Name of Teacher: DIPANWITA DAS

Department : Physics

B.sc (Honours)

➢ **Lesson Plan (CBCS System- 2018-2023)**

Class: SEM 1(H)

Paper: PHS-A-CC-1-1

Name of topic: Mathematical Physics I

Details of sub-topics:

Sub topic: (a) Recapitulation of Vector Algebra. Idea of linear independence, completeness, basis and representation of vectors. Properties of vectors under rotations. Scalar product and its invariance under coordinate rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively.

(b) Vector Differentiation: Scalar and Vector fields. 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.

(c) 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).

(d) Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Spherical and Cylindrical Coordinate Systems.

No. of Classes: 25 Lectures

Materials needed:

- Board and chalk
- Projector for multimedia presentations
- Printed handouts with key concepts and diagrams

Learning objective of the course:

By the end of this study on Vector Algebra and Vector Calculus, students should be able to understand and apply fundamental concepts, operations, and theorems related to vectors. Also they will gain a solid understanding of orthogonal curvilinear coordinates, including their definitions, transformations, and applications. They should be proficient in utilizing vector calculus techniques to solve problems in multivariable calculus. Additionally students should be able to work comfortably with coordinates like cylindrical and spherical systems and apply them to solve problems in physics.

1. Understanding Vector Representation:
- Define vectors and scalars.
- Comprehend vector representation in different coordinate systems.

2. Vector Operations:
- Perform vector addition subtraction geometrically and algebraically.
- Understand scalar multiplication and its gemetric interpretation.
- Apply the dot and cross product in various contexts.

3. Vector Spaces:
- Define vector spaces and their properties.
- Explore the concepts of linear independence and basis vectors.
- Understand subspaces and their significance.

4. Applications in Geometry:
- Apply vectors to solve problems related to lines and planes.

5. Vector Calculaus Basics:
- Introduce the concept of vector-valued functions.
- Differentiate vector-valued functions with respect to a scalar variable.

6, Parametric Equations and Curves:
- Represent curves using parametric equations.
- Explore tangent vectors and curveture for parametric curves.

7.Limits and Continuity:
- Understand limits and continuity for vector-valued functions.
- Explore the concept of differentiability in vector calculus.

8. Derivatives of Vector Functions:
- Compute derivatives of vector-valued functions using the limit definition.
- Explore tangent vectors and normal vectors to curves.

9. Vector Fields:
- Define vector fields and understand their significance.
- Explore gradient vectors and their interpretation.

10. Line Integrals:
- Understand line integrals and their applications in vector calculus.
- Compute line integrals for scalar and vector fields.

11. Surface Integrals:
- Introduce surface integrals and their applications.
- Compute surface integrals for scalar and vector fields.

12. The Divergence Theorem:
- State and understand the divergence theorem.
- Apply the divergence theorem to compute volume integrals.

13. The Curl of a Vector:
- Define the curl of a vector field and understand its geometric interpretation.
- Compute the curl and apply it in various contexts.

14. Green's Theorem:

- Introduce Green’s theorem and its applications.
- Apply Green’s theorem to evaluate the line integrals and solve problems in planer regions.

15. Orthogonal curvilinear coordinate systems

- Define orthogonal curvilinear coordinate systems and advantages of such coordinate systems.
- Cylindrical coordinate system: Definition, transformation equations, and applications.
- Spherical coordinate system: Definition, transformation equations, and applications.
- Define gradient, divergence, and curl in curvilinear coordinates.
- Derive expressions for thee operators in cylindrical and spherical coordinate systems.
- Discuss Laplace’s equation in curvilinear coordinates and solve Laplace’s equation in cylindrical and spherical coordinates.

Assessment:

Weekly tests and quizzes on both the topics vector algebra and vector calculus including coordinate transformations and basic applications.

Pattern of questions for assessment:

- What is the difference between a scalar and a vector? Provide examples.
- Calculate the dot product and cross product of given vectors
- Explain the concept of linear independence in vector spaces.
- Define a vector-valued function.
- Compute the derivative of vector valued function.
- Interpret the geometric meaning of the gradient, divergence and curl.
- Solve real world problem using vector algebra(e.g. forces in equilibrium).
- Apply vector calculus to find the tangent vector and arc length of a parametric curve.
- Use Green’s theorem to solve physics related problems.
- Derive the transformation equations between Cartesian and cylindrical coordinates.
- Explain how spherical coordinates transform into Cartesian coordinates.
- Solve physics problem using spherical coordinates.
- Express gradient, divergence, and curl in cylindrical coordinates.
- Derive Laplace’s equation in cylindrical coordinate.
- Solve Laplace’s equation in spherical coordinates for a specific boundary condition.

