POST GRADUATE DEPARTMENT OF PHYSICS

UNIVERSITY OF KASHMIR, SRINAGAR

(Course Curriculum M.Sc Physics SEMESTER-II)

Academic years 2021, 2022 and 2023

Type of Course	Course Code	Title of Course	No. of Credits
Core (CR)			
CR	PHY18201CR	Statistical Mechanics	04
CR	PHY18202CR	Electrodynamics	04
CR	PHY18203CR	Quantum Mechanics - II	04
CR	PHY18204CR	Lab. Course	04
Discipline Centric Electives (DCE)			
DCE	PHY18205DCE	Mathematical Physics - II	04
DCE	PHY18206DCE	Digital Electronics	04
DCE	PHY18207DCE	Fluid Dynamics	04
Generic Electives (GE)			
GE	PHY18208GE	Renewable Energy Resources	02
GE	PHY18209GE	Crystallography	02
Open Electives (OE)			
OE	PHY18210OE	Philosophical Foundations of Physics	02

Table 1: Semester - II Course Details

Title:Statistical Mechanics **(Course Code:PHY18201CR)**

Max.Marks:100 **Int. Assessment:** 20 **Ext. Examination:** 80 **Credits:** 04

Course Outcome:

Learning Outcome:

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Unit-I

Statistical Distributions; Statistical independence, Liouvilles theorem, Significance of energy, Statistical Matrix, Statistical Distributions in quantum Statistics, Microcanonical, Canonical and Grand Canonical ensemble, Partition Function, Calculation of Statistical Quantities, Energy and Density Fluctuations.

Unit-II

Gibbs distribution, Maxwellian distribution, Probability distribution for an Oscillator, Free energy in the Gibbs distribution, Gibbs distribution for rotating bodies and for a variable number of particles, Derivation of thermodynamics relations from the Gibbs distribution.

Unit-III

Fermi distribution, Bose distribution, Fermi and Bose gases of elementary particles, Degenerate electron gas, Specific heat of degenerate electron gas, Weak fields, Strong fields, Relativistic degenerate electron gas, Degenerate Bose gas, Black body Radiation. Deviation of gases from the ideal state, Expansion in powers of density, Relationship of the virial coefficients

Unit-IV

Conditions for phase equilibrium; the Clapeyron-Clausius formula, Critical point, Law of Corresponding states, Phase transitions of the second kind, Discontinuity of Specific heat, Effect of an external field on a phase transition, Change in symmetry in a phase transition of the second kind, Fluctuations of the order parameter, Critical indices, scale invariance.

Text Books:

1. Statistical Physics, Landau and Lifshitz, Butterworth-Heineman, An imprint of Elsevier, Linacre House, Jordan Hill, Oxford OX2 8DP, UK

References:

1. Statistical Mechanics by K Huang

2. Statistical and Thermal Physics by F. Reif

3. Statistical Mechanics by Pateria Neise and Stocker

4. Fundamentals of Statistical Mechanics by B. B. Laud.

5. Thermodynamics and Statistical Mechanics by Greiner,

Title: Electrodynamics **(Course Code: PHY18202CR)**

Max.Marks:100 **Int. Assessment:** 20 **Ext. Examination:** 80 **Credits:** 04

Course Outcome: The course aims to equip students with a comprehensive understanding of electrodynamics. This includes topics such as the four potential formulation, equations governing charge motion in electromagnetic fields, gauge invariance, and the analysis of constant electric, magnetic, and electromagnetic fields using Maxwell's equations. Students will develop proficiency in Laplace equations, boundary conditions, and methods of images, enabling them to address electrostatic energy, dipole moments, and multipole moments, along with the impact of external magnetic fields. Additionally, the course covers advanced concepts in electromagnetic wave propagation, encompassing wave equations, plane waves, monochromatic waves, spectral resolution, partially polarized light, and principles of reflection, refraction, and propagation through conducting media. Students will also delve into topics such as retarded potentials, Lienard-Wiechert potentials, and radiation phenomena, including dipole radiation, quadrupole, and magnetic dipole radiation, synchrotron radiation, and radiation damping. Throughout the course, students will apply these theoretical principles to practical scenarios, enhancing their analytical and problem-solving skills in the field of electrodynamics.

