# P.P.N. (P.G.) College, Kanpur

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## PG PHYSICS

### COURSE OUTCOMES (COs)

#### DEGREE IN MASTERS OF SCIENCE – PREVIOUS YEAR

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| | | **TITLE** | | **CODE** | **T/P/R** | **TYPE** | **CREDIT** |
| **FIRST YEAR** | **SEMESTER - I** | **Mathematical Physics-I** | | **B010701T** | **THEORY** | **CORE** | **04** |
| | | **CO1** | Understand the fundamental concepts of complex analysis, including continuity, differentiability, analytic functions, Cauchy-Riemann equations, and their applications. | | | | |
| | | **CO2** | Develop proficiency in solving linear differential equations and special functions, including hypergeometric, Bessel, Legendre, Laguerre, and Hermite equations, and their applications in physics. | | | | |
| | | **CO3** | Gain a working knowledge of linear vector spaces, including inner products, norms, linear operators, matrices, eigenvalues, and eigenvectors. | | | | |
| | | **CO4** | Understand the basic principles of probability theory and statistics, including random variables, distributions, central limit theorem, hypothesis testing, and data analysis. | | | | |
| | | **CO5** | Develop an understanding of tensor analysis, including coordinate transformations, contravariant and covariant vectors, tensors, and their applications in physics | | | | |
| | | **Classical Mechanics** | | **B010702T** | **THEORY** | **CORE** | **04** |
| | | **CO1** | Analyze the mechanics of a system of particles including constraints, generalized coordinates, virtual displacement, principle of virtual work and D'Alembert's Principle. | | | | |
| | | **CO2** | Apply Lagrange's equations and generalized momenta to solve problems involving cyclic coordinates and conservation laws | | | | |
| | | **CO3** | Analyze central forces, two-body problem, orbits, and Kepler's laws using calculus of variation and Hamilton's principle. | | | | |
| | | **CO4** | Be familiar with canonical transformations, generating function, Poisson brackets and its invariance under canonical transformations, Invariance of symmetry and Noether's theorem and solve problems based on Hamilton's equations. | | | | |
| | | **CO5** | Analyze Hamilton-Jacobi equations, Hamilton's characteristic function, Inertia tensor, Euler's equation of motion, and torque-free motion of a rigid body. | | | | |
| | | **CO6** | Analyze the motion of a heavy symmetrical top and the theory of small oscillations including normal modes. | | | | |
| | | **Electromagnetic Theory** | | **B010703T** | **THEORY** | **CORE** | **04** |
| | | **CO1** | The course is designed for an understanding about laws and their mathematical approach to elaborate the physical properties related to accelerated charge particle. This unit comprises the detailed study of Maxwell's Equations, Displacement current, Boundary conditions, and conservation of energy and momentum for an accelerated charge particle or position and time varying electromagnetic fields or electromagnetic wave. | | | | |
| | | **CO2** | This unit explains the concepts of Vector and scalar potentials, gauge transformation, electromagnetic wave equation in terms of potentials with solution and transformation properties of electromagnetic fields. | | | | |
| | | **CO3** | The conceptual and mathematical understanding of physical properties (wave equation, velocity, impedance, pointing vector etc.) of an electromagnetic wave in vacuum, non-conducting, conducting, and plasma medium is developed in this section. The unit also explores the concepts about reflection, refraction, total internal reflection, polarization, and dispersion of Electromagnetic Waves. | | | | |