Class: SEM 2(H)

Paper: PHS-A-CC-2-4

Name of topic: Waves and Optics
Details of sub-topics:
Interferometers

(a) Michelson Interferometer (1)Idea of form of fringes (No theory required),(2)Determination of Wavelength, (3)Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes.

(b)Multiple beam interferometry, Fabry-Perot interferometer.

Diffraction

(a) Fraunhofer diffraction: Single slit. Circular aperture (solution may be assumed), Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. Rayleigh criterion for resolution.

(b) 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.

No. of Classes: 25 Lectures

Materials needed:

- Board and chalk
- Projector for multimedia presentations
- Printed handouts with key concepts and diagrams

Learning objective of the course:

Students will gain a thorough understanding of interferometers, including their principles, types, applications, and the underlying physics.

- Overview of essential interferometer components(beam splitter, mirrors, detectors)
- Different types of interferometers: Michelson, Fabry-Perot.
- Detailed study of Michelson interferometer.
- Practical applications and historical significance.
- Understanding Fabry-Perot interferometer.
- Applications in spectroscopy and telecommunications.
- Multiple beam interferometers.
- Real world applications in physics, astronomy, biology, and engineering.

Assesment:

Weekly quizzes and tests interferometer components.

Pattern of questions for assessment:

- Compare and contrast the Michelson, and Fabry Perot interferometers.
- Discuss the advantages and disadvantages of each type in specific applications.
- Describe the applications of interferometers in fields such as astronomy, telecommunications, quantum information science.
- Discuss the concept of multiple beam interferometers and their advantages.

Class: SEM 3(H)

Paper: PHS-A-CC-3-7

Name of topic: Modern Physics

Details of sub-topics:

Nuclear Structure

(a) 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. (b) Nature of nuclear force, NZ graph.
(c) Nuclear Models: Liquid Drop model. semi-empirical mass formula and binding energy. Nuclear Shell Model. Magic numbers.

Interaction with and within nucleus

(a) Radioactivity: Beta decay - energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

(b) Fission and fusion: mass deficit, relativity and generation of energy. Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions)

Lasers

Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He- Ne Laser. Basic lasing action.

No. of Classes: 40 Lectures

Materials needed:

- Board and chalk
- Projector for multimedia presentations
- Printed handouts with key concepts and diagrams

Learning objective of the course:

Students will develop a comprehensive understanding of nuclear structure, including the composition of atomic nuclei, nuclear models, and forces that govern interactions within the nucleus. By the end of the course, students should be able to analyze and explain various nuclear phenomena and their applications.

Students will understand the processes of radioactivity, including beta decay and gamma ray emission, as well as the concepts of fission and fusion, including mass deficit, relativity, and energy generation.

Students will gain an understanding of the fundamental principles of lasers, including Einstein's A and B coefficients, meta-stable states, spontaneous and stimulated emissions, optical pumping, population inversion, and the operation of three-level and four-level lasers. Specific focus will be given to the Ruby Laser and HE-Ne Laser.

- Introduction to the nucleus and its significance.
- Historical development of nuclear physics.
- Strong nuclear force among the nucleons and its role in binding nucleons.
- Liquid Drop Model: Basic concepts and applications.
- Shell Model: Introduction and explanation of magic numbers.
- Shell closures and their impact on nuclear stability.
- Applications of shell model.
- Discuss the history of the discovery of radioactivity and the contributions of scientists like Marie Curie.
- Introduce the concept of beta decay and the release of energy.
- Briefly mention Pauli's prediction of the neutrino.
- Define beta decay and discuss its types(beta-minus and beta-plus).
- Explain the energy released during beta decay and how it relates to the stability of nuclei.
- Discuss the spectrum of beta particles and how it varies.
- Introduce gamma ray emission and its characteristics.
- Explain energy-momentum conservation in the emission of gamma rays.
- Discuss electron-positron pair creation by gamma photons in the vicinity of a nucleus.

