

**DEPARTMENT OF APPLIED PHYSICS**  
**INSTITUTE OF TECHNOLOGY**  
**BANARAS HINDU UNIVERSITY**



**Course Structure and Syllabus of**  
**Five Year Integrated**  
**M- Tech. in Engineering Physics**

**DEPARTMENT OF APPLIED PHYSICS  
INSTITUTE OF TECHNOLOGY  
BANARAS HINDU UNIVERSITY  
VARANASI-221005**

**FIVE –YEAR INTEGRATED M.TECH. PROGRAMME IN “ ENGINEERING PHYSICS”**

**FIRST YEAR**

<b>I- Semester:</b>	Contact Hrs/Week	Credit
<b>Theory:</b> Same as B.Tech.Part-I (1st Semester )	17	17
<b>Practicals:</b> Same as B.Tech.Part-I (1 <sup>st</sup> Semester)	12	08
<b>Total</b>	<b>29</b>	<b>25</b>

**II- Semester:**

<b>Theory:</b> Same as B-Tech.Part-I ( 2 <sup>nd</sup> Semester)	20	20
<b>Practicals:</b> Same as B-Tech.Part-I (2 <sup>nd</sup> Semester )	09	06
<b>Total</b>	<b>29</b>	<b>26</b>

## SECOND YEAR

<b>III-Semester:</b>	Contact Hrs/Week	Credit
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**Theory:**

AP- 2101: Thermal Physics	03	03
AP- 2102: Quantum Physics	03	03
AM-2101: Mathematical Methods	03	03
AC- 2101: Chemistry of Polymers	03	03
EE- 2112A: Electrical Engineering	03	03
EC- 2112A: Electronic Devices & Components	03	03

**Practicals:**

AP- 2301: Physics Lab.	03	02
AC- 2301: Chemistry Lab	03	02
AM-2301: Computer Lab	03	02
<b>Total</b>	<b>27</b>	<b>24</b>

<b>IV-Semester:</b>	Contact Hrs/Week	Credit
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**Theory:**

AP- 2201: Electromagnetic theory & wave guides	03	03
AP- 2202: Fluid Dynamics	03	03
AM-2201: Numerical Analysis	03	03
AC- 2201: Chemical Thermodynamics	03	03
EE- 2212A: Power Transmission & Distribution	03	03
EC- 2212A: Analog Circuits & Systems	03	03

**Practicals:**

AP- 2401: Physics Lab.	03	02
AC- 2401: Chemistry Lab.	03	02
AM-2401: Computer Lab.	03	02
<b>Total</b>	<b>27</b>	<b>24</b>

### **THIRD YEAR**

<b>V-Semester:</b>	Contact Hrs/Week	Credit
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**Theory:**

AP- 3101: Space Physics	03	03
AP- 3102: Physics of Materials	03	03
AP- 3103: Digital Electronics & Microprocessors	03	03
AP- 3104: Semiconductor Physics & Devices	03	03
AM-3105: Linear Algebra	03	03
MS-3105A: Crystallography & crystal structure	03	03

**Practicals:**

AP- 3301: Physics Lab.	03	02
EC-3312A: Digital Communication Lab.	03	02
EE -3312A: Electrical Engg. Lab.	03	02
Total:	27	24

<b>VI-Semester:</b>	Contact Hrs/Week	Credit
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**Theory:**

AP- 3201: Advances Electromagnetic theory & special Relativity	03	03
AP- 3202: Atomic Physics & Nuclear Engg.	03	03
AP- 3203: Microwave and Radar Engg.	03	03
AP- 3204: Statistical Mechanics	03	03
AM-3203: Statistics & Stochastic process	03	03
HU- 320X: Humanatics (Open elective) *	03	03

**Practicals:**

AP- 3401: Physics Lab.	03	02
EC- 3412A: Microwave Engg. Lab.	03	02
EE- 3412A: Electrical Engg. Lab.	03	02
Total	27	24

**\* any one of:**

HU-3201: History of science & technology  
HU-3202: Industrial & Organizational Psychology  
HU-3203: Intellectual Property Rights  
HU-3204: Energy Management  
HU-3205: Industrial Sociology  
HU-3206: Ethics Philosophy & Values  
HU-3207: Entrepreneurship Development

## **FOURTH YEAR**

<b>VII-Semester:</b>	Contact Hrs/Week	Credit
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**Theory:**

AP-4101: Alternative Energy Sources	03	03
AP-4102: Elements of Fiber Optics	03	03
AP-4103: Quantum Electronics	03	03
AP-4104: Condensed Matter Physics	03	03
EE-4112A: Digital Control System	03	03
EC-4112A: Optical Communication	03	03

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**Practicals:**

AP-4301: Physics Lab.	03	02
EC-4312A: Optical Communication Lab.	03	02
Seminar / Group Discussion	03	02
Summer Training *	-	02
Total	27	26

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<b>VIII-Semester:</b>	Contact Hrs/Week	Credit
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**Theory:**

AP-4201: Magnetohydrodynamics	03	03
AP-4202: Nano Materials	03	03
AP-4203: Elements of Microwave Remote Sensing	03	03
AP-4204: Instrumentation, Measurement & Analysis	03	03
AP-4205: Seismology & Heliseismology	03	03

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**Practicals:**

AP-4401: Physics Lab.	03	02
EC-4312A: CAD Lab.	03	02
Project	06	04
Total	27	23

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**\* Summer Training of Six weeks duration**

