

Maharaja Surajmal Brij University
Bharatpur

SYLLABUS



M.Sc.(Physics)
(Semester I & II)
(2025-2026)

Maharaja Surajmal Brij University
Bharatpur


प्रभारी अकादमिक प्रथम


(Dr.Anju Tanwar)


(Dr.H.K.Mahavar)

1. Eligibility
As per the rules formed/framed by the Commissionerate College Education Rajasthan, Jaipur.
2. Scheme of Examination
As per the M.S.Brij University official notification issued from time to time.
3. Course Detail
The details of the courses with code, title and credits are as given below –

Abbreviation Used –

CCC	Compulsory Core Course
ECC	Elective Core Course
SEC	Skill Enhancement Course
IEC	Interdisciplinary Elective

Note:- The Medium of Instruction and Examination shall be English only.


(Dr. Anju Tanwar)


प्रभारी अकादमिक प्रथम


(Dr. H.K. Mahavar)

SEMESTER-I

Semester-I			ECC
Course Category	Course Title	Credit Score	
CC	Classical Mechanics	4	1. Classical Electrodynamics
CC	Quantum Mechanics	4	2. Electronics
CE	Elective Course-I	4	3. Energy Studies-I
CE	Elective Course-II	4	4. Astrophysics-I
SEC	Skill Enhancement Course	4	5. General Theory of Relativity
	Practical	4	6. Cosmology
	Total Credit Score	24	7. Laser Physics
			8. Thermal Physics

COURSE CODE - PHY - 20101 - T

Classical Mechanics

(Course Category - CC)

Objectives of the Course

This course is an introduction to concepts of classical mechanics. It is a compulsory and core paper for M.Sc. Physics. It is meant to introduce the basic concepts classical mechanics, i.e., Constraints, D'Alembert's Principle, Method of Lagrange's Multipliers, Hamilton's principle, Noether's Theorem, Hamilton's canonical Equations, Canonical transformation, Hamilton-Jacobi Equation, Action angle variables, The Kepler's problem, a theory of small oscillations and Euler's theorem.

Unit I

Constraints, holonomic and non-holonomic constraints, D'Alembert's Principle and Lagrange's Equation, velocity dependent potentials, applications of Lagrangian formulation, Hamilton's Principle, Calculus of variations, Derivation of Lagrange's Equation from Hamilton's principle, Extension of Hamilton's principle for non- conservative and non-holonomic systems, Method of Lagrange's Multipliers, Conservation theorems and symmetry properties, Noether's Theorem, Conservation of energy, linear momentum and angular momentum as a consequence of homogeneity of time and space and isotropy of space.

(15 Lectures)

Unit II

Generalized momentum, Legendre transformation and the Hamilton's Equations of Motion, applications of Hamiltonian formulation, cyclic coordinates, Routh's procedure, Derivation of Hamilton's canonical Equations from Hamilton's variational Principle. Hamiltonian Formulation of Relativistic Mechanics. The principle of least Action.

(15 Lectures)

Unit III

Canonical transformation, integral invariance of Poincare, Lagrange's and Poisson brackets as canonical invariants, Equation of motion in Poisson bracket formulation. Infinitesimal contact transformation and generators of symmetry, Liouville's Theorem, Hamilton-Jacobi Equation and its application.

3


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)


प्रमारी अकादमिक प्रथम

Unit IV

Action angle variables, the Kepler's problem in action angle variables, theory of small oscillations in Lagrangian formulation, normal coordinates and its applications, orthogonal transformation, Euler's theorem. Eigenvalues of the Inertia tensor, Euler equations, force free motion of a rigid body.

(15 Lectures)

Suggested References:

1. Classical Mechanics, H. Goldstein, Poole and Safco, Narosa Publication.
2. Mechanics, L.D. Landau and E.M. Lifshitz.
3. Classical Mechanics, A.K. Raychaudhuri.
4. Classical Mechanics, N.C. Rana and P.S. Joag.
5. Classical Dynamics, J. B. Marion.
6. Classical Mechanics of particles and rigid bodies, K.C. Gupta, (John Wiley).
7. Theoretical Mechanics, Murray Spiegel.
8. Classical Mechanics, J.C. Upadhyaya, Himalaya Publishing House Pvt. Ltd.

Course Learning Outcomes:

1. Apply analytical mechanics principles to model physical systems using constraints, D'Alembert's principle, Lagrangian, and Hamiltonian formulations.
2. Derive and utilize conservation laws (energy, momentum, angular momentum) using symmetry considerations and Noether's theorem.
3. Employ variational methods (Hamilton's principle, calculus of variations, Poisson brackets, canonical transformations) to solve complex dynamical problems.
4. Analyze rigid body dynamics and oscillatory systems using action-angle variables, normal coordinates, inertia tensor, and Euler's equations.
5. Demonstrate proficiency in advanced mechanics techniques such as Hamilton-Jacobi theory, Liouville's theorem, and relativistic Hamiltonian formulation for theoretical and applied problems.

COURSE CODE - PHY-20102-T

Quantum Mechanics

(Course Category- CC)

Objectives of the Course

Students should have a sound understanding of key concepts in quantum mechanics and be able to apply this understanding to analyze and make both qualitative and quantitative understanding of the problems.

Unit I

States, Amplitude and Operators: States of a quantum mechanical system, Representation of quantum mechanical states, properties of quantum mechanical amplitude, operators and change of state, a complete set of basis states, products of linear operators, language of quantum mechanics, postulates, essential definitions and commutation relations

Observables and Description of Quantum system: Process of measurement expectation values, time dependence of quantum mechanical amplitude, observable with no classical analogue, spin

4


(Dr. Anju Tanwar)


प्रभारी अकादमिक प्रथम


(Dr. H.K. Mahavar)

dependence of quantum Mechanical amplitude of position, the wave function, superposition of amplitudes. Identical particles.

(15 Lectures)

Unit II

Hamiltonian matrix and the time-evolution of Quantum mechanical States: Permittivity of the Hamiltonian matrix. time independent perturbation of an arbitrary system, simple matrix examples of time independent perturbation, energy given states of a two-state system, diagonalizing of energy matrix, time independent perturbation of two state system. the perturbative solution: Weak field and Strong field cases, general description of two state system, Pauli matrices, Ammonia molecule as an example of two state system.

(15 Lectures)

Unit III

Transition between stationary States: Transitions in a two-state system, time-dependent perturbations - The Golden Rule, Phase space, emission and absorption of radiation, induced dipole transition and spontaneous emission of radiation energy, width of a quasi-stationary state.

The co-ordinate Representation: Compatible observables, quantum conditions and uncertainty relation, Coordinate representation of operators, position, momentum and angular momentum, time dependence of expectation values, The Ehrenfest Theorem, the time evolution of wave function, the Schrodinger equation, energy quantization, periodic potential as an example.

(15 Lectures)

Unit IV

Symmetries and Angular Momentum:

Compatible observables and constants of motion, symmetry transformation and conservation laws, invariance under space and time translations and space rotation and conservation of momentum, energy and angular momentum.

Angular momentum operators and their eigenvalues, matrix representations of the angular momentum operators and their eigenstates, coordinate representations of the orbital angular momentum operators and their eigenstates (Spherical Harmonics), composition of angular momenta, Clebsch-Gordon Coefficients, tensor operators and Wigner-Eckart theorem, Commutation relations of J_x, J_y, J_z with reduced tensor operator, matrix elements of vector operators, time reversal invariance and vanishing of static electric dipole moment of stationary state.

(15 Lectures)

Suggested References:

1. Ashok Das and Adrian Constantin Melissinos, Quantum Mechanics: A Modern Approach, (Gordon & Breach Science Publishers).
2. P.A.M. Dirac, Quantum Mechanics.
3. E. Merzbacher: Quantum Mechanics, Second Edition (John Wiley and Sons)
4. L.P. Landau and L.M. Lifshitz, Quantum Mechanics - Relativistic theory (Pergamon Press)
5. A. Ghatak and S. Lokanathan: Quantum Mechanics -Theory and Applications, Third Edition. (Mac. Milian, India Ltd.)
6. <https://nptel.ac.in/courses/115106066>
7. <https://archive.nptel.ac.in/courses/122/106/122106034/>
8. <https://ocw.mit.edu/courses/8-04-quantum-physics-i-spring-2016/>

Course learning outcomes:

The student will be able to learn after completion of the course:

1. Understand the foundational principles and mathematical framework of quantum mechanics.
2. Apply advanced mathematical techniques to solve quantum mechanical problems.
3. Analyze the time evolution and dynamics of quantum systems using the Schrödinger equation.
4. Utilize quantum operators to compute expectation values and probabilities in quantum systems.
5. Identify symmetries and relate them to conservation laws in quantum mechanics.
6. Evaluate and apply quantum mechanical models to physical systems.
7. Develop critical analysis, problem-solving, and communication skills in quantum mechanics.

COURSE CODE - PHY - 20103 - T

Classical Electrodynamics

(Course Category: CE)

Unit I

Electrostatics: Electric field, Gauss Law. Differential form of the Gaussian law. Another equation of electrostatics and the scalar potential, surface distribution of charges and dipoles and discontinuities in the electric field and potential, Poisson and Laplace equations, Green's Theorem, Uniqueness of the solution with the Dirichlet or Neumann boundary Conditions, Formal Solutions of electrostatic Boundary value problem with Green's function, Electrostatic potential energy and energy density, capacitance.

Boundary Value Problems in Electrostatics: Methods of images, point charge in the presence of a grounded conducting sphere, point charge in the presence of a charged insulated conducting sphere, point charge near a conducting sphere at a fixed potential, conducting sphere in a uniform electric field by method of images, green function for the sphere, General solution for the potential. conducting sphere with hemispheres at different potentials, orthogonal functions and expansion.

(15 Lectures)

Unit II

Multipoles, electrostatics of Macroscopic Media Dielectric: Multipole expansion. multipole expansion of the energy of a charge distribution in an external field. Elementary treatment of electrostatics with permeable media. Boundary value problems with dielectrics. Molar polarizability and electric susceptibility. Models for molecular polarizability, electrostatic energy in dielectric media.

(15 Lectures)

Unit III

Magnetostatics: Introduction and definition, Biot and Savart law, the differential equations of magnetostatics and Ampere's law, Vector potential and magnetic induction for a current loop, Magnetic fields of a localized current distribution, Magnetic moment, Force and torque on and energy of a localized current distribution in an external induction, Macroscopic equations, Boundary conditions on B and H, Methods of solving boundary value problems in magnetostatics, Uniformly magnetized sphere, a magnetized sphere in an external field, permanent magnets, magnetic shielding, spherical shell of permeable material in a uniform field.

6


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

Unit IV

Time varying fields, Maxwell's equations, conservation laws: Energy in a magnetic field, vector and scalar, potential, Gauge transformations. Lorentz gauge, Coulomb gauge, green function for the wave equation, Derivation of the equations of Macroscopic Electromagnetism. Poynting's Theorem and conservation of energy and momentum for a system of charged particles and EM fields. Conservation laws for macroscopic media. Electromagnetic field tensor, transformation of four potentials and four currents, tensor dissipation of Maxwell's equations.