Learning Outcome:

- Demonstrate a deep understanding of the four potential formulation and equations governing the motion of charges in electromagnetic fields.
- Apply gauge invariance principles to analyze constant electric, magnetic, and electromagnetic fields, employing Maxwell's equations in covariant form.
- Proficiently solve Laplace equations and address boundary conditions in the context of constant electromagnetic fields.
- Analyze electrostatic energy and the electromagnetic field of moving charges, including the effects of external magnetic fields.
- Understand and apply the principles of dipole moments, multipole moments, and the behavior of a system of charges in an external field.
- Gain practical knowledge of waveguides and their applications, including propagation through conducting media.
- Analyze electromagnetic wave propagation, covering wave equations, plane waves, monochromatic waves, and spectral resolution.

- Understand the principles of partially polarized light and apply them in the context of reflection and refraction phenomena.
- Demonstrate knowledge of advanced topics, including retarded potentials, Lienard-Wiechert potentials, and various radiation phenomena such as dipole, quadrupole, and magnetic dipole radiation, synchrotron radiation, and radiation damping.
- Apply theoretical concepts to practical scenarios, enhancing analytical and problem-solving skills in the field of electrodynamics.

Unit-I

Four Potential Formulation, Equations of motion of charge in electromagnetic field, Gauge invariance, Constant electric field, constant magnetic field and constant electromagnetic field. Electromagnetic field tensor, invariants of the field. Maxwells equations in covariant form, continuity equation, Energy- momentum field tensor.

Unit-II

Constant EM Field: Laplace equation, Boundary Conditions, Methods of Images. Electrostatic energy of charges, The field of a uniformly moving charge, Motion in the Coulomb field, The dipole moment, Multipole moments, System of charges in an external field, Constant magnetic field, Magnetic moments, Larmor's theorem.

Unit-III

EM waves: The wave equation, Plane waves, Monochromatic plane waves, Spectral resolution, Partially polarized light. Reflection and Refraction. Rectangular Waveguide. Propagation through conducting medium.

Unit-IV

The retarded potentials, The Lienard-Wiechert potentials, The field of a system of charges at large distances, Dipole radiation, Dipole radiation during collisions. Quadrupole and magnetic dipole radiation, Synchrotron radiation, Radiation damping.

Text Books:

1. The Classical Theory of Fields, L. D. Landau and E. M. Lifshitz
2. Electrodynamics of Continuous Media,L. D. Landau and E. M. Lifshitz

References:

1. Classical Electrodynamics byJ. D. Jackson
2. Theory of Charged Particles by Rohrlich

Title: Quantum Mechanics - II **(Course Code: PHY18203CR)**

Max.Marks:100 **Int. Assessment:** 50 **Ext. Examination:** 50 **Credits:** 04

Course Outcome: Upon completion of this advanced quantum mechanics course, students will achieve a profound understanding of diverse theoretical frameworks and practical applications within the realm of quantum physics. They will master time-independent perturbation theory, distinguishing between non-degenerate and degenerate cases, and apply this knowledge to real-world scenarios such as the linear harmonic oscillator, Zeeman effect, Stark effect, and higher-order perturbations. The variational method and WKB approximation will be within their repertoire for optimizing approximations and solving bound state problems. Additionally, students will gain competence in time-dependent perturbation theory, scattering theory in three dimensions, and the analysis of identical particles, covering spin, statistics, and collision dynamics. They will also delve into the semi-classical theory of radiation, exploring transition probabilities for absorption and induced emission, as well as electric dipole and forbidden transitions. The course will culminate with a comprehensive understanding of relativistic quantum mechanics, encompassing the Klein-Gordon and Dirac equations, free particle solutions, and the interpretation of negative energy states, offering students a well-rounded expertise in advanced quantum phenomena and their applications.