**FIFTH YEAR**

<b>VIII-Semester:</b>	Contact Hrs/Week	Credit
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**IX-Semester:**

**Theory:**

AP-5101: Physics of Atmospheric Sciences	03	03
AP-5102: Fiber & Integrated Optics	03	03
Electives: I, II, and III		
AP-5103: Solar Physics & Space Physics	03	03
AP-5104: Photonics & Optoelectronics	03	03
AP-5105: Fluids & Plasmas	03	03
AP-5106: Microwave Remote Sensing	03	03
AP-5107: Atmospheric & Meteorology	03	03
MS-5122: Nano materials and Nano structures	03	03
MS-5124: Diffraction Techniques in materials sciences	03	03
MS-5125: Advanced Polymers	03	03
MC-5109: Chemistry of Electronic Ceramics	03	03
AC-5108: Solid State Chemistry	03	03
CR-5104: Nano Ceramics	03	03
CH-5110: Renewable Energy Technology	03	03

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**PG-Practicals:**

AP-5301: Physics Lab.	03	02
Dissertation Interim Evaluation	09	05
Seminar on Dissertation	-	05
<b>Total</b>	<b>27</b>	<b>27</b>

<b>X-Semester:</b>	Contact Hrs/Week	Credit
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PG-Seminar	02	01
Dissertation Evaluation	-	10
Dissertation Open Defence	--	05
<b>Total</b>	<b>02</b>	<b>16</b>

## SECOND YEAR

### AP- 2101: Thermal Physics

Principles of thermodynamics and illustration with applications to simple fluids. Concept of thermodynamics state, extensive and intensive variables; internal energy function and first and second law of thermodynamics. Fundamental relation and equations of states; concepts of entropy and temperature as conjugate pair of variables; entropy maximum and energy minimum principles. Thermodynamic potential, enthalpy, Helmholtz potential, Gibbs potential; conditions of equilibrium, concepts of state, metastable and unstable equilibrium, components and phase, Gibbs-Duchem relations, Maxwell relations, first order phase transitions and Clausius-Clapeyron equation; concepts associated with critical and multicritical phenomena.

Basic Postulates, partition functions, ensembles, fluctuations, simple applications, quantum statistics of ideal gases, non-ideal system, phase equilibria.

#### Text Books:

1. A Treatise on Heat by M.N.Saha and B.N.Srivastava, The Indian Press.
2. An Introduction to Thermodynamics by Y.V.C.Rao, Willey-Eastern Ltd.

### AP- 2102: Quantum Physics

Foundation and formulation of quantum theory, Schrodinger equation, Potential-well, Kronig-Penny model, Angular momentum, Two and three dimensional problems, Degeneracy, Central potentials, Hydrogen atom, Identical particles. Symmetric and anti-symmetric states, Helium atom, Schrodinger and Heisenberg pictures, Canonical commutation. Annihilation and Creation operators. Approximation methods for bound states. WKB approximation, Time-independent and time-dependent perturbations theory, Scattering theory, Condensed Matter.

#### Text Books:

1. Quantum Mechanics by A.S.Davydov, Peragamon Press, Newyork.
2. Quantum Mechanics by John I. Powell and Bernd Crasemann, Narosa Publishing House.

### AM 2101: Mathematical Methods

Solutions in series, Bessel function and Legendre function: Self – adjoint differential equations, Power series method of solving second order differential equation, Bessel's functions of first kind  $J_n(x)$  and second kind  $Y_n(x)$ , Recurrence relations, Generating functions of  $J_n(x)$ , Orthogonal property of Bessel functions, Legendre's equation, Legendre polynomials  $P_n(x)$ , Rodrigues formula, Generating function of  $P_n(x)$ , Orthogonal property of  $P_n(x)$ , Sturm-Liouville problem.

Integral Transform: Laplace transform and its properties, Inverse Laplace Transform. Use of partial fractions, Convolution theorem. Applications in solving differential equations. Fourier transform and its properties. Inverse Fourier Transform. Convolution theorem. Application of Fourier Transform in solving initial and boundary value problems. Laplace equation. Probability and Statistics: Probability: definitions, addition and multiplication laws, Baye's Theorem. Random variables Discrete and continuous probability distributions. Binomial, Poisson, normal and exponential distributions, mean variance moment Generating function, Characteristic function of a probability distribution. Joint probability distribution of two random variables. Linear regression and correlation analysis.

#### Books Suggested:

1. E. Kreyszig- Advanced Engineering Mathematics, John Wiley & Sons.
2. R. K. Jain, S.R.K. Iyenger- Advanced Engineering Mathematics, Narosa Publishing.
3. Irwin Miller and John E. Freund- Probability and Statistics for Engineers , Prentice Hall of India.

### **AC-2101 Chemistry of Polymers**

Introduction- Definition, classification, mechanism of polymerization, addition polymerization, condensation polymerization, thermosetting, thermoplastic polymers. Chemical geometrical structures, glass transition temperature crystallinity of polymers. Chemistry of selected organic polymers, Chemistry of selected inorganic polymers, polymer degradation mechanisms, polymer reactions, polymer processing, molecular weight & size of polymer dissolution, thermodynamics of polymers, Florry Huggin theory, viscosity of polymer solution, size and shape of polymers.