(15 Lectures)

Suggested References:

1. J.D.Jackson: Classical Electrodynamics
2. Panofsky C Phillip: Classical electrodynamics and Magnetism
3. Griffith: Introduction to Electrodynamics
4. Landau • Clifshitz: Classical Theory of Electrodynamics
5. Landau Clifshitz: Electrodynamics of continuous media

Course learning outcomes:

Students will have achieved the ability to:

1. Describe the nature of the electric and magnetic fields and their propagation through different media and interfaces.
2. Describe Maxwell equations and their physical consequences
3. Synthesize specific electrodynamic phenomena into precise mathematical language
4. Describe physical phenomena in the language of fields, Formulate the covariant form of electrodynamics.

COURSE CODE - PHY - 20104 - T
Electronics

(Course Category - CE)

Objectives of the Course

The course aims to provide students with theoretical knowledge in operational amplifiers, active filters, oscillators, digital concepts, logic circuits, flip-flops, counters, and digital signal processing. Emphasizing design, analysis, and troubleshooting, it prepares students for practical applications and advanced research in modern electronics and digital signal processing.

Unit I

Operational Amplifiers - Theory and Applications: Differential amplifier - circuit configurations - dual input, balanced output differential amplifier. DC analysis, inverting and non-inverting inputs, CMRR - constant current bias level translator. Block diagram of typical OP-AMP analysis. Open loop configuration, inverting and non-inverting amplifiers, OP-AMP with negative feedback, voltage series feedback, effect of feedback on closed loop gain, input resistance, bandwidth and output offset voltage, voltage follower. Practical OP-AMP: Input offset voltage, input bias current,

7



(Dr. Anju Tanwar)



(Dr. H.K.K. Mahavar)

input offset current, total output offset voltage, CMRR, frequency response. DC and AC amplifier. Integrator and differentiator.

(15 Lectures)

Unit II

Oscillators and Waveform Generation Circuits: Oscillator principle, frequency stability response, the phase-shift oscillator, Wien bridge oscillator, LC tuneable oscillators. Multivibrators - monostable, astable and bistable. Comparators. Square wave and triangle wave generation, clamping and clipping circuits.

(15 Lectures)

Unit III

Combinational Digital Logic and Integrated Circuits: Combinational logic; standard representations for logic functions; Karnaugh Map representation of logical functions. Simplification of logical functions using K-map. Minimization of logical functions specified in minterms/maxterms or truth table. Don't-care conditions. Adder (half and full), subtractor (half and full). Comparator. Multiplexers and their uses, demultiplexer. Decoders and their uses. BCD arithmetic, parity generators/checkers, code converters, priority encoders, decoders. Drivers for display devices, seven-segment display device, ROM, programmable logic array. Basic concept about fabrication and characteristics of integrated circuits.

(15 Lectures)

Unit IV

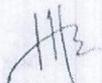
Sequential Logic, Data Conversion, and Opto-Electronic Devices: Flip-flops: one-bit memory, RS, JK, JK master-slave, T and D-type flip-flops. Shift registers - synchronous and asynchronous. Counters - cascade counters, binary counter, decade counter. A/D and D/A conversion - basic principles, circuitry and simple applications. Voltage regulators - fixed regulators, adjustable voltage regulators, switching regulators. Basic idea of IC-555 and its applications as a multivibrator and square-wave generator. Opto-electronic Devices: photo diode, phototransistor, LED and their applications.

(15 Lectures)

Suggested Reference Books

1. Electronic Devices and Circuit Theory, Boylestad, R. L., & Nashelsky, L., PHI Learning Pvt. Ltd., New Delhi, 1991.
2. Integrated Electronics, J. Millman and C.C. Halkias, Tata Mc-Graw Hill, 1991.
3. Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., Tata McGraw Hill, 2012.
4. Op-Amps and Linear Integrated Circuits, Gayakwad, R. A., 2nd ed., PHI Learning Pvt. Ltd., New Delhi, 1991.
5. Digital Principles and Applications, Malvino, A. P., & Leach, D. P., Tata McGraw-Hill, New Delhi, 1993.


(Dr. Anju Tanwar)

8

(Dr. H.K. Mahavar)

6. Fundamentals of Digital Circuits, Anand Kumar, 2nd ed., PHI Learning Pvt. Ltd, 2009.
7. Digital Circuits and systems, Venugopal, Tata McGraw Hill, 2011.
8. Digital Electronics G K Kharate, Oxford University Press, 2010
9. Logic circuit design, Shimon P. Vingron, Springer, 2012.

Course Learning Outcomes

After successful completion of this course, students will be able to:

1. Analyse the characteristics and configurations of operational amplifiers, including differential amplifier behaviour, feedback effects, and practical limitations such as offset voltages and bias currents.
2. Design and evaluate analog circuits using Op-Amps for amplification, integration, differentiation, waveform generation, and oscillator applications such as Wien-bridge and phase-shift oscillators.
3. Simplify and implement combinational logic functions using Boolean algebra, Karnaugh Maps, and logic gates; design arithmetic and logic circuits including adders, subtractors, multiplexers, decoders, and display drivers.
4. Construct and analyse sequential logic circuits including flip-flops, shift registers, and various counters; explain the working of memory devices and basic programmable logic components like ROM and PLA.
5. Explain the principles of A/D and D/A conversion, voltage regulation techniques, and demonstrate understanding of integrated circuits such as IC 555 and opto-electronic devices for real-world applications.

COURSE CODE - PHY-20105-T

Energy Studies-I

(Course Category- CE)

Objectives of the Course

1. To provide a fundamental understanding of photovoltaic energy conversion and the essential physics and materials involved.
2. To familiarize students with the types, operation principles, and advanced concepts of solar cells and photoelectrochemical systems.
3. To introduce the significance of hydrogen as a clean energy carrier and explore various hydrogen production and storage methods.
4. To develop awareness about the safe handling, utilization, and applications of hydrogen energy and other clean energy sources.

Unit I

Solar Energy: Fundamentals of photovoltaic Energy Conversion Physics and Material Properties Basic to Photovoltaic Energy Conversion: Optical properties of Solids. Direct and indirect transition semiconductors, interrelationship between absorption coefficients and band gap recombination of carriers.

(15 Lectures)

9


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

Unit II

Types of Solar Cells, p-n junction solar cell, Transport Equation, Current Density, Open circuit voltage and short circuit current, Brief descriptions of single crystal silicon and amorphous silicon solar cells, elementary ideas of advanced solar cells e.g. Tandem Solar Cells. solid Liquid Junction Solar Cells, Nature of Semiconductor, Electrolyte Junction, Principles of Photoelectrochemical Solar Cells.

(15 Lectures)

Unit III

Hydrogen Energy: Relevance in depletion of fossil fuels and environmental considerations. Hydrogen Production: Solar Hydrogen through Photo electrolysis and Photocatalytic process, Physics and material characteristics for production of Solar Hydrogen. Storage of Hydrogen: Brief discussion of various storage processes, special features of solid-state hydrogen storage materials, structural and electronic characteristics of storage materials. New Storage Modes.

(15 Lectures)

Unit IV

Safety and Utilisation of Hydrogen: Various factors relevant to safety, use of Hydrogen as Fuel, Use in Vehicular transport, Hydrogen for Electricity Generation, Fuel Cells, Elementary concepts of other Hydrogen-based devices such as Air Conditioners and Hydride Batteries. Other Renewable Clean Energies: Elements of Solar Thermal Energy, Wind Energy and Ocean Thermal Energy Conversion.

(15 Lectures)

Suggested References:

1. Fonash: Solar Cell Devices - Physics.
2. Fahrenbruch & Bube: Fundamentals of Solar Cells Photovoltaic Solar Energy.
3. Chandra: Photoelectrochemical Solar Cells.
4. Winter & Nitch (Eds.): Hydrogen as an Energy Carrier Technologies System Economy.

Course Learning Outcomes:

After successful completion of this course, students will be able to:

1. Explain the optical and electronic properties of materials essential for photovoltaic energy conversion and carrier recombination mechanisms.
2. Describe the working principles and performance parameters (e.g., current density, open-circuit voltage) of different types of solar cells including advanced cells like tandem and photoelectrochemical cells.
3. Evaluate different methods of hydrogen production using solar energy and understand the role of materials in these processes.
4. Analyze and compare hydrogen storage methods, especially solid-state storage, based on material properties and efficiency.
5. Discuss safety considerations, practical applications, and emerging uses of hydrogen energy in transportation and power generation, including the working of fuel cells.
6. Demonstrate a basic understanding of other renewable energy technologies such as solar thermal, wind, and ocean thermal energy conversion.


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

Astrophysics-I

(Course Category- CE)

Objectives of the Course

COURSE CODE - PHY-20106-T

1. To introduce the basic principles of observational astronomy and radiative processes in astrophysical contexts.
2. To develop an understanding of stellar parameters, motions, classifications, and their physical interpretation through radiation and spectra.
3. To impart knowledge of stellar evolution, internal structure of stars, and end stages such as white dwarfs and neutron stars.
4. To provide insight into galactic structure, stellar dynamics, cosmology, and recent advances in gravitational wave astronomy.

Unit I

Astronomy fundamentals, Black body radiation, Radiation mechanism, Flux density and luminosity, basics of Radiative transfer and Radiative processes, Magnitudes, Motions and Distances of Stars: Absolute stellar magnitude and distance modulus, Bolometric and radiometric magnitudes, Colour-index and luminosities of stars.

(15 Lectures)

Unit II

Stellar positions and motions, Velocity dispersion, Statistical and moving cluster parallax, Extinction, Stellar temperature, Effective temperature, Brightness temperature, Color temperature, Kinetic temperature, Excitation temperature, Ionization temperature, Spectral Classification of stars, Utility of stellar spectrum, stellar atmospheres.

(15 Lectures)

Unit III

Overview of the major contents of the universe, Sun and stars, stellar interiors, HR diagram, nuclear energy generation, neutrino astronomy, white dwarfs and neutron stars, plasma processes, compact objects, shape, size and contents of our galaxy

(15 Lectures)

Unit IV

Basics of stellar dynamics, normal and active galaxies, gravitational wave astronomy. Newtonian cosmology, microwave background, early universe.

(15 Lectures)

Suggested References:

1. Theoretical Astrophysics Vol,-I, T. Padmanabhan, Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, India
2. An Introduction to Modern Astrophysics, Bradley W. Carroll, Dale A. Ostlie
3. Astrophysics Concepts: M. Harwit
4. Art Introduction to Astrophysics: Baidyanath Basu
5. Astronomical Physics: Stars and Galaxies: K. D. Abhayankar
6. The Sun: An Introduction: M. Stix
7. Stellar Atmospheres: D. Mihalas


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

8. An Introduction to the Study of Stellar Structures: S.Chandrasekhar
9. Spherical Astronomy: W.M.S-mar

Course learning outcomes:

After successful completion of this course, students will be able to:

1. Explain astronomical measurement systems, blackbody radiation, radiative mechanisms, and determine stellar distances and magnitudes using standard techniques.
2. Analyze stellar spectra to classify stars, estimate various stellar temperatures, and understand stellar atmospheres and extinction.
3. Interpret the Hertzsprung-Russell diagram, describe nuclear fusion in stellar interiors, and assess the properties of compact stellar remnants.
4. Describe the structure and dynamics of galaxies, understand cosmological principles, and explain the significance of gravitational wave and neutrino astronomy in the context of the early universe.

COURSE CODE - PHY-20107-T

General Theory of Relativity

(Course Category- CE)

Objectives of the Course

The primary objective is to teach the students the physical and mathematical basis of Einstein's relativistic theory of gravitation.

Unit I

Special Relativity: Principles of special relativity, Lorentz transformations. Relativistic Mechanics.

