DEPARTMENT OF PURE AND APPLIED PHYSICS

B. Sc. (Physics) Course structure under CBCS/LOCF

Academic year 2021 – 2022

Sem.	Course	Course Code	Course Name	Credits	Credits (L+T+P)	Internal Marks/	ESE Max. Marks	Total Marks
I	Core 1	PPUATT1	Mathematical Physics-I	5	4+1+0	30	70	100
	Core 2	PPUATT2	Mechanics	3	3+0+0	30	70	100
		PPUALT2	Mechanics Lab	2	0+0+2	30	70	100
	GE-1		Opted from the pool Course and offered by Sister Departments	5		30	70	100
	AEC-1		Opted from the Pool Course offered by University	2		30	70	100
	SEC-1		Opted from the Pool Course offered by University	2		30	70	100
			Total	**19**				**600**
II	Core 3	PPUBTT1	Electricity and Magnetism	3	3+0+0	30	70	100
		PPUBLT1	Electricity and Magnetism Lab	2	0+0+2	30	70	100
	Core 4	PPUBTT2	Waves and Optics	3	3+0+0	30	70	100
		PPUBLT2	Waves and Optics Lab	2	0+0+2	30	70	100
	GE-2		Opted from the pool Course and offered by Sister Departments	5		30	70	100
	AEC-2		Opted from the Pool Course offered by University	2		30	70	100
	SEC 2		Opted from the Pool Course offered by University	2		30	70	100
			Total	**19**				**600**
III	Core 5	PPUCTT1	Mathematical Physics-II	5	4+1+0	30	70	100
	Core 6	PPUCTT2	Thermal Physics	3	3+0+0	30	70	100
		PPUCLT2	Thermal Physics Lab	2	0+0+2	30	70	100
	Core 7	PPUCTT3	Analog Systems and Applications	3	3+0+0	30	70	100
		PPUCLT3	Analog Systems & Applications Lab	2	0+0+2	30	70	100
	GE-3		Opted from the pool Course and offered by Sister Departments	5		30	70	100
	AEC-3		Opted from the Pool Course offered by University	2		30	70	100
	Additional Credit Courses					30	70	100
			Total	**22**				**800**
IV	Core 8	PPUDTT1	Mathematical Physics-III	5	4+1+0	30	70	100
	Core 9	PPUDTT2	Elements of Modern Physics	3	3+0+0	30	70	100
		PPUDLT2	Elements of Modern Physics Lab	2	0+0+2	30	70	100
	Core 10	PPUDTT3	Digital Systems and Applications	3	3+0+0	30	70	100
		PPUDLT3	Digital Systems and Applications Lab	2	0+0+2	30	70	100
	GE 4		Opted from the pool Course and offered by Sister Departments	5		30	70	100
	AEC -4		Opted from the Pool Course offered by University	2		30	70	100
	Internship*			6**		30	70	100
	Additional Credit Course					30	70	100
			Total	**22+6****				**900**

V	Core 11	PPUETT1	Quantum Mechanics & Applications	5	4+1+0	30	70	100
	Core 12	PPUETT2	Statistical Mechanics	5	4+1+0	30	70	100
	DSE - 1	PPUETD1	Fundamentals of Nano Materials	3	3+0+0	30	70	100
		PPUELD1	Basic Nano Materials Lab	2	0+0+2	30	70	100
	DSE - 2	PPUETD2	Experimental Techniques	3	3+0+0	30	70	100
		PPUELD3	Experimental Techniques Lab	2	0+0+2	30	70	100
	AEC-5		Opted from the Pool Course offered by University	2		30	70	100
	Additional Credit Courses					30	70	100
			Total	**22**				**800**
VI	Core 13	PPUFTT1	Electromagnetic Theory	5	4+1+0	30	70	100
	Core 14	PPUFTT2	Solid State Physics	3	3+0+0	30	70	100
		PPUFLT2	Solid State Physics Lab	2	0+0+2	30	70	100
	DSE 3	PPUFTD1	Basics Nuclear Physics	3	3+0+0	30	70	100
		PPUFLD2	Basics Nuclear Physics Lab	2	0+0+2	30	70	100
	Seminar	PPUFS01#	Seminar	2		30	70	100
	Dissertation	PPUFD01#	Dissertation/ project work followed by seminar	7		30	70	100
			Total	**23**				**600**
Ability Enhancement Course (AEC) offered by Department								
1	AEC	AECPP01	Indian Contribution to Physics	2	2+0+0	30	70	100
2	AEC	AECPP02	Physics for Sustainable Future	2	2+0+0	30	70	100
Skill Enhancement Course offered by Department								
1	SEC	SECPP01	Analytical Techniques in Physics	2	1+0+1	30	70	100
2	SEC	SECPP02	Renewable Energy and Energy harvesting	2	1+0+1	30	70	100
Generic Elective offered by Department								
1	GE	PPUATG1	Mechanics	3	3+0+0	30	70	100
		PPUALG1	Mechanics Lab	2	0+0+2	30	70	100
2	GE	PPUBTG2	Electricity and Magnetism	3	3+0+0	30	70	100
		PPUBLG2	Electricity and Magnetism Lab	2	0+0+2	30	70	100
3	GE	PPUCTG3	Thermal Physics	3	3+0+0	30	70	100
		PPUCLG3	Thermal Physics Lab	2	0+0+2	30	70	100
4	GE	PPUDTG4	Elements of Modern Physics	3	03+0+0	30	70	100
		PPUDLG4	Elements of Modern Physics Lab	2	0+0+2	30	70	100

#The Code generated by the Department.

PHY- Physics, T- Theory, P- Practical, S- Seminars

Semester - I

Core - 1: Mathematical Physics-I
Course Code: PPUATT1 **Credits = 5 (4+1+0)**
Course Objectives

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

Unit – I: Calculus: First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients.Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral.

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

Unit – III: Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian.Notion of 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).

Unit – IV: Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.
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.

