SEMESTER - VI

Subject Title: Digital and Analog Circuits
Subject Code: PCMP-521
Weekly Load/Credits: 4h/04

L	T	P
3	1	0

Course Outcomes (COs): After successful completion of the course, the students will be able to:

CO1: Understand the basic knowledge of terms/concepts of digital circuits.
CO2: Explain the various functions of semiconductor devices and amplifiers.
CO3: Gain knowledge of various types of transistors.
CO4: Understand the fundamental criterion of oscillators and function of CRO.
CO5: Understand the importance of rectifiers and diodes in electronic circuits.

UNIT - I

Semiconductor Devices: Semiconductor diodes: p and n type semiconductors, barrier formation in PN junctiondode, qualitative idea of current flow mechanism in forward and reverse biased diode, PN junction and its characteristics, static and dynamic resistance. **(4 Lectures)**

Bipolar Junction Transistors: n-p-n and p-n-p transistors, characteristics of CB, CE andCC configurations, active, cutoff, and saturation regions, current gains α and β, relations between α and β, load line analysis of transistors, DC load line and Q- point. voltage divider bias circuit for CE amplifier, h-parameter equivalent circuit, analysis of a single-stage CE amplifier using hybrid model, input and output impedance, current, voltage and power gains. **(9 Lectures)**

Field Effect Transistors: Structure, characteristics, operation of FET, JFET and MOSFET, pinch off voltage, enhancement and depletion mode, comparison of JFETs and MOSFETs, difference in field effect transistor and junction type transistor.

(8 Lectures)

UNIT-II

Digital Circuits: Difference between analog and digital circuits, binary numbers, decimal to binary and binary to decimal conversion, and, OR and NOT gates (realization using diodes and transistor), NAND and NOR gates as universal gates, XOR and XNOR gates, De Morgan's Theorems. Boolean Laws, simplification of logic circuit using Boolean algebra, fundamental product, minterms and maxterms, conversion of a truth table into an equivalent logic circuit by (1) sum of products method and (2) Karnaugh map. **(8 Lectures)**

Sinusoidal Oscillators: Barkhausen's Criterion for Self-sustained Oscillations.

Determination of Frequency of RC Oscillator. **(4 Lectures)**

Introduction to CRO: Block Diagram of CRO. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. **(4 Lectures)**

Power Supply: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency, Zener Diode and Voltage Regulation. **(5 Lectures)**

Theory: 42 hrs

Reference Books:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronic devices and circuits, S. Salivahanan and N. Suresh Kumar, 2012, TataMc-Graw Hill.
- Microelectronic Circuits, M.H. Rashid, 2ndEdn.,2011, Cengage Learning.
- Modern Electronic Instrumentation & Measurement Tech., Helfrick&Cooper,1990,PHI Learning.
- Digital Principles & Applications, A.P. Malvino, D.P. Leach & Saha, 7th Ed.,2011,Tata McGraw Hill.
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn.,Oxford University Press.
- Fundamentals of Digital Circuits, A. Anand Kumar, 2nd Edition, 2009, PHI LearningPvt. Ltd.
- OP-AMP and Linear Digital Circuits, R.A. Gayakwad, 2000, PHI Learning Pvt. Ltd.

Subject Title: Digital and Analog Circuits Lab
Subject Code: PCMP-522
Weekly Load/Credits: 4h/02

L	T	P
0	0	4

Course Outcomes (COs): After successful completion of the course, the students will be able to:

CO1: Design and verify the basic gates of digital electronics.
CO2: Design various circuits of digital electronics and explain their overall function.
CO3: Explain the various characteristics of transistors.
CO4: Explain the various functions of semiconductor devices.
CO5: Understand the importance of Digital and Analog circuits and instruments in engineering and technology.

List of Practicals:

1. To verify the truth table of AND, OR, NOT, NOR, NAND, EXNOR and EXOR gates
2. To design AND, OR, NOT and XOR gates using NAND gates.
3. To verify the De-Morgan's theorem.
4. To design and implement half adder, full adder and 4-bit binary adder.
5. To design and implement the ALU.