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| | | **CO4** | This section explains the waveguide and its types and properties (mode of propagation, cut off frequency, energy Flow, attenuation, cavity resonance etc.) related to propagation of electromagnetic Waves in rectangular and cylindrical waveguides. | | | | |
| | | **Quantum Mechanics-I** | | **B010704T** | **THEORY** | **CORE** | **04** |
| | | **CO1** | Understand the mathematical foundations of linear algebra, including vector spaces, linear independence, basis, and dimensionality. | | | | |
| | | **CO2** | Learn the concepts of inner product, orthogonality, and completeness in the context of Hilbert spaces. | | | | |
| | | **CO3** | Explore Hermitian and unitary operators, concepts of orthonormality, completeness, and closure using Dirac's bra and ket notation. | | | | |
| | | **CO4** | Develop skills in matrix representation and change of basis. | | | | |
| | | **CO5** | Understand the concepts of operators and observables, and commutation relations, including the uncertainty principle for two arbitrary operators. | | | | |
| | | **CO6** | Analyze the time evolution operator, stationary states, and the Schrodinger equation, including the difference between the Schrodinger and Heisenberg pictures. | | | | |
| | | **CO7** | Evaluate the energy eigenvalues and eigenfunctions of simple harmonic oscillator, and connect quantum mechanics to classical mechanics using Ehrenfest theorem, Poisson brackets & commutators | | | | |
| | | **CO8** | Study the formalism of angular momentum, including the eigenfunctions and eigenvalues of orbital angular momentum, addition of angular momenta, Clebsch-Gordan coefficients, Pauli matrices and spinors. | | | | |
| | | **General Lab** | | **B010705P** | **PRACTICAL** | **CORE** | **04** |
| | | **CO1** | Determine the thickness of a mica sheet using a biprism and understand the principles of interference and diffraction. | | | | |
| | | **CO2** | Calculate the resolving power of a prism and understand the relationship between the resolving power, wavelength of light, and the angle of deviation. | | | | |
| | | **CO3** | Analyze the properties of a Babinet compensator and understand how it can be used to measure the retardation of a material and determine its refractive index. | | | | |
| | | **CO4** | Demonstrate an understanding of the Michelson interferometer and its use in measuring the wavelength of light, the refractive index of a material, and in the detection of gravitational waves. | | | | |
| | | **CO5** | Evaluate the properties of a Fabry-Perot interferometer and understand its use in the measurement of the wavelength of light, the linewidth of lasers, and the properties of thin films and surfaces. | | | | |
| | | **CO6** | Find the forbidden energy bandgap through the inter-relation between change in temperature and resistivity of intrinsic semiconductor. | | | | |
| | | **CO7** | Study of thermal and electrical conductivity of metal and find the Lorentz number and also determining the k/e using simple transistor. | | | | |
| | | **CO8** | Measure the velocity of ultrasonic waves in liquids and analyze the relationship between the velocity, frequency, and wavelength of the waves, as well as the properties of the medium through which the waves propagate. | | | | |

