECOND SEMESTER			
GE-II (Theory + Practical)	Electricity, Magnetism and EMT	15+25+60	6
CC-III (Theory + Practical)	Electricity and Magnetism	15+25+60	6
CC-IV (Theory + Practical)	Waves and Optics	15+25+60	6
AECC-2	MIL, Communication English/Odia/Hindi)	20 + 80	4
EV-2 (Ethics and Values)	Values and Good Citizenship	25	1
THIRD SEMESTER			
GE-III (Theory + Practical)	Thermal Physics and Statistical Mechanics	15+25+60	6
CC-V (Theory + Practical)	Mathematical Physics-II	15+25+60	6
CC-VI (Theory + Practical)	Thermal Physics	15+25+60	6
CC- VII (Theory + Practical)	Analog Systems and Applications	20 + 80	4
SEC-1	Communicative English	20 + 80	4
EV-3 (Ethics and Values)	Issues of Drug, Tobacco and Alcohol Addiction	25	1

FOURTH SEMESTER			
GE-IV (Theory + Practical)	Waves and Optics	15+25+60	6
CC-VIII (Theory + Practical)	Mathematical Physics-III	15+25+60	6
CC-IX (Theory + Practical)	Elements of Modern Physics	15+25+60	6
CC-X (Theory + Practical)	Digital Systems and Applications	15+25+60	6
SECC -2	Skill Enhancement Compulsory Course -2	20 + 80	4
EV-4 (Ethics and Values)	Ethical Values for students life	25	1
FIFTH SEMESTER			
DSE-I (Theory + Practical)	Classical Dynamics	15+25+60	6
DSE-II (Theory + Practical)	Nuclear and Particle Physics	15+25+60	6
CC-XI (Theory + Practical)	Quantum Mechanics and Applications	15+25+60	6
CC-XII (Theory + Practical)	Solid State Physics	15+25+60	6
EV-5 (Ethics and Values)	Vulnerable section of society: Understanding their issues	25	1

SIXTH SEMESTER			
DSE-III (Theory + Practical)	Nano Materials and Applications	15+25+60	6
DSE-IV	Basic Instrumentation	15+25+60	6
	PROJECT	100	6
CC-XIII (Theory + Practical)	Electro-magnetic Theory	15+25+60	6
CC-XIV (Theory + Practical)	Statistical Mechanics	15+25+60	6
EV-6 (Ethics and Values)	Environmental and Techno Ethics	25	1
		Total Marks=2750	**Total Credit=154**

RELEVANCE TO THE LOCAL, NATIONAL, REGIONAL AND GLOBAL DEVELOPMENTAL NEEDS

The contents incorporated in all the courses of the syllabus are relevant to **global developmental needs**.

Continuous Assessment	**Practical**	**End semester Assessment**
Mid Term -		

EVALUATION SCHEME

Mid term – Evaluation will be conducted by the course instructor. The mid term question, to be set by the course instructor, will contain 10 compulsory Multiple choice questions with 4 questions each carrying 2.5 Marks.

Practical – ***(i) Continuous assessment (5 marks)***

Student will perform the assigned experiments/innovative project in the predefined slots to be allotted in time table. There will be weekly evaluation for each experiment.

(ii) End semester Assessment (20 Marks)

Students need to perform an experiment from the list as allotted during continuous assessment by lucky draw basis. There will be evaluation **(out of 12 marks)** on the basis of the experiments conducted, innovative learning, capability of experimentation and a viva-voce **(out of 8 marks)** by external expert as allotted examination section.

End term – 8 compulsory multiple choice questions, 8 questions each carrying 1.5 marks (2 questions are compulsory from each unit), 8 questions each carrying 2marks (2 questions are compulsory from each unit), 4 questions each carrying 6 marks (1 question is compulsory from each unit),
4 questions each carrying 6 marks)

FIRST SEMESTER

GENERIC ELECTIVE -1

Course Name- MECHANICS

Course Objective: Understand mechanical properties of matter, various types of oscillatory system, heat-transfer mechanism and theory of electricity-magnetism.

Prerequisites: *Knowledge of differential equation, kinematics and dynamics of Physics, Electrostatic, magnetostatic and laws of thermodyanamics*

Syllabus

UNIT	Content	Hours
I	**UNIT-I** **Rotational Dynamics:** Centre of Mass, Motion of CM , 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 frames and fictitious Forces: Uniformly Rotating frame, laws of Physics in rotating Coordinate system, centrifugal Forces, Coriolis force and its applications.	10
II	**Gravitation:** Newton's Law of gravitation. Gravitational field Intensity and Potential, . Potential and field Applications. Central Force: 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). Physiological effects on astronauts.	10
III	**Elasticity:** Relation between Elastic constants. Torsion of a right circular cylinder, torsional wire, Bending of Beams, External Bending Moment, flextural rigidity, single Cantilever, double cantilever(weightless cantilever, and with its own weight) **Fluid Properties:** Surface Tension- Express Pressure across a curved membrane, S.T., Quincke's drop, gravity waves and ripple, Viscocity: Poiseuille's Equation for Flow of a Liquid with corrections.	10
IV	**Oscillations:** Simple Harmonic Oscillations. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Equation of motion and solution, (cases of oscillatory, critically damped and over damped) Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality	10

	Factor. Bar Pendulum, Kater's Pendulum. Composition of two SHMs propagating perpendicularly to each other (with frequency in the ratio 1:1, 2:1) Lissajous figures	

Text Books:

1. Mechanics, D.S. Mathur (S. Chand Publishing)-2010
2. Introduction to Special Relativity-R. Resnick (John Wiley)-2007

Reference books:

1. Mechanics, Berkeley Physics, vol.1, C.Kittel, W. Knight, etal (Tata McGraw-Hill)-2017
2. Physics, Resnick- Halliday and Walker (8/e. 2008,Wiley)
3. Schaum's outline of theoretical Mechanics-M.R. Spiegel (Tata McGraw Hill)-1980
4. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands (Pearson)-2012
5. Mechanics-M.Das, P.K.Jena and R.N. Mishra (Srikrishna Publications)

Course Outcomes

CO1: Understand the rotational properties like angular momentum, moment of inertia in various coordinate systems.
CO2: Apply the laws of gravity for satellite systems.
CO3: Apply theory of Elasticity to determine various properties of matter
CO4: Differentiate various oscillating systems like simple harmonic, damped and forced oscillations.

CO-PO Mapping (GE-I)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3
CO2	3	2	3	2	3	1	1	2
CO3	2	3	3	2	2	2	2	1
CO4	2	2	3	1	3	2	2	1

Programme articulation matrix row for GE-I

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course GE-I	3	2	3	2	3	2	2	2

CO-PSO Mapping (GE-I)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3
CO2	3	2	3	2	2	2	2
CO3	3	3	3	3	2	2	2
CO4	2	3	3	2	3	3	2

Generic Elective Paper I Lab

Course Objective

Able to know the practical methods to determine the physical parameters like elastic constants, rigidity of modulous, moment of inertia, gravitational acceleration etc.

Prerequisites: Knowledge of using slide caliper, screw gauge, electrical bridges.

(Minimum 6 experiments are to be done)

1. To determine the moment of inertia of a fly wheel.
2. To determine the Young's modulus Y of a wire by Searl's method.
3. To determine the modulus of rigidity of a wire by Maxwell'sneedle/Torsion Pendulum (Dynamic method).
4. To determine g by bar pendulum.
5. To determine the value of Y of a rubber by using travelling microscope.
6. To determine the Rigidity of modulus by static method.
7. To determine the frequency of a telescope by using Sonometer.
8. Verification of Laws of Vibration of a string by using Sonometer.
9. To compare capacitances using De Sauty bridge.
10. To determine the Law of resistance by using Foster bridge.
11. Compare the specific heat of two liquids by method of Cooling.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flintand H.T.Worsnop, 1971,Asia Publishing House
2. A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal (1985), Vani Publication
3. A Text Books of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition (2011), KitabMahal, NewDelhi

COURSE OUTCOME

CO1: Learn to find various physical parameters of substances moment of inertia, Young's modulous, specific heat, gravitational acceleration etc. by physics experiments.

CO2: Verify various physics laws like laws of vibration, Law of resistance etc experimentally.

CO-PO Mapping (GE-I-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3
CO2	3	2	3	2	3	1	1	2

Programme articulation matrix row for GE-I-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course GE-I-P	3	2	3	2	3	2	2	2

CO-PSO Mapping (GE-I-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3
CO2	3	2	3	2	2	2	2

Core Course Paper -I

Course Name- Mathematical Physics-1

Course Objective: Can able to solve differential equation and vector integrals in various problems of Physics

Prerequisites: *Elementary idea of differentiation, integration, vectors and their dot and cross products*

Syllabus

UNIT	Content	Hours
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.	10
II	**Calculus-II:** Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration, Constrained Maximization using Lagrange Multipliers, **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.	10
III	**Orthogonal Curvilinear Coordinates:** Orthogonal Curvilinear Coordinates, Derivation of Gradient, Divergence, Curl and Laplacian in	10

	Cartesian, Spherical and Cylindrical Coordinate Systems, Comparison of velocity and acceleration in cylindrical and spherical coordinate system **Dirac Delta function and its properties:** Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular Function, Properties of Dirac delta function.	
IV	**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 Vector Integration: Ordinary Integrals of Vectors, Multiple integrals, Jacobian, Notion of infinitesimal line, surface and volume elements, Line, surface and volume integrals of Vector fields, Flux of a vector field, Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs)	10

Text Books:

1. MathematicalMethodsforPhysicists,G.B.Arfken,H.J.Weber,F.E.Harris (2013,7th Edition., Elsevier)
2. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India) , 2008

Reference books:

1. Mathematical Physics C. Harper (Prentice Hall India), 2006
2. Complex Variable: Schaum's Outlines Series M. Spiegel (2nd Edition , McGraw Hill Education)
3. Complex variables and applications, J. W. Brown and R.V.Churchill Mathematical Physics, Satya Prakash (Sultan Chand)
4. Mathematical Physics, B. D. Gupta (4th edition, Vikas Publication), 2009
5. Mathematical Physics and Special Relativity, M. Das, P.K. Jena and B.K.Dash (SrikrishnaPrakashan),2009 6. Mathematical Physics–H.K.Dass, Dr. Rama Verma (S. Chand Publishing) , 2011

Course Outcomes

CO1: Understand the mathematical methods to solve the 1st and 2nd order linear differential equations.
CO2: Understand the methods to solve exact differentials and to optimize a multivariable function.
CO3: Apply vector algebra to scalar and vector triple products and vector rotations.
CO4: Determine various vector derivatives associated with related physical quantities in various coordinate system (Cartesian, Spherical-polar and cylindrical).
CO5: Apply vector differentiation (grad, div and curl) for evaluation of line, surface and volume integral of scalar and vector fields.

CO-PO Mapping (CC-I)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	2	1	1	2	1	2	3
CO2	3	1	3	2	2	1	2	2
CO3	2	3	3	3	2	2	1	1
CO4	2	2	3	2	3	2	2	1
CO5	2	2	3	2	3	2	2	1

Programme articulation matrix row for CC-I

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-I	3	2	3	2	3	2	2	2

CO-PSO Mapping (CC-I)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3
CO2	3	2	3	2	2	2	2
CO3	3	3	3	3	2	2	2
CO4	2	3	3	2	3	3	2
CO 5	2	3	3	2	3	3	2

CORE PAPER I LAB

SCi-Lab

Course Objective

The students will learn computational methods i.e. programming to formulate problems in Physics and to solve them.

Pre-requisites: Knowledge of operating system like Microsoft and LINUX.

SYLLABUS

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

Basics of scientific computing: Binary and decimal arithmetic, Floating pointnumbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow and overflow emphasize the importance of making equations in terms of dimension less variables, Iterative methods. Algorithm

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

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

Programs: Sum and average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search, **Random number generation:** Area of circle, area of square, volume of sphere, value of π and applications in physics lab.

Reference Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edition., 2012, PHI Learning Pvt. Ltd.
2. Schaum's Outline of Programming with C++.J.Hubbard,2000, McGraw– Hill Pub.
3. Numerical Recipes in C:The Art of Scientific Computing, W.H. Pressetal, 3rd Edition. 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 Dover Pub.
7. An Introduction to computational Physics,T.Pang, 2nd Edn., 2006, Cambridge Univ. Press.

COURSE OUTCOMES

CO1: Highlights the use of computational methods to solve physical problems
CO2: Formulate computational problem through computer programming.