- Define fission and explain the concept of mass deficit.
- Discuss the role of relativity in understanding mass-energy equivalence.
- Explain the nature of fragments produced during fission and emission of neutrons.
- Introduce the basic principles of nuclear reactor, focusing n slow neutrons interacting with Uranium 235.
- Define fusion and discuss its role in stellar energy generation.
- Provide a brief qualitative discussion on the process of fusion.
- Explain the concept of mass-energy equivalence in fusion reactions.
- Briefly introduce the concept of lasers and their applications in various fields.
- Highlight the importance of understanding the basic principles behind laser operation.
- Discuss Einstein's A and B coefficients and their significance in the theory of lasers.
- Explain the distinctions between spontaneous and stimulated emissions.
- Introduce the concept of meta-stable states in the context of laser operation.
- Define spontaneous and stimulated emissions and discuss their roles in laser operation.
- Emphasize how stimulated emissions contribute to the amplification of light.
- Define optical pumping and its role in achieving population inversion.
- Explain the concept of population inversion and its importance in laser gain medium.
- Introduce the concepts of three-level and four-level laser systems.
- Explain how population inversion achieved in each system.
- Discuss the advantages and limitations of three-level and four-level lasers.
- Provide an overview of the Ruby Laser, including its construction and operation.
- Discus the characteristics and applications of the He-Ne Laser.
- Compare and contrast the two laser systems.

Assignment:
- Assign readings and problems related to beta decay, gamma ray emission.
- Assign readings and problems related to Einstein's coefficients, meta-stable states, and population inversion.
- Divide students into groups and assign each group a specific aspect of the lesson to research further and present to the class.
- Encourage students for open discussion.

Assessment:

Weekly quizzes and tests on nuclear models, forces. Evaluate student understanding through class participation, group presentations, and short quiz.

Pattern of questions for assessment:

- Compare and contrast the Liquid Drop Model and Shell Model.
- Explain how magic numbers contribute to the stability of atomic nuclei.
- Describe the characteristics of strong nuclear force.
- Describe how the properties of neutrons and protons contribute to nuclear stability.
- Define beta decay and explain how it occurs in a radioactive nucleus.

- Discuss the energy released during beta decay and its relation to the stability of the nucleus.
- Elaborate on Pauli's prediction of the neutrino and its significance in beta decay.
- Define gamma ray emission and its characteristics.
- Explain the principle of energy momentum conservation in the emission of gamma rays.
- Describe the process of electron-positron pair creation by gamma photon in the vicinity of a nucleus.
- Define mass deficit and explain its relationship to Einstein's theory of relativity.
- Discuss how mass-energy equivalence contributes to the generation of energy in nuclear reactions.
- Describe the nature of fragments produced during fission and explain the role of nuclear emission.
- Discuss how the emission of neutrons contribute to sustaining a chain reaction in a fission process.
- Explain the interactions of slow neutrons with U-235 in a nuclear reactor.
- Discuss the role of control rods in regulating the fission reactions within a nuclear reactor.
- Provide a brief qualitative discussion on fusion reactions and how they contribute to stellar energy.
- Explain the role of the thermonuclear reactions in sustaining the energy balance of the stars.
- Discuss how the principle of radioactivity, specifically beta decay and gamma ray emission, are connected to the processes of fission and fusion.
- Provide an example of a nuclear reaction that involves both beta decay and fission.
- What are Einstein's A and B coefficients, and how do they contribute to the understanding of laser operation?
- Explain the differences between the roles of A and B coefficients in the context of spontaneous and stimulated emissions.
- Define meta-stable states and their significance in the operations of lasers.
- How do meta-stable states contribute to achieving population inversion?
- Differentiate between spontaneous and stimulated emissions, providing examples of each.
- How does stimulated emission play a crucial role in the amplification of light in lasers?
- Explain the concept of optical pumping and its role in the process of achieving population inversion.
- Why is population inversion essential for laser operation, and how is it achieved?
- Compare and contrast three-level and four-level laser systems, highlighting their advantages and limitations.
- How does each system achieve and maintain inversion?
- Describe the construction and operation of the Ruby Laser.
- Discuss the characteristics nd applications of the He-Ne Laser.
- Explain the fundamental principles of basic lasing action, including the role of mirrors and the amplification process.
- What factors influence the output of a laser, and how do they impact on its performance?
- How do the concepts of a and B coefficients, meta-stable states, and population inversion collectively contribute to the overall functionality of a laser?
- Provide an example scenario where the principles of lasers can be applied in a real world context.

Class: SEM 4(H)

Paper: PHS-A-CC-4-9

Name of topic: Analog Electronics

Details of sub-topics:

Field Effect transistors: JFET and MOSFET (both depletion and enhancement type) as a part of MISFET. Basic structure & principle of operations and their characteristics. Pinch off, threshold voltage and short channel effect.
Regulated power supply: Load regulation and line regulation. Zener diode as a voltage regulator. The problem with the zener regulator circuit. Requirement of feedback and error amplifier. Study of series regulated power supply using pass and error transistor assisted by zener diode as a reference voltage supplier.
Amplifiers: Transistor amplifier; CB, CE and emitter follower circuit and their uses. Load Line analysis of Transistor amplifier. Classification of Class A, B & C Amplifiers with respect to placement to Q point. Frequency response of a CE amplifier. The role of series and parallel capacitors for cut off frequencies. The idea about the value of coupling and bypass capacitor with respect to lower cut-off frequencies. Miller capacitance and its role in higher cut-off frequency.