Equivalence principle: Non-inertial frames and non-Euclidean geometry; General coordinate transformations and the general covariance of physical laws.

Equality of gravitational and inertial masses, Equivalence principle, Principle of general covariance.

(15 Lectures)

Unit II

Tensor Analysis: Covariant and contravariant tensors. Tensors of arbitrary rank. Metric tensor. Parallel transport and covariant differentiation. Affine connection and its relation to metric tensor. Curvature tensor and its symmetries. Bianchi identities. Weyl tensor and conformal invariance.

Energy-momentum tensor and conservation laws, Einstein's equation, Hilbert's variational principle, Gravitational energy-momentum pseudotensor.

(15 lectures)

Unit III

Geodesics: Equation of motion of particles. Weak fields and Newtonian approximation. Time and distance in general theory, gravitational red and blue shifts, experimental verification, Einstein's field equation - Newtonian gravity as an approximation, Schwarzschild solution, Radial motion towards centre. Nature of singularities, black holes, event horizon, Kruskal co-ordinates

(15 lectures)


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

Unit IV

General orbits, constants of motion, deflection of light, precession of perihelion and radar echo. Standard, isotropic and harmonic coordinates. Parametrised post-Newtonian formalism and status of observational verification. Mach's principle.

Energy momentum tensor for a perfect fluid, equation of motion from field equation for equation for dust. Action principle for field equations. Conservation laws in curved space and pseudo-energy tensor for the gravitational field.

(15 lectures)

Course Learning Outcomes:

Students will be trained in tensor analysis and tensor calculus. This course will teach the formalism of general relativity (GR). They will learn how to obtain an exact solution of GR, namely, the Schwarzschild solution.

Suggested References:

1. Introducing Einstein's Relativity, Ray D'Inverno (Clarendon Press, 1992)
2. Principles of Gravitation and Cosmology, M. Berry (Cambridge University Press, 1976)
3. Introduction to General Relativity & Cosmology, Steven Weinberg (John Wiley & Sons, 1972)
4. The Classical Theory of Fields, L.D. Landau and E. M. Lifshitz (Pergamon, 1975)
5. Classical Fields: General Relativity and Gauge Theory, Moshe Carmeli (World Scientific, 2001)
6. General Theory of Relativity, P.A. M. Dirac (John Wiley, 1975)
7. Gravity, Black Holes and the Very Early universe: An Introduction to General Relativity and Cosmology, Tai L. Chow (Springer, 2008)

COURSE CODE — PHY-20108-T

Cosmology

(Course Category- CE)

Objectives of the Course

The course aims –

1. To introduce students to standard cosmological models, including Einstein's and De Sitter's universe and the FRW-Lemaitre metric.
2. To provide an understanding of particle physics processes and nucleosynthesis in the early universe.
3. To explore inflationary cosmology and the origin of structure through density perturbations.
4. To critically examine alternative cosmological models such as the Quasi-Steady State theory.

Unit I

Einstein's model of the Universe. De-Sitter Universe. Friedman-Robertson-Walker-Lemaitre model of the Universe. Big Bang and the Physics of the early Universe.

(15 Lectures)

Unit II

Particle and the Nucleosynthesis in the early Universe. Various phase transitions and timeline of the Universe.

(15 Lectures)

13


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

Unit III

Inflationary cosmology and generation of density perturbations.

(15 Lectures)

Unit IV

Alternative cosmologies: Quasi-Steady State Theory of the Universe.

(15 Lectures)

Suggested References:

1. "An Introduction to Modern Cosmology" — Andrew Liddle
2. "Cosmology: The Science of the Universe" — Edward Harrison
3. "Principles of Physical Cosmology" — P.J.E. Peebles
4. "Modern Cosmology" — Scott Dodelson
5. "Cosmological Physics" — John A. Peacock

Course learning outcomes:

After successful completion of this course, students will be able to:

1. Compare different cosmological models and explain the features of the Big Bang and early universe using the FRW metric.
2. Describe key particle interactions and nucleosynthesis events during the early universe, and outline major cosmological phase transitions.
3. Explain the theory of cosmic inflation and its role in generating density fluctuations leading to structure formation.
4. Evaluate the strengths and limitations of standard and alternative cosmological models, particularly the Quasi-Steady State theory.

COURSE CODE — PHY-20109-T

Laser Physics

(Course Category- CE)

Objectives of the Course

The topics cover a broad range of theoretical and practical knowledge essential for understanding and working with lasers with the following objectives:

1. To understand the basic principles of laser operation, laser components and laser optics.
2. To know and understand different types of lasers such as solid-state, gas and dye lasers.
3. To understand the techniques for measuring laser power, wavelength, and beam quality etc.

Unit I

Interaction of radiation with matter: Absorption, spontaneous and stimulated emission, Einstein's Coefficients, population inversion, metastable states, gain, absorption Coefficients, stimulated cross section, threshold condition. Two-level system (Ammonia Maser-Physical separation of excited species from those in the ground state). Three and four-level system, Rate equations for three and four-level systems, threshold pump power, relative merits and demerits of three and four-level systems.

(15 Lectures)


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

Unit II

Optical resonators: Resonator configurations, Stability of resonators, Characteristics of Gaussian beam, Transverse and longitudinal modes, mode selection techniques (at least two techniques in each case), losses in a resonator, Hardware design-laser support structure, mirror mounts, optical coating etc.

(15 Lectures)

Unit III

Gas and dye lasers: excitation in gas discharge, collisions of 1st and 2nd kind, electron impact excitation-its cross section, different types of gas lasers: He-Ne, N₂, CO₂, Metal vapour lasers, Excimer and chemical laser, dye laser.

(15 Lectures)

Unit IV

Laser Parameters and their measurement: Near field and Far field regimes, Internal and external parameters in the near and far field, Detectors and their operational mechanism, including specific properties like rise time, spectral response etc.

(15 Lectures)

Suggested References:

1. "Lasers-Fundamentals and Applications", K. Tyagarajan and A. Ghatak, 2nd Edition, Springer US, 2011.
2. "Principles of lasers", O. Svelto, 4th Edition, Springer US, 2010.
3. "Laser Fundamentals", W. T. Silfvast, 2nd Edition, Cambridge University Press, 2008.
4. "Optical Electronics", A. Ghatak, K. Tyagarajan, Cambridge University Press, 1989.
5. "Handbook of Laser Technology and Applications: Principles", Volume 1, C.E. Webb and J.D.C. Jones, Institute of Physics, 2004.
6. "Handbook of Laser Technology and Applications: Laser design and laser systems", Volume 2, C.E. Webb and J.D.C. Jones, Institute of Physics, 2004.

Course Learning Outcomes:

1. Understanding the Laser Principles: Ability to explain the fundamental concepts of the operation of the laser, including the stimulated emission, and optical pumping.
2. Knowledge of the Laser components: Expertise in understanding the functions of key laser components such as gain medium, optical resonator, and beam manipulators.
3. Identification of Laser Types: Knowledge of various types of laser, namely, solid- state, Gas, and Dye lasers.
4. Measurement Techniques and Beam Analysis: Ability to measure and analyze laser parameters such as power, wavelength, and beam quality using appropriate instruments.

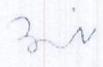
COURSE CODE - PHY-20110-T

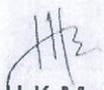
Thermal Physics

(Course Category- CE)

Objectives of the Course

To develop a fundamental understanding of atomic bonding, crystal structures, and thermal properties in ceramics and glasses.


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

1. To explore the thermal behavior of complex materials, including polymer composites, foams, and nano-structured materials.
2. To examine the mechanisms of thermal conduction in nanofluids, focusing on material and scale effects.
3. To understand the thermal dynamics of permafrost and geophysical conditions influencing its behavior.

Unit I

Heat Conduction Fundamentals: The significance of heat conduction; Heat flux; Fourier's law for heat conduction; Heat conduction equation in different orthogonal coordinate systems; Boundary conditions; dimensionless heat conduction parameters; Homogeneous and non-homogeneous heat conduction problems; Conduction heat transfer in solids, fluids and complex materials.

(15 Lectures)

Unit II

Methods of solution of heat conduction problems: The use of Green's function in the solution of non-homogeneous, time dependent heat-conduction problems; Application of Laplace transform in the solution of time dependent heat conduction problems; one dimensional composite medium; generalized orthogonal expansion technique for homogeneous heat conduction problems; Eigen values and Eigen functions.

(15 Lectures)

Unit III

Approximate Analytical Methods: The Integral method—basic concepts and applications; The variational Principles: Basic concepts, variational form of one-dimensional steady state heat conduction equation; The Ritz method: steady state heat conduction problem for a solid cylinder; The Galerkin method: construction of (P_j) functions, Boundary conditions, steady state heat conduction problem for a rectangular region with heat generation at a constant rate.

(15 Lectures)

Unit IV

Numerical methods for conduction heat transfer: Finite difference approximation of derivatives through Taylor's series; Finite difference representation of steady state heat and time dependent conduction problems; errors involved in numerical solutions; Accuracy of solutions: Optimum step size; Method of choosing optimum step size; Applications of Finite difference methods to time dependent heat conduction problems.

(15 Lectures)

Suggested References:

1. Heat conduction by M. N. Ozisik; John Wiley C Sons.
2. Thermal conductivity of solids by J. E. Parrott and A. D. Stuckes; Pion Limited.
3. Introduction to ceramics by Kingery, Bowen and Uhlmann, John Wiley C Sons (Second edn.).
4. Heat transfer in cold climates by Virgil J. Lunardini, Van Nostrand Reinhold Company (VNR).


(Dr. Anju Tanwar)

16

(Dr. H.K. Mahavar)

Course Learning Outcomes:

1. Formulate and analyze heat conduction problems in different coordinate systems using governing equations and boundary conditions.
2. Apply Green's functions, Laplace transforms, and eigenfunction expansions to solve complex conduction problems.
3. Employ approximate analytical techniques to estimate solutions for heat conduction in engineering systems.
4. Implement finite difference schemes for solving steady-state and transient heat conduction problems, and evaluate numerical accuracy and stability.

SEMESTER-II

Semester-II			CE
Course Category	Course Title	Credit Score	
CC	Mathematical Physics	4	1. Microwave Electronics
CC	Atomic & Nuclear Physics	4	2. Energy Studies-II
CE	Elective Course	4	3. Astrophysics-II
IEC***	Interdisciplinary Elective Course	4	4. Computational Physics
	Research Methodology	4	
	Practical	4	
	Total Credit Score	24	
***	Paper to be selected from the list of IEC courses available for PG students on the MSBU website		

COURSE CODE - PHY-20201-T

Mathematical Physics

(Course Category: CC)

Objectives of the course: The objective of this course is to equip students with some of the Mathematical methods that are widely used in Physics. The course aims to develop a deep understanding of tensors, tensor algebra, group theory and their application in physics and equip students with techniques of Fourier and Laplace transforms for solving differential equations and analyzing physical phenomena.

Unit I

Coordinates Transformation in N-dimensional space: Contravariant and covariant tensor, Jacobian. Relative tensor, pseudo tensors (Example: charge density, angular momentum), Algebra of tensors, Metric tensor, Associated tensors. Riemann space (Example: Euclidean space, and 4D Minkowski space). Christoffel symbols, transformation of Christoffel symbols, covariant differentiation. Ricci's theorem, divergence. Curved Laplacian tensor form, Stress and strain tensors, Hook's law in tensor form. Lorentz covariance of Maxwell equation, Klein-Gordon and Dirac Equation, Test of covariance of Schrodinger equation.