CO-PO Mapping (CC-I-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	3	3	3	3	3
CO2	3	2	3	2	3	2	2	2

Programme articulation matrix row for CC-I-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-I-P	3	3	3	3	3	3	3	3

CO-PSO Mapping (CC-I-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7

CO1	3	3	3	3	3	3	3
CO2	3	2	3	2	2	2	2

Core Course Paper -II

Course Name- MECHANICS

Course Objective: learn the basic concepts involving translational motion, circular motion, rotational motion, oscillatory motion and motion of fluids, concepts of special theory of relativity and its effect on motion of bodies when observed in different frames of references.

Prerequisites: *Elementary idea of differentiation, Vectors, kinematics, dynamics, idea of vibration.*

Syllabus

UNIT	Content	Hours
I	**Rotational Dynamics:** Centre of Mass, Motion of CoM, Centre of Mass and Laboratory frames, Angular momentum of a particle and system of particles, Principle of conservation of angular momentum, Rotation about a fixed axis, Moment of Inertia, Perpendicular and Parallel Axis Theorems, Routh Rule, Calculation of moment of inertia for cylindrical and spherical bodies, Kinetic energy of rotation, Eulers Equations of Rigid Body motion, Motion involving both translation and rotation. Moment of Inertia of a Fly wheel. **Non-Inertial Systems:** Non-inertial frames and fictitious forces, Uniformly rotating frame, Laws of Physics in rotating coordinate systems, Centrifugal force, Coriolis force and its applications.	10
II	**Elasticity:** Relation between Elastic constants, Twisting torque on a Cylinder or Wire, Bending of beams, External bending moment, Flexural rigidity, Single and double cantilever Surface Tension: Excess pressure across a curved membrane, Quink's drop **Fluid Motion:** Kinematics of Moving Fluids: Poiseuilles Equation for Flow of a Liquid through a Capillary Tube, Surface tension, Gravity waves and ripple Viscocity: Poiseuilles Equation for Flow of a Liquid with corrections.	10
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'sLaws of Planetary motion, **Satellites:** Geosynchronous orbits, Weightlessness, Basic idea of global positioning system (GPS), Physiological effects on astronauts.	10
IV	**Oscillations:** Simple Harmonic Oscillations. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation.	10

	Equation of motion and solution (cases of oscillatory, critically damped and over damped) **Forced oscillations:** Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor, Bar Pendulum, Katers Pendulum **Special Theory of Relativity**: Michelson-Morley Experiment and its 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, PS Hemne (S. Chand Publishing) ,2012
2. Introduction to Special Relativity, R. Resnick (John Wiley), 2007

Reference Books:

1. Introduction to Mechanics Daniel Klapnner and Robert Kolenkow, McgrawHill.2007
2. Mechanics by K.R Simon, 1971
3. Mechanics, Berkeley Physics, vol.1, C.Kittel, W. Knight, etal (Tata McGrawHill), 2007
4. Physics, Resnick, Halliday and Walker (8/e.2010,Wiley)
5. Theoretical Mechanics-M.R. Spiegel (Tata McGraw Hill), 2017
6. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands (Pearson),2012
7. Mechanics-M.Das, P.K.Jena and R.N. Mishra (Srikrishna Publications), 2009

Course Outcomes

CO1: Understand the mechanics of inertial and non-inertial Physical systems.
CO2: Interpret the properties of matter to quantify various physical properties of elastic bodies also for fluid systems.
CO3: Apply laws of gravitation for various satellite systems.
CO4: Differentiate various types of oscillations.
CO5: Develop understanding of special theory of relativity and its applications.

CO-PO Mapping (CC-II)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	2	2	2	2	2	3	3
CO2	3	2	3	2	1	1	2	1
CO3	2	3	3	3	2	2	1	1
CO4	2	2	3	2	3	2	2	1
CO5	2	2	3	2	3	2	2	1

Programme articulation matrix row for CC-II

	PO-	PO-	PO-	PO-	PO-	PO-	PO-	PO-

	1	2	3	4	5	6	7	8
Course CC-II	3	2	3	2	3	2	3	2

CO-PSO Mapping (CC-II)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3
CO2	3	2	3	2	2	2	2
CO3	3	3	3	3	2	2	2
CO4	2	3	3	2	3	3	2
CO5	2	3	3	1	3	3	1

CORE PAPER-II LAB
MECHANICS PRACTICAL

Course Objective: learn different techniques to determine some physical quantities associated with mechanical properties of materials like surface tension, coefficient of viscosity of any liquid, moment of inertia of an object, spring constant, elastic constants, gravitational acceleration etc.
Learning Outcome.

Pre-requisites: Use of slide caliper, screw-gauge and basic idea of compound pendulums.

(Minimum 5 experiments are to be done):

1. To study surface tension by capillary rise method
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuilles method).
6. To determine the Modulus of Rigidity of a Wire by Maxwells 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 Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash and Ramakrishna, 11thEdn, 2011, KitabMahal

COURSE OUTCOMES

CO1: Learn to find various physical parameters of substances moment of inertia, Young's modulous, gravitational acceleration etc. by physics experiments.
CO2: Compare the experimental value of acceleration due to gravity, moment of inertia with standard values.

CO-PO Mapping (CC-II-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	3	3	3	3	3
CO2	3	2	3	2	3	2	2	2

Programme articulation matrix row for CC-II-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-II-P	3	3	3	3	3	3	3	3

CO-PSO Mapping (CC-II-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3
CO2	3	2	3	2	2	2	2

SECOND SEMESTER

GENERIC ELECTIVE -II

Course Name- ELECTRICITY, MAGNETISM AND EMT

Course Objective: To Learn the theory of electricity-magnetism and to apply in various electromagnetic system.

Prerequisites: *Knowledge of Vector differentiation and integration, electrostatic and magnetostatic.*

Syllabus

UNIT	Content	Hours
I	**UNIT-I** **Vector Analysis:** Scalar and Vector product, gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only). **Electrostatics:** Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential.	10
II	Electrostatic Energy Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.	10
III	**Magnetostatics:** Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia, para-and ferromagnetic materials. **Electromagnetic Induction:** Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of	10

	two coils. Energy stored in magnetic field.	
IV	**Maxwell`s equations and Electromagnetic wave propagation:** Equation of continuity Of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.	10

Text Books:

1. Introduction to Electricity and Magnetism – D.C.Tayal (Himalaya Publishing house)-2014
4. Electricity and magnetism- R. Murugeshan (S.Chand publishing)-2017
5.

Reference books:

1. Electricity, Magnetism & Electromagnetic Theory- S. Mahajan and Choudhury (Tata McGraw Hill)-2017
2. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands (Pearson)-2012
3. Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I (Oxford Univ. Press)-2016
4. Foundations of Electromagnetic Theory-Ritz and Milford (Pearson)-2008

Course Outcomes

CO1: Understand the mathematical methods of vector differentiation and vector integrations.
CO2: Interpret the theory of electrostatic for dielectrics to be used in capacitors
CO3: Apply theory of magneto-static for electromagnetic induction
CO4: Design the Maxwell’s electrodynamics equation for electromagnetic wave propagation.

CO-PO Mapping (GE-II)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	2	2	3	3
CO2	3	3	3	3	3	2	1	2
CO3	2	3	3	2	2	2	2	2
CO4	2	2	3	2	3	1	2	1

Programme articulation matrix row for GE-II

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course GE-II	3	3	3	3	3	2	3	3

CO-PSO Mapping (GE-II)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	2	3	2	3

CO2	3	3	3	2	2	2	2
CO3	3	3	2	3	1	2	1
CO4	2	3	3	1	3	3	2

GENERIC ELECTIVE –II-PRACTICAL

Course Name- ELECTRICITY, MAGNETISM AND EMT PRACTICAL

Course Objective: Learn the experimental procedures associated with determination of electrical components through various electrical bridges.

Pre-Requisites: Knowledge of using potentiometer, wheatstone's bridge.

SYLLABUS

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

Reference Books:

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

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

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

COURSE OUTCOME

CO1: Apply theory of electricity and magnetism to operate various electrical bridges and potentiometer.

CO-PO Mapping (GE-II-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for GE-II-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course GE-II-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (GE-II-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

Core Course Paper -III
Course Name- ELECTRICITY AND MAGNETISM

Course Objective: To Learn the theory of electricity-magnetism and to apply in various electromagnetic system.
Prerequisites: *Knowledge of Vector differentiation and integration, electrostatic and magnetostatic.*

Syllabus

UNIT	Content	Hours
I	**Electric Field and Electric Potential Electric field:** Electric field lines, Electric flux, Gauss Law with applications to charge distributions with spherical, cylindrical and planar symmetry, Conservative nature of Electrostatic Field. Electrostatic Potential, Potential and Electric Field of a dipole, Force and Torque on a dipole placed in electric field, Potential calculation indifferent simple cases, Laplace and Poisson's equations, The Uniqueness Theorem, Method of Images and its application to (1) Plane Infinite Sheet and (2) Sphere. Electrostatic energy of system of	10

	charges, Electrostatic energy of a charged sphere, Conductors in an electrostatic Field, Surface charge and force on a conductor.	
II	**Magnetic Field:** Magnetic Force, Lorentz Force, BiotSavarts Law, Current 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 B:** curl and divergence, Vector Potential, **Ballistic Galvanometer:** Torque on a current Loop, Current and Charge Sensitivity, Electromagnetic damping, Logarithmic damping, CDR.	10
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, Lenzs Law, Self Inductance and Mutual Inductance, Reciprocity Theorem, Energy stored in a Magnetic Field, Introduction to Maxwell's Equations	10
IV	**Electrical Circuits:** AC Circuits: Kirchhoff's laws for AC circuits, Complex Reactance and Impedance, Series LCR Circuit: (1) Resonance (2) Power Dissipation (3) Quality Factor, (4) Band Width, Parallel LCR Circuit. Network theorems: Ideal Constant-voltage and Constant-current Sources, **Network Theorems:** Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem, Applications to DC and AC circuits. Transient Currents Growth and decay of current in RC and LR circuits.	10

Text Books:

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

Reference Books:

1. Classical Electrodynamics, J. D. Jackson (Wiley), 1998
2. Electricity and Magnetism D. C. Tayal (Himalaya Publishing house), 2014
3. Electricity, Magnetism and Electromagnetic Theory- S. Mahajan and Choudhury (Tata McGraw Hill)-2012
4. Feynman Lectures Vol.2, R. P. Feynman, R. B. Leighton, M. Sands (Pearson)-2008
5. Electricity and Magnetism, J. H. Fewkes and J. Yarwood. Vol. I (Oxford Univ. Press)

Course Outcomes

CO1: understand the basic concepts of electric and magnetic fields.
CO2: Apply theory of magnetism for working of Ballistic galvanometer
CO3: Analyze the electromagnetic induction principles for various applications
CO4: Design various electrical networks by the principle of network theorems.

CO-PO Mapping (CC-III)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	2	2	2	3	2	2	2
CO2	3	2	3	1	2	2	3	2
CO3	2	3	2	2	3	2	1	1
CO4	2	1	2	1	2	2	2	1

Programme articulation matrix row for CC-III

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-III	3	3	3	2	3	2	3	2

CO-PSO Mapping (CC-III)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3
CO2	3	2	3	2	2	2	2
CO3	3	3	3	3	2	2	2
CO4	2	3	3	2	3	3	2

CORE PAPER III LAB
ELECTRICITY AND MAGNETISM PRACTICAL

Course Objective

know the working of different bridge circuits and resonance circuits to determine unknown quantities like resistance, current/ voltage, inductance, capacitance etc.

Pre-requisites: Knowledge of using potentiometer, wheatstone's bridge.

SYLLABUS

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. And compare capacitances using DeSautysbridge.
5. Measurement of field strength B and its variation in a solenoid/ artificial coil (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) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
9. To study the response curve of a parallel LCR circuit and determine its (a) Antiresonance frequency and (b) Quality factor Q.

Reference Books:

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

COURSE OUTCOME

CO1: Apply theory of electricity and magnetism to operate various electrical bridges and potentiometer.