Reference Books:

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
3. Differential Equations, George F. Simmons, 2007, McGraw Hill.
4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
5. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
6. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
7. Mathematical Physics, Goswami, 1st edition, Cengage Learning
8. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
9. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
10. Essential Mathematical Methods, K.F.Riley&M.P.Hobson, 2011, Cambridge Univ. Press.
11. Mathematical Physics, H.K. Dass and R. Verma, S. Chand & Company.

Core - 2: Mechanics **Credits = 3 (3+0+0)**
Course Code: PPUATT2

Course Objectives

- This course would empower the student to acquire theoretical concept and practical knowledge regarding mechanical motions. This syllabus will cater the basic requirements for their higher studies. This course will provide a theoretical basis for doing experiments in related areas

Learning Outcomes

- Upon successful completion of this course, students will be able to understand basic concept about Newtonian mechanics and Special theory of relativity, which is very fundamental for further higher studies in physics.

Unit – I: Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Momentum of variable-mass system: motion of rocket.Motion of a projectile in uniform gravitational field Dynamics of a system of particles.Centre of Mass. Principle of conservation of momentum.
Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces.PotentialEnergy.Energy diagram.Stable and unstable equilibrium.Elastic potential energy. Force as gradient of potential energy. Work & Potential energy.Work done by non-conservative forces.Law of conservation of Energy
Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Unit – II: Rotational Dynamics: Angular momentum of a particle and system of particles. Torque.Principle of conservation of angular momentum.Rotation about a fixed axis.Moment of Inertia.Calculation of moment of inertia for rectangular, cylindrical and spherical bodies.Kinetic energy of rotation.Motion involving both translation and rotation. **Fluid Motion:** Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube**.**

Unit – III: Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy.Inertial and gravitational mass.Potential and field due to spherical shell and solid sphere.Motion of a particle under a central force field.Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler'sLaws.Satellite in circular orbit and applications.
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

Unit – IV: Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity.Lorentz Transformations.Simultaneity and order of events.Lorentz contraction.Time dilation.Relativistic transformation of velocity, Variation of mass with velocity. Mass-energy Equivalence (only problems)

Reference Books:
1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
5. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
8. Additional References:
9. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
10. University Physics. F.W Sears, M.WZemansky, H.D Young 13/e, 1986, Addison Wesley
11. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
12. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

Core - 2: Mechanics Lab **Credits = 2 (0+0+2)**
Course Code: PPUALT2
Name of the experiments
1. Measurements of length (or diameter) using verniercalliper, screw gauge and travelling microscope.
2. To study the Motion of Spring and calculate (a) Spring constant, (b) g
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
5. To determine the elastic Constants of a wire by Searle's method.
6. To determine the value of g using Kater's Pendulum.
7. To determine coefficient ofviscosity of Glycerine by stoke's method

GE -1: Mechanics **Credits = 3 (3+0+0)**
Course Code: PPUATG1

Course Objectives

- This course would empower the student to acquire theoretical concept and practical knowledge regarding mechanical motions. This syllabus will cater the basic requirements for their higher studies. This course will provide a theoretical basis for doing experiments in related areas

Learning Outcomes

- Upon successful completion of this course, students will be able to understand basic concept about Newtonian mechanics and Special theory of relativity, which is very fundamental for further higher studies in physics.

Unit – I: Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Momentum of variable-mass system: motion of rocket. Motion of a projectile in uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum.
Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy
Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Unit – II: Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.
Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube**.**

Unit – III: Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications.
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

Unit – IV: Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity, Lorentz Transformations. Simultaneity and order of events, Lorentz contraction. Time dilation. Relativistic transformation of velocity, Variation of mass with velocity. Mass-energy Equivalence (only problems)

Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
5. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
8. Additional References:
9. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
10. University Physics. F.W Sears, M.WZemansky, H.D Young 13/e, 1986, Addison Wesley
11. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
12. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

GE -1: Mechanics Lab
Course Code: PPUALG1 **Credits = 2 (0+0+2)**
Name of Experiments

1. Measurements of length (or diameter) using verniercalliper, screw gauge and travelling microscope.
2. To study the Motion of Spring and calculate (a) Spring constant, (b) g
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Modulus of Rigidity of a Wire by Maxwell’s needle.
5. To determine the elastic Constants of a wire by Searle’s method.
6. To determine the value of g using Kater’s Pendulum.
7. To determine coefficient ofviscosity of Glycerine by stoke'smethod

AEC -1: Indian Contribution to Physics **Credits = 2 (2+0+0)**
Course Code: AECPP01

Course Objectives
- This course would empower the student to understand the ancient contribution of India towards Classical Physics.
- It will also enable the students to analysis Vaiseshika Darshan originated by Kanada with the principles of Classical Physics.
- The students will also be able to understand the great contribution of Indian Physicists towards the growth of Science and Technology

Learning Outcomes
- Upon successful completion of this course, students will be able to understand understand the ancient contribution of India towards Classical Physics.
- It will also enable the students to analysis Vaiseshika Darshan given by Kanada with the principles of Classical Physics.
- The students will also be able to understand the great contribution of Indian Physicists towards the growth of Science and Technology

Unit -1
- ❖ Need to understand the ancient contribution of India towards Classical Physics.
- ❖ Devlopment of Classical Physics in Western civilization, Ancient Engineering, temples, Dam, Monastery etc.
- ❖ Basic framework of Classical Physics of ancient indian origin.
- ❖ vaisheshika darshan- introductioncommentries on important vaisheshika sutras
- ❖ Dharma of physical world, Kanada atomic theory of universe, importance of ancient thoughts in this context.

Unit -2
- ❖ Contributions of contemporary indian physicists towards the growth of science and technology:
  - a) Dr. C.V. Raman (1888-1970), and discovery of Raman effect.
  - b) Satyendranath Bose (1894-1974), Bose-Einstein condensate.
  - c) Dr. Chandrashekhar (1910-1995) and Chandrashekhar limit in Astrology.
  - d) Dr. Meghnad Saha (1893-1956) and Saha Ionization equation.
  - e) Dr. H.J.Bhabha (1909-1966)
  - f) Vikram Sarabhai (1919-1971)
  - g) G.N. Ramachandran (1922-2001)
  - h) Jayant Narlikar (1938)

SEC -1: Analytical Techniques in Physics **Credits = 1 (1+0+0)**
Course Code: SECPP01

Course Objective
- The course focuses on the properties, functions of the internal structure, and arrangement of atoms in a crystalline material. It offers an insight into how x-ray diffraction, can solve crystallographic issues related to single and poly-crystalline material, right from the base. This course will also cover the basic principles and techniques of scanning electron microscopy and Atomic Force microscopies along with demonstrations on the instrument details and imaging experiments. The sample preparation techniques

for the microstructural analysis and surface Morphology analysis will be discussed. Structural studies by Fourier transform IR (FTIR) and Raman spectroscopies will be discussed.