No. of Classes: 20 Lectures

Materials needed:

- Board and chalk
- Projector for multimedia presentations
- Printed handouts with key concepts and diagrams
- Breadboards, resistors, capacitors, Zener diodes, and transistors for demonstration.

Learning objective of the course:

Students will understand the basic structure, principles of operation, and characteristics of JFET and MOSFET, including both depletion and enhancement types. The lesson will cover key concepts such as pinch-off, threshold voltage, and short channel effects in MOSFETs.

Students will comprehend the principles of regulated power supply, load regulation, line regulation, and the use of zener diode as voltage regulator. Explore the need for feedback, error amplifiers, and series regulated power supplies with pass and error transistors.

Students will understand the principles and applications of transistor amplifiers, including CB, CE, and Emitter Follower circuits. The lesson will cover load-line analysis, classification of class A, B, and C amplifiers, frequency response of CE amplifier, the role of coupling and bypass capacitors, and the concept of Miller capacitance.

- Introduction to Field Effect Transistors.
- Brief review of BJT and their limitations and use of FET as an alternative.
- Introduction to JFET.
- Explain how the JFET controls the current flow using an electric field.

- Discuss key characteristics such as input impedance and voltage controlled operation.
- Introduction to MOSFET.
- Draw the symbols for n-channel and p-channel MOSFETs, discuss the layered structure, operation both in depletion and enhancement types.
- Define pinch-off and threshold voltage.
- Discuss how these parameters affect the transistor's behaviour.
- Highlight the main differences and similarities between JFET and MOSFET.
- Discuss advantages and disadvantages of each type.
- Provide examples of applications where JFETs and MOSFETs are commonly used.
- Discuss the importance of these transistors in modern electronics.
- Introduction to Regulated Power supply which include,Concept of Regulated Power Supply, importance of maintaining a constant output voltage in electronic circuits, brief introduction the term "load regulation" and "line regulation".
- Define load regulation and explain how it measures the ability of a power supply to maintain a constant output voltage under varying loads.
- Define line regulation and explain how it measures the ability of a power supply to maintain a constant output voltage despite changes in the input voltage.
- Draw and explain the basic circuit of a zener diode voltage regulator.
- Discuss how Zener diodes maintain a constant voltage across their terminals.
- Identify common issues such as poor load regulation and sensitivity to variations in Input voltage.
- Explain why feedback is essential in maintaining a stable output voltage in a RPS
- Introduce the concept of error amplifier in feedback system.
- Explain the use of pass and error transistors in a series RPS.
- Discuss hoe these components work together to enhance load and line regulation.
- Illustrate how a Zener diode can be used as a stable reference voltage in a series RPS.
- Briefly review the basics of amplifiers.
- Introduce the concept of transistor amplifiers and their importance in electronic circuits.
- Explain the structure and operation of a CB amplifier.
- Discuss applications and advantages of CB amplifiers.
- Describe the characteristics and applications of a CE amplifier.
- Highlight the importance of CE amplifiers in signal processing.
- Explain the purpose and benefits of an emitter folower.
- Discuss scenario where an emitter follower is preferable.
- Load line and its significance in analyzing transistor amplifier.
- Demonstrate load line analysis fo CB, CE. And emitter follower circuits.
- Discuss how load line analysis helps determine biasing points and operating regions.
- Define class A, B, and C amplifiers.
- Explain the placement of the Q point for each class.
- Discuss the efficiency and applications of each class.
- Explain the concept of frequency response in amplifiers.
- Introduce the lower and upper cut-off frequencies in a CE amplifier.
- Discuss the role of series and parallel capacitors in determining cut-off frequencies.
- Explain the purpose of coupling and bypass capacitors in amplifier circuits.
- Discuss the impact of capacitor values on lower ct-off frequencies.
- Highlight the importance of proper capacitor selection.

- Define Miller capacitance and its role in higher ct-off frequencies.
- Discuss how Miller capacitance affects the BW of the amplifier.
- Provide examples and illustrations of Miller capacitance in CE amplifier.

Q & A and Discussion:

Encourage students to ask questions and participate in discussions.
Clarify the doubts and reinforce key concepts.