CO-PO Mapping (CC-III-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for CC-III-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-III-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (CC-III-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

Core Course Paper -IV

Course Name- WAVES AND OPTICS

Course Objective: Learn the optical phenomena like reflection, refraction, diffraction, interference and polarization occurring in their surrounding

Prerequisites: *Knowledge of laws of reflection, refraction, Huygen's theory of wave optics.*

Syllabus

UNIT	Content	Hours
I	**Geometrical Optics:** Fermats principle, reflection and refraction at plane interface,Matrix formulation of geometrical Optics, Cardinal points and Cardinal planes of an optical system, Idea of dispersion, Application to thick Lens and thin Lens, Ramsdenand Huygens eyepiece. **Wave Optics:** Electromagnetic nature of light. Definition andproperties of wave front, Huygens Principle. Temporal and Spatial Coherence.	10
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 Transport, Intensity of Wave. Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods, Lissajous Figures (1:1 and 1:2) and their uses, Superposition ofN harmonic waves.	10
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 equalinclination (Haidinger Fringes), Fringes of equal thickness (Fizeau Fringes), **Newton's Rings:** Measurement of wavelength and refractive index. **Interferometer :**MichelsonsInterferometer-(1) Idea of form of fringes (No theory required), (2) Determination ofWavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility ofFringes, Fabry-Perot interferometer.	10
IV	**Fraunhofer diffraction:** Single slit, Circular aperture, Resolving Power of atelescope, Double slit, Multiple slits, Diffraction grating, Resolving power of grating.Fresnel Diffraction: Fresnels Assumptions, Fresnels Half-Period Zones for Plane Wave, Explanation of Rectilinear Propagation of Light. **Theory of a Zone Plate**: Multiple Foci of a Zone Plate, Fresnels Integral, Fresnel diffraction pattern of astraight edge, as lit and a wire.	10

Text Books:

1. OpticsP.K.Chakrabarty, New Central Agency 3rd Edition 2012
2. Optics - AjoyGhatak (McGraw Hill)- 2017

Reference Books:

1. Optics-E.Hecht (Pearson)-2008
2. Fundamentals of Optics- F.A. Jenkins and H.E.White (McGraw-Hill)-2017
3. Geometrical and Physical Optics R.S. Longhurst (Orient Black swan)-1986
4. A text book of Optics N. Subrahmanyam and BrijLal (S.Chand Publishing), 2006
5. The Physics of Vibrations and Waves- H.J. Pain (JohnWiley)-2013
6. Principles of Optics- Max Born and Emil Wolf(Pergamon Press) 7th Edition 1999
7. The Physics of Waves and Oscillations-N.K.Bajaj (McGraw Hill)-1998

Course Outcomes

CO1: Understand the laws associated with geometrical and wave optics.
CO2: Understand the Physics associated with various wave motions.
CO3: Apply the coherent superposition for various interferometer.
CO4: Differentiate Fresnel and Franhoffer diffraction

CO-PO Mapping (CC-IV)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	2	3	3	2	2	1
CO2	3	3	2	2	2	1	2	2
CO3	3	2	2	2	2	2	2	2
CO4	2	1	2	1	2	2	2	1

Programme articulation matrix row for CC-IV

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-IV	3	3	2	3	3	2	2	2

CO-PSO Mapping (CC-IV)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3
CO2	3	2	3	2	2	2	2
CO3	3	3	3	3	2	2	2
CO4	2	3	3	2	3	3	2

CORE PAPER-IV PRACTICAL

WAVES AND OPTICS PRACTICAL

Course Objective

To learn the technique to determine optical parameters like refractive index, dispersive power of prism, wavelength of different light sources etc. using plane diffraction gratings.

Pre-requisites

Knowledge of using screw gauge, focal length of lens, dispersion through prism.

(Minimum 5 experiments are to be done)

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

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, 11thEd., 2011, KitabMahal
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

COURSE OUTCOMES

CO1: Determine wavelength of monochromatic light by various interference systems and diffracting devices.

CO-PO Mapping (CC-IV-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for CC-IV-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-IV-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (CC-IV-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

THIRD SEMESTER

GENERIC ELECTIVE -III

Course Name- THERMAL PHYSICS AND STATISTICAL MECHANICS

Course Objective: Learn the basic phenomena in Physics related to heat, temperature and thermodynamic systems and the physical parameters associated with thermodynamic behavior of a system like entropy, internal energy, enthalpy, free energy etc. and the equations governing them.

Prerequisites: *Knowledge of Laws of thermodynamics, concept of heat, temperature.*

Syllabus

UNIT	Content	Hours
I	**Laws of Thermodynamics:** Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law and Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero. **Thermodynamical Potentials:** Enthalpy, Gibbs, Helmholtz and Internal Energyfunctions, Maxwell's relations and applications - Joule-Thomson Effect, Clausius- Clapeyron Equation, Expression for ($C_P - C_V$), C_P/C_V, TdS equations.	10
II	**Kinetic Theory of Gases:** Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.	10
III	**Theory of Radiation:** Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.	10
IV	**Classical Statistical Mechanics:** Macrostate & Microstate, Elementary Concept of Ensemble, Microcanonical, Canonical and grand canonical ensemble. Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox.	10

Text Books:

1. Thermal Physics, A. B. Gupta (Books and allied Ltd)-2010
2. Theory and experiments on thermal Physics, P.K.Chakrabarty (New central book agency limited)-2011

Reference books:

1. Thermal and Statistical Physics – M.Das, P.K. Jena, S. Mishra, R.N.Mishra (Shri Krishna Publication)
2. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman (McGraw-Hill)-2017
3. Thermal Physics, S. Garg, R. Bansal and Ghosh-(Tata McGraw-Hill)-2017
4. Thermodynamics, Kinetic Theory & Statistical Thermodynamics- Sears & Salinger (Narosa)-1998
5. A Treatise on Heat- Meghnad Saha and B.N.Srivastava (The Indian Press)-1973
6. Heat, Thermodynamics and Statistical Physics-- N.Subrahmanyam and Brij Lal (S.Chand Publishing)-2008

Course Outcomes

CO1: Understand the laws of thermodynamics and principles of free energy; describe thermodynamic processes and heat engines and master the use of the chemical potential to describe diffusive equilibrium, phase equilibrium and chemical processes.
CO2: Understand the kinetic theory of gases and behaviour of real gaseous systems.
CO3: Determine the energy distribution using the theory of radiation.
CO4: Correlate thermodynamic functions in various ensembles.

CO-PO Mapping (GE-III)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	2	3	3	3	3	2	2
CO2	3	3	2	2	2	2	2	2
CO3	2	3	3	3	3	3	2	2
CO4	2	2	3	2	2	2	1	1

Programme articulation matrix row for GE-III

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course GE-III	3	3	3	3	3	2	2	2

CO-PSO Mapping (GE-III)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	2	2	2	2	2	2
CO3	2	3	3	3	2	2	2
CO4	2	3	3	2	3	2	1

GENERIC ELECTIVE –III-PRACTICAL

Course Name- Thermal Physics and Statistical Mechanics Practrical

Course Objective: learn the experimental techniques to determine some universal constants like mechanical equivalent of heat, thermal properties of materials like thermal conductivity, specific heat, temperature co-efficient of resistance of different materials.

Pre-Requisites: Knowledge of Newton's law of cooling, knowledge of conversion of temperature to various scales (units).

SYLLABUS

(Any five experiments to be conducted)

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

Reference Books:

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

COURSE OUTCOME

CO1: Demonstrate the experiments associated with laws of thermodynamics.

CO-PO Mapping (GE-III-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for GE-III-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course GE-III-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (GE-III-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

Core Course Paper -V

Course Name- MATHEMATICAL PHYSICS-II

Course Objective: Learn problem solving in Physics by understanding the concepts of Fourier series and to solve ordinary differential equations using standard procedures like separation of variables, series expansion (Fourier-type series)

Pre-requisites: *Knowledge of solving differential equations, basic integrations.*

Syllabus

UNIT	Content	Hours
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.	10
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: Legendre and Hermite Differential Equations, Legendre and Hermite Polynomials: Rodrigue's Formula, Generating Function, Orthogonality.	10
III	**Polynomials:** Simple recurrence relations of Legendre and Hermite Polynomials, Expansion of function in a series of Legendre Polynomials, Associated Legendre Differential Equation, Associated Legendre polynomials, Spherical Harmonics **Some Special Integrals:** Beta and Gamma Functions and relation between them, Expression of Integrals in terms of Gamma Functions, Error Function (Probability Integral).	10
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	10

Text Books:

1. MathematicalMethodsforPhysicists,G.B.Arfken,H.J.Weber,F.E.Harris(2013, 7th Edn., Elsevier)
2. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India) 9th Edition2011
3. Mathematical Physics–H. K. Dass (S. Chand Publishing) -2011

Reference Books:

1. Mathematical Physics C. Harper (Prentice Hall India)-1978
2. Schaum's Outlines Series M. Spiegel (2nd Edition, McGraw Hill Education)-2004
3. Complex variables and applications J.W.Brown and R.V.Churchill-2017
4. Mathematical Physics, Satya Prakash (Sultan Chand)-2014
5. Mathematical Physics B.D. Gupta (4th edition, Vikas Publication-2009
6. Mathematical Physics and Special Relativity, M. Das, P.K. Jena andB.K. Dash (SrikrishnaPrakashan)-2009

Course Outcomes

CO1: Understand the Fourier series expansion of periodic and nonperiodic functions and their importance.
CO2: Solve ordinary second order differential equations using Frobenius Method
CO3: Differentiate the various types of polynomials (Legendre and hermite) in various problems of Physics.
CO4: Solve partial differential equations using separation of variables

CO-PO Mapping (CC-V)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	3	3	3	2	2
CO2	3	3	2	2	2	2	2	2
CO3	3	2	3	3	2	2	2	2
CO4	2	2	2	2	2	2	2	2

Programme articulation matrix row for CC-V

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-V	3	3	2	3	3	2	2	2

CO-PSO Mapping (CC-V)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	2	2	3	2	2	3
CO3	2	3	2	2	2	2	2
CO4	2	2	2	2	2	3	2

Core Course Paper –V-PRACTICAL

Course Name- Mathematical Physics- II Practical (Sci Lab)

Course Objective: Learn computational techniques to solve physical problems and to measure physical quantities e.g. Ohm's law, Hooke's law etc.

Pre-Requisites: Knowledge of using C-programming, FORTRAN, Curve plotting.

SYLLABUS

(Any five experiments to be conducted)

Topics

Introduction to Numerical computation software Scilab: Introduction to Scilab, Advantages and disadvantages, Scilab computation software Sci lab 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 whileloop, for loop, details of loop operations, break and continue statements, nested loops, logical arrays and vectorization (2) User defined functions, Introduction to Sci labfunctions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multi dimensional arrays (2) an introduction to Scilab file processing, file opening and closing, BinaryI/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, Hooke's law to calculate spring constant**Solution of Linear system of equations by Gauss elimination Solutionmethod and Gauss Seidal method. Diagonalization matrices, Inverse of amatrix, Eigen vectors, problems:** Solution of mesh equations of electriccircuits(3meshes),Solution of coupled spring mass systems (3masses)

Solution of ODE :First order Differential equation Euler, modified Euler, Runge-Kutta

methods, Second order differential equation. Fixed difference method:First order differential equations, Radioactive decayCurrent in RC and LC circuits with DC sourceNewton's law of cooling**,** Classical equations of motion

Second order Differential Equation

- Harmonic oscillator (no friction)
- Damped Harmonic oscillator
- Over damped
- Critical damped

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

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.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 analys is with applications, D.G.Zill andP.D.Shanahan, 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.Fernndez. 2014 Springer
5. Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
6. Scilab (A free software to Matlab):H.Ramchandran,A.S.Nair.2011S.Chand and Company
7. Scilab Image Processing: Lambert M. Surhone. 2010 Beta script Publishing

COURSE OUTCOME

CO1: Learn the methods of curve fitting, least square fit and standard constant deviation to find physical quantities from various laws like resistance from Ohm's law, spring constant from Hooke's law and computational technique to find solutions of linear equations, first order and second order differential equations used to describe different physical phenomena

CO-PO Mapping (CC-V-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for CC-V-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-V-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (CC-V-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

Core Course Paper -VI
Course Name- THERMAL PHYSICS

Course Objective: Learn the basic phenomena in Physics related to heat, temperature and thermodynamic systems and the physical parameters associated with thermodynamic behavior of a system like entropy, internal energy, enthalpy, free energy etc. and the equations governing them.