6. To draw forward and reverse bias characteristics of a p-n junction diode and draw a load line.
7. To study Zener diode as voltage regulator.
8. To draw output and mutual characteristics of an FET and determine its parameters.
9. To study the characteristics of a transistor in CE configuration.
10. To design a CE amplifier of a given gain (mid-gain) using voltage divider bias.
11. To measure reverse saturation current in p-n junction diode at various temperatures and to find the approximate value of energy gap.
12. To study and plot the V-I characteristics of SCR.

Total Load: 56 hrs

Reference Books:

- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994,Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hll Electronic.
- Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.

Subject Title: Nuclear and Particle Physics
Subject Code: PCMP-523
Weekly Load/Credits: 4h/04

L	T	P
3	1	0

Course Outcomes (COs): After successful completion of the course, the students will be able to:

CO1: Understand basic atomic structure and general properties of nucleus and explain nucleus models.
CO2: Explain basics of radioactive decay and its types.
CO3: Understand the kinematics of nuclear reactions.
CO4: Explain the interaction of nuclear radiation with matter and various particle accelerators.
CO5: Explain the basic features of particle interactions and conservation laws.

UNIT - I

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about size, mass, charge density (matter energy), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excited states. **(6 Lectures)**

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of various terms, condition of nuclear stability. Two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in

Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force. **(7 Lectures)**

Radioactivity Decay:(a) Alpha decay: basics of α-decay processes, theory of α-emission, gamow factor, Geiger Nuttall law, α-decay spectroscopy (b) decay: energy kinematics for decay, positron emission, electron capture, neutrino hypothesis, (c) Gamma decay, gamma rays emission & kinematics, internal conversion. **(8 Lectures)**

UNIT -II

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). **(6 Lectures)**

Interaction of Nuclear Radiation with Matter: Energy loss due to ionization (Qualitative idea Bethe-Block formula), energy loss of electrons, Cerenkov radiation, gamma ray interaction through matter (qualitative idea). **(4 Lectures)**

Particle Accelerators: Van-de Graaff generator (Tandem accelerator), linear accelerator, cyclotron. **(4 Lectures)**

Particle Physics: Particle interactions, basic features, types of particles and its families, symmetries and conservation laws: energy and momentum, angular momentum, parity, baryon number, lepton number, isospin, strangeness and charm, concept of quark model, color quantum number and gluons. **(7 Lectures)**

Theory: 42 hrs

Reference Books:

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004)
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991.

Subject Title: Astrophysics
Subject Code: PCMP-524
Weekly Load/Credits: 3h/03

L	T	P
3	0	0

Course Outcomes (COs): After successful completion of the course, the students will be able to:

CO1: Explain the night sky, diurnal and annual motions and apply basic celestial coordinate systems.
CO2: Describe methods to determine stellar distance, brightness, temperature, size, mass and interpret spectra and the H–R diagram.
CO3: Explain the principles of telescopes, atmospheric effects and major ground- and space-based observatories.
CO4: Describe the Sun's structure, atmosphere, solar activity and basic magneto-hydrodynamic processes.
CO5: Analyse Milky Way rotation using Oort constants and the virial theorem and explain evidence for dark matter.

UNIT - I

Introduction to Astronomy: Overview of the night sky; diurnal and yearly motions of the sun; basic concepts of positional astronomy; celestial sphere, astronomical coordinate systems (Horizon and equatorial systems of coordinates), circumpolar star. **(9 Lectures)**

Basic Parameters of Stars: Measurement of astronomical distances (stellar parallax, aberration, proper motion), measurement of brightness, radiant flux and luminosity (apparent and absolute magnitude scales, distance modulus), determination of stellar mass (visual binaries, eclipsing binaries, spectroscopic binaries), measurement of stellar temperature and radius, stellar spectra, dependence of spectral types on temperature, stellar classification (Harvard classification scheme), H-R diagram. **(12 Lectures)**