Course learning outcomes:

- Students will have achieved the ability to: 1. apply appropriate characterization techniques for microstructure examination at different magnification level and use them to understand the microstructure of various materials 3. Determine crystal structure of specimen and estimate its crystallite size by X-ray Diffraction technique 4. Use appropriate spectroscopic technique to measure vibrational / electronic transitions.

Unit – I: Structure and Microstructure analysis by X-ray and electron diffraction: The geometry of crystals and reciprocal lattice, Basics of x-rays and their production and detection, X-ray diffraction, Determination of crystal structure: Qualitative and quantitative analysis, Particle size determination by x-rays, X-rays and stress analysis,

Unit – II: Scanning electron microscopy techniques and Composition analysis by Energy dispersive X-ray (EDX): Introduction to Scanning electron microscopy, Basic principles and components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast,Instrumental details and image formation, Energy-dispersive x-ray spectroscopy (paired with scanning electron microscopy) analysis to gain elemental information about samples.

Unit – III: Structural studies by Fourier transform IR (FTIR) and Raman spectroscopies: Basics of Fourier Transform Infrared (FT-IR) spectrometry,Different regions in infrared radiations, Modes of vibrations in diatomic molecule. characteristic absorption bands, Instrumental details, Qualitative treatment of Rotational Raman effect, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, Instrumental details& data accusation process.

Unit – IV: Ultra-violet and Visible Absorption Spectroscopy: Principle of UV Spectroscopy, Beer's Law and Quantitation, Deviations and limitations to Beer's Law, Instrumentation for UV-VIS spectroscopy i) Components and design ii) Actual commercial instruments, Methods and applications of absorption spectroscopy

Reference Books:

1. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).
2. Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction”, Prentice-Hall, (2001).
3. Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Liss, Inc. USA, (2001).

SEC -1: Analytical Techniques in Physics Lab **Credits = 1 (0+0+1)**
Course Code: SECPP01

1. Study X-ray diffraction for the purpose of (a) identifying (cubic) crystal systems, (b) determining the lattice constant, a,
2. Study scanning electron microscopy (SEM) technique to obtain real space atomic resolution images of conductive surfaces, Energy-dispersive x-ray spectroscopy (paired with scanning electron microscopy) analysis to gain elemental information about samples.
3. Observation and analysis of a given Spectra to understand IR & Raman spectroscopy. .
4. StudyUltra-violet and Visible Absorption Spectroscopy for finding the bandgap of a given sample. (Only Data Analysis)

Ability Enhancement Course (AEC) offered by Department for the Pool AEC courses of the University

AEC -1: Physics for Sustainable Future **Credits = 2 (2+0+0)**
Course Code: AECPP02

Course Objectives

- The students will explore the physics of energy, learning to calculate the energy content of a wide variety of systems such as speeding cars, toasty houses and hot tubs, wind, solar illumination, nuclear powerplants
- To study the basic concepts to the various energy production schemes and usages found in our lives.
- This course is meant to provide a scientific foundation for understanding the energy issues facing our country and world so that students will be able to make informed decisions regarding and participate in the ongoing debate surrounding this important global issue.
- The course goals are for each student to learn how to understand and analyze issues related to energy production and usage and its influence on the environment around us (both local and global).

Learning Outcome:

By the end of the course, the student will be able to:

- Discuss the side–effects of energy production and use, and estimate energy content and conversion.
- Explain the physical concept of energy and identify it in the world around us.
- Analyze the energy usage in our lives and be well informed on the topic of energy, its use in our society, and the impacton our environment.
- Participate in the ongoing global debate and make smart decisions.

Unit – I: Fundamental laws of Nature

Basic laws of Nature that govern all energy transformations like: statisticsand data, the second law of thermodynamics, exponential grow depletion time of a non–renewable resource, principles of relativity and anti–matter.

Unit – II: Need of energy and power losses

Power transmission and power loss.The status and current developments of energy in third–world countries.Power requirements and basics of related terminologies.

Unit – III: Nuclear Energy

Radiation and human health, radioactive wastes, history and future of nuclear power technologies, nuclear fuel resources, processing, use, and disposal. Fission and fusion power, three key issues related to reprocessing, storage and disposal.

Unit – IV: Renewable Energy

Types of renewable energies. Fundamentals of solar and wind energies and their environmental advantages/disadvantages. General characteristics of passive and active solar thermal energy, power generation with thermal solar energy, and solar photovoltaic systems. Wind tower and turbine design and their sustainability attributes.

Books Recommended:

1. University Physics with Modern Physics, Fourtheenth Edition, By Pearson.
2. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
3. Sustainable Energy Si Edition by Dunlap R A, Cengage Learning.
4. Textbook of Renewable Energy by S. C. Bhatia, R. K. Gupta, Woodhead Publishing India PVT.

Skill Enhancement Course (SEC) offered by Department for the Pool SEC courses of the University

SEC : Renewable Energy and Energy Harvesting **Credits = 2 (2+0+0)**
Course Code: SECPP02

Course Outcomes:

- To understand the Energy policies and to know some of the renewable energy sources such as solar energy, off-shore wind energy, tidal energy, biogas energy and hydroelectricity.
- Illustrate Photovoltaic conversion mechanism.
- Appraise wind energy conversion and ocean energy
- Conversion of vibration into voltage using piezoelectric materials,

- Conversion of thermal energy into voltage using thermoelectric modules.
- The students are expected to learn not only the theories of the renewable sources of energy, but also to have hands-on experiences on them wherever possible.