Prerequisites: *Knowledge of Laws of thermodynamics, concept of heat, temperature.*

Syllabus

UNIT	Content	Hours
I	**Introduction to Thermodynamics** Recapitulation of Zeroth and First law ofthermodynamics, **Second Law of Thermodynamics:** Reversible and Irreversible process with examples, Kelvin-Planck and Clausius Statements and their Equivalence, Carnots Theorem, Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. **Entropy:** Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Lawof Thermodynamics in terms of Entropy, Entropy of a perfect gas, Principle ofincrease of Entropy, Entropy Changes in Reversible and Irreversible processes withexamples, Entropy of the Principle of Increase of Entropy, Temperature Entropydiagrams for Carnot's Cycle, Third Law of Thermodynamics, Unattainability ofAbsolute Zero.	10
II	**Thermodynamic Potentials:** Extensive and Intensive Thermodynamic Variables, **Thermodynamic Potentials:** Internal Energy, Enthalpy, Helmholtz Free Energy,Gibbs Free Energy, Their Definitions, Properties and Applications, Surface Filmsand Variation of Surface Tension with Temperature, Magnetic Work, Coolingdue to adiabatic demagnetization **Phase Transitions:** First and second order Phase Transitions with examples, ClausiusClapeyron Equation and Ehrenfest equations **Maxwell's Thermodynamic Relations:** Derivations and applications of Maxwell'sRelations, Maxwell's Relations: (1) ClausiusClapeyron equation (2) Relationbetween *Cp*and *Cv*(3) TdS Equations,(4)Joule-Kelvin coefficient for Ideal andVan der Waal Gases (5) Energy equations (6) Change of Temperature during AdiabaticProcess.	10
III	**Kinetic Theory of Gases** **Distribution of Velocities:** Maxwell-Boltzmann Law of Distribution of Velocities inan Ideal Gas and its Experimental Verification, Sterns Experiment, Mean, RMS andMost Probable Speeds, Degrees of	10

	Freedom, Law of Equipartition of Energy (Noproof required), Specific heats of Gases. **Molecular Collisions:** Mean Free Path, Collision Probability, Estimates of MeanFree Path, **Transport Phenomenon in Ideal Gases:** (1) Viscosity, (2) ThermalConductivity and (3) Diffusion. Brownian Motion and its Significance.	
IV	**Real Gases:** Behavior of Real Gases: Deviations from the Ideal Gas Equation, The Virial Equation, Andrews Experiments on CO_2 Gas. Critical Constants, Continuity of Liquid and Gaseous State. Vapour and Gas, Boyle Temperature, Vander Waals Equation of State for Real Gases, Values of Critical Constants, Law of Corresponding States, Comparison with Experimental Curves, P-V Diagrams, Joules Experiment, Free Adiabatic Expansion of a Perfect Gas, Joule- Thomson Porous Plug Experiment, Joule- Thomson Effect for Real and Van der Waal Gases, Temperature of Inversion, Joule-Thomson Cooling.	10

Text Books:

1. Thermal Physics, A. B. Gupta (Books and allied Ltd)-2010

2. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman(McGraw- Hill)-1981

Reference Books:

1. Theory and experiments on thermal Physics, P.K.Chakrabarty (New central book agency limited)-2017
2. Thermodynamics, Kinetic Theory and Statistical Thermodynamics-Sears and Salinger(Narosa)-1988
3. A Treatise on Heat- MeghnadSaha and B.N.Srivastava (The IndianPress) Heat, Thermodynamics and Statistical Physics, N.Subrahmanyamand BrijLal (S.Chand Publishing)-2008
4. Thermal and Statistical Physics M.Das, P.K. Jena, S. Mishra,R.N.Mishra (Shri Krishna Publication)-2009

Course Outcomes

CO1: Understand the laws of thermodynamics and principles of free energy; describe thermodynamic processes and heat engines.
CO2: Use of the chemical potential to describe diffusive equilibrium, phase equilibrium and chemical processes.
CO3: Understand the kinetic theory of gases and behaviour of real gaseous systems.
CO4: Apply the laws of thermodynamics and chemical potentials to know the behaviour of real gas system.

CO-PO Mapping (CC-VI)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	2	3	3	2	2	2
CO2	3	2	3	2	2	3	2	2
CO3	3	2	3	2	2	2	2	1
CO4	2	2	2	2	2	2	1	2

Programme articulation matrix row for CC-VI

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-VI	3	3	2	3	3	3	2	2

CO-PSO Mapping (CC-VI)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	2	2	3	2	2	3
CO3	2	3	2	2	2	2	2
CO4	2	2	2	2	2	3	2

Core Course Paper –VI-PRACTICAL

Course Name- Thermal Physics Practical

Course Objective: gain practical knowledge on the techniques to find the universal constants used to describe behavior of a thermodynamic system e.g. mechanical equivalent of heat, thermal properties of materials like thermal conductivity, specific heat, temperature co-efficient of resistance of different materials.

Pre-Requisites: Knowledge of Newton's law of cooling, conversion mechanism of temperature to various scales.

SYLLABUS

(Any five experiments to be conducted)

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barnesconstant flow method.
2. To determine the Coefficient of Thermal Conductivity of a badconductor by Lee and Charltons disc method.
3. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).

4. To study the variation of Thermo-emf of a Thermocouple with Difference of Temperature of its Two Junctions.

5. To determine the specific heat of liquid by the method of cooling

6. To determine the specific heat of solid by applying radiation 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, KitabMahal

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 Publications.

COURSE OUTCOME

CO1: learn the experimental techniques to determine some universal constants like mechanical equivalent of heat, thermal properties of materials like thermal conductivity, specific heat, temperature co-efficient of resistance of different materials.

CO-PO Mapping (CC-VI-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for CC-VI-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-VI-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (CC-VI-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

Core Course Paper -VII

Course Name- ANALOG SYSTEMS AND APPLICATIONS

Course Objective: Learn the principle, working and characteristics of electronic devices like diodes, transistors, Op-Amps and to analyze their performance in applications like rectifiers, amplifiers and oscillators.

Prerequisites: *Knowledge of intrinsic and extrinsic semiconductors*

Syllabus

UNIT	Content	Hours
I	**Semiconductor Diodes:** P and N type semiconductors, energy level diagram, conductivity and Mobility, Concept of Drift velocity, PN junction fabrication (simple idea), Barrier formation in PN Junction Diode, Static and Dynamic Resistance, Current flow mechanism in Forward and Reverse Biased Diode, Drift velocity, derivation for Barrier Potential, Barrier Width and current Step Junction. **Two terminal device and their applications:** (1) Rectifier Diode: Half 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, (2) Photo diode(3) Solar Cell.	10
II	**Bipolar Junction Transistors:** n-p-n and p-n-p transistors, Characteristics of CB, CE and CC Configurations, Current gains a and b, Relation between a and b, Load line analysis of Transistors, DC Load line and Q-point, Physical mechanism of current flow, Active, Cut-off and Saturation Regions. **Transistors Biasing:** Transistor Biasing and Stabilization circuits, Fixed Bias and Voltage Divider Bias. **Amplifiers:** Transistors as 2-port network h-parameter Equivalent Circuit, Analysis of a single stage CE amplifier using Hybrid Model, Input and Output impedance, Current, Voltage and Power Gains, Classification of class A, B and C amplifiers, Push-pull amplifier (class B)	10
III	**Coupled Amplifier:** RC-coupled amplifier and it's frequency response. **Feedback in Amplifiers:** Effect of Positive and Negative Feedback on In-put Impedance, Output Impedance, Gain Stability, Distortion and Noise. SinusoidalOscillations: Barkhausen's criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency, Hartley and Colpitt's oscillators.	10
IV	**Operational Amplifiers (Black Box approach):** Characteristics of an Ideal andPractical OP-AMP (IC741). Open-loop and Closed loop Gain. FrequencyResponse. CMRR, Slew Rate and concept of virtual ground. **Application of Op-Amps:** (1) Inverting and non-inverting amplifiers (2) Adder(3) Subtractor (4) Differentiator, (5) Integrator (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator.	10

Text Books:

1. Foundations of Electronics-Raskhit and Chattopadhyay (New age International Publication), 15th Edition-2018

2. Concept of Electronics- D.C.Tayal (Himalay Publication)-2018

Reference Books:

1. Electronic devices and circuits R.L.Boylstad (Pearson India)-2009
2. Electronic Principles- A.P.Malvino (Tata McGraw Hill)-2008
3. Electronic Devices and Circuits- S.Salivahar and NS Kumar -(Tata McGraw Hill) 3rd Edition-2012
4. OP-Amps and Linear Integrated Circuit-R. A. Gayakwad (Prentice Hall) 4th Edition, 2000
5. Physics of Semiconductor devices, Donald A Neamen (Prentice Hall)

Course Outcomes

CO1: understand the basics of p-n junction diodes like barrier formation, current flow mechanism; application as rectifiers and some special diodes like Zener diode, photodiode and solar cells.
CO2: Apply the concept of hybrid parameters of bipolar junction transistor to be used as various power amplifiers.
CO3: Use the barkhausen criterion for various transistor based oscillators.
CO4: Design various OP-AMP for mathematical operations.

CO-PO Mapping (CC-VII)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	3	3	3	3	3
CO2	3	2	3	3	3	3	2	3
CO3	3	3	3	2	2	2	2	2
CO4	2	2	2	2	2	2	2	2

Programme articulation matrix row for CC-VII

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-VII	3	3	3	3	3	3	3	3

CO-PSO Mapping (CC-VII)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	2	2	3	2	2	3
CO3	2	3	2	2	2	2	2
CO4	2	2	2	2	2	3	2

Core Course Paper –VII-PRACTICAL

Course Name- ANALOG SYSTEMS AND APPLICATIONS PRACTICAL

Course Objective: Gain practical knowledge on the basic electronic devices like diodes, transistors, opamp IC about their working and characteristics and applications in designing amplifiers, oscillators etc.

Pre-Requisites: Knowledge of using multimeter, method to record current and voltage.

SYLLABUS

(Any five experiments to be conducted)

1. To study the V-I characteristics of a Zener diode and its use as voltageregulator.
2. Study of V-I and power curves of solar cells, and find maximum powerpoint and efficiency.
3. To study the characteristics of a Bipolar Junction Transistor in CEconfiguration and draw load line
4. To study the various biasing configurations of BJT for normal class Aoperation.
5. To study the frequency response of voltage gain of a RC-coupled transistoramplifier.
6. To design and study OP Amp-IC (741/351) as inverting and non invertingamplifier
7. To design and study OP Amp-IC (741/351) as integrator and differentiation andstudy frequency response.
8. To design and study OP Amp-IC (741/351) as adder and subtractor.
9. To design a Wien bridge oscillator for given frequency using anop-amp.
10. To design a phase shift oscillator of given specifications using BJT.
11. To study the Colpitt's oscillator.

Reference Books:

1. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGrawHill.
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.
4. A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani Publications.

COURSE OUTCOME

CO1: Learn the working of different basic electronic devices like Zener diode, solar cells, transistors, Op-amps etc.

CO-PO Mapping (CC-VII-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for CC-VII-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-VII-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (CC-VII-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

FOURTH SEMESTER

GENERIC ELECTIVE -IV

Course Name- WAVES AND OPTICS

Course Objective: Learn the optical phenomena like reflection, refraction, diffraction, interference and polarization occurring in their surrounding

Prerequisites: *Knowledge of laws of reflection, refraction, Huygen's theory of wave optics.*

Syllabus

UNIT	Content	Hours
I	**Geometrical optics:** Fermat's principle, reflection and refraction at plane interface, Matrix formulation of geometrical Optics. Idea of dispersion. Cardinal Points and cardinal planes of an optical system, location of cardinal points and cardinal planes of (1) thick lens(2) thin lens and (3) co axial combination of two thin lenses using matrix formulation. **Aberrations:** Chromatic Aberration and remedy, Monochromatic Aberration: Spherical Aberration and remedy, Simple idea on Coma, Distortion, Astigmatism and Curvature and their Remedy, **Eyepiece:** Huygens eyepiece, Ramsden eye piece and their comparison.	10
II	**Wave Motion:** Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves. Wave Optics: Electromagnetic nature of light. Definition and properties of wave front Huygens Principle. Temporal and Spatial Coherence	10
III	**Interference-I:** Division of amplitude and wave front. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment **Interference-II:** 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 Interferometer-(1) Idea of form of fringes (No theory required), Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and Visibility of Fringes. Fabry- Perot interferometer. Fabry Perot etalon with theory. Applications Determination of wavelength (2) Wavelength difference of two sodium d-lines.	10

IV	**Fraunhofer 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, a slit and a wire.	10

Text Books:

1. A text book of Optics – N. Subrahmanyam and Brij Lal (S.Chand Publishing)
2. Optics - Ajoy Ghatak (McGraw Hill)

Reference books:

1. Optics-E.Hecht (Pearson)-4th Edition 2008
2. Fundamentals of Optics- F.A. Jenkins and H.E. White (McGraw-Hill)-2017
3. Geometrical and Physical Optics– R.S. Longhurst(Orient Blackswan)-1974
4. The Physics of Vibrations and Waves- H. J. Pain(John Wiley)-2006
5. Principles of Optics – B.K. Mathur, Gopal Printing-1964
6. Principles of Optics-Max Born and Emil Wolf (Cambridge University Press)-7th Edition 1999

Course Outcomes

CO1: Understand the laws associated with geometrical and wave optics.
CO2: Understand the Physics associated with various wave motions.
CO3: Apply the coherent superposition for various interferometer.
CO4: Differentiate Fresnel and Franhoffer diffraction

CO-PO Mapping (GE-IV)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	2	3	3	2	2	1
CO2	3	3	2	2	2	1	2	2
CO3	3	2	2	2	2	2	2	2
CO4	2	1	2	1	2	2	2	1

Programme articulation matrix row for GE-IV

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course GE-IV	3	3	2	3	3	2	2	2

CO-PSO Mapping (GE-IV)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3
CO2	3	2	3	2	2	2	2
CO3	3	3	3	3	2	2	2
CO4	2	3	3	2	3	3	2

Generic Elective –IV-PRACTICAL

Course Name- Waves and Optics Practical

Course Objective

To learn the technique to determine optical parameters like refractive index, dispersive power of prism, wavelength of different light sources etc. using plane diffraction gratings.