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| | | **TITLE** | | **CODE** | **T/P/R** | **TYPE** | **CREDIT** |
| | | **Mathematical Physics-II** | | **B010801T** | **THEORY** | **CORE** | **04** |
| | | **CO1** | Apply various techniques for solving partial differential equations, including Lagrange's linear equation, and use them to model physical systems in Cartesian, spherical, and cylindrical coordinates. | | | | |
| | | **CO2** | Analyze and solve inhomogeneous equations using Green's function, Fourier series, and Fourier integral, and apply them to physical systems. | | | | |
| | | **CO3** | Understand and apply group theory concepts such as groups, subgroups, homomorphism, representations, and characters to analyze the symmetries of physical systems. | | | | |
| | | **CO4** | Analyze and solve equations using numerical methods such as finite difference, interpolation formulae, and iterative algorithms, and understand their accuracy and limitations. | | | | |
| | | **CO5** | Use Laplace transform to solve differential equations with initial and boundary conditions, and apply it to physical systems. | | | | |
| | | **CO6** | Understand and apply Dirichlet and Neumann boundary conditions to solve Laplace's equation and Poisson's equation in various coordinate systems. | | | | |
| | | **CO7** | Analyze and solve wave equations, diffusion equations, and heat equations using various mathematical techniques, and apply them to physical systems. | | | | |
| | | **CO8** | Understand and apply the properties and applications of Dirac delta function and its relationship with Fourier transform and Laplace transform, and apply them to physical systems. | | | | |
| **FIRST YEAR** | **SEMESTER - II** | **Solid State Physics** | | **B010802T** | **THEORY** | **ELECTIVE** | **04** |
| | | **CO1** | The course is focused to explore the properties of condensed materials. This unit explains the classification of materials, crystal structure and its types & properties. | | | | |
| | | **CO2** | This section gives an understanding of characterization of materials based on X-ray diffraction with different techniques. It also provides the concepts of reciprocal lattice, Brillouin zones, atomic Scattering factor and Geometrical structure factor. | | | | |
| | | **CO3** | In this unit, an understanding about physical properties of metals (DC conductivity, magneto-resistance, thermal conductivity, thermoelectric effects, thermal properties of an electron gas) and their inter-relationship is done through Drude theory, Wiedemann-Franz law and free-electron model. | | | | |
| | | **CO4** | This section explores the vibrational properties of one- and three-dimensional lattices along with quantization of lattice vibrations and Einstein & Debye theories of specific heat. | | | | |
| | | **CO5** | Formation of band structure based on nearly free electron and tight binding approximation and details about Bloch theorem, Effective mass, Fermi surfaces, Cyclotron resonance is explored in this unit. | | | | |
| | | **CO6** | A brief study of semiconductor and its types & features (band structure, carrier statistics, conductivity, resistivity, mobility, drift, and diffusion currents etc.) is done in this section. It also gives a concept about Hall effect. | | | | |
| | | **CO7** | This section explores the features of the superconductors, its types, properties, and phenomenon related to it (Meissner effect, Isotope Effect, London equations, formation of Cooper pair, BCS theory). | | | | |
| | | **Statistical Mechanics** | | **B010803T** | **THEORY** | **CORE** | **04** |
| | | **CO1** | Understand the concept Phase space, microstates and macrostates, Liouville's equation, Postulates of statistical mechanics, probability concepts; Random walk problem in one dimension-binomial distribution, Specification of state of system, statistical equilibrium, Fundamental postulates of equal a priory probability. | | | | |
| | | **CO2** | Be familiar with Micro-canonical, Canonical, and grand canonical ensembles, Partition function, Calculation of statistical quantities in terms of partition function, Entropy of mixing of gases (Ising partition function), Gibbs paradox and its resolution; Derivation of equation of state of classical ideal gas using partition function. | | | | |