Assignments: Assign readings and online resources for further exploration of JFETs, MOSFETs, and their applications.
Provide problems for students to practice analyzing transistors circuits.
Assign Problems for students to analyze and design RPS circuits with specific load and line regulation requirements.

Assessment:

Evaluate students based on their participation in class discussions, understanding of key concepts, completion of assignments, tests, and quizzes.

Pattern of questions for assessment:

- Define a term "Field Effect Transistor(FET)"band briefly explain why FETs are considered an alternative to BJT.
- Draw and label the symbol of a JFET and explain the significance of the arrows in the symbol.
- Describe the basic physical structure of a JFET and how it functions as a voltage controlled device.
- What are the key characteristics of JFET, and how do they differ from those of BJT?
- Draw and label the symbols for n-channel and p-channel MOSFETs and explain the directional flow of current in each type.
- Discuss the layered structure of MOSFETs. How does the gate control the flow of current in a MOSFET?
- Differentiate between depletion-type and enhancement-type MOSFETs. Provide examples of each.
- Define "punch-off". How does pinch-off affect the current flow in a JFET?
- Explain the concept of threshold voltage in MOSFETs. How does it influence the transistor's operation?
- Compare the main differences between JFET and MOSFET in terms of structure, operation, and characteristics.
- Provide examples of real-world applications wher JFETs and MOSFETs are commonly used. Explain why one type might be preferred over the other in certain applications.
- Consider a scenario where you need a high input impedance device. Would you choose a JFET or a MOSFET, and why?

- Explain how advancements in semiconductor technology have have influenced the evolution of MOSFETs and their performance characteristics.
- Define a RPS and explain why it is essential in electronic circuits.
- Differentiate between unregulated and regulated power supply.
- Define load regulation and provide an example scenario where it is crucial.
- Explain the concept of line regulation and how it differs from load regulation.
- Draw and label the basic circuit of a zener diode voltage regulator.
- Explain how a zener diode maintains a constant voltage across its terminals.
- Identify and explain common issues associated with a zener diode voltage regulator circuit.
- Suggest possible solutions to address the problems in a zener regulator.
- Describe the role of feedback in RPS.
- Explain why error amplifier is necessary in feedback systems.
- Outline the basic components of a series RPS.
- Describe the functions of pass and error transistors in a series RPS.
- Explain how a zener diode can be used as a reference voltage supplier in series RPS.
- Given a scenario where a constant output voltage is critical, design a RPS with appropriate load and line regulation.
- Discuss the advantages of using a zener diode as a reference voltage supplier in a series regulated power supply.
- Consider a situation where a zener diode voltage regulator is not providing the expected output. What steps would you take to troubleshoot and rectify the issue?
- Explain the significance of load and line regulation in electronic devices, providing examples of devices that require stringent regulation.
- Explain the structure and operation of CB amplifier. In what applications is a CB amplifier commonly used?
- Discuss the characteristics and applications of a CE amplifier. How does a CE amplifier amplify signals differently from a CB amplifier?
- Define the purpose of an emitter follower. Provide examples of scenarios where an emitter follower circuit is advantageous.
- What is load line analysis in the context of transistor amplifiers, and why is it important?
- Demonstrate load line analysis for a CE amplifier. How does load line analysis aid in determining the operating point and biasing?
- Define class A, B, and C amplifiers. How they are classified with respect to the placement of the Q point?
- How are lower and upper cut-off frequencies defined in a CE amplifier?
- Discuss the factors influencing the frequency response of a CE amplifier.
- Describe the role of series capacitor in determining lower ct-off frequencies in amplifier circuits.
- Explain how parallel capacitors contribute to the frequency response of an amplifier.
- Why are coupling capacitors used in amplifiers circuits, and what is their role in preventing DC offsets?
- Discuss the importance of bypass capacitors in amplifies circuits, particularly with respect to lower cut-off frequencies.
- Define Miller capacitance and it significance in amplifier circuits.
- How does Miller capacitance impact the upper ct-off frequency in CE amplifiers?

- Given a specific amplifier circuit, design a set of coupling and bypass capacitors to achieve desired lower cut-off frequencies.

Class: SEM 5(H)

Paper: PHS-A-DSE-A2

Name of topic: Nuclear and Particle Physics

Details of sub-topics:

Introduction

Recapitulation of general properties of nuclei, nuclear models and radioactivity.

Nuclear Reactions

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).

Interaction of Nuclear Radiation with matter

Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric eect, Compton scattering, pair production, neutron's interaction with matter.