Pre-requisites

Knowledge of using screw gauge, focal length of lens, dispersion through prism.

SYLLABUS

(Any five experiments to be conducted)

1. To investigate the motion of coupled oscillators
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ2 – T Law.
3. To study Lissajous Figures
4. Familiarization with Schuster`s focussing; determination of angle of prism.
5. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
6. To determine the Refractive Index of the Material of a Prism using Sodium Light.
7. To determine Dispersive Power of the Material of a Prism using Mercury Light
8. To determine the value of Cauchy Constants.
9. To determine the Resolving Power of a Prism.
10. To determine wavelength of sodium light using Fresnel Biprism.
11. To determine wavelength of sodium light using Newton's Rings.
12. To determine the wavelength of Laser light using Diffraction of Single Slit.
13. To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Grating
14. To determine the Resolving Power of a Plane Diffraction Grating. 15. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits

Reference Books:

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

COURSE OUTCOMES

CO1: Determine wavelength of monochromatic light by various interference systems and diffracting devices.

CO-PO Mapping (GE-IV-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for GE-IV-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course GE-IV-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (GE-IV-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

Core Course Paper -VIII

Course Name- Mathematical Physics-III

Course Objective: Learn solving problems of interest to physicists where concepts like complex numbers, Fourier transforms , Laplace transforms etc. are involved.

Prerequisites: *Knowledge of complex numbers, periodic function, Fourier series*

Syllabus

UNIT	Content	Hours
I	**Complex Analysis:** Brief Revision of Complex Numbers and their Graphical Representation Eulers formula, De Moivre's theorem, Roots of complex Numbers, Functions of Complex Variables, Analyticity and Cauchy-Riemann Conditions, Examples of analytic functions, Singular functions: poles and branch points, order of singularity, branch cuts, Integration of a function of a complex variable, Cauchys Inequality, Cauchy's Integral formula, Simply and multiply connected region, Laurent and Taylors expansion, Residues and Residue Theorem, Application in solving simple Definite Integrals.	10
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.	10
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.	10
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.	10

Text Books:

1. MathematicalMethods for Physicists, G.B.Arfken, H.J.Weber, F.E.Harris(2013,7thEdn., Elsevier)

2. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India) 10th Edition 2014

3. Mathematical Physics–H. K. Das, Dr. Rama Verma (S. Chand Publishing)2011

Reference Books:

1. Mathematical Physics and Special Relativity–M.Das, P.K. Jena and B.K. Dash(SrikrishnaPrakashan)-2009

2. Complex Variable: Schaum's Outlines Series M. Spiegel (2nd Edition ,Mc- GrawHill Education)-2004

3. Complex variables and applications J.W.Brown and R.V.Churchill 7th Edition 2003

4. Mathematical Physics, Satya Prakash (Sultan Chand)-2014

5. Mathematical Physics B.D.Gupta (4th edition, Vikas Publication)-2009

Course Outcomes

CO1: Solve the complex integrations through Cauchy's integral concept and by using residue theorem.
CO2: Apply Fourier sine, cosine and complex integrals for determination of Fourier transforms.
CO3: Solve one dimensional Wave and Diffusion/Heat flow Equations by using the theory of Fourier transformations.
CO4: Apply Laplace transformation to solve differential equations and to determine voltage for half wave and full wave rectifiers.

CO-PO Mapping (CC-VIII)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	3	2	2	3	2
CO2	3	3	2	3	2	3	2	2
CO3	3	2	3	2	2	1	2	1
CO4	3	2	2	1	1	2	2	2

Programme articulation matrix row for CC-VIII

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-VIII	3	3	3	3	2	3	3	2

CO-PSO Mapping (CC-VII)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	3	2	3	2	3	2
CO3	2	3	2	2	1	1	2
CO4	2	2	2	1	2	3	2

Core Course Paper –VIII-PRACTICAL

Course Name- Mathematical Physics- III (Sci-Lab)

Course Objective: Learn computer based Scilab programming to solve simple differential equations and to evaluate special functions, Fourier coefficients.

Pre-requisites: Knowledge of C-programming/FORTRAN, LINUX/MS operating system, Fourier/Laplace transformation

SYLLABUS

(Any five experiments to be conducted)

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

- Solve Simple Differential Equations like

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

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

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

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

- Direct Delta Function

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

- **Fourier Series:**

Program to sum

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

- **Frobenius method and Special functions:**

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

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

Show recursion relation

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

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

• Evaluation of trigonometric functions e.g. sin θ, Given Bessels function at N points find its value at an intermediate point.

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

• Integral transform: FFT of e^{-x^2}

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley,M.P.Hobson and S. J. Bence, 3rd ed., 2006, Cambridge UniversityPress
2. Mathematics for Physicists, P.Dennery and .Krzywicki,1967,DoverPublications
3. 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
4. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
5. Scilab(A free software to matlab):H.Ramchandran, A.S.Nair. 2011 S.Chand and Company
6. Scilab Image Processing: Lambert M. Surhone. 2010 Beta script Publishing

COURSE OUTCOMES

CO1: Apply Scilab based programming to solve simple differential equations and to evaluate some basic special functions.

CO-PO Mapping (CC-VIII-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for CC-VIII-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-VIII-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (CC-VIII-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

Core Course Paper -IX

Course Name- ELEMENTS OF MODERN PHYSICS

Course Objective: Gain knowledge on structure and properties of atoms and nuclei, their decay processes and understand how a matter behaves as particle and wave and the experiments used to verify them.

Prerequisites: *Knowledge of atomic Physics, radiation theory of thermodynamics*

Syllabus

UNIT	Content	Hours
I	**Atomic Spectra and Models:** Inadequacy of classical physics, Brief Review of Black body Radiation, Photoelectric effect, Compton Effect, dual nature ofradiation wave nature of particles, Atomic spectra, Line spectra of hydrogen atom, Ritz Rydberg combination principle, Alpha Particle Scattering, Rutherford Scattering Formula, Rutherford Model of atom and its limitations. **Atomic Model:** Bohr's Model of Hydrogen atom, explanation of atomic spectra, correction for finite mass of the nucleus, Bohr correspondence principle, limitations of Bohr model, discrete energy exchange by atom, Frank Hertz Experiment, Sommerfelds modification of Bohr's Theory.	10
II	**Wave Packet:** superposition of two waves, phase velocity and group velocity, wave packets, Gaussian Wave Packet, spatial distribution of wave packet, Localization of wave packet in time, Time development of a wave packet, Wave Particle Duality, Complementarity. **Wave Particle Duality:** de Broglie hypothesis, Experimental confirmation ofmatter wave, Davisson Germer Experiment, velocity of de-Broglie wave, wave particle duality, Complementarity. **Uncertainty Principle:** Heisenberg Uncertainty Principle, Illustration of thePrinciplethroughthoughtExperimentsofGammaraymicroscopeandelectrondiffraction through a slit, Estimation of ground state energy of harmonic oscillator and hydrogen atom, non existence of electron in the nucleus, Uncertainty and complementarities.	10
III	**Nuclear Physics- I:** Size and structure of atomic nucleus and its relation withatomic weight, Impossibility of an electron being in the nucleus as a con- sequence ofthe uncertainty principle, Nature of the nuclear force, NZ graph, Liquid Drop model: semi empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.	10
IV	**Nuclear Physics- II:** Radioactivity, stability of the nucleus, Law of radioactivedecay, Mean life and Half life Alpha decay, Beta decay-energy released, spectrum and Pauli's prediction of neutrino, Gamma ray emission energy-momentum conservation:electron-positron pair creation by gamma photons in the vicinity of a nucleus,Fission and fusion mass deficit, relativity and generation of energy, Fission- nature offragments and emission of neutrons, Nuclear reactor: slow neutron interacting withUranium 235, Fusion and thermo nuclear reactions driving stellar energy (brief qualitative discussion).	10

Text Books:

1. Concepts of Modern Physics Arthur Beiser (McGraw Hill)-2002

2. Modern Physics Murugeshan and Sivaprasad (S.Chand) 18th Edition 2016

Reference Books:

1.QuantumMechanics:TheoryandApplications,A.K.GhatakandS.Lokanathan,(Macmillan)-2004

2. Introduction to Quantum Theory, David Park (Dover Publications)-1974

3. Theory and Problems of Modern Physics, Schaum's outline,R.Gautreau and W.Savin- (Tata McGraw-Hill) 2nd Edition

4. Physics for scientists and engineer with Modern Physics-Jewell and Serway - (CENGAGE Learnings) 2010.

5. Modern Physics of Atoms and Molecules Bransden and Joachim (PearsonIndia)-2003

6. Atomic and Nuclear Physics-A.B.Gupta (New Central)-2009

7. Theoretical Nuclear Physics, J.M.Blatt and V.F. Weisskof (Springer)-2003

Course Outcomes

CO1: Understand the proposed models by experiments to describe the structure of atoms and nuclei

CO2: Interpret the dual nature of matter and experiments that describe the either nature.

CO3: Determine nuclear stability, binding energy on the basis of various nuclear models.

CO4: Apply the theory of radioactivity on nuclear fission/fusion to meet the demand for energy in todays' world.

CO-PO Mapping (CC-IX)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	2	3	3	3
CO2	3	3	2	2	2	2	2	2
CO3	3	2	3	2	3	2	1	1
CO4	3	2	2	2	2	2	2	1

Programme articulation matrix row for CC-IX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-IX	3	3	3	2	3	3	3	2

CO-PSO Mapping (CC-IX)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	3	2	3	2	3	2
CO3	2	3	2	2	1	1	2
CO4	2	2	2	1	2	3	2

Core Course Paper –IX-PRACTICAL

Course Name- Elements of Modern Physics Practical

Course Objective: Learn simple experiments to gain practical knowledge on determination of physical constants used in modern physics.

Pre-requisites: Knowledge of using single slit, double slit, grating and concept of Plank's radiation law.

SYLLABUS

(Any five experiments to be conducted)

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

Reference Books:

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

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,11th Edn, 2011,KitabMahal

COURSE OUTCOMES

CO1: determine constants widely used in modern physics like Planck's constant, e/m of electron and find wavelength of lasers by optical experiments

CO-PO Mapping (CC-IX-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for CC-IX-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-IX-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (CC-IX-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

Core Course Paper -X

Course Name- DIGITAL SYSTEMS AND APPLICATIONS

Course Objective: will gain knowledge on ICs, Number systems, logic circuits and data processing circuits.