#### Recommended Books:

1. R.B. Seymour, C.E. Carraher, E. Charles, Polymer Chemistry an Introduction, Marcel Dekker, New York.
2. George Odian, Principles of Polymerization, John Wiley & Sons. 4<sup>th</sup> Ed.

### **EE-2112A: Electrical Engineering**

Electrical Circuits: Network elements- Voltage and Current sources, Kirchchoffs voltage and current law, loop and nodal analysis, Superposition theorem, Thevenins theorem, Nortons theorem, Maximum Power Transfer theorem. Sinusoidal Steady State analysis- R L and C elements, power and power factor, phasor diagram, resonance, mutual inductance and coefficient of coupling. Three-phase circuits, line and phase relationship, power measurement.

Electrical Machines: Transformer- Principle of working, EMF equation, Equivalent circuit, voltage regulation and efficiency, Open-circuit and short-circuit tests, autotransformer. DC Machines- Constructional features, DC Generators- No load Magnetization and external characteristic. DC motor- starting, speed-torque characteristics, speed control, applications.



Induction Machines - Principle of operation, constructional details, torque-slip characteristics, starting and speed control. Synchronous Machines- Constructional features. Alternators- Voltage regulation and its determination by synchronous impedance method. Synchronous Motor- Starting, V and Inverted-V curves, applications. Distribution of Electrical Power: Tariff calculation. House and factory wiring. Introduction to Electrical Measurements: Indicating instruments, voltmeter, ammeter, wattmeter and energy meter.

## **EC-2112 A: Electronic Devices and Components**

Semiconductors: Energy band diagram, bulk properties, conduction mechanism. Haynes-Shockley experiment, Rectifying and Ohmic contacts.

p-n junction : characteristics, low frequency model, transient response and breakdown mechanism.

Zener diode, Step-recovery diode, Tunnel diode, Backward diode, Schottky diode, LED and photodiodes. Solar cells.

Bipolar Junction Transistor: Conduction mechanism, characteristics, transient, low and high frequency models.

BJT : CE, CB & CC configuration, biasing techniques and stability.

UJT and JFET MOSFET: Physical mechanism, characteristics and models.

## **AP- 2201: Electromagnetic Theory and Waveguides**

Electrostatics; Boundary value problems Dielectrics, Steady currents, Magnetostatics; Time-varying fields, Maxwell's equations, Lorentz force equation and motion of charges, Plane electromagnetic waves. Waveguides and resonant cavities, fields at the surface of and within a conductor, cylindrical cavities and waveguides, modes in a rectangular waveguide, energy flow and attenuation in waveguides, perturbation of boundary conditions, resonant cavities, power losses in a cavity, Earth and ionosphere as resonant cavity, dielectric waveguide.

### **Text Books:**

1. Introduction to Electrodynamics by Griffiths,D.J., Printice- Hall Pvt.Ltd.
2. Electromagnetics by J.D.Kraus, Tata- McGraw Hill.

## **AP- 2202: Fluid Dynamics**

Neutral fluids, Boltzmann equation, collisions in a dilute neutral gas, collision integral, Maxwellian distribution, Conservation equations, Moment equations, Zero-order approximation, transport phenomena, hydrodynamic properties of ideal fluids, macroscopic derivation of hydrodynamic equations, equations of motion, equation of energy, vorticity equation, incompressible and barotropic fluids, hydrodynamic equations in conservative forms, Bernoulli's

principle for steady flows, tangential stress in a Newtonian fluid, Navier-Stokes equation, flow through a circular pipe, scaling and Reynolds number, viscous flow past solid bodies, boundary layers, aerodynamic lift, accretion discs in astrophysics, thermodynamic properties of a perfect gas, acoustic waves.

**Text Books:**

1. Applied fluid Mechanics by D.N.Roy, Affiliated East-West Press Pvt Ltd.
2. Elements of fluid Mechanics by Sesshadri ,C.V. and S.V. Patankar, Printice-Hall.

## **AC – 2201 Chemical Thermodynamics**

An overview of the First and Second Laws of Thermodynamics. The Third Law of Thermodynamics. Unattainability of Absolute Zero. Fundamental equations of Thermodynamics. Partial molar quantities. Thermodynamic potentials. Material equilibrium. Chemical potential and material equilibrium. Phase and reaction equilibria.

Real gases. Real-gas equations of state. Critical state. The law of corresponding states. Non-ideal gas mixtures, fugacity and fugacity coefficient. Real solutions. Activities and activity coefficients. Determination of activities and activity coefficients. Gibbs-Duhem equation. Reaction equilibrium in non-ideal systems.

The Clapeyron equation. Solid-solid phase transitions. Higher order phase transitions. Two-component phase diagrams. Thermodynamics of surfaces. Gibbs' adsorption equation. Bio-chemical Thermodynamics.

## **AM-2202 Numerical Analysis**

Errors and their estimation.

Interpolation: Finite differences; Newton's forward and backward interpolation formula; Lagrange's formula; Central differences; Formula of Gauss, Bessel and Everett curve fitting; Method of least squares; Cubic splines.

Solution of algebraic and transcendental equations: Iterative methods, Newton-Raphson method, convergence and efficiency of method.

Matrices: Eigen value and eigen vectors, matrix decomposition, inverse of matrix, norm of matrix.

Solution of System of Linear equations: Direct methods: Gauss elimination method, LU – Decomposition, Cholesky method, iteration methods: Jacobi method, Gauss-Seidel method; Ill conditioned systems.

Numerical integration and differentiation.