No. of Classes: 40 Lectures

Materials needed:

- Board and chalk
- Projector for multimedia presentations
- Printed handouts with key concepts and diagrams

Learning objective of the course:

Students will review general properties of nuclei, nuclear models, and radioactivity. The lesson will then cover nuclear reactions, including types, conservation laws, kinematics, Q value, reaction rate, reaction cross section, and concepts of compound and direct reactions. The latter part of the lesson will focus on the interaction of nuclear radiation with matter, including energy loss due to ionization, Cerenkov radiation, and gamma-ray interactions through photoelectric effect, Compton scattering, and pair production. The lesson will conclude with a discussion on neutron interaction with matter.

- Recapitulate general properties of nuclei, nuclear models, and radioactivity.
- Emphasize the importance of understanding nuclear reactions and interactions.
- Briefly explain various types of nuclear reactions (e.g., fusion, fission)
- Review the conservation laws (mass, energy, momentum) in nuclear reactions.
- Explain the basics of kinematics involved in nuclear reactions.
- Define and explain the Q value of a reaction.
- Introduce the concepts of reaction rate and reaction cross sections.
- Explain the difference between compound and direct reactions.
- Discuss the characteristics and significance of resonance reactions.

- Introduce Coulomb scattering and its applications
- Discuss the Bethe-Bloch formula for energy loss due to ionization.
- Discuss how it applies to charged particles like electrons.
- Explain the phenomenon of Cerenkov radiation and its significance.
- Describe interactions through the photoelectric effect, Compton scattering, and pair production.
- Briefly discuss how neutrons interact with different materials.

Additional activities:

- Assign readings and online resources for further exploration of specific topics covered in the lesson.
- Provide problems and scenarios for students to practice calculations related to nuclear reactions and radiation interactions.

Assessment:

Evaluate students based on their participation in class discussion, understanding of key concepts, and completion of assigned activities.

Pattern of questions for assessment:

- Explain the importance of studying nuclear physics and its applications in various fields.
- Summarize the general properties of nuclei, briefly describing one propty indetail.
- Differentiate between fission and fusion reactoins. Provide an example of each.
- State the conservation laws involved in nuclear reactions and explain their significance.
- Define the kinematics of nucclear reactions. How does it differ from classical mechanics?
- Explain the concept of Q value in a nuclear reaction and how it influences the reaction outcome.
- Define reaction rate in the context of nuclear reactions.
- Explain the importance of reaction cross-section in studying nuclear reactions.
- Describe the characteristics of compound and direct reactions.
- Discuss the significance of resonance reactions in nuclear physics.
- Explain Coulomb scattering and role in studying atomic structure.
- Explain the Bethe-Bloch formula and its significance in calculating energy loss due to ionization.
- Discuss the enrgy loss of electrons in a medium and its implications.
- Define Cerenkov radiation. Under what condition does it occur?
- Explain the practical applications of Cerenkov radiation detection.
- Describe the photoelectric effect in gamma-ray interactions. How does it differ from Compton scattering?
- Explain the conditions under which pair production occurs in gamma-ray interactions.
- Discuss the interaction of neutrons with matter. How is it different from charged particles?
- Explain one application of neutron interaction in a real-world scenario.

Class: SEM 6(H)

Paper: PHS-A-CC-6-13
Name of topic: Digital Systems and Applications

Details of sub-topics:

Integrated Circuits

Principle of Design of monolithic Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only w.r.t. micron/submicron feature length).

Number System

Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. Signed and unsigned number representation of binary system. Representation of negative number. 1's Complement and 2's Complement method of subtraction.

Digital Circuits

(a) Difference between Analog and Digital Circuits. Introduction of switching algebra, Huntington's postulates. Combinational logic, Truth table. Introduction of basic logic functions AND, OR and NOT. Implementation of OR, AND, NOT Gates (realization using Diodes and Transistor). De Morgan's Theorems. NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. Circuit representation of gates (both Usual and IEEE symbols). Introduction to different logics like DTL, TTL, MOS and CMOS. MOS and CMOS inverter circuit. NAND/NOR circuit using MOS logic.
(b) Product term and sum term in logical expression. Sum of Product and Product of Sum and mixed expression. Minterm and Maxterm in the expressions. Conversion between truth table and logical expression. Simplification of logical expression using Karnaugh Map.

No. of Classes: 35 Lectures

Materials needed:

- Board and chalk
- Projector for multimedia presentations
- Printed handouts with key concepts and diagrams
- ICs for demonstration.