(15 Lectures)


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

Unit II

Group of Transformation: (Example: symmetry transformation of a square) Generators of a finite group, Normal subgroup, Direct product of groups. Isomorphism and Homomorphism, Representation theorem of finite groups, Invariant subspace and reducible representation, irreducible representation, crystallographic point groups, Irreducible representation of C_{4v} , Translation group and the reciprocal lattice.

(15 Lectures)

Unit III

Fourier Transforms: Development of the Fourier integral from the Fourier Series; Fourier and inverse Fourier transform: Simple Applications: Finite wave train, Wave train with Gaussian amplitude, Fourier transform of derivatives, solution of wave equation as an application, Convolution theorem. Intensity in terms of spectral density for quasi-monochromatic EM Waves, Momentum representation, Application of the Fourier transform to diffraction theory: diffraction pattern of one and two slits

(15 Lectures)

Unit IV

Laplace transforms and their properties: Laplace transform of derivatives and integrals, derivatives and integral of Laplace transform—convolution theorem. Impulsive function, Application of Laplace transform in solving linear differential equations with constant coefficients with variable coefficients and linear partial differential equations.

(15 Lectures)

Suggested References:

1. Mathematical Methods for Physicists: George Arfken (Academic Press)
2. Mathematical Method for Physics and Engineering- Riley, Hobson, Bence (Cambridge University Press)
3. Mathematical Methods, M. C. Potter and J. Goldberg (Prentice Hall of India)
4. Elements of Group Theory for Physicists- A. W. Joshi (Wiley Eastern Ltd.)
5. Applied Mathematics for Engineers and Physicists: L.A. Pipe (Mc Graw Hill)
6. A Student's Guide to Vectors and Tensors, Daniel A. Fleisch, Daniel A. Fleisch (Cambridge University Press)

Course Learning Outcomes: On completing this course, students should be able to use tensor algebra and calculus to solve physical problems, analyze physical systems by identifying symmetries and apply group theory. Students will be equipped with the widely used tools of the Fourier transform and Laplace transform techniques to solve differential equations and analyzing various physical problems.

COURSE CODE - PHY-20202-T

Atomic & Molecular Spectroscopy

(Course Category- CC)

Objectives of the Course

The main objective is to teach the students the basic atomic and molecular (diatomic) Structures


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

with quantum mechanical approach leading to their fundamental spectroscopies. The fundamentals and properties of a coherent light source as Laser (various types) will also be taught.

Unit I

Atomic Physics: Fine structure of hydrogenic atoms, Mass correction, spin-orbit term, Darwin term. Intensity of fine structure lines. Effect of magnetic and electric fields: Zeeman, Paschen-Bach and Stark effects. The ground state of two-electron atoms – perturbation theory and variational methods. Many-electron atoms – Central Field Approximation-LS and jj coupling schemes, Lande interval rule. The Hartree-Fock equations. The spectra of alkalis using quantum defect theory. Selection rules for electric and magnetic multipole radiation. Auger process.

(15 Lectures)

Unit II

Molecular Structure: Born-Oppenheimer approximation for diatomic molecules, rotation, vibration and electronic structure of diatomic molecules. Spectroscopic terms. Centrifugal distortion. Electronic structure-Molecular symmetry and the states. Molecular orbital and valence bond methods for H_2^+ and H_2 . Morse potential. Basic concepts of correlation diagrams for heteronuclear molecules.

(15 Lectures)

Unit III

Molecular Spectra: Rotational spectra of diatomic molecules-rigid and non-rigid rotors, isotope effect, Vibrational spectra of diatomic molecules- harmonic and anharmonic vibrators, Intensity of spectral lines, dissociation energy, vibration-rotation spectra, electronic spectra of diatomic molecules- vibrational structure of electronic transitions (coarse structure)-progressions and sequences. Rotational structure of electronic bands (Fine structure)-P,Q,R branches. Fortrat diagram. Intensities in electronic bands-The Franck-Condon principle. The electron spin and Hund's cases. Raman Effect. Electron Spin Resonance. Nuclear Magnetic Resonance.

(15 Lectures)

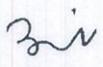
Unit IV

Lasers: Life time of atomic and molecular states. Multilevel rate equations and saturation. Coherence and profile of spectral lines. Rabi frequency. Laser pumping and population inversion. He-Ne Laser, Solid State laser, Free-electron laser. Non-linear phenomenon. Harmonic generation. Liquid and gas lasers, semiconductor lasers.

(15 Lectures)

Suggested References:

1. Physics of Atoms and Molecules, B. H. Bransden and C. J. Joachain (2nd Ed., Pearson Education, 2003)
2. Atomic Spectra and Atomic Structure, G. Herzberg (Dover Publications, 2003)
3. Molecular Spectra and Molecular Structure, G. Herzberg (Van Nostrand, 1950)
4. Atoms, Molecules and Photons, W. Demtroder (Springer, 2006)
5. Fundamentals of Molecular Spectroscopy, C. N. Banwell (McGraw Hill, 1983)
6. Basic atomic & Molecular Spectroscopy, J. M. Hollas (Royal Society of Chemistry, 2002)
7. Principles of Lasers, O. Svelto (5th Ed., Springer, 2010)
8. Laser Spectroscopy, W. Demtroder (3rd Ed., Springer, 2003)


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

9. Molecular Quantum Mechanics, P Atkins & R. Friedman (Oxford Univ. Press, 2005)
10. Quantum Chemistry, I. N. Levine (7th Ed., Pearson, 2016)

Course learning outcomes:

Students will learn the details of atomic and diatomic molecular (diatomic) structures in terms of quantum mechanical treatment elaborately beyond the basic models. It will give the descriptions of fine structure of atoms and rotational, vibrational and electronic energies of molecules manifesting in their respective spectroscopies. The details of these spectroscopies would serve as the fundamentals for various concerned experimental results. The basic principles of light coherence as laser with their types and variants will also be covered exposing the students to the important modern spectroscopic tool.

COURSE CODE - IRM-20203-T

Research Methodology

(Compulsory)

Objectives of the Course

The objectives of the course are to develop research skills, to train students to examine and critically analyze complex information from current scientific literature, methodology design, experimentation and enable students to conduct scientific research effectively.

Unit I

Introduction: Meaning and importance of research, Different types and styles of research, Role of serendipity, Critical thinking, Creativity and innovation, Hypothesis formulation and development of research plan, Art of reading and understanding scientific papers, Literature survey, Interpretation of results and discussion.

(Lectures 15)

Unit II

Library: Classification systems, e-Library, Reference management, Web-based literature search. Entrepreneurship engines, and Intellectual Property Rights (IPRs).

Entrepreneurship and Business Development: Importance of Entrepreneurship and its relevance in career growth, Types of enterprises and ownership.

(Lectures 15)

Unit III

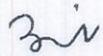
Scientific and Technical Writing: Role and importance of communication, Effective oral and written communication, Scientific writing, Research paper writing, technical report writing, Making R and D proposals, Dissertation/Thesis writing, Letter writing and official correspondence, Oral and poster presentation in meetings, Seminars, Group discussions, Use of modern aids; Making technical presentations.

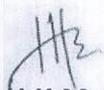
(Lectures 15)

Unit IV

Research and Academic Integrity: Plagiarism, Copyright issues, Ethics in research, and case studies. Laboratory Safety Issues: Lab, Workshop, Electrical, Health and fire safety, Safe disposal of hazardous materials.

(Lectures 15)


(Dr. Anju Tanwar)

20

(Dr. H.K. Mahavar)

Suggested References:

1. R. Kumar, (2012). Research Methodology, SAGE Publications India Pvt. Ltd., New Delhi, India.
2. S. Gupta, (2005). Research Methodology and Statistical techniques, Deep and Deep Publications (P) Ltd. New Delhi, India.
3. R. Kothari, (2008). Research Methodology, New Age International, New Delhi, India.
4. Standard /Reputed Journal authors' instructions.
5. www.sciencedirect.com for journal references, www.aip.org and www.aps.org for reference styles.
6. www.nature.com, www.sciencemag.org, www.springer.com, www.pnas.org, www.tandf.co.uk, www.opticsinfobase.org for research updates.

Course Learning Outcomes:

The course Research Methodology has been framed to introduce basic concepts of Research Methods. The course covers preparation of research plan, reading and understanding of scientific papers, scientific writing, research proposal writing, ethics, plagiarism, computer laboratory safety issues etc.

COURSE CODE-PHY-20204-T

Microwave Electronics

(Course Category- CE)

Objectives of the course

1. To provide a comprehensive understanding of wave propagation in rectangular and cylindrical waveguides, and the associated field distributions and characteristics.
2. To familiarise students with cavity resonators and microwave components used in microwave propagation.
3. To introduce conventional microwave sources, including klystrons, magnetrons, and travelling wave tubes, along with their construction and operational principles.
4. To study the propagation in Ferrite medium, Faraday Rotation, and devices employing Faraday Rotation, Complex permittivity of material and its measurement

Unit I

Wave guides: Introduction to microwaves and their frequency spectrum, Application of microwaves.

Rectangular wave guides: Wave Equation and its solutions, TE and TM modes. Dominant mode and choice of waveguide dimensions, Methods of excitation of waveguide.

Circular wave guide: Wave equation and its solutions, TE and TM modes.

Attenuation: Cause of attenuation in wave guides, wall current and derivation of attenuation constant, Q of the wave guide.

(Lectures 15)

Unit II

Resonators: Resonant Modes of rectangular and cylindrical cavity resonators, Q of the cavity resonators, Excitation techniques, Introduction to Microstrip and Dielectric resonators, Frequency meter.

Microwave Detectors: Power, Frequency, Attenuation, Impedance Using smith chart, VSWR, Reflectometer, Directivity, coupling using direction coupler.

(Lectures 15)

(Dr. Anju Tanwar)

(Dr. H.K. Mahavar)

Unit III

Microwave tubes: Space charge spreading of the electron beam, Beam focusing
Klystrons: Velocity Modulation, Two Cavity Klystron, Reflex Klystron, Efficiency of Klystron, Electric and Magnetic fields of oscillations, Modes of oscillation and operating characteristics
Travelling wave tubes: O and M type travelling wave tube.
Gyrotrons: Constructions of different Gyrotrons, Field-Particle Interaction in Gyrotrons.

(Lectures 15)

Unit IV

Ferrites: Microwave propagation in ferrites, Faraday rotation, Devices employing Faraday rotation (isolator, Gyrator, Circulator). Introduction to single-crystal ferromagnetic resonators and YIG-tuned solid-state resonators.

Complex permittivity of material and its measurement: Definition and Determination of complex permittivity of Solids, liquids and powders using shift of minima method.