Unit – I: Introduction to Energy Policy:
Overview of world energy scenario; Energy Demand- present and future energy requirements; Review of conventional energy resources, Global warming; Green House Gas emissions, impacts, mitigation; sustainability; Clean Development Mechanism (CDM); Prototype Carbon Fund (PCF). Need and characteristics of photovoltaic (PV) systems, PV modules and sun tracking systems
(6)

Unit – II: Renewable Energy Sources & Instruments: Solar, wind, small hydro, biomass, geothermal and ocean energy, energy flow in ecosystem, Solar Energy Resources, Solar radiation: Spectrum of EM radiation, sun structure and characteristics.
Sunshine recorder, Pyranometer, Pyrheliometer, Albedometer, Radiation measurement stations, solar radiation data. (8)

Unit – III: Photovoltaic Materials and Devices:
Bulk and thin film forms of materials, single crystal and polycrystalline, amorphous and nano-crystalline semiconductor materials, Intrinsic, extrinsic and compound semiconductor, Electrical and optical properties of photovoltaic / semiconductor materials, p-n junction: homo and hetero junctions; solar cell design, Dark and illumination characteristics; Principle of photovoltaic conversion of solar energy, various parameters of solar cell. (8)

Unit – IV: Solar Thermal Conversion:
Solar radiation, its measurements and prediction; Solar thermal collectors- flat plate collectors, concentrating collectors; solar heating of buildings; solar still; solar water heaters; solar driers; conversion of heat energy in to mechanical energy, solar thermal power generation systems.
Introduction to Geothermal Energy, Hydro Energy and Piezoelectric Energy harvesting (8)

Reference Books

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford
5. University Press, in association with The Open University. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
7. on- conventional energy resources, B H Khan, Tata McGraw-Hill Publication 2006, ISBN 0-07-060654-42
8. Renewable Energy Resources Paperback John Twidell and Tony Weir ,Routledge, Taylor& Francis, 2015
9. Solar Photovoltaic’s: Fundamentals, Technologies And Applications, CHETAN SINGH SOLANKI, PHI Learning Pvt. Ltd., Third Edition 2015
10. Non – Conventional Energy Resources: G. D. Rai, KhannaPublishers,2008.
11. Solar Energy Fundamentals, Technology, and Systems, Klaus JägerOlindoIsabella Arno H.M. SmetsRenéA.C.M.M. van SwaaijMiroZeman Delft University of Technology, 2014

Semester - II

Core - 3: Electricity and Magnetism **Credits = 3 (3+0+0)**

Course Code: PPUBTT1

Course Objective

The course aims to develop an understanding of:

- Electric field, Magnetic field, and Electromagnetic theory.
- To learn how to apply Gauss's law to problems.
- Describe how static charge produces electricity and list examples where its effects are observed. Explain various phenomenon’s like polarization.
- Describe how dynamic/moving charge produces magnetic field and list examples where its effects are observed. Explain various phenomenon’s like magnetization in materials.
- Identify the connection between electricity and magnetism & to understand what is meant by electromotive force (emf).
- To learn different electrical networks theorems.

Learning Outcome

Upon successful completion of this course, students will be able to address following points:

- The use of Coulomb's law and Gauss' law for the electrostatic force.
- The use of the Lorentz force law for the magnetic force
- Ampere’s law and how to apply Ampere's law to problems.
- Explain various phenomenon like polarization, dielectrics, magnetization, diamagnetic, paramagnetic and Ferromagnetism, etc.
- What is meant by electromotive, motional emf and learn the formula for induced emf.
- Understand the relation in between Electromagnetic theory.
- The basic laws that underlie the properties of electric circuit elements.

Unit – I: Electric Field and Electric Potential

Electric field: Electric field lines. Electric flux.Gauss’ Law with applications to chargedistributions with spherical, cylindrical and planar symmetry.

Divergence and Curl of Electric Field, Conservative nature of electric field, Electrostatic Potential.Electrostatic energy of system of charges, Electrostatic energy of a charged sphere.Conductors in an electrostatic Field.Laplace’s and Poissonequations,Capacitance of a system of charged conductors. Parallel-plate capacitor.Capacitance ofan isolated conductor.

Method of Images and its application to: (1) Plane Infinite Sheetand (2) Sphere.

Unit – II: Dielectric Properties of Matter: Electric Field in matter. Force and Torque on a dipole. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant, Displacement vector **D**. Relations between**E**, **P** and **D**, Gauss’ Law in dielectrics and its application.

Unit – III: Magnetic Field: Magnetic force between current elements and definition of Magnetic Field **B**. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Biot-Savart’s Law and its simple applications: straight wire current, plane current and circular loop current. Ampere’s Circuital Law and its application to straight wire and Solenoid. Curl and divergence B, Vector Potential. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole).Torque on a current loop in a uniform Magnetic Field.

Unit – IV: Magnetic Properties of Matter: Magnetization vector (**M). ** Magnetic Intensity (**H).**Magnetic Susceptibility and permeability. Relation between **B, H, M**. B-H curve and hysteresis loop.

Electromagnetic Induction: Faraday’s Law. Lenz’sLaw. Self-Inductance and MutualInductance.Reciprocity Theorem. Introduction toMaxwell’s Equations. Charge Conservation and Displacement current.

Reference Books:

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
2. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
3. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
4. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education

5. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
6. Electricity and Magnetism, J.H.Fewkes&J.Yarwood. Vol. I, 1991, Oxford Univ. Press.

Core - 3: Electricity and Magnetism Lab **Credits = 2 (0+0+2)**
Course Code: PPUBLT1
Name of Experiments

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To verify the Thevenin theorems.
3. To verify the Norton theorems.
4. To verify the Superposition, and Maximum Power Transfer Theorems.
5. 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.
6. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
7. To determine the frequency of AC mains using Sonometer.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, AsiaPublishing House
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition,reprinted 1985, Heinemann Educational Publishers
4. Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning.
5. A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.