Prerequisites: *Knowledge of basic binary algebra, logic gates.*

Syllabus

UNIT	Content	Hours
I	**Integrated Circuits (Qualitative treatment only):** Active and Passive Components, Discrete components, Wafer Chip, Advantages and Drawbacks of ICs, Scale of Integration: SSI, MSI, LSI and VLSI (basic idea and definitions only), Classification of ICs, Examples of Linear and Digital ICs. **Digital Circuits:** Difference between Analog and Digital Circuits, Binary Numbers, Decimal to Binary and Binary to Decimal Conversation, BCD, Octal and Hexadecimal numbers, AND, OR and NOT. Gates (realization using Diodes and Transistor), NAND and NOR Gates as Universal Gates, XOR and XNOR Gates and application as Parity Checkers.	10
II	**Boolean algebra:** De Morgans Theorems: Boolean Laws, Simplification of LogicCircuit using Boolean Algebra, Fundamental Products, Idea of Minterms andMaxterms, Conversion of a Truth table into Equivalent	10

	Logic Circuit by(1) Sum of Products Method and (2) Karnaugh Map. **Introduction to CRO:** Block Diagram of CRO, Electron Gun, Deflection systemand Time Base, Deflection Sensitivity, **Applications of CRO:** (1) Study of Wave Form, (2) Measurement of Volt-age,Current, Frequency and Phase Difference.	
III	**Data Processing Circuits:** Basic Idea of Multiplexers, De-multiplexers, Decoders, Encoders. **Arithmetic Circuits:** Binary Addition. Binary Subtraction using 2's complement. Halfand Full Adders. Half and Full Subtractors, 4 bit binary Adder/ Subtractor. **Timers: IC 555:** block diagram and application is Astable multivibrator and Monostable multivibrator.	10
IV	**Introduction to Computer Organization:** Input/output Devices, Data storage(idea of RAM and ROM), Computer memory, Memory organization andaddressing, Memory Interfacing, Memory Map. **Shift registers:** Serial-in-serial-out, Serial-in-Parallel-out, Parallel-in-Serial- outand Parallel-in-Parallel-out. Shift Registers (only up to 4 bits) **Counters (4 bits):** Ring Counter, Asynchronous counters, Decade Counter. Synchronous Counter.	10

Text Books:

1. Foundation of Electronics-Rakshit Chattopadhaya (New Age) -2015

2. Digital Circuits and Logic design: Samuel C. Lee(Printice Hall)-1976

3. Digital Principles and Applications - A.P. Malvino, D.P.Leach and Saha(Tata McGraw)-7th Edition 2011

Reference Books:

1. The Art of Electronics by Paul Horowitz and WilfieldHill ,Cambridge University -2006

2. Electronics by Allan R. Hambley, Prentice Hall - 1994

3. Digital Logic and Computer design M. Morris Mano (Pearson) -2016

4. Concepts of Electronics D.C.Tayal (Himalaya Publishing house) -2018

Course Outcomes

CO1: Understand the fundamentals of number systems used in computers, binary arithmetic, logics and Boolean functions.
CO2: Apply basic Boolean algebra for logic gates.
CO3: Understand the basic working mechanism of CRT and CRO.
CO4: Use the multivibrator circuit for working of timer and arithmetic circuits.
CO5: Apply the idea of computer hardwares for computing purposes.

CO-PO Mapping (CC-X)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3
CO3	3	3	3	3	3	2	3	2
CO4	3	2	2	2	2	2	2	2
CO5	3	3	3	3	3	3	3	3

Programme articulation matrix row for CC-X

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-X	3	3	3	3	3	3	3	3

CO-PSO Mapping (CC-X)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	3	2	3	2	3	2
CO3	2	3	2	2	2	2	2
CO4	2	2	2	2	2	3	2
CO5	2	2	2	2	2	2	2

Core Course Paper –X-PRACTICAL

Course Name- DIGITAL SYSTEMS AND APPLICATIONS PRACTICAL

Course Objective: Learn the function of basic gates and hence to design other logic circuits like Flip Flops

Pre-requisites: Knowledge of using truth tables of logic gates.

SYLLABUS

(Any five experiments to be conducted)

1. Student should know how to measure (a) Voltage, and (b) Time period ofa periodic waveform using CRO and to test a Diode and Transistorusing a Millimeter.
2. To design a switch (NOT gate) using a transistor.
3. To verify and design AND, OR, NOT and XOR gates using NAND gates.
4. Half Adder, Full Adder and 4-bit binary Adder.
5. Half Subtractor, Full Subtractor, Adder- Subtractor using Full AdderI.C.

6. To build Flip-Flop(RS,Clocked RS,D- type and JK) circuits usingNAND gates.

7. To design astablemultivibrator of given specifications using 555Timer.

8. To design a monostablemultivibrator of given specifications using 555Timer.

Reference Books:

1. Basic Electronics: A Text Books lab manual, P.B. Zbar, A.P. Malvino,

2. M.A. Miller, 1994, Mc-Graw Hill.

3. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition,2000, Prentice Hall.

4. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.Electronic Devices and circuit Theory, R.L.Boylestad and L.D.Nashelsky, 2009, Pearson

COURSE OUTCOMES

CO1: make familiar with design and function of various logic circuits which are the building blocks in digital logic systems.

CO-PO Mapping (CC-X-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for CC-X-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-X-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (CC-X-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

FIFTH SEMESTER

Discipline Specific Elective (DSE) Paper-I

Course Name: CLASSICAL DYNAMICS

Course Objective: Learn the basic mechanism associated with Classical Physics (Lagrangian and Hamiltonian formulation) and special theory of relativity.

Pre-requisites: Knowledge of Newtonian mechanics, Galilean Theory of relativity, space and time coordinates.

Syllabus

UNIT	Content	Hours
I	Generalised co-ordinates and Velocities, Generalised Force, Principle of virtual work Derivation of Lagranges equation of motion from D Alemberts Principles, Lagrangian and its Application to Simple, Compound and Double Pendulums, Single Particle in Space, At woods Machine, Dumbbell, Linear harmonic oscillator.	10
II	Hamiltons Principle, Calculus of Variation and derivation of Euler-Lagranges equation, Langranges Equations derived from Hamiltons Principles, Hamiltoian and its applications to Shortest Distance between two points in a plane, Geodesic Problem, minimum surface of revolution, Brachistochrone problem, The Equations of motion and first integrals, The equivalent one-dimensional problem and classification of orbits, canonical momenta, Hamiltions equations of motion, Motion of charged particles in external electric and magnetic fields, Applications to central force motion and coupled oscillators.	10
III	Special theory of Relativity (Postulates of special theory of relativity), Lorentz transformations, Minkowski space, The invariant interval, light cone and world lines, space time diagrams, Times-dilation, length contraction and Twin paradox, Variation of mass with velocity mass energy relation.	10
IV	Four Vectors: Space Like, Time-like and light-like. Four velocity and acceleration, Four momentum and energy-momentum relation. Doppler effects from a four vector perspective, Concept of four-force, Conservation of four momentum, Application to two body decay of anun stable particle.	10

Text Books:

1.Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko (Pearson) - 2011

2. Classical Mechanics J.C. Upadhyay (Himalayan Publisher)-2017

Reference Books:

1. Mechanics-D.S.Mathur (Sultan Chand)-2000
2. Solved problems in Classical Mechanics, O.L. Delange and J.Pierrus (Oxford Press) (2010)
3. Classical Mechanics-M. Das, P.K. Jena, M. Bhuyan, R.N. Mishra (Srikrishna Prakashan)-2009
4. Mathematical Physics with Classical Mechanics-Satya Prakash (Sultan Chand and sons)-2014
5. Introduction to classical dynamics R.K.Takwale and S.Puranik (Tata McGraw Hill)-2017

Course Outcomes

CO1: Solve the mechanics of various oscillating system through Lagrangian mechanism.
CO2: Use Hamiltonian formulism to find shortest distance between two points in a plane, Geodesic Problem, minimum surface of revolution, Brachistochrone problem
CO3: Understand central force motion and coupled oscillators.
CO4: Apply special theory of relativity to determine space time diagrams, Times-dilation, length contraction.
CO5: Apply the four vector form of energy-momentum to understand the conservation principles with respect to relativity.

CO-PO Mapping (DSE-I)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	2	3	3	3
CO2	3	3	2	2	2	2	2	2
CO3	3	2	3	2	3	2	1	1
CO4	3	2	2	2	2	2	2	1
CO5	2	2	2	2	2	2	1	1

Programme articulation matrix row for DSE-I

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course DSE-I	3	3	3	2	3	3	3	3

CO-PSO Mapping (DSE-I)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	3	2	3	2	3	2
CO3	2	3	2	2	1	1	2
CO4	2	2	2	1	2	3	2
CO5	2	2	2	2	2	2	2

Discipline Specific Elective (DSE) Paper-II

Course Name: NUCLEAR AND PARTICLE PHYSICS

Course Objective: Learn the basic properties of nucleus like stability, binding energy, feasibility for nuclear fusion and fission.

Pre-requisites: Knowledge of the inference drawn from Ruthorfor's scattering, atomic Physics.

Syllabus

UNIT	Content	Hours
I	**General properties of Nuclei:** Constituents of nucleus and their intrinsic properties, Quantitative facts about mass, radius, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment electric moments, nuclear excites states. **Radioactivity decays:** (a) Alpha decay: basics of alpha- decay processes, theory of alpha-emission, Gamow factor, Geiger Nuttall law (b) beta-decay: energy kinematics for beta-decay, positron emission, electron capture, neutrino hypothesis. (c) Elementary idea of Gamma decay.	10
II	**Nuclear Models:** Liquid drop model approach, semi empirical mass formula and significance of its various terms, conditions of nuclear stability, two nucleon separation energies, evidence for nuclear shell structure, nuclear magic number, basic assumption of shell models.	10
III	**Detector for nuclear radiations**: Detector for nuclear radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic Principle of Scintillation Detectors and Construction of photo- multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge Particle and photo detection (Concept of charge carrier and mobility), neutron detector. **Particle Accelerators:** Van-de Graff generator (Tandem Accelerator), Lin- ear accelerator, Cyclotron, Synchrotrons.	10
IV	**Particle Physics:** Particle interactions, basic features, types of particles and its families. **Symmetries and conservation laws:** Energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, strangeness and charm, Elementary ideas of quarks and gluons.	10

Text Books:

1. Introduction to Nuclear Physics By Roy and Nigam-2014
2. Atomic and Nuclear Physics- N.Subramanyam, Brij Lal and Jivan Seshan (S. Chand Publishing)-2007

Reference Books:

1. Introduction to Modern Physics- H.S.Mani and G.K. Mehta(Affilated east and west) - 2018
2. Introductory nuclear Physics-Kenneth S. Krane (Wiley India Pvt. Ltd)- 1987
3. Introduction to Elementary Particles-D. Griffith (John Wiley and Sons)-2008
4. Concepts of Nuclear Physics - Bernard L. Cohen. (Tata Mcgraw Hill). - 2017
5. Concepts of Modern Physics-Arthur Beiser (McGraw Hill)-2017

Course Outcomes

CO1: Understand the basic properties of nucleus and the associated radioactive decay process.
CO2: Interpret the nuclear stability, angular momentum, parity through nuclear models.
CO3: Understand the basic principle of detectors as used in nuclear reactors and particle accelerators.
CO4: Differentiate various types of particle interaction with associated symmetry and conservation principles.

CO-PO Mapping (DSE-II)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	3	2	2
CO2	3	3	3	2	2	2	2	2
CO3	3	3	3	2	3	2	2	1
CO4	3	2	2	2	2	1	2	1

Programme articulation matrix row for DSE-II

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course DSE-II	3	3	3	2	3	3	3	3

CO-PSO Mapping (DSE-II)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	3	2	3	2	3	2
CO3	2	3	2	2	1	1	2
CO4	2	2	2	1	2	3	2

Core Course Paper -XI

Course Name- QUANTUM MECHANICS AND APPLICATIONS

Course Objective: Able to get the idea of wave function, solving Schrödinger equation, eigenvalue problems.

Prerequisites: *Knowledge of elementary idea of modern Physics, failure of classical Physics, Plank's radiation law, solving differential equation.*

Syllabus

UNIT	Content	Hours
I	**Schrodinger equation:** Time dependent Schrodinger equation, Properties of Wave Function, Interpretation of wave function, Probability and probability current densities in three dimensions, Conditions for Physical Acceptability of Wave Function, Normalization, Linearity and Superposition Principles. Wave function of a free particle, Wave Packet, Fourier Transform and momentum space, Wave function Spread of Gaussian Wave packet, Evolution with time, Position and Momentum Uncertainty.	10
II	**Operators:** Operators, Commutator Algebra, Position, Momentum AngularMomentum and Energy operators, Hermitian Operators, Expectation values ofposition and momentum, Ehrenfest Theorem, Eigenvalues and Eigen functions ofHermitian Operator, Energy Eigen Spectrum, Degeneracy, Orthonormality of Eigen functions, Linear Dependence. Orthogonalisation.	10
III	Time Independent Schrodinger equation in one dimension (1d), 2d and 3d,Hamiltonian, stationary states and energy eigen values, expansion of an arbitrarywave function as a linear combination of energy eigen functions, General solution ofthe time dependent Schrodinger equation in terms of linear combinations of stationarystates. General Discussion of Bound states in an arbitrary potential: Continuity ofwave function, Boundary condition and emergence of discrete energy levels,Application to one dimensional problem-Square well potential, Quantum mechanicsof simple Harmonic Oscillator-Energy Levels and energy eigen functions, groundstate, zero point energy and uncertainty principle, One dimensional infinitely rigidbox energy eigen values and eigen functions, normalization, quantum dot as example, Quantum mechanical scattering and tunnelling in one dimension across a steppotential and rectangular potential barrier.	10
IV	**Atoms in Electric and Magnetic Fields:** Electron angular momentum. Spacequantization, Electron Spin and Spin Angular Momentum, Larmors Theorem,Spin Magnetic Moment, Stern Gerlach Experiment,Vector Atom Model, L-S andJ-J coupling, Zeeman Effect, Electron Magnetic Moment and Magnetic Energy,Gyro magnetic Ratio and Bohr Magnet on Atoms in External Magnetic Fields:-Normal and Anomalous Zeeman Effect, Paschenback and Stark Effect(qualitative Discussion only)	10

Text Books:

1. Introduction to Quantum Theory, D. J. Griffiths(Pearson)-2015

2. Introduction to Quantum Theory David Park (Dover Publications)-1974

Reference Books:

1. Quantum Mechanics, Theory and applications A. Ghatak and S.Lokanathan (McMillan India)-2004

2. Quantum Mechanics-G.Aruldhas (Printice Hall of India)-2008

3. Quantum Physics–S. Gasiorowicz (Wiley)-2007

4. Quantum Mechanics -J.L. Powell and B. Craseman (Narosa)-1998

5. Introduction to Quantum Mechanics M.Das and P.K.Jena (Shri KrishnaPublication)-2006

Course Outcomes

CO1: Understand the origins of quantum mechanics and explain the differences between classical and quantum mechanics and the idea of wave packets satisfying uncertainty relation.
CO2: Apply the various types of operator formalism to find the expectation value of physical observables.
CO3: Use time independent Schrodinger equation to solve the problem of 1D harmonic oscillator and various bound state problems.
CO4: Apply the general theory of quantum mechanics to determine the spectral splitting due to LS and JJ-Coupling.