UNIT-II

Astronomical Instrumens: Observing through the atmosphere (scintillation seeing, atmospheric windows, and extinction), basic definitions for telescopes (magnification, light gathering power, limiting magnitude, resolving power, diffraction limit), optical telescope (Galilean, newtonian, Cassegrain), basic overview of Hubble space telescope, James Webb space telescope, Fermi Gamma ray space telescope, radio astronomy (overview of GMRT). **(6 lectures)**

Sun: Solar parameters, sun's internal structure, solar photosphere, solar atmosphere, chromosphere, corona, solar activity, basics of solar magneto-hydrodynamics. **(8 lectures)**

Physics of Galaxies: Nature of rotation of the milky way, differential rotation of the galaxy and Oort constants, rotation curve of the galaxy and the dark matter, virial theorem.

Cosmology: Standard candles (Cepheids and SNe Type 1a); cosmic distance ladder; expansion of the Universe, cosmological principle, Newtonian cosmology and Friedmann models. **(7 lectures)**

Theory: 42 hrs

Reference Books:

- Fundamental Astronomy, H. Karttunen et al., Springer Berlin, Heidelberg
- Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison-Wesley Publishing Co.
- Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, Saunders College Publishing.
- Astronomy in India: A Historical Perspective, T. Padmanabhan, Springer
- Foundation of Astrophysics, B.Ryden and B.M. Peterson, Cambridge University Press.

Subject Title: Fundamental of Artificial Intelligence
Subject Code: PCME-522P1
Weekly Load/Credits: 3h/03

L	T	P
3	0	0

Course Outcomes (COs): After successful completion of the course, the students will be able to:

CO1: Explain fundamental AI concepts, problem-solving methods, state spaces and search strategies.
CO2: Apply heuristic search, game-playing and graph-based reasoning to solve deterministic and adversarial problems.
CO3: Represent knowledge using logic and perform inference and reasoning in knowledge-based systems.
CO4: Analyse reasoning under uncertainty using Bayesian models, planning and sequential decision-making.
CO5: Describe machine learning paradigms, including neural networks and an overview of deep learning.

UNIT-I

Fundamentals of Artificial Intelligence and Knowledge Representation: Introduction to AI, problem solving as state space search, uniformed search, Heuristic search, informed search, constraint satisfaction problems, searching AND/OR graph game playing, minimax+ Alpha-Beta, introduction to knowledge representation, propositional Logic, first order logic -I, first order logic -II, inference in first order logic - I, Inference in FOL - II, answer extraction, procedural control of reasoning. **(21 Lectures)**

UNIT-II

Reasoning Under Uncertainty, Planning, and Machine Learning: Reasoning under uncertainty, Bayesian network, decision network, introduction to planning, plan space planning, planning graph and graph plan, practical planning and acting, sequential decision problems, making complex decisions, introduction to machine learning, learning decision trees, linear regression, support vector machines, unsupervised learning, reinforcement learning, learning in neural networks, deep learning: a brief overview. **(21 Lectures)**

Theory: 42 hrs

Reference Books:

- Search methods in Artificial Intelligence-Deepak Khemani.
- Artificial Intelligence Basics: A Non-Technical Introduction -Tom Taulli.
- Machine Learning for Absolute Beginners -Oliver Theobald.
- Artificial Intelligence: A Modern Approach- Stuart Russell & Peter Norvig.

Subject Title: Elements of Modern Physics
Subject Code: PCME-522P2
Weekly Load/Credits: 3h/03

L	T	P
3	0	0

Course Outcomes (COs): After successful completion of the course, the students will be able to:

CO1: Understand fundamental quantum concepts such as photons, matter waves and key experiments validating quantum theory.
CO2: Explain atomic structure using Bohr's model and calculate energy levels and spectra of hydrogen-like atoms.
CO3: Apply Heisenberg's uncertainty principle and wave particle duality to explain limits of measurement in quantum systems.
CO4: Use Schrödinger equation to analyze stationary states, superposition and basic quantum systems like particle in a box and tunnelling.
CO5: Understand nuclear structure, nuclear forces, radioactivity and stability of atomic nuclei