Core - 4: Waves and Optics **Credits = 3 (3+0+0)**
Course Code: PPUBTT2
Course Objectives:
The course aims to develop an understanding of:

- The type of waves and various phenomenon of optics.
- The superposition of waves, progressive and stationary waves, optical phenomenon based on superposition of waves such as Interference and Diffraction.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:

- The physics behind various phenomenon in wave and optics.
- The significance of superposition of waves and optical phenomenon based on principle of superposition of waves.

Unit – I: Superposition of Harmonic oscillations:
Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.
Superposition of two perpendicular Harmonic Oscillations, Graphical and Analytical Methods of Lissajous Figures with equal and unequal frequency and their uses.

Unit – II: Wave Motion and Velocity:
Plane Wave. Longitudinal and Transverse Waves. Plane Progressive (Traveling) Waves. Wave Equation. Particle and Wave Velocities. Group Velocity, Graphical Relation between Wave and Group Velocity, Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave.
Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

Unit – III: Interference:
Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. (9 Lectures)

Unit – IV: Fraunhofer and Fresnel Diffraction:
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.

Reference Books:
1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
3. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
4. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
5. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

Core - 4: Waves and Optics Lab **Credits = 2 (0+0+2)**
Course Code: PPUBLT2
Name of Experiments
1. To determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda 2$ –T law.
2. To investigate the motion of coupled oscillators.
3. Familiarization with: Schuster`s focusing; determination of angle of prism.
4. To determine refractive index of the Material of a prism using sodium source.
5. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
6. To determine wavelength of sodium light using Fresnel Biprism.
7. To determine wavelength of sodium light using Newton's Rings.
8. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
9. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
10. To determine dispersive power and resolving power of a plane diffraction grating.

Semester - III

Core - 5: Mathematical Physics-II **Credits = 5 (4+1+0)**
Course Code: PPUCTT1
Course Objectives:
The course aims to develop an understanding of:
- Student will learn to solve different types of periodic functions using Fourier series.
- In physics, generally we encounter different types differential equations. Ordinary differential equations and series solution methods with special functions are taught here in this course to solve various types of differential equations.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- To analyse the periodic functions by Fourier series methods.
- To solve differential equations using special functions and other differential equation methods.

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

Unit – II: Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues

Formula, Generating Function, Orthogonality. Simple recurrence relations. Bessel Functions of the First Kind: Generating Function, simple recurrence relations.

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

Unit – IV: Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry.

References:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
2. Fourier analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
4. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
5. Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
6. Mathematical methods for Scientists & Engineers, D.A. Mc-Quarrie, 2003, Viva Books

Core - 6: Thermal Physics **Credits = 3 (0+0+0)**
Course Code: PPUCTT2
Course Objectives:
The course aims to develop:

- To learn how to apply thermodynamic principles in order to interpret thermodynamic systems and predict their behaviors.
- To make familiar with laws of thermodynamics
- The understanding of the biggest natural force 'Heat' and its manifestations in natural phenomenon
- To become familiar with the thermodynamic potentials and statistics of gas theory.

Learning Outcomes:
Upon successful completion of this course, students will be able to:

- Understand the thermodynamic systems in nature.
- Understand the law of thermodynamics, concept of efficiency of heat engines and Carnot engine.
- Understand different thermo dynamical processes and explanation of various natural phenomena.
- Understand of the various thermodynamical relations and heat transport
- Understand the different behavior of the gases under temperature and their distribution laws

Unit – I: Introduction to Thermodynamics Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.

Unit – II: Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Second Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics. Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy.Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

Unit – III: Thermodynamic Potentials: Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, ClausiusClapeyron Equation and Ehrenfest equations. Maxwell's Thermodynamic Relations:

Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) Tds Equations.

Unit – IV: Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy. Specific heats of Gases. Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. Van der Waal's Equation of State for Real Gases, P-V Diagrams. Joule's Experiment, Free Adiabatic Expansion of a Perfect Gas. Temperature of Inversion,

Reference Books:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
3. Thermal Physics, Charles Kittel, H. Kroemer, Publisher: W. H. Freeman, 1980
4. Concepts in thermal Physics by B. Stephen, 2nd Edition, Oxford University Press, 2010.

Core - 6: Thermal Physics Lab **Credits = 2 (0+0+2)**
Course Code: PPUCLT2
Name of the experiments

1. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
2. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's 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 calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.
6. Coefficient of linear expansion using Gumber method.
7. Specific heat determination by calorimeter method.

Core - 7: Analog Systems and Applications **Credits = 3 (3+0+0)**
Course Code: PPUCTT3

Course Objectives:

- To understand basic analog circuit and their applications using active devices.
- To understand electronic system (oscillators) with a continuously variable signal.
- To learn use of active component in linear circuit.
- To understand component symbol, working principle, classification and specification of amplifiers.
- To learn different theorems for simplification of basic linear electronic circuits

Learning Outcomes:

Upon successful completion of this course, students will be able to address following points:

- Basic of semiconductors like energy level, drift velocity, fabrication process, Barrier Potential, Barrier Width
- Fundamentals of N-P-N and P-N-P Transistors and use of transistor as Amplifier
- Working of different oscillators
- Basic of Op-AMP

Unit – I: Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity.PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode.Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction.(10 Lectures)
Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation.(4 Lectures)

Unit – II: Bipolar Junction transistors: N-P-N and P-N-P Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cut-off and Saturation Regions. (6 Lectures) Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network.h-parameter Equivalent Circuit. Analysis of 29 a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. (10 Lectures)

Unit – III: Coupled Amplifier: RC-coupled amplifier and its frequency response. (4 Lectures) Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability (4 Lectures)

Unit – IV: Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley &Colpitts oscillators. (4 Lectures) Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response.CMRR. Slew Rate and concept of Virtual ground. (4 Lectures)

Reference Books:

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill
2. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
3. Solid State Electronic Devices, B.G.Streetman&S.K.Banerjee, 6th Edn.,2009, PHI Learning
4. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
5. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India 8. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

Core - 7: Analog Systems and Applications Lab **Credits = 2 (0+0+2)**
Course Code: PPUCLT3
Name of the experiments

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
6. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
7. To design a phase shift oscillator of given specifications using BJT.
8. To study the Colpitt`s oscillator.