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| | | **CO3** | Understand the concept of Ideal quantum gas, Indistinguishability, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics, Photon statistics, Ideal Bose gas, Bose-Einstein condensation, Ideal Fermi gas, Correlation function. | | | |
| | | **CO4** | Develop an understanding of Interacting spin systems. The Ising model, Exact solution of Ising model in 1-dimension, mean-field solution in higher dimensions, Paramagnetic and ferromagnetic phases. Critical exponents. Order parameter, Landau theory. | | | |
| | | **Electronics** | | **B010804T** | **THEORY** | **ELECTIVE** | **04** |
| | | **CO1** | The course is design to learn about Ideal operational amplifier, inverting and non-inverting amplifier configurations, Biasing and offset currents, and offset voltages, Feedback theory, and negative feedback in op-amp circuits, DC and AC characteristics, Log and antilog amplifiers. | | | |
| | | **CO2** | Demonstrate the applications of waveform generators, timers, and voltage regulators. Learn Frequency response, gain-bandwidth product, slew rate, compensation, and stability. | | | |
| | | **CO3** | Learn various applications which includes; voltage summation, subtraction, scaling, voltage and current sources, wave shaping, integration, and differentiation. Learn Op-amp oscillators types include; RC-phase shift, Wien bridge. | | | |
| | | **CO4** | Classify and comprehend the working principle of various data converters, compare the working of multivibrators | | | |
| | | **CO5** | The course is an introduction to the fundamentals of optoelectronics and principles of the optoelectronic devices' operation. Building on the basic understanding of how light interacts with semiconductor materials and how electron-hole pairs generates and recombine in semiconductor. | | | |
| | | **CO6** | Discuss the principles of operation of optoelectronic devices, such as LED, Photo-diode, Photo-transistors, Solar cell. Learn some of the critical parametric considerations, and some of the finer distinction of device application. | | | |
| | | **CO7** | Realize basic elements in optical fibers, different modes, and configurations. Learn the basic elements of optical fiber transmission, fiber modes configurations and structures. | | | |
| | | **CO8** | Understand the different kind of losses, signal distortion in optical wave guides and other signal degradation factors. Also learn the different techniques to manufacture optical fibers. | | | |
| | | **General Lab** | | **B010805P** | **PRACTICAL** | **CORE** | **04** |
| | | **CO1** | Plot LCR series and parallel circuit resonance curves and determine L, C. | | | |
| | | **CO2** | Study IV characteristics of SCR. | | | |
| | | **CO3** | Study Characteristics of MOSFET. | | | |
| | | **CO4** | Measure L and C using AC bridges. | | | |
| | | **CO5** | Study low pass, high pass, and band pass filters. | | | |
| | | **CO6** | Determine bang gap of a semiconductor using four probe method. | | | |
| | | **CO7** | Analyze IV characteristics of a UJT. | | | |
| | | **CO8** | Study a regulated power supply. | | | |
| | | **Research Project** | | **BO10806R** | **RESEARCH** | **PROGRESSIVE** | **08** |
| | | **CO1** | Learn to identify, refine, and then determine the research problem of their choice and ability. | | | |
| | | **CO2** | Understand the importance of conducting literature review and developing a theoretical /conceptual framework. | | | |
| | | **CO3** | Prepare synopsis on chosen problem stating objectives, hypothesis brief background of the selected topic. It must identify the importance of study, its relevance and applicability of results. | | | |
| | | **CO4** | Develop ability to perform the planning and preparation as well as to lead and manage research projects. | | | |

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## PG PHYSICS

### COURSE OUTCOMES (COs)

#### DEGREE IN MASTERS OF SCIENCE – FINAL YEAR

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| | | **TITLE** | **CODE** | **T/P/R** | **TYPE** | **CREDIT** |
| **SECOND YEAR** | **SEMESTER - III** | **Classical Electrodynamics and Plasma Physics** | **B010901T** | **THEORY** | **CORE** | **04** |
| | | **CO1** | Concept of Lorentz groups, Pseudo-Euclidean space, Minkowski space, Space-time co-relation in relativity, Matrix representation of Lorentz transformations, Four-vectors/tensors is explored in section. | | | |
| | | **CO2** | Tensor representation of equation of continuity, gauge transformation conditions, electromagnetic fields, electromagnetic wave equation, and transformation of them under Lorentz transformation is explored in this section. Along with it, Lagrangian and Hamiltonian formulation for a relativistic charged particle in external electromagnetic field and solution of the wave equation in covariant form is also explained. | | | |
| | | **CO3** | The solution of electromagnetic wave (Retarded Potentials), Lienard-Wiechert potentials for a moving point charge, Fields produced by a charge in uniform and accelerated motion is explained in this section. Along with it, the properties of radiation emitted by non-relativistically and relativistically accelerated charge (Radiated power, Larmor's formula, Linnard Formula etc.) is also explained in it. | | | |
| | | **CO4** | Understanding is developed about basic properties of plasma (formation condition, Plasma oscillation, Debye shielding, plasma confinement etc.), formulation MHD equations, properties of hydromagnetic waves (magnetosonic and Alfven waves) this section. | | | |
| | | **Quantum Mechanics-II** | **B010902T** | **THEORY** | **CORE** | **04** |
| | | **CO1** | Learn the principles and mathematical techniques used in stationary perturbation theory, WKB approximation methods, connection formula, and boundary conditions. | | | |
| | | **CO2** | Apply time-independent perturbation theory to problems such as anharmonic oscillator and other applications. | | | |
| | | **CO3** | Knowledge of time-dependent perturbation theory for a constant perturbation and its applications. | | | |
| | | **CO4** | Understanding of scattering cross-section, method of partial wave analysis, resonance, scattering from a square potential well and a rigid sphere. | | | |
| | | **CO5** | Knowledge of the Born approximation | | | |
| | | **CO6** | Ability to solve the Dirac equation for a free particle, covariant form of Dirac equation, probability and current densities. | | | |
| | | **Nuclear Physics-I** | **B010903T** | **THEORY** | **CORE** | **04** |
| | | **CO1** | Be familiar with the concepts of Mass and binding energy, Semi-empirical mass formula, nuclear size determination using X-rays and scattering of fast electrons | | | |
| | | **CO2** | Develop an understanding of nuclear spin and magnetic moment of nuclei, Molecular beam resonance method, nuclear induction method, Electric quadrupole moment. | | | |
| | | **CO3** | Understand the Alpha spectra, Selection rules, Geiger-Nuttall relation, Theory of alpha decay, Beta-spectra, Fermi's theory of beta decay, Sergeant's law, and Kurie Plot. | | | |
| | | **CO4** | Knowledge of key concepts such as Allowed and forbidden transitions, Fermi and Gamow Teller Transition, Extraction of Fermi constant, Parity violation in beta-decay, Detection of neutrino. | | | |
| | | **CO5** | Be familiar with multi-polarity of gamma rays, Selection rules, Theoretical prediction Transition probability, estimation of transition probability for single particle (Weisskopf unit), Internal conversion, Angular correlation, nuclear isomerism, Mossbauer Effect and its applications. | | | |