Learning Outcome: Learn

- Attain proficiency in time-independent perturbation theory, distinguishing between non-degenerate and degenerate cases, and apply this knowledge to real-world scenarios such as the linear harmonic oscillator, Zeeman effect, Stark effect, etc.
- Master the variational method and its applications, demonstrating the ability to optimize approximations and solutions for quantum systems.
- Develop competence in the WKB approximation method, enabling the accurate solution of bound state problems in quantum mechanics.

  Understand the principles of time-dependent perturbation theory, particularly harmonic perturbation, Fermi's golden rule, and the adiabatic and sudden approximation methods.
- Demonstrate understanding of collision in three dimensions and scattering phenomena, distinguishing between laboratory and center-of-mass reference frames. Apply this knowledge to calculate scattering amplitudes, differential scattering cross-sections, and total scattering cross- sections for various potentials.

- Apply the concept of partial waves and phase shifts to analyze scattering by spherically symmetric potentials, including cases involving a perfectly rigid sphere and square well potential. Understand the role of complex potentials and absorption in scattering phenomena.
- Gain proficiency in the quantum mechanics of identical particles, understanding symmetric and antisymmetric wave functions, spin and statistics, the exclusion principle, and distinguishability of identical particles. Explore collision dynamics of identical particles and spin angular momentum in many-electron systems.
- Understand the semi-classical theory of radiation, including transition probabilities for absorption and induced emission. Gain insights into electric dipole transitions and forbidden transitions within the quantum framework.
- Develop a comprehensive understanding of relativistic quantum mechanics, studying the Klein- Gordon equation and Dirac equation. Analyze free particle solutions, probability density,

  probability current density, and interpret negative energy solutions in the context of the Klein- Gordon and Dirac equations.
- Explore the spin of an electron and interpret negative energy states within the Dirac equation, gaining insights into the relativistic quantum behavior of fundamental particles.

Unit-I

Time-independent perturbation theory, Non-degenerate & degenerate cases, Applications such as linear harmonic oscillator, Zeeman effect, Stark effect, Perturbation of the type X2, X3, X4. Variational method and its applications, WKB approximation, Solution of bound state problems, Time -dependent perturbation theory, Harmonic perturbation, Fermi's golden rule, Adiabatic and sudden approximation.

Unit-II

Collision in 3-D and scattering, Laboratory and CM reference frames, Scattering amplitude, differential scattering cross and total scattering cross, Scattering by spherically symmetric potentials, Partial waves and phase shifts, Scattering by a perfectly rigid sphere and by square well potential, Complex potential and absorption.

Unit-III

Identical particles, Symmetric and antisymmetric wave functions, Spin and Statistics, The Exclusion Principle, Distinguishability of Identical Particles, Collision of identical particles; Spin angular momentum, Spin functions for a many-electron system. Semi classical theory of radiation, Transition probability for absorption and induced emission, Electric dipole and forbidden transitions.

Unit-IV

Relativistic QM: The Klein-Gordon equation, Free particle solutions, probability density & probability current density, interpretation of negative energy solutions of the K-G equation. The Dirac equation, Free particle solutions, Probability density and probability density current for the free particle Dirac equation, Spin of an electron, Interpretation of negative energy states.

Text Books:

1. L. I. Schiff, Quantum Mechanics, McGraw Hill, New York, Toronto, London, Kogakush Company Pvt. Ltd. Tokyo
2. Mechanics by Landau and Lifshitz

References:

1. Cohen, Dieu, Laloe, Quantum Mechanics
2. A. P. Messiah, Quantum MechanicsA.
3. J. J. Sakurai, Modern Quantum Mechanics
4. Mathews and Venkatesan, Quantum Mechanics
5. Bjorken and Drell, Relativistic Quantum Mechanics
6. J. R. Atchison, Relativistic Quantum Mechanics
7. Greiner, Relativistic Quantum Mechanics

Title: Lab. Course **(Course Code: PHY18204CR)**

Max.Marks:100 **Int. Assessment:** 50 **Ext. Examination:** 50 **Credits:** 04

Course Outcome: Develop proficiency in using various laboratory apparatus and instruments and verify the laws of Physics.