Semester - IV

Core - 8 : Mathematical Physics-III
Course Code: PPUDTT1 **Credits: 5 (4+1+0)**
Course Objectives:
The course aims to develop an understanding of:
• The concept of Laplace transforms and inverse Laplace transforms.
• The concept of complex analysis and Fourier transform

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
• Apply Laplace and inverse Laplace transform to different applications
• Apply Fourier transform to different applications.
• Use the complex analysis for finding singularity, residues and integral value of a given complex function.

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

Unit – II: Integrals Transforms: Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral.

Unit – III: Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.

Unit – IV: Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of ScaleTheorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals ofLTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT, Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence,3rd ed.,2006, Cambridge University Press
2. Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications
3. Complex Variables, A.S. Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
4. Complex Variables and Applications, J.W. Brown &R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
5. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett

Core - 9: Elements of Modern Physics
Course Code: PPUDTT2 **Credit: 3 (3+0+0)**

Course Objectives:
This course covers certain conceptual courses of physics by virtue of which the students will be able to understand some concepts of Quantum Mechanics and Nuclear Physics.
It also imparts the basic principles of Quantum mechanics, Schrodinger equation and its applications

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
Understand and explain the differences between classical and quantum mechanics.
Solve Schrodinger equation for simple potentials.
Assess whether a solution to a given problem is physically reasonable.
Identify properties of the nucleus and other sub-atomic particles.

Unit – I: Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions.

Unit – II: Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.

Unit – III: One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; tunneling in one dimension-across a step potential & rectangular potential barrier, Position measurement-gamma ray microscope thought experiment; Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- range of an interaction.

Unit – IV: Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers, Introduction to fission and fusion.
Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission.

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
3. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
4. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
5. Quantum Mechanics: Theory & Applications, A. K. Ghatak & S.Lokanathan, 2004, Macmillan
6. Quantum Mechanics: Concepts and Applications, Wiley Publisher , Nouredine Zettili

Core - 9: Elements of Modern Physics Lab
Course Code: PPUDLT2 **Credit: 2 (0+0+2)**
Name of the experiments

1. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
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 wavelength of H-alpha emission line of Hydrogen atom.
6. Determination of Planks constant by Photo electric effect.
7. Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).

Core - 10 : Digital Systems and Applications
Course Code: PPUDTT3 **Credit: 3 (3+0+0)**
Course Objectives:

- To make the student understand the digital system.
- To understand the Boolean algebra and data processing circuit.
- Understanding the arithmetic and sequential circuit

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:

- Gain both theoretical and experimental knowledge about digital electronics..
- Verify and design various logic gates.
- Use combinational logic circuit in various applications.
- Test various asynchronous sequential circuits.
- Build the sequential circuits based on algorithmic state machines (ASM) chart.

Unit – I: Digital Circuits: Difference between Analog and Digital Circuits**.** Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal, and Hexadecimal numbers. AND, OR, and NOT Gates ,NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application.

Unit – II: Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of LogicCircuit using Boolean algebra. Fundamental Products. The idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and and (2) Karnaugh Map.

Unit – III: Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. Data processing circuits: Basic idea of Multiplexers, Demultiplexers, Decoders, Encoders.

Unit – IV: Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop. Shift Registers: SISO, SIPO, PISO,PIPO. Counters: Asynchronous Counters and Synchronous Counters.

Reference Books:

1. Fundamentals of Digital Circuits, Anand Kumar, 2ndEdn, 2009, PHI Learning Pvt. Ltd.
2. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
3. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
4. Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.
5. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill

Core - 10 : Digital Systems and Applications Lab
Course Code: PPUDLT3 **Credit: 2 (0+0+2)**
Name of the experiments

1. To design a switch (NOT gate) using a transistor.
2. To verify and design AND, OR, NOT and XOR gates using NAND gates.
3. To design a combinational logic system for a specified Truth Table.
4. To convert a Boolean expression into the logic circuit and design it using logic gate ICs.
5. To minimize a given logic circuit..
6. Half Adder, Full Adder and 4-bit binary Adder.
7. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder
8. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
9. To build JK Master- Slave Flip-Flop circuits using Flip-Flop ICs.
10. To build a 4-bit Counter using D-type /JK Flip-Flop ICs.

Semester - V

Core 11 : Quantum Mechanics & Applications
Course Code: PPUETT1 **Credit: 5 (4+1+0)**
Course Objectives:

- To introduce the modern concepts of quantum mechanics in a stimulating, elegant, exhaustive and explanatory manner.
- To explore the nature of the microscopic world into substantial depth in terms of meaning and interpretation so as to acquaint the learners to initiate thinking and analysing the physically observable phenomena quantum mechanically without exceeding the mathematical level of complexity.
- To lay down the foundation and enhance capabilities of students to pursue various aspects of modern physics and interdisciplinary fields confidently.

Course Outcomes:

After the completion of course, students should be able to understand and grasp

- The basic concepts of quantum mechanics including the solution of wave equation, interpretation of dynamical variables and applying wave mechanics to various situations in terms of boundary value problems so as to understand the quantum well, barriers and particle motion in different types of force field (potentials). Its basic applications in modelling Quantum dots Quantum wires and wells in nanotechnology, understanding and implication of quantum tunnelling.
- Applying special functions as the solutions of differential equation as the wave function/state functions and understanding the physical situations where these can be applied.
- Calculating states of electrons in hydrogen atom and harmonic oscillators and the interpretation of quantum states.
- Applying the stationary perturbation problems to various problems including particle states splitting in electric and magnetic field.
- Introduction of Algebraic method (Heisenberg matrix mechanics) to learners
- Application of Commutator algebra and operators in finding the states and properties of various quantum systems

Unit – I: Introduction to Schrodinger equation; probability interpretation, probability current, Admissible wave functions; Stationary states, Schrodinger equation in one dimensional problems, wells and barriers;

Extension to three dimensional problems, Applications in Quantum dots Quantum wires and wells in nanotechnology, understanding and implication of quantum tunnelling, Harmonic oscillator solution by Schrodinger Equation

Unit – II: General Formalism of wave mechanics; Commutation Relations; Representation of states and dynamical variables; Completeness of eigen functions; Dirac delta function; Bra and ket Notation; Matrix representation of an operator; Unitary transformation. Solution of Harmonic oscillator by operator method.