Learning objective of the course:

Students will get an understanding of Integrated Circuits (ICs), the principles of monolithic chip design, advantages and drawbacks of ICs, and the scale of integration (SSI, MSI, LSI, and VLSI). The lesson will also cover number systems, with a focus on binary numbers, conversions, and signed/unsigned representations. Additionally, students will learn about digital circuits, including the difference between analog and digital circuits, switching algebra, basic logic functions, and simplification techniques using Karnaugh Maps.

- Define Integrated Circuits (ICs) and their role in electronic circuits.

- Explain the principle of the design of monolithic chips.
- Discuss the advantage and drawbacks of using ICs in electronic systems.
- Introduce the scale if integration, including SSI, MSI, LSI, and VLSI.
- Provide basic definitions, emphasizing micron/submicron feature length in VLSI.
- Explain the binary number system and its importance in digital electronics.
- Discuss the conversion between decimal and binary numbers.
- Introduce BCD, octal, and hexadecimal number systems.
- Explin the representation of signed and unsigned numbers in binary.
- Introduce the concepts of 1's compliment and 2's compliment for negative numbers.
- Highlight the distinctions between analog and digital circuits.
- Introduce switching algebra and Huntington's postulates.
- Explain the role of these concepts in digital circuit design.
- Introduce basic logic functions including AND, OR, and NOT.
- Explain the implementation of AND, OR, and NOT gates using diodes and transistors.
- Introduce De Morgnan's theorem and their application in logic circuit design.
- Explain NAND and NOR gates as universal gates.
- Introduce XOR and XNOR gates and their application as parity checkers.
- Explain product terms and sum terms in logical expressions.
- Introduce the concepts of sum of product, product of sum, and mixed expressions.
- Explain how to convert between truth tables and logical expressions.
- Introduce the concept of simplification using Karnaugh Maps.

Q & A and Discussion

- Encourage students to ask questions and engage in discusions.
- Discuss practical applications of ICs and digital circuits.

Additional activities:

- Assign problems or scenarios for students to practice binary conversions and logical simplifications using Karnaugh Maps.
- Provide readings and pnline resources for further exploration of ICs and digital circuits.

Pattern of questions for assessment:

- Explain the principle behind the design of a mnlithic chip.
- How does the monolithic chip design contribute to the miniaturization of electronic devices?
- List three advantages of using ICs in electronic systems.
- Discuss two drawbacks or challenges associated with the use of ICs.
- Define SSI, MSI, LSI, and VLSI in the context of integrated circuits.
- Provide absic idea of the definitions, particularly with respect to micron/submicron feature length in VLSI.
- Convert the decimal number 79 to binary.
- Convert the binary number 110011 to decimal.
- Explain the significance of BCD.
- Convert the octal number 64 to binary and hexadecimal.
- Represent the signed binary number -110 in 8-bit signed-magnitude form.

- Discuss the advantages of using signed binary representation.
- Represent the decimal number -29 using 2’s compliment binary representation.
- Explain the difference between 1’s compliment and 2’s compliment methods of subtraction.
- Define switching algebra and its relevance to digital circuits.
- State Huntigton’s postulates in the context of digital login design.
- Implement an OR gate using diodes and transistors.
- State De Morgan’s theorems for logic simplifications.
- Explain how NAND gates can be used as universal gates.
- Provide the truth table for an XOR gate.
- Discuss an application scenario for XNOR gates.
- Draw the circuit representation of a NOR gate using both usual and IEEE symbols.
- Briefly introduce the characteristics of different logics like DTL,TTL,MOS, aand CMOS.
- Explain the concept of product terms in logical expressions.
- Convert a given truth table to minterm and maxterm expressions.
- Given a truth table, simplify the logical expression using a Karnaugh Map.
- Discuss the advantages of using Karnaugh Maps for logical simplification.

Class: SEM 6(H)

Paper: PHS-A-DSE-A1

Name of topic: Communication Electronics
Details of sub-topics:

Electronic communication

Introduction to communication means and modes. Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio

Analog Modulation

(a) Amplitude Modulation, mathematical analysis for modulation index, frequency spectrum and power in AM Generation of AM (Emitter Modulation), Diode/square law modulator, Amplitude Demodulation (diode detector), Balanced modulator for DSB, Concept of Single side band generation and detection, concept of vestigial side band.

(b) Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, Transistor/FET reactance modulator, equivalence between FM and PM, Generation of FM using VCO, FM detector : slope detector, Balanced slope detector, Idea of Phase discriminator and ratio detector, Qualitative idea of IF and Super heterodyne receiver.