Learning Outcome: Learn

- Experimental Technique
- Data Collection and Analysis
- Relate theoretical concepts learned in lectures to real-world physical phenomena
- Utilize technology and software for data collection, analysis, and visualization
- Create clear and accurate graphical representations of experimental data.
- Follow safety guidelines and protocols when conducting experiments.
- Apply theoretical knowledge from lectures to design and conduct experiments.
- Evaluate and understand the uncertainty associated with experimental measurements.
- Develop an understanding of the scientific method through hypothesis testing and experimentation.

Description

There shall be about 20 experiments available in the lab out of which the student shall have to complete at least 06 experiments in this semester.

List of Experiments

The list of experiments presently available is as follows:

1. To determine the wave length of a laser with a diffraction grating.
2. TTo determine the energy gap of a semiconductor using Four probe method.
3. To determine the curie temperature of an electrical material BaTio3
4. To determine the dead time and absorption Co-efficient using G.M. Counter.
5. ESR: Electron Spin Resonance.

6. To determine the velocity of ultrasound in a given liquid medium (kerosene)
7. To determine the Hall coefficient for a semiconductor sample.
8. Designing and studying RC filters Active and Passive.
9. To Determination of e/m ratio of electron by J.J. Thomson's method.
10. To Determination of e/m ratio of electron by Helical method
11. To determine the velocity of sound using Lissajous figures.
12. Determination of Plank's constant using Photoelectric Effect.
13. Antenna measurements
14. Michelson Interferometer
15. Fabry-Perot Interferometer
16. Study of Regulated Power Supply
17. Study sinusoidal steady-state response of a resonant circuit in the phasor domain.
18. To determine the characteristics of a Solar Cell.
19. Study Digital Fiber Optical Transmitter and Receiver.
20. Fast Fourier Transform (FFT) in Excel

Text Books:

1. Advance Practical Physics Vol I S.P.Singh Pragati Prakashan
2. Advance Practical Physics Vol II S.P.Singh Pragati Prakashan
3. An advanced course in practical Physics D Chattopadhyay and P C Rakshit, New Central book agency Pvt. Ltd.
4. A Manual on Experiments in Physics R Srinivasan, K R Priolkar and T G Ramesh Indian Academy of Science.
5. Experimental Physics Principles and Practice for the Laboratory Ist Edition , Walter Fox Smith Routledge Taylor & Francis

Title: Mathematical Physics - II **(Course Code: PHY18205DCE)**

Max.Marks:100 **Int. Assessment:** 20 **Ext. Examination:** 80 **Credits:** 04

Course Outcome:he course is designed to introduce the student to the mathematical tools and techniques so as to equip him/her with the skills to solve problems in all of Physics, particularly Quantum Mechanics, Classical Physics, Condensed Matter, Nuclear Physics, Electronics etc.

Learning Outcome: Upon completion of the course, the students should:

- have an understanding of the Greens functions for solving inhomogeneous differential equations
- be able to apply various theorems and formulas of probability and statistical for sample analysis
- be able to identify finite and infinite time period problems and using Fourier Series and Fourier transform for solving such problems
- be able to conveniently use various kinds of numerical methods for solving various problems numerically if not analytically.

Unit-I

Green's Functions in One Dimension: Calculation of Green's Functions for simple differential operators, Green's Functions for Second order Linear Differential Operators (SOLDOs), Self Adjoint SOLDOs, Generalized Green's identity. Multidimensional Green's Functions: Second-Order PDEs in m Dimensions, Multidimensional GFs and Delta Functions, Spherical Coordinates in m Dimensions, Green's Function for the Laplacian.

Unit-II

Probability: Definition and simple properties, Discret and Continous Random variables, Binomial distribution, Poisson and Gaussian distributions, Central limit theorem. Statistics: Error propagation, Fitting curves to data, The Chi-square distribution. Students t distribution.orem.