Unit – III: Angular momentum in QM; Central force problems: Spherically symmetric potential, Schrodinger equation in spherical polar coordinates, Solution of Schrodinger equation for spherically symmetric potentials; Hydrogen atom problem. Interpretation of hydrogenic states.

Unit – IV: Need for approximation methods, Time independent perturbation theory, its validity/conditions for applications; non-degenerate and degenerate cases; calculating corrections in state functions and energy up to first order, Applications such as Stark effect, Zeeman effect, etc.

Core 12 : Statistical Mechanics
Course Code: PPUETT2 **Credit: 5 (4+1+0)**
Course Objectives:

- To understand connection between Thermodynamics and Statistical Mechanics.
- To understand Ensemble and Phase space.
- To learn use of Partition function.
- To understand different distribution law
- To learn the use of different distribution function

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:

- Difference of Macro state & Microstate and limitation of Thermodynamics and quantum mechanical calculations
- Fundamental difference of classical and quantum statistical distribution
- Application of Fermi distribution function to understand electronic contribution of Heat capacity, behaviour of metal
- Application of B-E distribution function to understand lattice contribution of Heat capacity, Blackbody Radiation, Bose Einstein condensation

Unit – I: Classical Statistics: Thermodynamic potentials, Macrostate& Microstate, Concept of Ensemble, Phase Space, Dynamical variable, Entropy, Partition Function, relation of partition function with Thermodynamic Functions, application of partition function. Thermodynamic Probability, Law of Equipartition of Energy (with proof) (15 Lectures)

Unit – II: Maxwell-Boltzmann Distribution Law, B-E distribution law, Fermi-Dirac Distribution Law (10 Lectures)

Unit – III: Fermi-Dirac Statistics: Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Fermi sphere, Electron gas in a Metal, Specific Heat of Metals. (15 Lectures)

Unit – IV: Bose-Einstein Statistics: Heat capacity, Bose Einstein condensation, Radiation as a photon gas, Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law. (13 Lectures)

Reference Books:

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
2. Statistical mechanics by Kerson Huang (2Ed, Wiley, 1987)
3. Statistical Physics: Volume 5: EvgenyLifshitz and Lev Landau
4. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
5. Statistical Mechanics *by D. A.* McQuarrie.

DSE - 1 : Fundamentals of Nano Materials **Credit: 3 (3+0+0)**
Course Code: PPUETD1
Course Objectives:
The course aims to develop an understanding of:
- To develop basic understanding of nanomaterials.
- To provide the knowledge on synthesis of various nanomaterials.
- To acquire the knowledge on characterization of nanomaterials.
- To able to understand the charge transport in nanoscale materials.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- Learn the basic physics of materials at nanoscale.
- Learn the various experimental techniques for synthesis of nanomaterials.
- Learn about structural and morphological characterizations of nanomaterials.
- Knowledge of the charge transport in nanomaterials.

Unit – I: Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.

Unit – II: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition.

Unit – III: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.

Unit – IV: Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects.

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

DSE - 1 : Basic Nano Materials Lab **Credit: 2 (0+0+2)**
Course Code: PPUELD1
Name of the experiments
1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of ZnO nanoparticles
3. Study UV-Visible spectroscopy of nanomaterials.
4. XRD pattern of nanomaterials and estimation of particle size.
5. To prepare composite of CNTs with other materials.
6. Growth of quantum dots by thermal evaporation.
7. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.

DSE - 2 : Experimental Techniques **Credit: 3 (3+0+0)**
Course Code: PPUETD2
Course Objectives:
The course aims to develop an understanding of:
- Various measurement parameters like precession, accuracy and variety of signals, frequency response of systems and noise measurements

- Working and construction of digital multimeter
- Working and construction of transducers and sensors
- The working, construction of variety of vacuum pumps and techniques of vacuum level measurement

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- Knowledge of accuracy, precession, types of errors and variety of noise
- The course intends to impart knowledge of basic instrumentation tools and techniques to physics
- Course intends to impart knowledge of variety of transducers/sensors required for industrial instrumentation
- Knowledge about variety of vacuum pumps and vacuum measurement techniques

Unit – I: Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation) and curve fitting. Gaussian distribution.

Unit – II: Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise.
Digital Multimeter: Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement.

Unit – III: Electrical, Thermal and Mechanical system. Calibration. Characteristics of Transducers. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35) and signal conditioning. Linear position transducers: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector.

Unit – IV: Vacuum Systems: Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization).

Reference Books:

1. Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk, 2008, Springer.
2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, Mc-Grew Hill.
3. Measurements, Instrumentation and Experimental Design in Physics & Engineering, M. Sayer and A. Mansingh, 2005, PHI Learning.
4. Electrical and Electronic Measurements and Instrumentation, A. K. Sawhney.
5. Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.

DSE - 2 : Experimental Techniques Lab
Course Code: PPUELD2 **Credit: 2 (0+0+2)**
Name of the experiments
1. Determine output characteristics of a LVDT & measure displacement using LVDT.
2. To study the characteristics of a Thermostat and determine its parameters.
3. Study of distance measurement using ultrasonic transducer.
4. Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75).
5. To measure the change in temperature of ambient using Resistance Temperature Device (RTD).
6. Create vacuum in a small chamber using a mechanical (rotary) pump and measure the chamber pressure using a pressure gauge.
7. Design and analyze the clippers and Clampers circuits using junction diode.
8. Measurement of Strain using Strain Gauge.
9. Measurement of level using capacitive transducer.