Numerical solution of ordinary differential equations: Euler method, Modified Euler method and Runge-Kutta method.

Finite difference method for solution of boundary value problems of ordinary and partial differential equations.

**Books Suggested:**

1. S. S. Sastry.. Numerical Analysis, Prentice Hall of India Pvt. Ltd., New delhi.
2. M. K. Jain et. al..Numerical Methods for Scientists and Engineers, New Age International Publishers, New Delhi

## **EC-2201: Analog Circuits & Systems**

Semiconductor diodes, Bipolar Junction Transistors and MOSFETs.

Half-wave and full-wave rectifiers. Filters and regulated power supplies.

Biasing circuits of BJT, FET and MOSFET, RC and DC coupled amplifiers, wide-band and tuned amplifiers. Active impedance transformers, power amplifiers, impedance matching.

Feedback Amplifiers. RC and LC Oscillators, Blocking Oscillators.

Characteristics, limitations and applications of OP-AMPS. Internal structure of OP-AMPS.

Special purpose amplifiers. Analog multipliers.

Voltage regulators, Timers, VCO, PLL and function generators.

Analog switches and multiplexers. ADC and DAC.

## **EE-2202: Power Transmission and Distribution**

Introduction: Generation, transmission and distribution of electrical power, AC and DC systems, underground and overhead lines.

Economics of Generation: Cost of electrical energy, load and diversity factors, combined operation of power stations.

Distribution Systems : Radial and ring systems, selection of feeders and distributors, DC and AC distribution, concentrated and distributed loads, design considerations of a distribution system, house and factory wiring, power factor improvement, economic aspects, tariff.

Underground Cables: Constructional details of various types of cables, oil and gas-filled cables, voltage gradient, grading, sheath loss, thermal ratings, parameters.

Line Insulators: Different types, string efficiency, voltage equalization.

Overhead Transmission Lines: Resistance, inductance, capacitance, GMR, GMD, Bundled and hollow conductors, inductive interference, surge impedance

Line Performance: Generalized circuit constants, nominal and equivalent T and representation, long line equations, efficiency and regulation, power circle diagram, series and shunt compensation, surge impedance loading

## **THIRD YEAR**

### **AP- 3101: Space Physics**

The Sun and the Solar wind, Solar wind plasma interactions with the planetary magnetosphere, Convection in the magnetosphere; coupling with ionosphere, dynamics of particles and fields in the Van-Allen radiation Belt, magnetospheres of inner planets; Venus, Mars, Mercury, magnetospheres of outer planets, basic plasma processes in magnetosphere, Single particle motion, statistical description, fluid description of plasma, waves in plasma, plasma waves in magnetized plasma, kinetic theory of waves and instabilities, dispersion relations, Whistler and VLF emissions in earth's magnetosphere, parametric instabilities and striations in ionosphere modification.

#### **Text Books:**

1. Fundamentals of plasma physics by J.A. Bittencourt, Pergamon Press. New York.
2. The solar-terrestrial environment by J.K.Hargreaves, Cambridge University Press,
3. Physics of solar system plasmas by Thomas E Cravens, Cambridge University Press.

### **AP- 3102: Physics of Materials**

Crystal structure, atomic bonding, atomic packing, atomic shape and size, crystal imperfection, atomic diffusion, thermal properties of materials, electrical properties of materials, local field and Clausius-Mossotti relation, types of polarization, piezo, ferro and pyro dielectricity, free electron model of metals, density of states, concept of plasmons, polarons, optical properties of materials, excitons, photo-conductivity, dia, para, ferro and anti-ferro magnetism, magnetic domains, magnetic materials and applications.

#### **Text Books:**

1. Material Science and engineering: An Introduction by William D. Callister, Jhon Wiley & Sons, New York.
2. Solid State Physics by C. Kittel, Wiley- Eastern.

### **AP- 3103: Digital Electronics and Microprocessors**

Logic families; characteristics, limitation and application SSI and MSI basic building blocks, analog and digital signals, digital circuits, logic functions and logic gates, binary numbers, combinational logic NAND/NOR logic, exclusive or logic, architecture of a microprocessor, software instruction set, addressing scheme, arithmetic logic and control schemes, memory systems, input/output interface, technology of microprocessor. Transducers and signal conditioning, instrumentation, amplifiers, choppers, filters, analog multiplexers, A/D, D/A converters, payload design.

**Text Books:**

1. Microprocessor Architecture, Programming and Applications by R.S. Gaonker, Penra International Publishing (India).
2. Digital Principles and Applications by A.P. Maluino and D.P. Leach, McGraw-Hill.
3. Moderns Digital Electronics by R.P.Jain, Tata McGraw-Hill.

**AP- 3104: Semiconductor Physics and Devices**

Semiconductor Physics; Semiconductor, Bonds in Semiconductors, Energy band, Effect of temperatures on Semiconductor, Hole currents, Intrinsic & extrinsic semiconductor, Majority and minority carriers, p-n junction, Volt- ampere characteristics of p-n junction. Semiconductor Diode: Semiconductor diode, Crystal diode rectifiers, Half wave rectifiers, Efficiency of half wave rectifier, Full wave rectifier, Centre tap full wave rectifier, Ripple factor, Filter Circuits, Voltage stabilization, Zener diode, Zener diode as Voltage stabilizer. Transistors: Transistors, Transistors connections, Common base connection, Common emitter connection, common collector connection, Comparison of transistor connections, Transistor as an amplifier in CE arrangement, Transistor load to me analysis, Operating point, Cut off and saturation points, Applications of Common base amplifier, Bipolar junction Transistors, Field effect Transistor: JFET/MESFET, MOSFET, Unipolar Devices.