Unit-III

Fourier Series, Properties and Applications. Fourier transform, Sine, Cosine and Complex transforms with examples, Definition, Properties and Representations of Dirac

Delta Function, Properties of Fourier Transforms, Transforms of derivatives, Applications to Partial differential equations. Laplace transform, Properties and examples of Laplace Transform, Laplace transform method of solving differential equations.

Unit-IV

Numerical analysis: interpolation, Finite difference, Forward, Backward and Central differences, Symbolic relations and separation of symbols, detection of errors by using difference tables, Newton's formula, Gauss central difference interpolation, Lagrange interpolation formulation, Integration by tapezoid and Simpson's rule, solve first order differential equations using Taylor, Eular and Runge-Kutta .

Text Books:

1. Mathematical Methods for Physicists (6th Ed.), G. B. Arfken and H. J. Weber,AcademicPress
2. Mathematical Physics: AModern Introduction to Its Foundations, Sadri Hassani, Springer
3. Intordductory methods of numerical analysis (5th Ed.) S. S. Shastri, PHI Learning Pvt. Ltd.

References:

1. Numerical Mathematical Analysis (6th Ed.) J. B. Scarborough, Oxford
2. Elements of Group Theory for Physicists (2nd Ed.) A. W. Joshi, Wiley
3. Group theory and its applications to physical problems, Morton Hammermesh, Addison Wiley Publishing Co. (1962)
4. Probability in Physics by Y. Ben-Menaheml and M. Hemmo, Spring-Verlag, berlin-Heidelberg (2012).
5. Mathematical Methods For Students of Physics and Related Fields, Sadri Hassani, Springer (2009)
6. Advanced Engineering Mathematics by Michel D, Greenberg
7. Mathematical Methods for Physics and Engineering (3rd Ed.), Riley, Hobson and Bence, Cambridge
8. Advanced Engineering Mathematics, E Kreyzig (8th Ed.), Wiley

Title: Digital Electronics **(Course Code: PHY18206DCE)**

Max.Marks:100 **Int. Assessment:** 20 **Ext. Examination:** 80 **Credits:** 04

Course Outcome:This course introduces the concept of number system and binary operations and how to build simple logic circuits using basic gates as well as able to simplify Boolean functions by using the basic Boolean properties. To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits. To prepare students to perform the analysis and design of various digital electronic circuits. To teach how to design simple combinational logics using basic gates and to optimize Boolean logic using Karnaugh maps. To introduce the basic sequential logic components: SR Latch, D Flip-Flop and their usage and make the students able to analyze sequential logic circuits.

Learning Outcome: Upon completing Unit I, students should be able to:

- After studying this course the students would gain enough knowledge.
- Able to perform the conversion among different number systems.
- Be introduced to basic logic gates- AND, OR and NOT, XOR, XNOR and be able to build simple logic circuits using basic gates.
- To implement the basic properties of Boolean algebra to simplify Boolean functions and construct circuits from them.
- Able to minimize the Boolean functions using Karnaugh maps and "don't care" condition. Consequently a student can then design any combinational circuits based on the real life scenarios.
- Ability to identify basic requirements for a design application and propose a cost effective solution. The ability to identify and prevent various hazards and timing problems in a digital design.
- Understand the various digital codes and characteristics of memory.
- Analyze the operation and working of Flip-Flops, Registers & Counters by their Truth-Table.
- Classify various combinational, sequential logic circuits & Convertors.
- To develop skill to build, and troubleshoot digital circuits.

Unit-I

Number Systems: Decimal, binary, octal, hexadecimal number system and conversion , binary weighted codes, signed numbers, 1s and 2s complement codes, Binary arithmetic . Boolean Algebra: Binary logic functions , Boolean laws, truth tables, associative and distributive properties, DeMorgans theorems, Implementation of boolean functions using Logic gates, sum of product & product of sums ,Karnaugh Map , two and three variable Karnaugh maps

Unit-II

Digital Logic Gates:Introduction to logic gates:Logic NOT gate (Digital Inverter), Digital Buffer,Logic OR gate, Logic AND gate ,Logic NAND, Logic NOR,Exclusive-OR Gate,Exclusive-NOR Gate,SOP Boolean Function Implementation using logic gates,POS Boolean Function Implementation using logic gates.