(Lectures 15)

Suggested References:

1. Electromagnetic Waves and Radiating Systems: Jorden and Balman
2. Theory and Application of Microwaves by A.B. Bronwell and M.S. M.B.A. (McGraw Hill).
3. Introduction to Microwave Theory by Atwater (McGraw Hill).
4. Principles of Microwave Circuit by G.C. Montgomery (McGraw Hill)
5. Microwave Circuits and Passive Devices by M.L. Sisodiya and G.S. Raghuvanshi (New Age International, New Delhi)
6. Foundations of Microwave Engineering by R.E. Collin (McGraw Hill).
7. Microwaves by M.L. Sisodia and Vijay Laxmi Gupta (New Age, New Delhi)
8. Handbook of Microwave Measurement, Vol. II by M. Sucher and J. Fox (Polytechnic Press. New York)
9. Simple Microwave Techniques for Measuring the Dielectric Parameters of Solids and their Powder by J.M. Gandhi, J.S. Yadav, J. of Pure and Applied Physics Vol. 30, pp. 427- 431. 1992

Course Learning Outcomes:

students will be able to learn about:

1. Microwaves, associated field distributions, characteristics, attenuation and propagation characteristics through rectangular and circular waveguides.
2. Cavity resonators and microwave components used in microwave propagation.
3. The working principles, performance characteristics, and limitations of conventional microwave vacuum tube devices.
4. Ferrite medium, Faraday Rotation, and devices employing Faraday Rotation such Isolator and Gyrator. Complex permittivity and its measurement for Solids, liquids and powders using shift of minima method.

(Dr. Anju Tanwar)

(Dr. H.K. Mahavar)

Energy Studies-II

(Course Category- CE)

COURSE CODE - PHY-20205-T

Objectives of the Course

1. To impart knowledge of fundamental principles of heat conduction and the techniques to solve heat conduction problems analytically and numerically.
2. To understand the concepts of convective and radiative heat transfer, and their practical applications in solar energy systems.
3. To provide insights into the design, operation, and thermal analysis of various types of solar energy collectors.
4. To familiarize students with thermal energy storage systems and solar thermal devices, including their design, operation, and energy economics.

Unit I

Heat conduction: Differential equation of heat conduction, Initial and boundary conditions. Methods of solving heat conduction problems: separation of variable method for one dimension, The Greens' functions method, Integral transform method for finite and infinite ranges. Problems with and without internal heat generation. Numerical analysis of transient and periodic state of heat conduction Measurement techniques for thermal conductivity and their comparative study (static and dynamic), Guarded not plate method, Thermal probe, parallel wire.

(15 Lectures)

Unit II

Convective and Radiative Heat Transfer: Theory of convective heat transfer, Laminar and turbulent flow, Boundary layer theory. Heat transfer in duct. heat exchangers: basic thermal sign met Applications of heat pipes. Direct and diffused thermal radiation. Radiative properties of real surfaces. Radiation exchange between surfaces. Atmospheric attenuation, solar radiation measurements solar radiation geometry.

(15 Lectures)

Unit III

Solar Energy collectors: Flat Plate solar energy collectors. Selective absorber surfaces. Transparent plates. Collector energy losses. Thermal analysis of collectors. Air heating collectors. Collector performance testing. Concentrating collectors. Thermal analysis of concentrating collectors. Tracking requirements.

(15 Lectures)

Unit IV

Thermal Energy Storage and Solar Thermal Devices: Storage of solar energy. Water storage. Stratification fo water storage, Packed bed storage. Phase change storage. Solar pond. Chemical storage. Solar space conditioning- Energy requirements in buildings, Passive system architecture, Performance and design; coiling processes. Vapor compression refrigeration cycle, Absorption refrigeration cycle, Performance of solar absorption air conditioning. Solar energy process economics.

(15 Lectures)

Suggested References:

1. Heat Conduction: M. Necati Ozisik-John Wiley & Sons.


(Dr. Anju Tanwar)

23

(Dr. H.K. Mahavar)

2. Hand Book of Heat transfer Applications: Edited by Warren M. Rohsenow, James P. Harnou and Fjup N. Ganic.
3. Conduction of Heat in Solids: H.S. Carslaw and J.C. Jsegar, Oxford Clarendon Press, 1959.
4. Heat and Mass Transfer: A Luikov, Mir Publishers, Moscow.
5. Thermal conductivity of Solids: J.E. Parrot and Audrey D. Stuckers: Pion Limited, London.
6. Solar Energy Thermal Processes: DluAe and Backman. Wiley & Sons. New York.
7. Solar Energy Engg.: Jui Sheng Haieh, Prentice Hall, New Jersey. 8. Solar Energy: s.P, Tata McGraw-Hill, New Delhi.

Course Learning Outcomes:

After successful completion of this course, students will be able to:

1. Apply analytical and numerical methods to solve heat conduction problems in various physical scenarios.
2. Explain the principles of convective and radiative heat transfer and their relevance in thermal system design.
3. Analyze the design, performance, and efficiency of flat plate and concentrating solar energy collectors.
4. Evaluate different thermal energy storage systems and solar thermal applications, including space conditioning and solar refrigeration.

COURSE CODE - PHY-20206-T

Astrophysics-II

(Course Category- CE)

Objectives of the Course

1. To develop an understanding of astronomical coordinate systems, time standards, and fundamental observational corrections.
2. To introduce instruments and techniques used in astronomy across various wavelengths, and the principles behind imaging, spectroscopy, and interferometry.
3. To impart knowledge of the mathematical and statistical foundations required for astronomical data analysis, including Fourier analysis and probability distributions.
4. To train students in numerical methods and error analysis for solving physical problems relevant to astrophysics and data reduction.

Unit I

Coordinate systems, precession, time, heliocentric corrections, methods of observation, resolution, sensitivity, noise, quantum efficiency. spectral response. Johnson noise, signal-to-noise ratio, background, and aberrations. (15 Lectures)

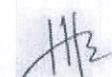
Unit II

Telescopes at different wavelengths, detectors at different wavelengths, imaging, spectroscopy, polarimetry, calibration, atmospheric effects at different wavelengths, active/adaptive optics, interferometry, speckle interferometry, aperture synthesis, methods of data reduction, (15 Lectures)

Unit III

Fourier transforms, calibrations, neutrino astronomy. gravitational wave astronomy. Numerical


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

techniques, in physics and astrophysics, errors and error propagation. numerical integration and interpolation, random numbers, astrostatistics, probability distributions, hypothesis testing, sampling methods. (15 Lectures)

Unit – IV

Multivariate analysis, regression, time-series analysis, data reduction, error analysis, Numerical solutions of algebraic, ordinary differential and partial differential equations. (15 Lectures)

Suggested References:

1. Roy, A.E., & Clarke, D., Astronomy Principles and Practice, 4th ed.. Institute of Physics. 2003.
2. Kitchin, C.R.: Astrophysical Techniques, 4th ed., Institute of Physics, 2005
3. W. M. Smart, Text Book on Spherical Astronomy, Cambridge University Press
4. William H. Press et. al., Numerical Recipes in C, Cambridge University Press
5. Gutti Jogesh Babu (Author), E.D. Feigelson (Author), Astro statistics, Chapman & Hall/
6. Swapan K Saha, DiUraction-Limited Imaging with Large and Moderate Telescopes, World Scientific

Course learning outcomes:

After successful completion of this course, students will be able to:

1. Apply coordinate transformations, heliocentric corrections, and analyze observational parameters like resolution, sensitivity, and signal-to-noise ratio.
2. Describe the working of telescopes, detectors, and advanced techniques such as adaptive optics and interferometry; assess the impact of atmospheric effects on observations.
3. Utilize Fourier transforms, numerical integration, and probability theory for analyzing astronomical data; interpret results from neutrino and gravitational wave observations.
4. Implement numerical algorithms for solving algebraic and differential equations; perform multivariate and time-series analyses, and quantify uncertainties through rigorous error analysis.

COURSE CODE - PHY-20207-T

Computational Physics

(Course Category- CE)

Objectives of the Course

1. Learning basic methods, tools, and techniques of computational physics.
2. Developing practical computational problem-solving skills.

Unit I

Introduction to computational Physics, computer architecture overview, tools of computational Physics, Machine representation, precision and errors.

Tools of the trade: Quadratic equations, Power series, Delicate numerical expressions, Dangerous subtractions, preserving small numbers, Partial Fractions, Cubic equations, Sketching functions.

(15Lectures)

Unit II

Roots of equations: Real roots of single variable function, iterative approach, qualitative behaviour of the function, Closed domain methods (bracketing): Bisection, False position

25


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

method, Open domain methods: Newton-Raphson, Secant method, Muller's method, Complications, Roots of polynomials, Roots of nonlinear equations.

Quadrature: Direct fit polynomials, Quadrature methods on equal subintervals, Newton-Cotes formula, Romberg Extrapolation, Gaussian quadrature, Adaptive step size; Special cases.

(15 Lectures)

Unit III

Random numbers and Monte-Carlo: Random number generators; Monte-Carlo integration, non-uniform distribution, Random Walk, Metropolis algorithm.

Ordinary differential equations: Initial value problems: First order Euler method, Second order single point methods, Runge-Kutta methods, Multipoint methods, Boundary value problems: Shooting method; equilibrium boundary value method.

(15 Lectures)

Unit IV

Fourier methods: Fast Fourier transform, Convolution, Correlation, Power spectrum

Numerical Linear Algebra: Matrix Factorizations, QR Factorization, Gram-Schmidt Orthogonalization, Householder Triangularization, LU and Cholesky factorization, Schur factorization, Direct elimination methods: Gauss elimination (pivoting, scaling), Tri-diagonal systems, Iterative methods: Jacobi iteration, Conjugate Gradients, Eigenvalue problems: Rayleigh Quotient, Arnoldi and Lanczos methods.

(15 Lectures)

Suggested References:

1. Mark Newman, Computational Physics, CreateSpace Independent Publishing Platform (2013).
2. Rubin H. Landau, Manuel J. Paez and Cristian Bordeianu, Computational Physics, 3rd Ed Problem Solving with Python, Wiley (2015).
3. A. Klein and A. Godunov, Introductory Computational Physics, Cambridge University Press (2006).
4. Forman Acton, Real computing made real: Preventing Errors in Scientific and Engineering Calculations, Dover Publications.
5. Lloyd N. Trefethen and David Bau, Numerical Linear Algebra, SIAM

Course Learning Outcomes: Learn basic programming and applying it to physics problems.

COURSE CODE - SEC - 20208 - T

Numerical Methods

(Course Category-SEC)

Objectives of the Course

The course aims to provide a broad range of numerical methods for solving mathematical problems. The goal is to provide a basic understanding of the derivation, analysis, and use of these numerical methods along with the error in measurement and inherent limitations of numerical methods is also discussed. The concept of random variables, discrete and continuous distributions, and probability distribution function is explained.



(Dr. Anju Tanwar)



(Dr. H.K. Mahavar)

Unit I

Error Analysis, Interpolation, and Linear Algebraic Equations: Errors in numerical analysis: sources of error, round-off error, computer arithmetic, error analysis, condition and stability, approximation, functional and error analysis, method of undetermined coefficients. Use of interpolation formulae, iterated interpolation, inverse interpolation, Hermite interpolation, and spline interpolation. Solution of linear equations: direct and iterative methods. Calculation of eigenvalues and eigenvectors for symmetric matrices.

(15 Lectures)

Unit II

Nonlinear Equations and Numerical Integration: Solution of nonlinear equations: bisection method, Newton's method, modified Newton's method, method of iteration, Newton's method and method of iteration for a system of equations, Newton's method for the case of complex roots. Integration of a function: trapezoidal and Simpson's rules, Gaussian quadrature formula, singular integrals, double integration.

(15 Lectures)

Unit III

Numerical Methods for Differential Equations and Data Analysis: Integration of ordinary differential equations: predictor-corrector methods, Runge-Kutta method. Simultaneous and higher-order equations. Numerical integration and differentiation of data. Least squares approximation. Fast Fourier Transform (FFT).