**Text Books:**

1. Fundamentals of Semiconductor Devices by Joseph Lindmayer, Charles Y. Wrigly, Litton Educational Publishing Inc.
2. Physics of Semiconductor Devices by S.M.Sze, John Wily & Sons, New Delhi.
3. Semiconductor Electronics by A.K. Sharma, New Age International (P) Limited Publisher, New Delhi.

**AM-3105: Linear Algebra**

Review of vector spaces over arbitrary fields and linear transformations. Rank Nullity theorem. The minimal and characteristic polynomials. Linear functional and dual spaces. Diagonalization of linear transformations. The primary decomposition theorem. The Rational and Jordan canonical forms and some applications. Inner product spaces, Best approximation, Cauchy Schwarz inequality, Positive definite matrix, Hermitian, Unitary and Normal linear operators. Quadratic forms. Bilinear forms. Symmetric and skew symmetric forms. Function of matrices. Matrix norms. Spectral radius.

**Books Suggested:**

1. K. Hoffman and R. Kunze: Linear Algebra , Prentice Hall of India, 1991.
2. Surjit Singh: Linear Algebra, Vikas Publishing.
3. David W. Lewis: Matrix Theory, Allied Publisher

## **AP- 3201: Advanced Electromagnetic Theory and Special Relativity**

Maxwell's equations, wave equations in scalar and vector potential, solutions of scalar and vector wave equations by Fourier analysis. Relativistic motion in electromagnetism, postulates of special theory of relativity, Lorentz transformation, relativistic mechanics, contraction of length, dilation of time, magnetism as relativistic effect, four vector, co-variance of Maxwell's equations, Lienard-Wiechert potentials and the field of a uniformly moving electron, radiation from an accelerated charge, cyclotron synchrotron, Bremsstrahlung and Cerenkov radiations. Scattering and absorption of electromagnetic waves, antenna, radiated power and angular distribution of radiation, electric dipole radiation.

### **Text Books:**

1. Introduction to Special Relativity by R. Resnik, Wiley Eastern Ltd.
2. Classical Electrodynamics by J.D. Jackson,

## **AP- 3202: Atomic Physics and Nuclear Engineering.**

Electron spin, Vector model, coupling of angular momentum, spin-orbit interaction, atomic magnetism, Zeeman and Paschen back effects, electronic, vibrational and rotational spectra of diatomic molecules, static properties of nuclei, nuclear binding energy and forces.  $\alpha, \beta, \gamma$  decay, interaction of radiations with matter, fission and fusion as energy source. nuclear reactors, neutron cross sections, condition for criticality, types of nuclear reactors, breeder reactor, consideration of reactor design, control rods, scintillation counters, solid state detectors.

### **Text Books:**

1. Nuclear Physics by I. Kaplan, Addison-Wiley.
2. Introduction to Atomic Spectra by H.E. White, McGraw-Hill.
3. Atomic Spectra and Atomic Structure by G. Herzberg, Dover, New York

## **AP- 3203: Microwave and Radar Engineering**

Microwave, classification of microwave bands, microwave sources, Tunnel diode, Gun diode, IMPATT diode oscillator, Reflex klystron microwave amplifier, measurement of Microwave power, microwave antennas, radiation pattern, directivity, gain, impedance, bandwidth, polarization, size of antenna, Microwave radar system, radar equation, pulsed radar, CW doppler radar, FMCW radar, microwave communication system, terrestrial system, satellite communication system, Industrial application of microwave.

### **Text Books:**

1. Microwave & Radar Electronics by Erensest C. Pollar & Julian M. Sturtevant, Jhon Willey & Inc, New York
2. Microwave Engineering by David M. Pozer, John Willy & Sons, Inc, New York.
3. Microwave Engineering by Annapurna Dass & Sisir K. Das, Tata Mc Graw-Hill Publishing Company Ltd.

### **AP- 3204: Statistical Mechanics**

Review of thermodynamics and kinetic theory, phase space, Liouville theorem, the most probable distribution in energy, distinguishable and indistinguishable systems, Boltzmann, Bose-Einstein and Fermi-Dirac statistics, Partition function, Boltzmann statistics and its applications to ideal gas, Bose-Einstein statistics and its application to black body radiation, Fermi-Dirac statistics and its applications to free electron gas, Grand canonical ensemble.

#### **Text Books:**

1. Statistical Mechanics by Pathariya.
2. Introductory Statistical Mechanics by Bowely, R. and M. Sanchez, University Press, New York.

### **AM-3203: Statistics & Stochastic Process**

Statistics: Sampling techniques, Test of significance, Normal tests,  $\chi^2$  – tests, t – test and F – test. Design of experiments, Analysis of variance, one way and two way classifications.

Stochastic Processes: Definition and classification of general stochastic processes. Markov chains, finite and infinite ergodic chains. Transition probability matrix, Markov chains with discrete state space. Poisson process. Markov process with continuous state space. Birth and death processes and its applications in queuing theory. Renewal process. Renewal equation, mean renewal time, stopping time, Introduction to Brownian motion.