CO-PO Mapping (CC-XI)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	2	2	2	2
CO2	3	3	2	1	2	3	2	2
CO3	3	3	3	2	2	2	2	2
CO4	3	2	3	2	2	2	1	1

Programme articulation matrix row for CC-XI

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-XI	3	3	3	2	2	3	2	2

CO-PSO Mapping (CC-XI)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	3	2	3	2	3	2
CO3	2	3	3	3	2	2	2
CO4	3	3	3	3	2	2	2

Core Course Paper –XI-PRACTICAL

Course Name- QUANTUM MECHANICS AND APPLICATIONS PRACTICAL

Course Objective: Learn computer based programs like C++ ad scilab to solve quantum mechanical problems.

Prerequisites: *Knowledge of using C-programming/FORTRAN, LINUX/MS-Operating system.*

SYLLABUS

(Any five experiments to be conducted)

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

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

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

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 $e = 3.795\sqrt{(eV\mathring{A})},\ \hbar c = 1973(eV\mathring{A})$ and $m = 0.511 \times 10^6 eV/c^2$

2. Solve the s-wave radial Schrodinger equation for an atom:

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

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wave function. Take $e = 3.795\sqrt{(eV\mathring{A})},\ \hbar c = 1973(eV\mathring{A})$ and $m = 0.511\times10^6 eV/c^2$, and $a = 3\mathring{A}, 5\mathring{A}, 7\mathring{A}$. The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m: $\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2m}{\hbar^2}[V(r) - E]$, 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 $m = 940MeV/c^2, k = 100MeV/fm^2, b = 0, 10, 30MeV/fm^3$. In these Units, c = 197.3 MeV fm. [The ground state energy is expected to lie between 90 and 110 M eV for all three cases.]

4. 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 mass of the two-atom system for the Morse potential $V(r) = D(e^{-2\alpha r} - e^{-\alpha r})$, where $r = r - r_0$ Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave functions for the choices given below:

a) $m = 940x10^6 eV/c^2, D = 0.755501eV, \alpha = 1.44, r_0 = 0.131349\mathring{A}$

b) $m = 940x106eV/c^2, D = 0.755501eV, \alpha = 1.44, r_0 = 0.131349\mathring{A}$

Laboratory Based Experiments: (to be taken up depending on availability of equipment)

1. Study of Electron spin resonance- determine magnetic field as a functionof the resonance frequency
2. Study of Zeeman effect: with external magnetic field; Hyper fine 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. Pressetal,3rd Edition., 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. VandeWouwer, P. Saucez, C.V. Fernndez.2014 Springer.
5. Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair.2011S. Chand and Co.
6. Scilab Image Processing: L.M.Surhone.2010 Beta script PublishingISBN:9786133459274

COURSE OUTCOMES

CO1: Use the computer based programs like C++ and Scilab to solve quantum mechanical problems

CO-PO Mapping (CC-XI-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for CC-XI-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-XI-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (CC-XI-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

Core Course Paper -XII

Course Name- SOLID STATE PHYSICS

Course Objective: understand the crystal structures of solids and diffraction of X-rays by them and the properties of magnetic, dielectric and superconducting materials and the theoretical concepts governing their specific properties.

Prerequisites: *Knowledge of elementary idea of Quantum mechanics, semiconductors, dilectrics, Theory of diffraction.*

Syllabus

UNIT	Content	Hours
I	**Crystal Structure:** Solids, Amorphous and Crystalline Materials, Lattice translation Vectors, Lattice with a Basis. Central and Non-Central Elements. Unit Cell, Miller Indices, Types of Lattices, Reciprocal Lattice, Brillouin zones, Diffraction of X-rays by crystals, Bragg's Law, Atomic and Geometrical Factor	10
II	**Elementary Lattice Dynamics:** Lattice Vibrations and Phonons: Linear, Monotomicand Diatomic Chains, Acoustical and Optical Phonons, Qualitative Description of thephonon spectrum in solids, Dulong and Petit's Law, Einstein and Debye theories ofspecific heat of solids, T^3 Law **Magnetic Properties of Matter:** Dia-, Para-, Ferri- and Ferromagnetic Materials,Classical Langevin's theory of dia and Paramagnetic Domains, Curies law, WeissTheory of Ferromagnetism and Ferromagnetic Domains, Discussion of B-HCurve, Hysteresis and Energy Loss.	10
III	**Dielectric Properties of Materials:** Polarization Local Electrical Field at anAtom, Depolarization Field, Electric Susceptibility, Polari ability, ClausiusMosotti Equation, Classical theory of Electronic Polarizability. **Lasers:** Einsteins A and B coefficients, Meta stable States, Spontaneous andStimulated emissions, Optical Pumping and population Inversion, Three Level and Four Level Lasers, Ruby Laser and He-Ne Laser.	10
IV	**Elementary band theory:** Kronig-Penny model of band Gap, Conductor, Semiconductor (P and N type) and insulator, Conductivity of Semiconductor, mobility, Hall Effect, Measurement of conductivity (04 problem method) and Hall Coefficient. **Superconductivity:** Experimental Results, Critical Temperature, Critical magnetic field, Meissner effect, Type I and type II Superconductors, Londons Equation and Penetration Depth, Isotope effect, Idea of BCS theory (No derivation).	10

Text Books:

1. Introduction to Solid State Physics- Charles Kittel (Wiley India) 8th Edition2012

2. LASERS: Fundamentals and Applications-Thyagarajan and Ghatak(McMillan India)-2011

Reference Books:

1. Solid State Physics-N. W. Ashcroft and N.D. Mermin(Cengage)-2003

2. Solid State Physics- R.K.Puri and V.K. Babbar (S.Chand Publication)-2010

3. Solid State Physics S. O. Pillai (New Age Publication)-2008

4. Lasers and Non linear Optics B.B.Laud (Wiley Eastern)-2011

5. Elements of Solid State Physics-J.P. Srivastava (Prentice Hall of India)-2014

6. Elementary Solid State Physics-Ali Omar (Addison Wiley)-2002

Course Outcomes

CO1: Understand the basics of crystal structure: lattice, basis, unit cells, reciprocal lattice concept and diffraction experiment
CO2: Understand crystal vibrations: phonon heat capacity and thermal conductivity
CO3: Understand the dielectric properties of matter.
CO4: Understand the mechanism of Lasing action for various LASERS.
CO5: understand electrons in periodic potential: energy bands theory classification of metals, semiconductors and insulators
CO6: understand the dielectric, magnetic properties of materials and theory of superconductivity which are frontier areas of research today.

CO-PO Mapping (CC-XII)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	2	2	2	3
CO2	3	3	2	2	2	3	2	2
CO3	3	3	3	1	2	3	3	2
CO4	3	2	3	2	3	2	1	2
CO5	2	3	2	2	3	2	1	1
CO6	2	2	3	2	2	2	2	1

Programme articulation matrix row for CC-XII

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-XII	3	3	3	2	2	3	3	3

CO-PSO Mapping (CCXII)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	3	2	3	2	2	2
CO3	2	2	3	2	2	2	2
CO4	3	3	3	3	2	2	2
CO5	2	3	3	2	2	1	2
CO6	3	2	3	2	2	2	1

Core Course Paper –XII-PRACTICAL

Course Name- SOLID STATE PHYSICS PRACTICAL

Course Objective: gain knowledge how to find the values experimentally like magnetic susceptibility, dielectric constant, Hall coefficient, hysteresis loss, resistivity, band gap.

Prerequisites: *Knowledge of semiconductors, direct and indirect band gap, T^3-Law*

SYLLABUS

(Any five experiments to be conducted)

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 and variationwith 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 energyloss from Hysteresis
6. To measure the resistivity and band gap of a given semiconductor by fourproblemmethod.
7. To study PE hysteresis loop of a ferroelectric crystal

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
4. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006,Prentice- Hall of India.

Laboratory Based Experiments: (to be taken up depending on availability of equipment)

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

COURSE OUTCOMES

CO1: learn the experimental techniques to determine the physical parameters of solids like magnetic susceptibility, dielectric constant, Hall coefficient, hysteresis loss, resistivity, band gap in different solid materials.

CO-PO Mapping (CC-XII-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for CC-XII-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-XII-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (CC-XII-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

SIXTH SEMESTER

Discipline Specific Elective (DSE) Paper-III

Course Name: Nano Materials and Applications

Course Objective: Understand the properties of materials at nano scale and Familiarize with different characterization techniques used in nanotechnology

Pre-requisites: Knowledge solid state Physics, basic quantum mechanics

Syllabus

UNIT	Content	Hours
I	**Nanoscale Systems:** Length scales in physics, Nanostructures: 1D, 2D and 3Dnanostructures (nanodots, thin films, nanowires, nanorods), Band structure anddensity of states of materials at nanoscale, size effects in nano systems, Quantum confinement Applications of Schrodinger equation-infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructure and its consequences.	10
II	**Synthesis of Nanostructure Materials:** Top down and bottoms up approach, Photo lithography Ball milling. Gas phase condensation, Vacuum deposition, Physical vapour deposition (PVT): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition, Chemical vapour deposition (CVD), Sol-Gel Electro deposition, Spray pyrolysis, Hydrothemal synthesis, Preparation through colloidal methods, MBE growth of quantum dots.	10
III	**Characterization:** X-Ray Diffraction, Optical Microscopy, Scanning ElectronMicroscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy	10
IV	**Applications:** Applications of nano particles, quantum dots, nanowires and thinfilms for photonic devices (LED, solar cells). Single electron devices (no derivation).CNT based transistors. Nonmaterial Devices: Quantum dots hetero structure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots magmetic data storage. Micro Electromechanical Systems (MEMS), NanoElectromechanical Systems (NEMS)	10

Text Books:

1. S.K. Kulkarni, Nanotechnology: Principles and Practices (CapitalPublishing Company)-3rd Edition 2014
2. Nano science and nano technology, K.K. Choudhary (Narosa)-2016

Reference Books:

1. Nano Science and nano technology, Sundar Singh (PragatiPrakashan)-2017

2. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (WileyIndia Pvt. Ltd.)-2007

3. Richard Booker, Earl Boysen, Nanotechnology(John Wiley and Sons)-2005

4. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle TechnologyHandbook (Elsevier, 2007)

5. K.K. Chattopadhya and A. N. Banerjee, Introduction to Nanoscienceand Technology (PHI Learning Private Limited)-2009

Course Outcomes

CO1: Understand the effect of dimensionality of the object at nanoscale on their properties
CO2: Understand synthesis technique to control size and shape of nanomaterials and their future applications in industry.
CO3: Understand important characterization techniques to analyze nanomaterials properties
CO4: Apply nano materials for various smart applications.

CO-PO Mapping (DSE-III)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	2	3	3
CO3	3	3	3	2	3	2	3	2
CO4	3	2	2	2	2	2	2	2

Programme articulation matrix row for DSE-III

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course DSE-III	3	3	3	3	3	3	3	3

CO-PSO Mapping (DSE-III)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	3	2	3	2	3	2
CO3	2	3	2	2	1	1	2
CO4	2	2	2	1	2	3	2

Discipline Specific Elective (DSE) Paper-IV

Course Name: Basic Instrumentation

Course Objective: know the use of basic measuring devices like analog and digital multimeter, voltmeter, CRO, signal generators.