(15 Lectures)

Unit IV

Probability Theory and Random Variables: Elementary probability theory. Random variables. Binomial, Poisson, and normal distributions.

(15 Lectures)

Suggested References:

1. A First Course in Numerical Analysis, A. Ralston and P. Rabinowitz, McGraw-Hill, 1985.
2. Introductory Methods of Numerical Analysis, S. S. Sastry, Prentice Hall of India, 1979.
3. Numerical Analysis, R. L. Burden and J. D. Faires, Cengage, 2011.

Course Learning Outcomes:

After successful completion of this course, students will be able to:

1. Understand different types of numerical errors, their sources, and their effect on numerical computations.
2. Analyse the stability, convergence, and efficiency of numerical algorithms.
3. Obtain numerical solutions of nonlinear equations using iterative methods.
4. Apply numerical techniques to solve systems of linear equations and eigenvalue problems.
5. Solve ordinary differential equations and definite integrals using numerical methods.
6. Use numerical techniques for data fitting, interpolation, and Fourier analysis.

(Dr. Anju Tanwar)

(Dr. H.K. Mahavar)

7. Understand the basic concepts of probability theory, random variables, and probability distributions.

COURSE CODE - SEC-20209-T

Basic Instrumentation Skills

(Course Category-SEC)

Objectives of the Course

After completion of this course, the student will be able to:

1. Understand the basic concepts of measurement including accuracy, precision, errors, resolution, and loading effects.
2. Explain the principles, operation, and specifications of analog measuring instruments such as multimeters, electronic voltmeters, and AC millivoltmeters.
3. Describe the construction and working of oscilloscopes (CRO and DSO) and use them for voltage, frequency, and time measurements.
4. Understand the working principles of signal generators, impedance bridges, Q-meters, and related testing instruments used in electronic measurements.
5. Explain the principles and advantages of digital instruments including digital voltmeters, digital multimeters, and frequency/time measurement using counters.

Unit I

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters. Block diagram ac millivoltmeter, specifications and their significance.

(15 Lectures)

Unit II

Oscilloscope: Block diagram of basic CRO. CRT, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence. Time base operation, synchronization. Front panel controls. Specifications of CRO and their significance.

Use of CRO for the measurement of voltage (dc and ac), frequency and time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: principle of working.

(15 Lectures)

Unit III

Signal and pulse Generators: Block diagram, explanation and specifications of low frequency signal generator and pulse generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

Impedance Bridges: Block diagram of bridge. Working principles of basic (balancing type) RLC

(Dr. Anju Tanwar)

(Dr. H.K. Mahavar)

bridge. Specifications of RLC bridge. Block diagram and working principles of a Q- Meter. Digital LCR bridges.

(15 Lectures)

Unit IV

Digital Instruments: Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time-base stability, accuracy and resolution.

(15 Lectures)

Suggested References:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.
2. Performance and design of AC machines - M G Say ELBS Edn.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
6. Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

Course Learning Outcomes:

After successful completion of this course, the student will be able to:

1. Explain fundamental measurement concepts such as accuracy, precision, errors, resolution, and loading effects in electrical and electronic measurements.
2. Describe the working principles, block diagrams, and specifications of analog measuring instruments including multimeters, electronic voltmeters, and AC millivoltmeters.
3. Use oscilloscopes (CRO and DSO) to measure voltage, frequency, and time parameters and interpret waveform characteristics.
4. Explain the operation and applications of signal generators, pulse generators, impedance bridges, and Q-meters used in testing and analysis of electronic circuits.
5. Explain the working principles of digital measuring instruments such as digital voltmeters, digital multimeters, and frequency counters, and evaluate their accuracy and resolution.

COURSE CODE - SEC-20210-T

Radiation Safety

(Course Category-SEC)

Objectives of the Course

This course focusses on the applications of nuclear techniques and radiation protection. It will not only enhance the skills towards the basic understanding of the radiation but will also provide the knowledge about the protective measures against the radiation exposure. It imparts all the skills required by a radiation safety officer or any job dealing with radiation such as X-ray operators, nuclear medicine dealing jobs: chemotherapists, PET MRI CT scan, gamma camera etc. operators etc.

Unit I

Basics of Atomic and Nuclear Physics: Basic concept of atomic structure; X-rays characteristic and production; concept of bremsstrahlung and Auger electron; the composition of nucleus and

29


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, mean life and half-life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, fusion, fission.

(15 Lectures)

Unit II

Interaction of Radiation with Matter: Types of radiation: Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources. Interaction of photons – photo-electric effect, Compton scattering, pair production, linear and mass attenuation coefficients. Interaction of charged particles: heavy charged particles – Bethe-Bloch formula, scaling laws, mass stopping power, range, straggling, channelling and Cherenkov radiation. Beta particles – collision and radiation loss (Bremsstrahlung). Interaction of neutrons – collision, slowing down and moderation.

(15 Lectures)

Unit III

Radiation quantities and units: basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, annual limit of intake (ALI) and derived air concentration (DAC).

Radiation detection: Basic concept and working principle of gas detectors (ionization chambers, proportional counter, multi-wire proportional counters (MWPC) and Geiger Muller counter), scintillation detectors (inorganic and organic scintillators), solid state detectors and neutron detectors, thermoluminescent dosimetry.

(15 Lectures)

Unit IV

Radiation Safety Management: Biological effects of ionizing radiation, operational limits and basics of radiation hazards evaluation and control; radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitations, introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about accelerator driven sub-critical system (ADS) for waste management.

Application of nuclear techniques: Application in medical science (e.g., MRI, PET, projection imaging gamma camera, radiation therapy), archaeology, art, crime detection, mining and oil. Industrial uses: tracing, gauging, material modification, sterilization, food preservation.

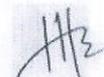
(15 Lectures)

Suggested References:

1. Basic Ideas and Concepts in Nuclear Physics: An Introductory Approach by K. Heyde, Third Edition, IOP Publication
2. Nuclear Physics by S. N. Ghoshal, First Edition, S. Chand Publication
3. Nuclear Physics: Principles and Applications by J. Lilley, Wiley Publication
4. Fundamental Physics of Radiology by W. J. Meredith and B. Massey, John Wright and Sons, UK
5. An Introduction to Radiation Protection by A. Martin and S. A. Harbison, John Wiley & Sons Inc., New York



(Dr. Anju Tanwar)



(Dr. H.K. Mahavar)

Course Learning Outcomes:

This course will help students in the following ways:

1. Awareness and understanding the hazards of radiation and the safety measures to guard against these hazards.
2. Learning the basic aspects of the atomic and nuclear Physics, especially the radiations that originate from the atom and the nucleus.
3. Having a comprehensive knowledge about the nature of interaction of matter with radiations like gamma, beta, alpha rays, neutrons etc. and radiation shielding by appropriate materials.
4. Knowing about the units of radiations and their safety limits, the devices to detect and measure radiation.
5. Learning radiation safety management, biological effects of ionizing radiation, operational limits and basics of radiation hazards evaluation and control, radiation protection standards, 'International Commission on Radiological Protection' (ICRP) its principles, justification, optimization, limitation, introduction of safety and risk management of radiation, nuclear waste and disposal management, brief idea about Accelerator driven Sub-Critical System 'ADS' for waste management.
6. Learning about the devices which apply radiations in medical sciences, such as MRI, PET.
7. Understanding and performing experiments like Study the background radiation levels using Radiation detectors, Determination of gamma ray linear and mass absorption coefficient of a given material for radiation shielding application.

COURSE CODE - SEC-20211-T

Medical Instrumentation

(Course Category-SEC)

Objectives of the Course

The course is designed to give the basic concepts of Instrumentation involved in medical field and human physiology. Biomedical Instrumentation is application of technology for medical field. During the course, students will explore Electrophysiological measurements, medical imaging etc. The course will make the students understand the devices used in diagnosing the diseases.

Unit I

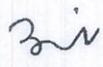
Physiology and transducers: Cell and its structure, Resting and Action Potential, Nervous system: Functional organization of the nervous system, Structure of nervous system, neurons, synapse, transmitters and neural communication, Cardiovascular system, respiratory system, Basic components of a biomedical system, Transducers, selection criteria, Piezo-electric, ultrasonic transducers, Temperature, measurements - Fiber optic temperature sensors

(15 Lectures)

Unit II

Electro – Physiological measurements: Electrodes: Limb electrodes, floating electrodes, pre-gelled disposable electrodes, Micro, needle and surface electrodes, Amplifiers: Preamplifiers,

31


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

differential amplifiers, chopper amplifiers, Isolation amplifier. ECG, EEG, EMG, ERG, Lead systems and recording methods, Typical waveforms. Electrical safety in medical environment: shock hazards, leakage current-Instruments for checking safety parameters of biomedical equipment.

(15 Lectures)

Unit III

Non-electrical parameter: Measurement of blood pressure, Cardiac output, Heart rate, Heart sound Pulmonary function measurements, spirometer, Photo Plethysmography, Body Plethysmography, Blood Gas analyzers : pH of blood, measurement of blood pCO₂, pO₂, finger-tip oximeter, ESR, GSR, measurements, Standard HL7

(15 Lectures)

Unit IV

Medical Imaging: Radiographic and fluoroscopic techniques, X rays, Computer tomography, Mammography, MRI, fMRI, Ultrasonography, Endoscopy, Thermography, Different types of biotelemetry systems and patient.

(15 Lectures)

Suggested References:

1. R.S.Khandpur, 'Hand Book of Bio-Medical instrumentation', Tata McGraw Hill Publishing Co Ltd., 2003.
2. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, 'Bio-Medical Instrumentation and Measurements', II edition, Pearson Education, 2002 / PHI.
3. J.Webster, 'Medical Instrumentation', John Wiley & Sons, 1995.
4. L.A. Geddes and L.E.Baker, 'Principles of Applied Bio-Medical Instrumentation', John Wiley & Sons, 1975.

Course Learning Outcomes:

After completing the course, the students will able to:

1. Understand the physiology of biomedical system.
2. Measure biomedical and physiological information.
3. Discuss the application of Electronics in diagnostics and therapeutic area.

COURSE CODE - SEC - 20212 - T

Disaster Management Techniques

(Course Category-SEC)

Objectives of the Course

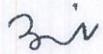
A disaster management syllabus covers understanding hazards (natural/man-made), the disaster cycle (mitigation, preparedness, response, recovery), risk/vulnerability assessment, policies (like India's DM Act), technology (GIS, Early Warning Systems), institutional frameworks (NDMA, NGOs), and practical aspects like relief, rehabilitation, and community-based approaches, with a focus on linking development to disaster resilience.

Unit I

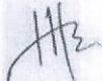
Introduction to Disasters: Definitions (hazard, risk, vulnerability, resilience), types (geological, hydrological, biological, man-made), impacts, and global trends.

Disaster Management Cycle: Mitigation, Preparedness (planning, early warning, training),

32


(Dr.Anju Tanwar)


प्रभारी अकादमिक प्रथम


(Dr.H.K.Mahavar)

Response (search, rescue, relief, medical), and Recovery (reconstruction, rehabilitation).
(15 Lectures)

Unit II

Risk Reduction & Vulnerability: Vulnerability assessment, hazard mapping, community-based disaster risk reduction (CBDRR), and climate change adaptation.

Policies & Governance: National Disaster Management Policy, Acts (India's DM Act, 2005), role of central/state/local bodies (NDMA, SDMA, NDRF).