#### **Books Suggested:**

1. Irwin Miller and John E. Freund.. Probability and Statistics for Engineers, Prentice Hall of India.
2. J. Medhi.. Stochastic Processes, Wiley Eastern Ltd.
3. Sheldon M. Ross.. Introduction to Probability Models, Academic Press.

## **FOURTH YEAR**

### **AP- 4101: Alternative Energy Sources**

Fundamentals of solar radiation, fundamentals of heat transfer flat plate solar collector, solar concentrator, Photo Voltaic effect, basic theory of a solar cell, homo and hetero type p-n junction, single crystalline silicon solar cell, solar cells, alternatives materials, PV module, Panel and Array, energy storage. Recent techniques of manufacturing, effect of temperature on the efficiency of a solar cell, Thermo Photo Voltaic devices, Photo electric conversion, solar energy collection and transmission from space. Photo chemical energy conversion, Photo Electro Chemical solar cells, fuel cells and Photo Galvanic effect, introduction to wind power, tidal power, bio-mass, bio-gas, plants, geothermal energy.

### **AP- 4102: Elements of Fiber Optics**

Over view of optical fiber communications, the evolution of fiber optics systems, elements of an optical fiber transmission links. Electromagnetic analysis of optical waveguides, classification of modes for a planar waveguide, TE and TM modes in a symmetric step index planar waveguide, power associated with a mode, excitation of guided modes, Maxwell equations in inhomogeneous media: TE and TM modes in planar waveguide. Leaky modes, leakage of power from the core, bending loss in optical waveguides. Optical fiber waveguides, optical fiber types, numerical aperture, pulse dispersion in step index fibers, scalar wave equations and modes of a fiber, Modal analysis for a step index fiber and graded-index fiber. Linearly polarized modes, power flow, multi mode fibers with optimum profiles, single mode fiber, propagation modes in single mode fibers, fiber materials, fiber fabrication. Vapor-deposition methods, Fiber optic cables, optical fiber connections, joints and couplers, signal degradation in optical fiber, absorption loss, radiation loss, attenuation, signal distortion in optical waveguides, pulse broadening, mode coupling.

#### **Text Books:**

1. Optical fiber communication by Keiser and Senior.
2. Introduction to Optical fiber by A.K.Ghatak, Cambridge University Press.

### **AP- 4103: Quantum Electronics**

Time dependent perturbation theory, transition probability, stimulated emission and absorption, quantization of electromagnetic field, Raman photon scattering, quantum electronic devices, Lasers, population inversion, amplification, various type of Lasers, gas Lasers, solid state lasers, semi-conductor lasers, masers, threshold requirement, steady state power output, optical detectors and receivers, Q-switching.



**Text Books:**

1. Quantum Electronics by A.Yariv, John-Wiley.
2. Optical Electronics by A.K.Ghatak, Cambridge University Press.

**AP- 4104: Condensed Matter Physics**

Crystal structure, point and space groups, reciprocal lattice, X-Ray, electron and neutron diffraction, lattice vibrations, normal modes, Einstein and Debye models, Phonons thermal conductivity and thermal expansion, free electron theory, Drude model of conductivity, Hall effect, Bloch theorem, energy bands in solids, density of states and conductivity, Effective mass, energy bands in semiconductors, Fermi surface, deHassVanAlphen effect. Superconductivity, Meissner effect, tunneling in superconductor, Josephson junctions, high T<sub>c</sub> superconductors, liquid crystals.

**Text Books:**

1. Solid State Physics by C. Kittel, Wiley- Eastern.
2. An Introduction to Solid State Physics by A.J.Deckar, Printice- Hall.

**EC-4102: Optical Communication**

Guided and space optical communication. Optical fibers: Structures, wave guiding and fabrication. Step and graded Index fibers. Single and multimode fibers. Fiberoptic components. Signal degradation in optical fibers: Attenuation and dispersion. Optical sources: Polar and spectral characteristics, LED and Laser diode, Light source linearity and reliability consideration, power launching and coupling, Fiber joints splicing, Optical Detectors: PIN and APD. Photoresponse characteristics and Noise analysis. Optical modulators and elements of integrated optics. Optical amplifiers: SLA and EDFA. Coherent optical communication: Optical receiver, homodyne and heterodyne systems, OOK, OTDR and DSA.

**AP- 4201: Magnetohydrodynamics**

Electromagnetic equations. Maxwell's equations. Ohm's Law, Generalized Ohm's law, Induction equations, Electric conductivity, Plasma equations, Mass continuity, Equation of motion, Perfect gas law, Energy equations, Different forms of the heat equations, Thermal conduction, Radiation heating, Energetic, Dimensionless parameters, Consequences of the induction equations, Diffusive limit, Perfectly conducting limit, Lorentz force, Cowling's antidynamo theorem, Tallar-Proudman theorem, Ferraro's law of iso-rotation. Magnetic flux tube behavior, current sheet behavior. Magnetohydrostatics: Current-free anti force-free fields, plasma structure in a prescribed magnetic field, structure of magnetic flux tubes (cylindrically symmetric), magnetohydrostatics fields.

**Text Books:**

1. Solar MHD by Priest, E.R., Reidel, Dordrecht, Netherlands.
2. Physics of fluids and plasmas by Choudhari, A.R., Cambridge University Press, UK.
3. Introduction to plasma physics and controlled fusion by Chen, F.F, Vol. 1, 1st edn Plenum Press.