No. of Classes: 30 Lectures

Materials needed:
- Board and chalk
- Projector for multimedia presentations
- Printed handouts with key concepts and diagrams

Learning objective of the course:
Students will gain an understanding of electronic communication, the need for modulation, and the basics of analog modulation, focusing on Amplitude Modulation (AM), Frequency Modulation (FM), and Phase Modulation (PM).
- Define communication and introduce various means and modes of communication (e.g. wired, wireless, optical).
- Discuss why modulation is necessary in electronic communication.
- Highlight the challenges of transmitting baseband signals.
- Present a block diagram of an electronic communication system.
- Briefly explain the function of each block.
- Provide a brief overview of frequency allocation for radio communication system in India.

- Discuss the role of regulatory bodies like TRAI.
- Introduce the electromagntic communication spectrum.
- Explain band designations and usage, emphasizing different frequency bands.
- Define channels and explain the concept of baseband signals.
- Introduce the concept of noicse in communications systems.
- Explain the importance of S/N ratio.
- Discuss the mathematical analysis for modulation index in AM.
- Explain the frequency spectrum and power in AM.
- Explain the generation of AM hrough emitter Modulation.
- Discuss the Diode/Square Law Modulator.
- Introduce the concept of amplitude demodulation using a diode detector.
- Discuss the use of Balanced Modulator Double Sided (DSB) AM.
- Briefly explain the concept of SSB generation and detection.
- Introduce the idea of vestigial sideband.
- Discuss the mathematical analysis for modulation index in FM and PM.
- Explain the frequency spectrum.
- Discuss FM detection using slope detectors (slope detector and balanced slope detector).
- Introduce the idea of a Phase Discriminator and Ratio Detector.
- Provide a qualitative idea of Intermediate Frequency (IF) and superheterodyne receiver concepts.

Q&A and Discussion:

- Encourage students to ask questions and engage in discussions.
- Discuss the real-world applications of electronic communication systems.

Additional activities:

- Assign problems or scenarios for students to practice modulation index calculations for AM, FM, and PM.
- Provide readings and online resources for further exploration of electronic communication.

Assessment:

Evaluate students based on their participation in class discussions, understanding of key concepts, and completion of assigned activities.

Pattern of questions for assessment:

- Define communication means and modes. Provide examples of different communication modes.
- Explain the importance of effective communication in various applications.

- Discuss the necessity for modulation in electronic communication.
- Provide specific examples of situations where modulation is crucial.
- Draw and label the block diagram of a generic electronic communication system.
- Explain the function of each block in the communication system.
- Provide a brief overview of frequency allocation for radio communication in India according to TRAI.
- Discuss the role and responsibilities of TRAI in managing frequency allocations.
- Define the electromagnetic communication spectrum and its importance in communication.
- Explain the concept of band designations and usage in the communication spectrum.
- Define communication channels and explain their significance.
- Differentiate between base-band signals and modulated signals.
- Define noise in the context of communication systems.
- Discuss the concept of S?N ratio and its importance in signal quality.
- Define modulation index in amplitude modulation.
- Discuss the mathematical expression for the modulation index.
- Explain how the frequency spectrum of an amplitude-modulated signal looks.
- Discuss the power distribution in amplitude-modulated signals.
- Explain the process of generating amplitude modulation using emitter modulation.
- Discuss the advantages and limitations of emitter modulations.
- Explain the working principle of a Diode/Square Law modulator.
- Discuss the characteristics and applications of Diode/Square Law modulator.
- Explain the process of amplitude demodulation using a diode detector.
- Discuss the advantages and limitations of Diode detectors.
- Describe the working principle of a balanced modulator for double-sideband (DSB) signals.
- Discuss the advantages of using a balanced modulator in DSB generation.
- Explain the concept of single-sideband(SSB) generation.
- Discuss the methods used for the detection of single-sideband signals.
- Define modulation index in frequency modulation (FM) and phase modulation(PM).

- Discus how the modulation index affects the frequency spectrum.
- Explain the working principle of a transistor/FET reactance modulator.
- Discuss the advantages and limitations of using reactance modulation.
- Discuss the equivalence between frequency modulation (FM) and phase modulation (PM).
- Explain how the modulation index relates to FM and PM.
- Explain the process of generating frequency modulation using a Voltage-Controlled Oscillator (VCO).
- Discuss the advantages of using VCO for FM generation.
- Explain the working principles of slope detectors for frequency modulation.
- Discuss the advantages of balanced slope detectors.
- Introduce the concept of phase discriminators and ratio detectors in FM demodulation.
- Discuss the advantages and limitations of these detectors.
- Explain the qualitative concept of Intermediate Frequency(IF) in superheterodyne receivers.
- Discuss the advantages of using superheterodyne receivers in FM systems.