Semester - VI

Core 13: Electromagnetic Theory **Credit: 5 (4+1+0)**

Course Code: PPUFTT1
Course Objectives:
The course aims to develop
- An understanding of Electromagnetic Waves and their fundamentals.
- Ability to understand the concept of Gauge and invariance of fields.
- Understanding of the propagation of waves in different media such as dielectric, metallic, anisotropic and plasma.
- Ability to interpret optical phenomenon by using Electromagnetic Waves theories
- Understanding of polarization phenomenon

Learning Outcomes:
At the end of this course student will demonstrate the ability to:
- Understand Maxwell's equations for electromagnetic waves using Gauge concept
- Understand the propagation of electromagnetic waves in different media and related characteristics
- Calculate reflection and transmission of waves at media interface
- Understand the aspects related to Polarized lights and its generation as superposition of different waves

Unit – I: Maxwell Equations: Review of Maxwell's equations. Vector and Scalar Potentials. Maxwells equations in terms of scalar and vector potentials. Concept of Gauge. Gauge Transformations: Lorentz and Coulomb Gauge. Propagation of electromagnetic plane waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density and Momentum Density. Radiation Pressure.

Unit – II: EM Wave Propagation in Unbounded Media: Transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, skin depth. Propagation of E.M. Waves in Anisotropic Dielectrics. Fresnel's law of normal velocities. Propagation of plane electromagnetic waves in ionized gases.

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

Unit – IV: Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Optical Rotation. Fresnel's Theory of optical rotation. Specific rotation. Laurent's half-shade polarimeter.

Reference Books:

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
2. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
3. Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
4. Electromagnetic Theory, Chopra & Agrawal, K. Nath Publishing
5. Optics, Ajoy Ghatak, Tata Mc-Graw Hill Publishing
6. Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
7. Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press

Core 14: Solid State Physics **Credit: 3 (3+0+0)**
Course Code: PPUFTT2
Course Objectives:
The course provides
- An overview of solid state physics and students how to apply classical and quantum mechanical theories needed to understand the properties of solids.
- The emphasis is on developing models that can describe a variety of solid-state phenomena.

- The fundamental knowledge in solid state physics and then study their physical properties

Learning Outcomes:

Upon successful completion of this course, students will be able to address following points:

- Students will be able to calculate the Braggs conditions for X-ray diffraction in crystals and will calculate the conditions for allowed and forbidden reflections in crystals.
- Know the concept of Lattice Vibrations and Phonons, and how the dispersion relationship appears for different lattice structures.
- Know the concept Depolarization Field, Electric Susceptibility, Polarizability.
- Classify solid state matter according to their band gaps.
- Know the basic physics behind dia, para and ferromagnetism**.**

Unit – I: Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law.

Unit – II: Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law

Unit – III: Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials.Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Unit – IV: Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion.

Elementary band theory and Superconductivity: Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators, P and N type Semiconductors, Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient.

Superconductivity: Experimental Results. Critical Temperature, Critical magnetic field, Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth, Isotope effect.

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
4. Solid State Physics, Neil W. Ashcroft and N. David Mermin, 1976, Cengage Learning
5. Solid State Physics, A J Dekkar Macmillan India Ltd., New Delhi, 2004.
6. Solid State Physics, Rita John, 2014, McGraw Hill
7. Solid-state Physics, H. Ibach and H Luth, 2009, Springer
8. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
9. Solid State Physics, M.A. Wahab, 2011, Narosa Publications

Core 14: Solid State Physics Lab
Course Code: PPUFLT2 **Credit: 2 (0+0+2)**
Name of the experiments

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solution (Gouy's Method).
3. To measurement of the Dielectric Constant.
4. To study of V-I characteristics curves of optoelectronics devices and verification of inverse square law.
5. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four-probe method (from room temperature to 150 C) and to determine its band gap.
6. To determine the Hall coefficient of a semiconductor sample.

DSE 3: Basics Nuclear Physics **Credit: 3 (3+0+0)**
Course Code: PPUFTD1
Course Objectives:
The course aims to develop an understanding of:
- To get an idea about the structure of atomic nucleus.
- To impart knowledge about basic nuclear properties
- To introduce nuclear models for understanding its structure
- To understand the basics of nuclear decay and reaction mechanism
- To import the knowledge of basics nuclear detectors and accelerators.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- explain the constituents of the nucleus, ground state properties of the nucleus
- describe the structure of the atom in terms basic nuclear structure models
- Understand the various types of radiations and its decay mechanism
- Understand the basic of interaction of radiations with matter and different types of detectors used for detecting the radiations.
- Basics of particle accelerators.

Unit – I: General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, nuclear fission and fusion N/A plot, angular momentum, parity, magnetic moment, electric moments.

Unit – II: Nuclear Models: Liquid drop model approach, semi empirical mass formula and, significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field.

Unit – III: Nuclear decay and Reactions: Alpha, beta, gamma decay, energy spectrum, Geiger-Nuttel law, disintegration energy, quantum theory of alpha decay, types of beta decay and energy spectrum, Pauli's prediction of neutrino.
Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).

Unit – IV: Nuclear Detector and Particle Accelerators: Interaction of charge particle through matter, 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. Accelerator facility available in India: Van-de Graaff generator, Pelletron accelerator, Linear accelerator, Cyclotron accelerator.

Reference Books:
1 Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
2 Concepts of nuclear physics by Bernard L. Cohen. (Tata Mc-Graw Hill, 1998).
3 Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
4 Nuclear Physics An Introduction S. B. Patel New Age International Publishers.
5 Introduction to Nuclear and Particle Physics V.K. Mittal, R. C. Verma, S. C. Gupta, Eastern Economy Edition.
6 Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).

DSE 3: Basics Nuclear Physics Lab **Credit: 2 (0+0+2)**
Course Code: PPUFLD2
1. To study the variation of count rate with applied voltage of Geiger-Müller counter and their by determine its plateau, operating voltage and slope of plateau.
2. Verify the inverse square law for γ-ray using Geiger-Müller counter.

3. To estimate the efficiency of GM detector for beta and gamma source.
4. To determine the different reaction channels for a given reaction using PACE4 software and draw the excitation function.
5. To perform energy calibration of NaI detector and determine the energy resolution of known decay transition.
6. To perform spectrum analysis of ^{60}Co and ^{137}Cs with NaI detector using single channel analyzer.
7. To determining the efficiency of a given unknown alpha emitting radio isotope