**AP- 4202: Nano Materials**

Physical chemistry of solid surfaces, quantum confinement in low-dimensional systems, zero-dimensional nanostructure, nano-particles, one-dimensional nanostructure, nano-wires and nano-rods, two dimensional nanostructures, thin films, special nano-materials, synthesis and fabrication of nanostructures, nanostructures fabricated by physical technique, characterization and properties of nanomaterials, nanoporous materials, carbon nano-tubes, characterization of nano-systems, thermal stability, basic materials properties, wear at the nanometer level semiconductor nanostructures, exciton polaritons in nanostructures and microcavities, light scattering in nanostructure, intraband optical spectroscopy of nanostructure, applications of nanomaterials.

**Text Books:**

1. Nano Structure and Nano Material by G.Cao.
2. Introduction to Nano Technology by Charles P. Poole Jr and F.J. Owens,

**AP- 4203: Elements of Microwave Remote Sensing**

Remote sensing, the importance of remote sensing, physical properties of the atmosphere, absorption and emission by gases, water vapor absorption, oxygen absorption, total atmospheric gases absorption and emission, electromagnetic interaction with individual particles, atmospheric windows, active and passive remote sensing, scattering coefficient, surface parameters, smooth surface criteria, dependence on surface, roughness, dielectric constant, the nature of volume scattering for vegetation and soil, simple models relating scattering coefficient to physical parameters of soils and vegetation canopies.

**Text Books:**

1. Microwave Remote Sensing Active & Passive, Vol. I, II, IV by F.T. Ulaby, R.K. Moore & A.K. Fung, Addison-Wesley Publishing Company, Massachusetts.
2. Introduction to the Physics & Techniques of Remote Sensing by Charles Elachi, John Wiley & Sons, New York.
3. Remote Sensing & its Applications by L.R.A. Warayan, University Press (India) Ltd. Hyderabad.

## **AP- 4204: Instrumentation, Measurement and Analysis**

General concepts of monitoring and control. Function elements of instruments. Classification of instrument, standards and calibration, errors and un-certainties in static performance parameters, the basic parameters, linearity, threshold, sensitivity resolution, hysteresis, impedance loading and matching, specifications of instruments. Generalized mathematical model of dynamic response of measurement systems. The operational transfer function, sinusoidal and Laplace transfer functions. Order of instruments, zero order instrument, step, ramp frequency and pulse/impulse response of first order and second order instruments. The basic idea of control system, basic control actions, proportional derivative and integral control. Stability criteria of control systems, Basic concepts of data analysis, measurement of dispersion, standard deviation of a sample, properties of Gaussian distribution, chi square test, curve fitting of data.

### **Text Books:**

1. Electronic Instrumentation by H.S.Kalsi, McGraw-Hill.
2. Automatic Control System by S.N. Verma, Khanna Publisher.
3. Automatic Control System, by B.C. Kuo, John Wiley Publisher.

## **AP- 4205: Seismology and Helioseismology**

Introduction to helioseismology, convection magnetoconvection, Schwarzschild criteria, convective instability, historical developments in helioseismology, Spatial and temporal filtering of oscillation data. Basic equations of hydrodynamics, perturbation analysis, radial and non-radial oscillation. Oscillation equations and properties, linear and adiabatic oscillation, dependence of frequencies on equilibrium model, physical nature of modes of oscillation, asymptotic theory for p and g modes, excitation and damping of oscillations.

### **Text Books:**

1. Solar MHD by Priest, E.R., Reidel, Dordrecht, Netherlands.
2. Physics of fluids and plasmas by Choudhary, A.R., Cambridge University Press, UK.

## **FIFTH YEAR**

### **AP- 5101: Physics of Atmospheric Sciences**

The hydrostatic equation of atmospheric structure, conservation equations for mass, momentum, and energy of a gaseous mixture, atmospheric composition, thermal structure, ozone in Earth's atmosphere, radiative transfer, radiative heating, Greenhouse effect, vertical mixing, diffusion equation, eddy diffusion, molecular diffusion, optical emissions from atmosphere, Airglow, excitation mechanism, solar extreme ultraviolet radiation (EUV), formation of ionosphere; ionization sources, basic theory of Photo-ionization, Chapman function, ion chemistry, continuity equation, transport processes in the ionosphere, thermal processes, ionization, excitation of atmospheric constituents by charged particles, aurora emissions, extraterrestrial atmospheres and ionospheres, Aurora and airglow.

#### **Text Books:**

1. Atmosphere by Kellogg William and Mead Margaret, Castle House Publications Ltd.
2. Introduction to ionospheric physics by Rishbeth and Garriot, Academic Press.
3. Aurora and Airglow by B.McCormac, VN Reinhold Publisher.

#### **Reference Books:**

1. Aurora by A. Vallance Jones, D.Reidel Publishing Company, 1974.
2. Aeronomy by P.M. Banks and G. Cockarts, 1973.

### **AP- 5102: Fiber and Integrated Optics**

Modes in an asymmetric planar waveguides. Ray analysis of planar waveguide, W. K. B. analysis of inhomogeneous planar waveguide, strip waveguides, periodic waveguide-coupled mode analysis, and rectangular core waveguides metal clad waveguides. Anisotropic polarizer, leaky modes in a planar structure. Polarization maintaining fibers and their applications different types of polarization maintaining fibers, high birefringent fibers, single polarization single mode fibers. Integrated optic devices: electro-optic effect, phase modulator, polarization modulators and wavelength filters. The Mach Zehnder Interferometric modulator, logic operations, optical directional coupler, leaky mode, metal clad polarizer.