UNIT - I

Quantum Nature of Light & Matter: Planck's quantum, Planck's constant and light as a collection of photons, photo-electric effect and Compton scattering, De Broglie wavelength and matter waves, Davisson Germer experiment. **(6 Lectures)**

Atomic Models & Bohr Theory: Problems with Rutherford model, instability of atoms and observation of discrete atomic spectra, Bohr's quantization rule and atomic stability, calculation of energy levels for hydrogen like atoms and their spectra. **(4 Lectures)**

Uncertainty Principle: Position measurement, gamma ray microscope thought experiment, Wave-particle duality, Heisenberg uncertainty principle impossibility of a particle following a trajectory, estimating minimum energy of a confined particle using uncertainty principle, energy time uncertainty principle. **(4 Lectures)**

Wave Mechanics & Schrödinger Equation: 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. **(7 Lectures)**

UNIT –II

Particle in a Box & Tunneling: One dimensional infinitely rigid box energy eigen values and eigen functions, normalization, quantum dot as an example, quantum mechanical scattering and tunnelling in one dimension across a step potential and across a rectangular potential barrier. **(9 Lectures)**

Nuclear Structure: Size and structure of atomic nucleus and its relationship with atomic weight, impossibility of an electron being in the nucleus because of the uncertainty principle, nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy. **(6 Lectures)**

Radioactivity and Nuclear Stability: Radioactivity, stability of nucleus, law of radioactive decay, mean life & half-life, decay, decay energy released, spectrum & Pauli's prediction of neutrinos. **(6 Lectures)**

Theory: 42 hrs

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill.
- Modern Physics, John R.Taylor, Chris D. Zafiratos, Michael A. Dubson, 2009, PHI Learning.
- Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, 2003, McGrawHill.
- Quantum Physics, Berkeley Physics Course Vol .4. E. H. Wichman, 2008, Tata McGraw-HillCo.
- Modern Physics, R. A. Serway, C. J. Moses, and C. A. Moyer, 2005, Cengage Learning.
- Modern Physics, G. Kaur and G. R. Pickrell, 2014, McGrawHill.

Subject Title: Fundamentals of Quantum Computing
Subject Code: PCME-522P3
Weekly Load/Credits: 3h/03

L	T	P
3	0	0

Course Outcomes (COs): After successful completion of the course, the students will be able to:

CO1: Understand fundamental principles of quantum physics and distinguish them from classical concepts.
CO2: Explain quantum states, qubits, quantum gates, and basic quantum circuit.
CO3: Identify different physical implementations of qubits and their advantages.
CO4: Describe the principles and applications of quantum sensing and measurement.
CO5: Understanding of the quantum communication concepts, security and emerging technologies.

UNIT - I

Quantum Technologies: Four verticals, motivation for quantum technologies.

(1 Lecture)

A qualitative overview of salient aspects of quantum physics: Quantum states, wavefunctions, probabilistic interpretation, physical observables, Hermitian operators, expectation values, Heisenberg uncertainty principle, Schrodinger equation, time evolution distinction from classical physics, Heuristic description of superposition, tunnelling and entanglement, no cloning theorem, simulating classical systems, Feynman's idea of a quantum simulator and the birth of the field. **(10 Lectures)**

Quantum Communication: Basics of digital communication, Quantifying classical information, Shannon entropy, basic ideas of quantum communication, security, eavesdropping, overview of quantum communication achievements, terrestrial fibre-based, free space, satellite-based. **(10 Lectures)**

UNIT – II

Quantum Computation: Basics of qubits, what is a qubit, How is it different from a classical bit, Review of classical logic gates, Di Vincenzo criteria for realising qubits, Basics of qubit gates and quantum circuits, Physical implementation of qubits (very qualitative description), solid state qubits, semiconducting qubits, quantum dots, spins, superconducting qubits, charge, flux and phase, topological qubits, proposals and advantages, atoms and ions, Trapped ions, Rydberg atoms, Neutral atoms, Photonic qubits, conventional linear optical setups, Integrated Photonics, NMR qubits, conventional NMR qubits, NV centers, overview of applications and recent achievements, RSA and Shor's algorithm, quantum advantage, long term goals and strategies being followed, error correction. **(12 Lectures)**

Quantum Sensing: Basics of quantum sensing, basics of photon (single and entangled) generation and detection, gravimetry, Atomic clock, magnetometry, state of the art in quantum sensing. **(9 Lectures)**

Theory: 42 hrs

Reference Books:

- Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
- Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010)
- Elements of Quantum Computation and Quantum Communication, A. Pathak, Boca Raton, CRC Press (2015).