(15 Lectures)

Unit III

Technology & Tools: Remote Sensing (RS), Geographic Information Systems (GIS), Information & Communication Technology (ICT) in early warning and response.

Social & Health Aspects: Psychological response, trauma care, public awareness (IEC), gender/caste impacts, and disaster medicine

(15 Lectures)

Unit IV

Emergency Response: Logistics, communication, medical response, search & rescue, managing panic.

Rehabilitation & Development: Post-disaster recovery, sustainable reconstruction, livelihood creation, linkage with development.

Case Studies: Analysis of major disasters (e.g., earthquakes, floods, pandemics) in India and globally.

(15 Lectures)

Suggested References:

1. Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012)
2. Damon, P. Copola, (2006) Introduction to International Disaster Management, Butterworth Heineman.
3. Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.
4. Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi.
5. Modh S. (2010) Managing Natural Disasters, Mac Millan publishers India

Course Learning Outcomes:

At the end of the course, the student shall be able to:

1. Explain about concepts of disaster management and types of disasters
2. Explain the Vulnerability profile of India & legal framework in India
3. Discuss about techniques about early warning systems for disaster risk reductions
4. Describe the policy and programmers for disaster risk reductions in India
5. Demonstrate rescue and relief operation in India during disaster

COURSE CODE - SEC-20213-T

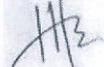
Basic IT Tools

(Course Category-SEC)

Objectives of the Course

1. To enable students develop IT skills that are a prerequisite in today's work environment.
2. To equip them with basic computing skills that will enhance their employability in general.
3. To enable the student to analyse and present information in a meaningful manner.


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

Unit I

Introduction to Spreadsheet: Spreadsheets: Concept of worksheets and workbooks, creating, opening, closing and saving workbooks, moving, copying, inserting, deleting and renaming worksheets, working with multiple worksheets and multiple workbooks, controlling worksheet views, naming cells using name box, name create and name define; Exchanging data using clipboard, object linking and embedding; Printing and Protecting worksheets: Adjusting margins, creating headers and footers, setting page breaks, changing orientation, creating portable documents and printing data and formulae; Implementing file level security and protecting data within the worksheet; Understanding absolute, relative and mixed referencing in formulas, referencing cells in other worksheets and workbooks, correcting common formula errors, working with inbuilt function categories like mathematical, statistical, text, lookup, information, logical, database, date and time and basic financial functions.

(Lectures 15)

Unit II

Data Analysis in Spreadsheets: Consolidating worksheets and workbooks using formulae and data consolidate command, choosing a chart type, understanding data points and data series, editing and formatting chart elements, and creating sparkline graphics, Analyzing data using pivot tables: Creating, formatting and modifying a pivot table, sorting, filtering and grouping items, creating calculated field and calculated item, creating pivot table charts, producing a report with pivot tables. Introduction to recording and execution of macros.

(Lectures 15)

Unit III

Word Processing: Introduction: Creating and saving your document, displaying different views, working with styles and character formatting, working with paragraph formatting techniques using indents, tabs, alignment, spacing, bullets and numbering and creating borders; Page setup and sections: Setting page margins, orientation, headers and footers, end notes and foot notes, creating section breaks and page borders; Working with tables: Creating tables, modifying table layout and design, sorting, inserting graphics in a table, table math, converting text to table and vice versa, Create newspaper columns, indexes and table of contents, Spell check your document using inbuilt and custom dictionaries, checking grammar and style , using thesaurus and finding and replacing text; Create bookmarks, captions and cross referencing, adding hyperlinks, adding sources and compiling and bibliography; Mail merge: Creating and editing your main document and data source, sorting and filtering merged documents and using merge instructions like ask, fill-in and if-then-else; Linking and embedding to keep things together.

(Lectures 15)

Unit IV

Databases: Introduction to Database Development: Database Terminology, Objects, Creating Tables, working with fields, understanding Data types, Changing table design, Assigning Field Properties, Setting Primary Keys, using field validation and record validation rules, Indexing, working with multiple tables, Relationships & Integrity Rules, Join Properties, Record manipulation, Sorting & Filtering; Select data with queries: Creating Query by design & by wizard (Select, Make Table, Append, Delete, Cross Tab, Update, Parameterized Query, Find Duplicate and Find Unmatched), Creating multi table queries, creating & working with table joins. Using operators & expressions: Creating simple & advance criteria; Working with forms: Creating Basic

34



(Dr. Anju Tanwar)



(Dr. H.K. Mahavar)

forms, working with bound, unbound and calculated controls, understanding property sheet, Working with Data on Forms: Changing Layout, creating Sub Forms, creating list box, combo box and option groups; Working with Reports: Creating Basic Reports, Creating Header & Footer, Placing Controls on reports, sorting & grouping, Creating Sub reports.

(Lectures 15)

Course Learning Outcomes:

The Learning Outcomes of this course are as follows:

1. By studying this course, students will be able to use word-processor to generate documents with appropriate formatting, layout, review and referencing.
2. By studying this course, students will be able to manage data in worksheets and workbooks and analyze it using spreadsheet functions and built-in formulas.
3. By studying this course, students will be able to draw an analysis on data using spreadsheets to make decisions.
4. By studying this course, students will be able to make meaningful representations of data in the form of charts and pivot tables.
5. By studying this course, students will be able to manage data in database tables and use the same for generating queries, forms and reports.

Suggested References:

1. Swinford, E., Dodge, M., Couch, A., Melton, B. A. (2013). Microsoft Office Professional 2013. United States: O'Reilly Media.
2. Wang, W. (2018). Office 2019 For Dummies. United States: Wiley. Microsoft
3. Lambert, J. (2019). Microsoft Word 2019 Step by Step. United States: Pearson Education.
4. Jelen, B. (2013). Excel 2013 Charts and Graphs. United Kingdom: Que.
5. Alexander, M., Jelen, B. (2013). Excel 2013 Pivot Table Data Crunching. United Kingdom: Pearson Education.
6. Alexander, M., Kusleika, R. (2018). Access 2019 Bible. United Kingdom: Wiley.

COURSE CODE - 20214-T

E-Tourism

(Course Category-SEC)

Objectives of the Course

Introduce students to the fundamentals of tourism and e-tourism.

1. Develop digital skills related to online tourism services and platforms.
2. Familiarize students with e-commerce, digital marketing, and data usage in tourism.
3. Provide exposure to emerging technologies used in smart tourism.
4. Enhance interdisciplinary employability skills relevant to the digital service sector.

Unit I

Concept, definition, and types of tourism, Components and stakeholders of tourism industry, Evolution of tourism and global tourism trends, Introduction to e-tourism: scope and significance, Role of Information and Communication Technology (ICT) in tourism, E-tourism ecosystem and digital value chain, Online Travel Agencies (OTAs) and Global Distribution Systems (GDS).


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

Unit II

Fundamentals of e-commerce and business models, Online reservation and booking systems, Digital payment systems and fintech applications, Tourism websites and mobile applications, Customer Relationship Management (CRM) in tourism, Cyber security, data privacy, and consumer protection, Legal and ethical aspects of e-tourism.

Unit III

Digital marketing concepts and tools, Search Engine Optimization (SEO) and social media marketing, Online branding and content management, Role of big data and analytics in tourism, Introduction to Artificial Intelligence in tourism, GIS and location-based services in tourism, Online reviews, feedback systems, and reputation management.

Unit IV

Smart tourism and smart destinations, Internet of Things (IoT) applications in tourism, Virtual Reality (VR) and Augmented Reality (AR) in tourism, Sustainable and eco-friendly tourism through digital platforms, E-tourism entrepreneurship and start-ups, Challenges and future prospects of e-tourism, Case studies of national and international e-tourism initiatives.

Suggested References:

1. Buhalis, D., E-Tourism: Information Technology for Strategic Tourism Management, Pearson Education.
2. Sheldon, P. J., Tourism Information Technology, CABI Publishing.
3. Höpken, W., Gretzel, U., & Law, R. (Eds.), Information and Communication Technologies in Tourism, Springer.

Course learning outcomes:

After successful completion of this course, students will be able to:

1. Understand the concepts, structure, and evolution of e-tourism.
2. Use digital platforms and online tools for tourism-related services.
3. Apply e-commerce and digital marketing techniques in tourism operations.
4. Analyze the role of data analytics and emerging technologies in tourism.
5. Evaluate sustainability, ethical, and security issues in e-tourism.
6. Demonstrate skill-based competence applicable to technology-driven industries.

COURSE CODE - SEC-20215-T

Cyber Sphere & Security: Global Concern

(Course Category-SEC)

Objectives of the Course

To spread awareness and enlightening visions of the indiscriminate and diversified students to ensure their immediate and basic cyber safety and prevent loss due to sheer ignorance.

Unit I

Introducing Cyber Sphere and Security: Cyber Terminologies: Cyber Sphere, Cyber Security, Cyber Crime, Cyber Attack, Cyber Espionage, Cyber Warfare, Cybernetics Cyber Security and Paradigms, Cyber Security: Objectives and Roles.

Cyber Crime: Insight, Mitigation and Control: Cyber Crime and Cyber Activism: An Overview. Typologies of Cyber Crimes: Generic Cyber Crimes, Advanced Persistent Threats (APTs), Cyber

(Dr. Anju Tanwar)

(Dr. H.K. Mahavar)

Unit II

Security Threat Management, Risk Assessment: Forensic Analysis: Security threat correlation, Threat awareness, Vulnerability sources and assessment, Vulnerability assessment tools, Threat identification, Threat Analysis, Threat Modeling, Model for Information Security Planning.

Cyber Policies and Cyber Law: Cyber Policies and Cyber Law, Dimensions, Determinants, Dilemmas Existing Cyber Policies and Must Follow Up Actions Grey Areas in Cyber Laws.

(Lectures 15)

Unit III

Security Tools and Usage: Knowledge and Identification of Security Tools Cyber Security Aspects, Cyber Security Toolkits.

Security Elements: Authorization and Authentication- types, policies and techniques: Security certification, Security monitoring and Auditing, Security Requirements, Specifications- Security Policies and Procedures, Firewalls, IDS, Log Files, Honey Pots.

(Lectures 15)

Unit IV

Cyber Security: Case Studies, Government Institutions, Banks and Financial Institutions, Commercial Websites, Point of Sale issues and Online Payment, Real Time Cases.

Access control, Trusted Computing and multilevel security - Security models, Trusted Systems, Software security issues, Physical and infrastructure security, Human factors: Security awareness, training, Email and Internet use policies.

(Lectures 15)

Suggestive References:

1. Swiderski, Frank and Syndex, "Threat Modeling", Microsoft Press, 2004.
2. William Stallings and Lawrie Brown, "Computer Security: Principles and Practice", Prentice Hall, 2008.
3. Joseph M Kizza, "Computer Network Security", Springer Verlag, 2005
4. Thomas Calabres and Tom Calabrese, "Information Security Intelligence: Cryptographic Principles & Application", Thomson Delmar Learning, 2004.
5. Bertrand Venard (2019). 'Cyber Security: The New Art of War', Lecture delivered at Developing Countries Research Centre [drcr], University of Delhi, 1 April 2019.
6. Bertrand Venard (2019). 'The Determinants of Cybersecurity Behaviours: Qualitative Research Among French Students' in C. Onwubiko, X. Bellekens, A.Erola, M. Jaatun and C. Nogueira (eds.), Proceedings of the Cyber Science 2019: Cyber Situational Awareness for Predictive Insight and Deep Learning. UK: University of Oxford.
7. Bertrand Venard (2019). Cybersecurity among students. UK: Wolfson College, University of Oxford.
8. Bertrand Venard (2019). Cyber Aggressions in the XXIst Century: Equation of a Crisis. UK: University of Oxford.
9. Cristopher Hadnagy (2018). Social Engineering: The Science of Human Hacking, 2nd Edition. New York: Wiley
10. John Erickson (2008). The Art of Exploitation (2nd Edition). San Francisco: No Starch Press.
11. Kevin Mitnick and Robert Vamosi (2017). The Art of Invincibility. Boston: Little, Brown and Company.
12. Kevin Mitnick (2012). The Ghost in the Wires: My Adventures as the World's Most Wanted



(Dr. Anju Tanwar)



(Dr. H.K. Mahavar)

Hacker. New York: Back Bay Books.