#### **Text Books:**

1. Optical Wave guide Theory by Snyder, A.W. and Love, J.D., Chapman and Hall.
2. Introduction to optical fiber by A.K.Ghatak, Cambridge University Press.

### **AP- 5103: Solar Physics and Space Physics**

Spectral classification of stars, electro-magnetic spectrum, doppler shift, Planck's radiation formula, thermal equilibrium and Boltzmann factor, Saha-Boltzmann ionization equation. The solar interior, solar neutrinos, nuclear reactions, formation and evolution of stars, White dwarves,

neutron stars and black holes, interstellar matter, galaxies and Quasars, solar wind, solar magnetic field and coronal flares.

**Text Books:**

1. Solar MHD by Priest, E.R., Reidel, Dordrecht, Netherlands.
2. Physics of fluids and plasmas by Choudhari, A.R., Cambridge University Press, UK.

**AP- 5104: Optoelectronics and Photonics**

Semiconductor lasers for optical fiber communications, Fabry-Perot cavity, heterostructure semiconductor lasers, single frequency semiconductor lasers, semiconductor lasers for coherent systems. Distributed feedback in Ga-As-P lasers. Device structure and fabrication, photo-detectors for fiber optics, reverse bias photo-detectors, dark current, quantum efficiency, signal to noise ratio, types of detectors. Receivers for digital fiber optic communication systems: basic components, detectors for digital fiber optic receivers, PIN diode, Avalanche photodiode, Front ends for digital fiber optic receivers, equalizer for optical communication, receivers, PIN-FET receivers for longer wavelength communication systems. Coherent optical fiber transmission systems, coherent detection principles, comparison of direct and coherent performance, homodyne and heterodyne systems. Non linear process in optical fibers, phase matching in waveguide, phase matched harmonic generation in waveguides. Second harmonic generation (SHG) in integrated optics, Cerenkov configuration SHG. Optical fiber sensor and devices, intensity modulation through light interruption, distributed sensing with fiber optics. Basic principles of interferometric optical fiber sensor, signal processing in mono mode fiber optic sensor, photonic band gap materials.

**Text Books:**

1. Optical fiber communication by G.Keiser, McGraw-Hill.
2. Optical fiber Communication by J.Seniar, Prentice- Hall International.

**AP- 5105: Fluids and Plasma**

Phase space and Liouville theorem, Boltzmann- Vlasov equations, distribution function, fluid pictures, Magnetohydrodynamics equations, natural plasmas, solar wind, Magnetosphere, radiation belts, ionosphere, wave in incompressible and compressible fluids, flow of neutral and ionized gases, past obstacles, shock waves, highly ionized conducting fluid, effect of magnetic field, Alfen waves, waves in cold and hot plasmas, and in hot magnetized plasmas, transport processes in plasmas, plasma instabilities.

**Text Books:**

1. Solar MHD by Priest, E.R., Reidel, Dordrecht, Netherlands.
2. Physics of fluids and plasmas by Choudhari, A.R., Cambridge University Press, UK.
3. Introduction to plasma physics and controlled fusion by Chen,F.F, Vol. 1,IInd edition Plenum Press.

### **AP- 5106: Microwave Remote Sensing**

Passive Microwaves sensing of Land: Emission behavior of Bare Soil surfaces, Volume scattering in a Soil volume, Emission behavior of vegetation canopies, Dielectric and Extinction properties of individual plant parts, Attenuation properties of canopy constituent, Total canopy attenuation, Emission behavior of canopy constituents, Soil moisture sensitivity.

Active Microwave sensing of Land: Scattering models for soil surfaces, Dependence on soil moisture content, Back Scattering behavior of cultural vegetation canopies- Modeling approaches, radiated transfer method, First order solution of radiative transfer model, First order model for a multi-constituent canopy, Penetration properties of Canopies.

#### **Text Books:**

1. Microwave Remote Sensing Active & Passive, Vol. I, II, IV by F.T. Ulaby, R.K. Moore & A.K. Fung, Addison-Wesley Publishing Company, Massachusetts.
2. Introduction to the Physics & Techniques of Remote Sensing by Charles Elachi, John Wiley & Sons, New York.
3. Remote Sensing & its Applications by L.R.A. Warayan, University Press (India) Ltd. Hyderabad.

### **AP- 5107: Atmospheric & Meteorology**

Particles, aerosols and cloud structure, Lapse rates, cloud densities, heat capacities and latent heats, vapor pressures, cloud models, solar controls of Earth's atmospheric processes, condensation and nucleation, temperature profiles in troposphere, stratosphere and mesosphere. Horizontal motion of the atmospheric winds, Hadley circulation, Thunderstorm and lighting processes, wave and cyclotron techniques of analyses and forecast, humidity prediction in the atmosphere, nature and scope of meteorological satellites, principles of meteorological satellites, Indian meteorological system and satellites, atmospheric energy budget, atmospheric moisture, wind circulation and global climatology, regional climatology. Linear and nonlinear disturbances of tropical weather, temperature of mid latitude and polar - regions, climate classification in view of the satellites data.

#### **Text Books:**

1. Atmosphere by Kellogg William and Mead Margaret, Castle House Publications Ltd.
2. Introduction to Ionospheric physics by Rishbeth and Garriot, Academic Prss.