Subject Title: Basic Electrical/Electronic Instruments for Measurements
Subject Code: PCMS-523P1
Weekly Load/Credits: 2h/02

L	T	P
2	0	0

Course Outcomes (COs): After successful completion of the course, the students will be able to:

CO1: Explain the principles and working of basic electrical measuring instruments and their errors.
CO2: Measure and analyse electrical power and energy in single-phase and three-phase systems.
CO3: Apply DC and AC bridges and CRO for measurement of electrical quantities.
CO4: Describe the operation and applications of potentiometers, instrument transformers, and electronic instruments.
CO5: Explain the principles and applications of electrical transducers.

UNIT-I

Introduction to Measuring Instruments: Classification of Instrument – deflecting, controlling and damping torques, ammeters and voltmeters PMMC, moving iron, Electrostatic, induction type instruments, expression for the deflecting torque and control torque, errors and compensations, extension of range of instruments. **(4 lectures)**

Measurement of Power & Energy: Single phase dynamometer wattmeter, expression for deflecting and control torques, measurement of active and reactive power in balanced and unbalanced systems, power factor meters, induction type energy meterm, single & three phase – driving and braking torques –errors and compensation. **(4 lectures)**

DC and AC Bridges: Method of measuring low, medium and high resistance, Wheatstone's bridge, Kelvin's double bridge for measuring low resistance, measurement of inductance, Maxwell's bridge, Hay's bridge, Anderson's bridge, Owens's bridge, measurement of capacitance and loss angle, De Sauty's bridge, Wien's bridge, Schering bridge, principle of CRO, time, frequency and phase angle measurements using CRO.

(6 lectures)

UNIT-II

Potentiometers, Instrument Transformer & Electronic Measurements: Principle and operation of D.C. Crompton's potentiometer standardisation, measurement of unknown resistance, current, voltage. A.C., potentiometers, polar and coordinate type's standardization application, CT and PT – Ratio and phase angle errors, electronic voltmeter, millimetre, Wattmeter & energy meter. **(6 lectures)**

Transducers: Definition of transducers, classification of transducers, advantages of electrical transducers, characteristics and choice of transducers; Principle operation of LVDT and capacitor transducers, LVDT applications, strain and its principle of operation, gauge factor, thermistors, thermocouples, piezo electric transducers, photovoltaic, photo conductive cells, and photo diodes. **(8 lectures)**

Theory: 28 hrs

References Books:

- A. K. Sawhney", "Electrical & Electronic Measurements", Dhanpat Rai & Co. Publications,2005.
- "G. K. Banerjee", "Electrical & Electronic Measurements", PHI Learning Pvt. Ltd., 2 ndEdition,2016
- "S. C. Bhargava", "Electrical Measuring Instruments and Measurements ", BS Publications,2012.

Subject Title: Analytical Techniques for Material Characterization
Subject Code: PCMS-523P2
Weekly Load/Credits: 2h/02

L	T	P
2	0	0

Course Outcomes (COs): After successful completion of the course, the students will be able to:
CO1: Explain the principles of X-ray generation, absorption and diffraction.
CO2: Describe the X-ray diffractometry, data acquisition, spectral distortions and applications.
CO3: Apply X-ray spectroscopy techniques for qualitative & quantitative elemental analysis.
CO4: Explain the working principles, instrumentation and contrast mechanisms of SEM.
CO5: Describe TEM instrumentation, specimen preparation, diffraction techniques and imaging of crystal defects.