Pre-requisites: Knowledge analog and digital electronics, basic concepts of electricity and magnetism

Syllabus

UNIT	Content	Hours
I	**Basic of Measurement:** Instruments accuracy, precision, sensitivity, resolutionrange etc. Errors in measurements and loading effects. **Multimeter:** Principles of measurement of dc voltage and dc current, ac volt- age, accurrent and resistance. Specifications of a multimeter and their significance. **Electronic Voltmeter:** Advantage over conventional multimeter for voltagemeasurement with respect to input impedance and sensitivity. Principles ofvoltage, measurement (block diagramonly).Specifications of an electronicVoltmeter/ Multimeter and their significance. **AC mill voltmeter:** Type of AC mill voltmeters: Amplifier- rectifier, and rectifieramplifier.Block diagram ac mill voltmeter, specifications and their significance.	10
II	**Cathode Ray Oscilloscope**: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only no mathematical treatment), brief discussion on screen phosphor, visual persistence and chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.	10
III	**Signal Generators and Analytical Instruments:** Block diagram, explanation andspecifications of low frequency signal generators, pulse generator, and function generator,Brief idea for testing, specifications, Distortion factor meter, wave analysis.	10
IV	**Digital Instruments:** Principle and working of digital meters, Comparison of analog and digital instruments, Characteristics of a digital meter, Workingprinciples 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.	10

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 voltageacross a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequencyvoltage 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 usingCRO.
5. Measurement of time period, frequency, average period using universalcounter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. MeasurementofdistortionofaRFsignalgeneratorusingdistortionfactormeter.
8. Measurement of R, L and Cusinga 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.

Text Books:

1. A Text Books book of electrical technology-B.L.Theraja and A.K. Theraja(S. Chand Publishing)-2014
2. Digital circuits and systems Venugopal (Tata McGraw Hill)-2011

Reference Books:

1. Digital Electronics-SubrataGhoshal (Cengage Learning)-2017

2. Electronic Devices and circuits - S. Salivahanan and N. S.Kumar (TataMc-Graw Hill)-2012

3. Electronic Devices-Thomas L. Floyd (Pearson)-2015

Course Outcomes

CO1: Understand the static and dynamic characteristics of an instrument.
CO2: Calculate and analyze the measurement error, accuracy, precision and limiting error.
CO3: Describe the basic electronic instruments like multimeter, CRO and signal generators etc.
CO4: Design various digital instruments.

CO-PO Mapping (DSE-IV)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	2	3	3
CO3	3	3	3	2	3	2	3	2
CO4	3	2	2	2	2	2	2	2

Programme articulation matrix row for DSE-IV

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course DSE-IV	3	3	3	3	3	3	3	3

CO-PSO Mapping (DSE-IV)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	3	2	3	2	3	2
CO3	2	3	2	2	1	1	2
CO4	2	2	2	1	2	3	2

Discipline Specific Elective (DSE) Paper-IV

Course Name: PROJECT

Students will perform conceptual/experimental/review/analytic/innovative projects. For this a faculty will be allotted for the supervision.

CO1: Develop the skill to plan, execute and report the result of extended experimental and theoretical Physics.

Evaluation

Continuous assessment (By supervisor) – 70 Marks

Dissertation – 20 Marks, Innovativeness/Conceptual understanding – 20 Marks

Literature survey (use of journal papers/conference proceedings, Book chapters) – 10 marks, Analytic representation- 10 marks, Continuous involvement- 10 marks

End semester assessment (By faculty council/external expert) – 30 Marks

Viva – 20 Marks, Innovativeness- 10 marks

CO-PO Mapping (DSE-IV)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	3	3	3	3	3

Programme articulation matrix row for DSE-IV

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course DSE-IV	3	3	3	3	3	3	3	3

CO-PSO Mapping (DSE-IV)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

Core Course Paper -XIII

Course Name- Electro-Magnetic Theory

Course Objective: Familiarize with polarization of EM waves, polarizing and analyzing instruments.

Prerequisites: *Knowledge of basic electricity, magnetism, Maxwell's Electrodynamic equation.*

Syllabus

UNIT	Content	Hours
I	**Maxwell Equations:** Maxwell's equations, Displacement Current, Vector andScalar Potentials, Gauge Transformations: Lorentz and Coulomb Gauge,Boundary Conditions at Interface between Different Media, Wave Equations, Plane Waves in Dielectric Media, Poynting Theorem and Poynting Vector,Electro- magnetic (EM) Energy Density, Physical Concept of Electromagnetic Field Energy Density	10
II	**EM Wave Propagation in Unbounded Media:** Plane EM waves through vacuumand isotropic dielectric medium, transverse nature of plane EM waves, refractiveindex 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 propagationthrough ionosphere.	10
III	**EM Wave in Bounded Media:** Boundary conditions at a plane interface betweentwo media, Reflection and Refraction of plane waves at plane interface betweentwo dielectric media, Laws of Reflection and Refraction, Fresnel's Formulae for perpendicular and parallel polarization cases, Brewster's law, Reflection and Transmission coefficients, Total internal reflection, evanescent waves, Metallicreflection (normal Incidence)	10
IV	**Polarization of Electromagnetic Waves:** Description of Linear, Circular and Elliptical Polarization, Uniaxial and Biaxial Crystals, Light Propagation in Uniaxial Crystal, Double Refraction, Polarization by Double Refraction, Nicol Prism, Ordinary and extraordinary refractive indices, Production and detection of Plane, Circularly and Elliptically Polarized Light, **Phase Retardation Plates:** Quarter-Wave and Half- Wave Plates. Babinets Compensator and its Uses, Analysis of Polarized Light. **Rotatory Polarization:** Optical Rotation, Biot's Laws for Rotatory Polarization, Fresnel's Theory of optical rotation, Calculation of angle of rotation, Experimental verification of Fresnel's theory, Specific rotation, Laurent's half-shade polarimeter.	10

Text Books:

1. Introduction to Solid State Physics- Charles Kittel (Wiley India) 8th Edition2012

2. LASERS: Fundamentals and Applications-Thyagarajan and Ghatak(McMillan India)-2011

Reference Books:

1. Classical Electrodynamics by J.D. Jackson (Willey)-2007

2. Foundation of electromagnetic theory: Ritz and Milford (Pearson)-2008

3. Electricity and Magnetism : D C Tayal (Himalaya Publication)-2014

4. Optics :A.K.Ghatak (McGraw Hill Education)- 2017

5. Electricity and Magnetism: Chattopadhyaya, Rakhit (New Central)-2018

Course Outcomes

CO1: Use Maxwell's equation for energy conservation in electrodynamics.
CO2: understand electromagnetic wave propagation in different type of mediums.
CO3: Interpret the laws of electromagnetic wave propagation through bounded media.
CO4: Apply the laws of polarization for proper understanding of the mechanism of of various polarizing devices.

CO-PO Mapping (CC-XIII)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	2	2	2	3
CO2	3	3	2	2	2	3	2	2
CO3	3	3	3	1	2	3	3	2
CO4	3	2	3	2	3	2	1	2

Programme articulation matrix row for CC-XIII

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-XIII	3	3	3	2	2	3	3	3

CO-PSO Mapping (CCXIII)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	3	2	3	2	2	2
CO3	2	2	3	2	2	2	2
CO4	3	3	3	3	2	2	2

Core Course Paper –XIII-PRACTICAL

Course Name- Electro-Magnetic Theory Practical

Course Objective: Familiarize with polarization of EM waves, polarizing and analyzing instruments.

Prerequisites: *Expertise of using prism spectrometer, Knowledge of Laws of polarization.*

SYLLABUS

(Any five experiments to be conducted)

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 using Wollastonsair-film.
5. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eye piece.
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 PNjunction diode.
9. To determine wavelength and velocity of ultrasonic wave in liquid.
10. Verify Brewster’s Law of polarization.
11. Determine spatial and temporal coherence of LASER source.
12. Determine width of a narrow wire by short range diffraction pattern.

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, 11Ed., 2011, KitabMahal Electromagnetic Field Theory for Engineers andPhysicists, G. Lehner, 2010,Springer

COURSE OUTCOMES

CO1: perform experiments related to polarization and wave propagation

CO-PO Mapping (CC-XIII-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for CC-XIII-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-XIII-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (CC-XIII-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3

Core Course Paper -XIV

Course Name- Statistical Mechanics

Course Objective: Learn the concept of ensembles, fermions, bosons, concept of radiation

Prerequisites: *Knowledge of Laws of thermodynamics, Chemical potentials.*

Syllabus

UNIT	Content	Hours
I	**Classical Statistics-I:** Macrostate and Microstate, Elementary Concept of Ensemble,Micro canonical, Canonical and Grand Canonical ensemble, Phase Space, Entropyand Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function.	10
II	**Classical Statistics-II :**Thermodynamic Functions of an Ideal Gas, classicalEntropy Expression, Gibbs Paradox, SackurTetrode equation, Law of equipartitionof Energy (with proof)- Applications to Specific Heat and its Limitations,Thermodynamic Functions of a two energy levels system, Negative Temperature.	10
III	**Quantum Statistics:** Identical particles, macrostates and microstates, Fermions andBosons, Bose Einstein distribution function and Fermi-Dirac distribution function.Bose- Einstein Condensation, Bose deviation	10

	from Plancks law, Effect oftemperature on Fermi-Dirac distribution function, degenerate Fermi gas, Density of States Fermi energy.	
IV	**Radiation:** Properties of Thermal Radiation, Blackbody Radiation, Pure Temperaturedependence, Kirchhoff's law, Stefan Boltzmann law: Thermodynamic proof,Radiation Pressure, Wein's Displacement law, Wien's distribution Law, Saha'sIonization Formula, Rayleigh Jean's Law, Ultra Violet catastrophe. **Planck's Law of Black body Radiation:** Experimental verification, Deduction of(1) Wiens Distribution Law, (2) Rayleigh Jean's Law, (3) Stefan Boltzmann Law,(4) Wein's Displacement Law from Planck's Law.	10

Text Books:

1. Introduction to Statistical Physics by Kerson Huang(Wiley).-2008

2. Statistical Physics,Berkeley Physics Course, F.Reif (Tata McGraw-Hill)-2017

Reference Books:

1. Statistical Mechanics, B.K.Agarwal and Melvin Eisner (New Age International)-2013

2. Thermodynamics, Kinetic Theory and Statistical Thermodynamics: FrancisW.Sears and Gerhard L. Salinger (Narosa) 1998

3. Statistical Mechanics: R.K.Pathria and Paul D. Beale (Academic Press)-2011

Course Outcomes

CO1: Evaluation of the laws of classical thermodynamics for macroscopic systems using the properties of its atomic particles.
CO2: Understand the nature of statistical errors and variations of thermodynamic parameters.
CO3: Understand micro and macrostates, fermions and bosons
CO4: Understand radiation and radiation laws

CO-PO Mapping (CC-XIV)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	2	2	2	3
CO2	3	3	2	2	2	3	2	2
CO3	3	3	3	1	2	3	3	2
CO4	3	2	3	2	3	2	1	2

Programme articulation matrix row for CC-XIV

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-XIV	3	3	3	2	2	3	3	3

CO-PSO Mapping (CCXIV)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	2	3	3
CO2	3	3	2	3	2	2	2
CO3	2	2	3	2	2	2	2
CO4	3	3	3	3	2	2	2

Core Course Paper –XIV-PRACTICAL

Course Name- <u>Statistical Mechanics Practical (SCi-Lab)</u>

Course Objective: Run the programs to verify various radiation laws and can able to simulate the distribution functions in statistical physics

Prerequisites: *Use of Computer programming*

SYLLABUS

(Any five experiments to be conducted)

1. Plot Plancks law for Black Body radiation,find Wein's constant and Stefan constant
2. Plot 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 hightemperature (room temperature) and low temperature and compare themfor these two cases
4. Plot Maxwell-Boltzmann distribution function
5. Plot Fermi-Dirac distribution function
6. Plot Bose-Einstein distribution function.

Reference Books:

1. Elementary Numerical Analysis, K.E. Atkinson, 3rdEdn. 2007, WileyIndia Edition
2. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Edition,1996, Oxford University Press.
3. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, FrancisW. Sears and Gerhard L. Salinger, 1986, Narosa.

4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich,2009,Springer

5. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB:Scientific and Engineering Applications: A. 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: 978-6133459274

COURSE OUTCOMES

CO1: Learn computer based programs like C/C++/Scilab to verify the radiation laws

CO-PO Mapping (CC-XIV-PRACTICAL)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO1	3	3	3	2	3	2	2	3

Programme articulation matrix row for CC-XIV-practical

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
Course CC-XIV-P	3	3	3	2	3	2	2	3

CO-PSO Mapping (CC-XIV-practical)

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
CO1	3	3	3	3	3	3	3