Unit-III

Introduction to Combinational Logic Circuits,Binary Adder and Subtractor,Carry look ahead Adder Binary multiplier,Binary encoder,Priority Encoder,Binary Decoder,BCD to 7 segment Display Decoder Multiplexer, Demultiplexer,Digital Comparator,Parity generator/checker Introduction to sequential logic,Latches,Flipflops,SR Flip flop,JK flip flop,D Flip flop,Flip Flop Applications Shift Registers, counters

Unit-IV

Digital integrated circuits: Logic levels , propagation delay time, power dissipation fan-out and fan- in transistor- transistor logic (TTL) gates, output stages, resistance-transistor logic (RTL) gates, direct coupled transistor logic (DCTL) gates, emitter coupled logic (ECL) gates, digital MOSFET circuits, complementary MOS (CMOS) logic gates, comparison of logic families.

Text Books:

1. M Morris Mano and Michael D Ciletti , Digital Design (fourth Edition))Robert L. Boylestad & Louis Nashelsky, Electronic Devices & Circuit Theory

References:

1. Gothmann and William H, Digital Electronics: An introduction to theory and practice
2. Modern Digital Electronics (3rd Ed.) by R. P. Jain

Title: Fluid Dynamics **(Course Code: PHY18207DCE)**

Max.Marks:100 **Int. Assessment:** 20 **Ext. Examination:** 80 **Credits:** 04

Course Outcome:Upon completion of this fluid dynamics course, students will emerge with a solid foundation in the principles governing fluid statics, kinematics, and dynamics. They will master the Langragian and Eulerian descriptions, Reynolds transport theorem, and governing equations for mass, momentum, and energy conservation. Proficiency in inviscid incompressible flows will be demonstrated through the analysis of stream functions, velocity potential functions, and various potential flows. Compressible flows, including concepts like Mach number, shock waves, and expansion waves, will be thoroughly understood. The course will equip students with the ability to analyze lift and drag in fluid systems, comprehend hypersonic flows, and apply principles to incompressible flows, boundary layers, and separation. Further, students will gain expertise in dimensional analysis, utilizing the Buckingham pi theorem and non-dimensional parameters, and apply these concepts to model and simulate fluid systems with relevance to prototypes. Overall, students will develop a holistic understanding of fluid dynamics principles and their practical applications.

Learning Outcome: Upon successful completion students will have the knowledge and skills to

- Demonstrate a comprehensive understanding of fluid statics and kinematics, including the ability to apply Langragian and Eulerian descriptions, Reynolds transport theorem, and integral and differential forms of governing equations for mass, momentum, and energy conservation.
- attain proficiency in understanding and manipulating the governing equations of fluid dynamics, including the Navier-Stokes equations, Euler's equation, and Bernoulli's Equation, showcasing the ability to analyze fluid motion under various conditions.
- Understand the principles of inviscid incompressible flows, exploring concepts such as stream function, velocity potential function, circulation, and basic plane potential flows. Apply knowledge to analyze flows past a circular cylinder, the Robins and Magnus effect, and the Kutta-Joukowski lift theorem.
- Conceptualize the principles of lift and drag in fluid dynamics, exploring the underlying physics and applications, particularly in the context of compressible flows. Understand the speed of sound, Mach number, isentropic relations, normal-shock wave, oblique shock wave, and Prandtl-Meyer expansion waves.

- Grasp the fundamentals of hypersonic flows, including Mach number independence and compressible viscous flows, with an understanding of compressible boundary layers and their behavior.
- Apply principles to incompressible flows, demonstrating proficiency in analyzing Couette flows, Poiseuille flows, and creeping flows. Understand the concepts of boundary layer and flow separation in practical scenarios.
- Develop proficiency in dimensional analysis, utilizing the Buckingham pi theorem and non- dimensional parameters in fluid mechanics. Understand the principles of modeling and similitude,flow similarity, and the relationship between models and prototypes.
- Gain insight into the principles of compressible viscous flows, including the behavior of compressible boundary layers and the impact of viscosity on fluid dynamics.
- Apply dimensional parameters to analyze fluid systems, demonstrating the ability to identify and manipulate key parameters in practical scenarios.
- Apply the concepts of modeling and similitude to understand flow behavior, showcasing the ability to design experiments and analyze results using distorted models while maintaining relevance to prototypes.