UNIT-I

X-ray Diffraction Methods: X-ray radiation, generation of X-rays, X-ray absorption, theoretical background of diffraction, diffraction geometry and intensity. **(3 lectures)**

X-ray Diffractometry: Instrumentation (XRD System), samples and data acquisition, distortions of diffraction spectra, applications, wide angle X-ray diffraction and scattering, small angle scattering. **(5 lectures)**

X-ray Spectroscopy for Elemental Analysis: Features of characteristic X-rays, types of characteristic X-rays, comparison of K, L and M series, X-ray fluorescence spectrometry, wavelength dispersive spectroscopy, energy dispersive spectroscopy, special features, scanning Modes, qualitative and quantitative analysis, qualitative analysis, quantitative analysis. **(6 lectures)**

UNIT-II

Scanning Electron Microscopy: Instrumentation (FESEM), optical arrangement, signal detection, probe size and current, contrast formation, electron specimen interactions, topographic contrast, compositional contrast, operational variables, working distance and aperture size, acceleration voltage and probe current, astigmatism, specimen preparation, preparation for topographic examination, preparation for micro-composition examination, dehydration. **(7 lectures)**

Transmission Electron Microscopy: Instrumentation (TEM), electron sources, electromagnetic lenses, specimen stage, specimen preparation, pre-thinning, final thinning, image modes, mass-density contrast, diffraction contrast, phase contrast, selected area diffraction, selected area diffraction characteristics, single-Crystal diffraction, multi-crystal diffraction, Kikuchi Lines, images of crystal defects, Wedge Fringe, bending contours, dislocations. **(7 lectures)**

Theory: 28 hrs

Reference Books:

- Materials Characterization, Yang Leng (Wiley)

Subject Title: Basics of Nuclear Instrumentation and Measurements
Subject Code: PCMS-523P3
Weekly Load/Credits: 2h/02

L	T	P
2	0	0

Course Outcomes (COs): After successful completion of the course, the students will be able to:

CO1: Explain nuclear structure, types of radiation, radiation–matter interactions, and detection principles.
CO2: Describe the working and characteristics of gas-filled radiation detectors.
CO3: Explain scintillation and semiconductor detectors and their applications.
CO4: Understand neutron detection methods and basic nuclear electronics for signal processing.
CO5: Apply radiation measurement techniques to medical, industrial, environmental and cosmological applications.

UNIT-I

Radiation Fundamentals & Detection Principles: Structure of the nucleus and types of nuclear radiation, Interaction of α, β, γ rays and neutrons with matter, principles of radiation detection, detector characteristics: efficiency, resolution, dead time, counting statistics, Poisson distribution, and detector calibration. **(7 Lectures)**

Gas-Filled Detectors: Ionization chambers: construction and operation, proportional counters: working and applications, Geiger–Müller counters: characteristics, plateau, quenching. **(4 lectures)**

Scintillation Detectors: Scintillation mechanism; inorganic and organic scintillators, Photomultiplier tubes and pulse formation. **(3 lectures)**

UNIT-II

Semiconductor Detectors: p–n junction principles, depletion region, silicon and HPGe detectors: cooling, resolution, applications. **(3 lectures)**

Neutron Detection & Nuclear Electronics: Neutron interactions with matter, BF_3 Scintillation-based neutron detection, Preamplifiers, shaping amplifiers, pulse-height analysis, Multichannel analyzers (MCA), timing systems, coincidence techniques, Dead-time correction. **(4 lectures)**

Measurement Techniques & Applications: Alpha, beta, and gamma counting techniques, Half-life measurement and absorption coefficient determination, Applications in medical imaging, Industrial radiography and non-destructive testing, Environmental radiation monitoring Cosmology: Standard Candles (Cepheids and SNe Type 1a); cosmic distance ladder; expansion of the Universe; Cosmological principle, Newtonian Cosmology and Friedmann models. **(7 lectures)**

Theory: 28 hrs

References:

- Radiation Detection and Measurement by Glenn F. Knoll.
- Introductory Nuclear Physics by Kenneth S. Krane.