13. Yogesh Atal and Sunil K Choudhary (2013). Combating Corruption: The Indian Case. Hyderabad and New Delhi: Orient Blackswan

Course Learning Outcomes:

1. After studying this course, students will be able to comprehend key terms of cyber domain and identify cyber threats.
2. After studying this course, students will be able to understand cyber law concepts, intellectual property and Digital Rights Management.
3. After studying this course, students will be able to diagnose and examine basic security loopholes, anomalous behavior in internet.
4. After studying this course, students will be able to understand principles of web security.
5. After studying this course, students will be able to secure and protect personal data with safe Internet usage.
6. After studying this course, students will be able to assimilate approaches for incident analysis and response, risk management and best cyber security practices.

COURSE CODE - SEC-20216-T

Personality Development and Communication

(Course Category-SEC)

Objectives of the Course

The learning objectives of this course are as follows:

1. To develop interpersonal and effective communication skills.
2. To develop problem-solving skills and understand its influence on the behaviour and attitudes of individuals.

Unit I

Introduction, need for communication, process of communication, written and verbal communication, visual communication, signs, signals and symbols, silence as a mode of communication, inter-cultural, intra-cultural, cross-cultural and international communication, communication through questionnaires, business letter writing, electronic communication.

(15 Lectures)

Unit II

Business cases and presentations, letters within the organizations, letters from top management, circulars and memos, business presentations to customers and other stakeholders, presenting a positive image through verbal and non-verbal cues, preparing and delivering presentations, use of audio-visual aids, report writing.

(15 Lectures)

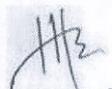
Unit III

Barriers to communication, improving communication skills, preparation of promotional material, non-verbal communication, body language, postures and gestures, value of time, organizational body language, importance of listening, emotional intelligence, working individually and in a team, leadership skills, leadership lessons, teamwork and team building, feedback, feed forward, interpersonal skills – delegation, humour, trust, expectations, values, status, compatibility and their role in building teamwork, conflict management – types of

38


(Dr. Anju Tanwar)


प्रभारी जयपुर


(Dr. H.K. Mahavar)

conflicts, how to cope with conflict.

(15 Lectures)

Unit IV

Negotiation skills, types of negotiation, negotiation strategies, selling skills – selling to customers, selling to superiors, selling to peer groups, teammates and subordinates, conceptual selling, strategic selling, selling skills – body language.

(15 Lectures)

Suggested References:

1. Mitra, B. K. – Personality Development and Soft Skills, Oxford University Press.
2. Kumar Sanjay and Pushplata – Communication Skills, Oxford University Press.
3. Mandal S. K. – Effective Communication and Public Speaking, Jaico Publishing.
4. Kushal Jin – Business Communication, VK India.
5. Krishnamacharyulu, C. S. G. & Ramakrishnan Lalitha – Personality Development, Interpersonal Skills and Career Management, Himalaya Publishing.
6. Corvette Budjac – Conflict Management: A Practical Guide to Developing Negotiation Strategies, Pearson.

Course Learning Outcomes:

The learning outcomes of this course are as follows:

1. After studying this course, students will be able to understand the importance of oral and written communication in the day-to-day working of an organization.
2. After studying this course, students will be able to develop interpersonal skills and problem-solving skills.
3. After studying this course, students will be able to understand the role of body language in effective communication.

COURSE CODE - SEC-20217-T **Material Characterization Techniques**

(Course Category-SEC)

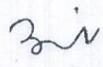
Objective of the course

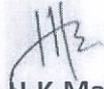
This course intends to provide knowledge on the advanced characterization techniques used to identify the physical and chemical properties of new materials prepared in laboratories. This includes, electrical, optical, magnetic, and dielectric properties of materials to suit specific application. The student will have the experience of different characterization techniques used in experimental condensed matter physics with the available theories, operation and instrumentation.

Unit I

Structure analysis: X-ray diffraction (XRD). Basic principle, Fourier analysis of the basis, structure factor and Atomic form factor, indexing and lattice parameter determination, features of XRD experiment, film negative and Straumannis, chamber, powder method, Laue method, information from peak position, intensity and width of XRD pattern. Crystal size and microstrain determination by Scherrer, modified Scherrer and Williamson-Hall methods.

(15 Lectures)


(Dr. Anju Tanwar)


(Dr. H.K. Mahavar)

Unit II

Imaging Techniques: Optical microscopies, Electron-Beam Specimen Interaction, Secondary and backscattered electrons, Interaction cross section and volume, Scanning electron microscope (SEM), Operational systems of SEM instrumentation and imaging modes, energy dispersive X-ray spectroscopy, transmission electron microscopy (TEM), selected area electron diffraction, pattern writing using optical and electron beams.

(15 Lectures)

Unit III

Spectroscopies: Characterization of fluorescence emission, Jablonski diagram, fluorescence quantum yield and life time, instrumentation for fluorescence spectroscopy, absorption and photoluminescence spectroscopy, Tauk plot, energy band gap determination, Raman spectroscopy, Fourier transform infrared spectroscopy, X-ray spectroscopy, X-ray photoemission spectroscopy, X-ray absorption spectroscopy, Nuclear magnetic resonance (NMR) spectroscopy.

Surface Morphology and Topography: Scanning probe microscopy, scanning tunnelling microscope (STM), atomic force microscope (AFM) concept and modes of operation of STM and AFM, conducting AFM.

(15 Lectures)

Unit IV

Physical Properties: Electrical measurements: Resistivity, temperature dependence of resistivity in materials, resistance in bulk and low dimensional systems, Current-voltage characteristics, elimination in resistivity using four probe Van-der Pauw methods.

Dielectric and magnetic measurements: Frequency dependence on capacitance-voltage characteristics, estimation of dielectric constants. diamagnetics, paramagnetics, ferromagnetics B-H loop, operation and analysis of vibrating-sample magnetometry, ferroelectrics, polarization electric field loop.

(15 Lectures)

Suggested References:

1. X-Ray Crystallography, M. J. Buerger, Wiley-Blackwell, 9th edition (1966)
2. Elements of X-ray Diffraction, B. D. Cullity, Addison Wesley Inc. (1978)
3. Analytical Electron Microscopy for Materials Science, Z. Shindo and T. Oikawa, Springer-Verlag, Japan; 2nd edition (2002)
4. Handbook of Spectroscopy, edited by Gunter Gauglitz, Tuan Vo-Dinh, Wiley-Vch Verlag GmbH & Co. (2003)
5. Scanning Microscopy: An Introduction to Non-Microscopy, Anne Voegtlin, Scanning Microscopy, Ben Voegtlin, Springer-Verlag, Berlin, Heidelberg (2015)

Course Learning Outcomes:

The students should be able to experience the advanced characterization techniques pursued in the experimental condensed matter physics for analyzing the physical properties of the material in the semiconductor technologies and nanotechnology.


(Dr. Anju Tanwar)


प्रभारी अकादमिक प्रथम


(Dr. H.K. Mahavar)

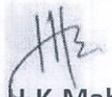
Physics Laboratory Experiments

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
I/II PHY-2011P PHY-2021B-P		General Physics Laboratory Experiments	4	4
Objectives of the course	i. To enable students to design and analyze basic wave-shaping, amplifier, and oscillator circuits using discrete and integrated components. ii. To provide hands-on experience in implementing sequential logic circuits such as flip-flops and counters. iii. To develop proficiency in using operational amplifiers and timer ICs for various analog signal processing applications. iv. To impart knowledge about transistor and FET characteristics, thermal stability, and biasing circuits. v. To familiarize students with analog-to-digital and digital-to-analog conversion techniques and power regulation circuits.			

1. Study the following wave shaping circuits using discrete components
(a) High pass and Low pass filters (b) Clipping circuits (c) Clamping circuit.
2. Study various flip-flop circuits and design counters to the base 16 up and down counter and an up counter to the base 10/9/7 using flip-flops.
3. Design and study a single-stage RC coupled transistor amplifier of a given voltage gain and lower cutoff frequencies.
4. Design and study an RC-coupled two-stage amplifier of a given gain and the cutoff frequencies.
5. Study the following quantities in relation to thermal bias stability of a given transistor amplifier circuit
(a) Variation of I_{CO} with temperature (b) Variation of I_C with temperature
(c) Variation of S with temperature (d) Distortion of the ac signal with temperature
6. Design and study any two of the following circuits using IC555 timer:
(a) Monostable oscillator (pulse width $W_{as} = 0.25$ ms)
(b) A stable oscillator (frequency 400 Hz and duty cycle 75%)
(c) Ramp generator (slope = 10V/ms)
(d) Voltage-controlled oscillator
7. Design and study the RC phase shift oscillator of frequency 1.5 kHz using the op-amp 741.
8. Design and study the Wein bridge oscillator frequency 2 kHz using the op- amp 741.
9. Study analog to digital / digital to analog conversion.
10. Design and study a stable multivibrator of frequency 3 kHz C 1 kHz both in symmetric and asymmetric modes.
11. Study the following application of the op-amp 741:
(a) Unity gain buffer (b) Adder (c) Subtractor (d) Integrator


(Dr. Anju Tanwar)


प्रभारी अकादमिक प्रथम

41

(Dr. H.K. Mahavar)

- (e) Differentiator (f) Comparator
12. Study the following characteristics of the op-amp 741:
(a) Inverting mode operation (b) non-converting mode operation
(c) Input impedance (d) output impedance (e) input offset current.
 13. To study the coupled oscillator, frequency response with mass variation.
(a) Amplitude response with frequency (b) Phase lag between driven and driver.
 14. To determine L_o , C_o , and R_f of a given coil, and to study the variations of R_f with frequency.
 15. To study the Hartley oscillator.
 16. To study the characteristics of FET and use it to design a relaxation oscillator and measure its frequency.
 17. To study the characteristics of a UJT and use it to design a relaxation oscillator and measure its frequency.
 18. To study regulated power supply using
(a) Zener diode only (b) Zener diode with a series transistor
(c) Zener diode with a shunt transistor.
 19. Study of DC gate control characteristics and Anode current characteristics of SCR.
 20. Study of multiplexer and demultiplexer.
 21. Study of 3 to 8 lines decoder.
 22. Study of Colpit's oscillator.
 23. Study of hybrid parameters.
 24. Study of active filters.
 25. Verification of Cauchy's relation.
 26. Verification of Fresnel's formula.
 27. Verification of Hartman's formula.
 28. Determination of Stephen's constant.
 29. To determine velocity of ultrasonic waves.


(Dr. Anju Tanwar)


प्रभारी अकादमिक प्रथम


(Dr. H.K. Mahavar)