Unit-I

Introduction to fluid statics and kinematics. Governing Equations of Fluid Motion. Langragian and Eulerian description, Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equations, Navier-Stokes equations, Euler's equation, Bernoulli's Equation.

Unit-II

Inviscid Incompressible Flows: Stream function and Velocity potential function, Circulation, Line vortex, Basic plane potential flows: Uniform stream; Source and Sink; Vortex flow, Doublet, Superposition of basic plane potential flows, Flow past a circular cylinder, Robins and Magnus effect; Kutta-Joukowski lift theorem.

Unit-III

Concept of lift and drag Compressible Flows: Speed of sound and Mach number, Basic equations for one dimensional flows, Isentropic relations, Normal-shock wave, Oblique shock wave, Prandtl- Meyer expansion waves. Fundamentals of hypersonic flows, Mach number independence, Compressible viscous flows, Compressible boundary layers Viscous

Unit-IV

Incompressible Flows: Couette flows, Poiseuille flows, Creeping flows, Concepts of boundary layer and flow separation.Dimensional Analysis Introduction to dimensional parameters, Buckingham pi theorem, Non-dimensional parameter in fluid mechanics, Modeling and similitude, Flow similarity, Models and prototype, Distorted model.

Text Books:

1. Fox W. Robert, McDonald T. Alan, Introduction to Fluid Mechanics, Fourth Edition, John Wiley & Sons, 1995.

2. Frank M. White, Fluid Mechanics, Tata McGraw-Hill, Singapore, Sixth Edition, 2008.

3. Goldstein J. Richard, Fluid Mechanics Measurements, Second Edition, Taylor & Francis Publication, 1996.

Title:Renewable Energy Resources **(Course Code: PHY18208GE)**

Max.Marks:50 **Int. Assessment:** 10 **Ext. Examination:** 40 **Credits:** 02

Course Outcome: This course update the students about all possible energy resources , associates risks and benefits . And emphasis over then need to revisit non exhaustive environmentally friendly sources

Learning Outcome:

- Understand the concept of connection between development and energy
- Differentiate between Renewable and Non Renewable Energy Sources
- Advantages and disadvantages of both the sources
- Fossil fuels such as petrol, diesel etc
- Biomass Solar wind geothermal hydrogen etc

Unit-I

Energy Senerio: Global Energy Scenario, Energy & GDP, energy consumption and Projected future demands, Non Renewable Energy Resources: Coal, Oil, Natural Gas, Nuclear Power. Renewable Energy Resources : Hydroelectricity. Solar Energy: Sun as Source of Energy, Nature of Solar Radiation, Photo thermal Systems, Photovoltaic systems. Geothermal Energy

Unit-II

Wind Energy: Wind Energy Fundamentals, Wind Measurements, Analysis and Energy Estimates , Aerodynamics Theory, Wind Turbines Technology, Issues and challenges in the wind energy sector. Biomass Energy: Biomass: Generation and utilization, Properties of biomass, Agriculture Crop & Forestry residues used as fuels. Biomass gasifiers Concept of Bioenergy: Photosynthesis process, Biofuels, Biomass resources Bio based chemicals and materials , Thermochemical Conversion: Pyrolysis, Combustion, Bio fuels: Importance, Production and applications. Hydrogen Energy

Text Books:

1. Energy Economics: Concepts, Issues, Markets and Governance Subhes C. Bhattachary Methane
2. Production Guide how to make biogas. Three simple anaerobic digesters for home construction by Richard Jemmett

3. Free Renewable Energy Book by The Clearlight Foundation
4. Energy systems and sustainability by Godfrey Boyle

References:

1. Energy Systems and Sustainability by Godfrey Boyle

Title: Crystallography **(Course Code: PHY18208GE)**

Max.Marks:50 **Int. Assessment:** 10 **Ext. Examination:** 40 **Credits:** 02

Course Outcome:The course outcome aim to provide students with a strong foundation in crystallography, including understanding crystal structures, symmetry, diffraction principles, and techniques used in structure determination using X-ray diffraction methods.

Learning Outcome: Upon completing the course students should be able to:

- Define crystal lattice in two and three dimensions, including crystal planes and directions within a lattice.
- Explain crystal symmetry, crystallographic point groups, and their applications in crystallography.
- Understand space groups, graphical representations of space , and building crystal structures based on them.
- Demonstrate understanding of direct and reciprocal lattices, specifically for simple, body-centered, and face-centered cubic lattices.
- Explain the phenomenon of diffraction of waves by crystals and understand the concept of scattered wave amplitude.
- Utilize reciprocal lattice concepts for diffraction techniques, including understanding diffraction conditions and Brillouin Zones.
- Calculate crystal structure factors and comprehend the intensity of diffraction maxima.
- Explain atomic scattering factors and their significance in diffraction.
- Differentiate between powder X-ray diffraction and single-crystal X-ray diffraction techniques.

Unit-I

Crystalline solids and their growth methods. Crystal lattice; two and three dimensional lattices, crystal planes and directions. Crystal symmetry, crystallographic point groups and their applications. Space groups, graphical representation of space groups, building crystal structure from space groups, crystal structure of some simple compounds. Direct and reciprocal lattice. Reciprocal lattice of simple, body centered and face centered cubic lattices.

Unit-II

Diffraction of Waves by Crystals, Scattered Wave Amplitude, Fourier Analysis of a crystal structure. Reciprocal Lattice and its applications to diffraction techniques, Diffraction Conditions, Brillouin Zones, Crystal structure factor and intensity of diffraction maxima, atomic scattering factor. Extinctions due to lattice centering. Powder X-ray diffraction, Single crystal X-ray diffraction. Structure determination using X-ray diffraction.

Text Books:

1. Crystal and Crystal Structure by Richard Tilly, Wiley Pub.
2. Introduction to Solid State Physics by Charles Kittel, Wiley Pubb.

References:

1. An Introduction to Crystallography by M. M. Woolfson, Cambridge University Press
2. Structure and Boding in Crystalline Materials by G. S. Rohrr, Cambridge University Press

Title: Philosophical Foundations of Physics **(Course Code: PHY18209OE)**

Max.Marks:50 **Int. Assessment:** 10 **Ext. Examination:** 40 **Credits:** 02

Course Outcome:Students will be able to Enables a student to ask questions and to gather some background information after the question is developed. Next a student learns to develop hypothesis . Develops a testable hypothesis, Designs an experiment and carries out. define the accepted value of a measurement, define absolute measurement error, define relative measurement error, calculate relative measurement error values.

Learning Outcome: Upon completing the course, students should be able to:

- The main objective of this course is to introduce the importance of experiments in research.
- Ability to conduct experiments, analyze and interpret data.
- For this course, the students will have to follow instructions, set-up experiments, collect data and interpret data, and discover any sources of error.

Unit-I

Laws, Explanation and Probability:

The value of laws: Explanation and prediction, Induction and statistical probability, Induction and logical probability, The experimental method. **Measurement and quantitative language:**

Three types of concepts in science, The measurement of quantitative concepts, Extensive magnitudes, Time, Length, Derived magnitudes and quantitative language, Merits of quantitative method, The magic view of language.

Unit-II

The structure of space:
The structure of space: Euclid's parallel postulate, Non-euclidean geometries, space in relativity theory, Poincare versus Einstein, advantages of non-Euclidean physical geometry. **Casualty and determinism:** Casualty, Does casualty imply necessity?, The logic of casual modalities, Determinism and free will.

Text Books:

1. Philosophical Foundations of Physics by Rudolph Carnap, Basic Books Foundation, New York

References:

1. Galileo and Einstein by Michael Fowler, UVa Physics