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| | | **CO6** | Understand ideas of nuclear reactions, Conservation laws, The Q-equation and deduction of nuclear energy, Compound nucleus, Bohr hypothesis, Resonance phenomenon, Breit-Wigner single level formula, Optical model, direct reactions. Nuclear fission, Bohr-Wheeler theory of nuclear fission, Controlled chain reaction, nuclear reactors and Nuclear Fusion. | | | |
| | | **Electronics-I** | | **B010904T** | **THEORY** | **ELECTIVE** | **04** |
| | | **CO1** | Understand the significance of EM wave propagation in the process of communication comprising propagation of Ground Wave, Space Wave and Sky Wave. Be familiar with the important terms like the line equation, characteristic impedance, reflection coefficient and standing wave ratio. | | | |
| | | **CO2** | Learn the basic concepts related to optical fiber communication and wireless communication. | | | |
| | | **CO3** | Learn basic antenna types and array techniques along with Systems and Characterization antenna matching. Explore the principle, operation and applications of Radar. | | | |
| | | **CO4** | Realize how noise affects communication and learn how it can be reduced. Being able to calculate Signal to Noise Ratio and comprehend basic principles of phase locking and lock-in amplifier. Study Sample and Hold Circuits. | | | |
| | | **CO5** | Understand the basic principles of Microprocessors in the light of 8085 microprocessor such as input/output interfacing devices, microprocessor-initiated operations, externally initiated operations, instruction set and addressing modes. | | | |
| | | **CO6** | Gain a knowledge of 8085 programming and being able to write simple programs of addition, subtraction, multiplication and division of two numbers. | | | |
| | | **CO7** | Develop an understanding of basic principles and operation of microwave devices like Two Cavity Klystrons, Reflex Klystrons, Magnetrons, Helix Travelling Wave Tubes. Have a knowledge of Velocity Modulation and Wave Modes. | | | |
| | | **CO8** | Study propagation of microwaves, atmospheric effects on propagation, Fresnel Zone Problem and various components like antennas used in microwave communication systems. Analyze advantages and disadvantages of Microwave Communication. | | | |
| | | **Practical – Electronics-I** | | **B010906P** | **PRACTICAL** | **CORE** | **04** |
| | | **CO1** | Demonstrate knowledge of analog electrical devices, particularly operational amplifiers and their applications. | | | |
| | | **CO2** | Learn to design simple circuits containing operational amplifiers, used to perform mathematical operations, such as addition, subtraction, differentiation and integration, on applied signals. | | | |
| | | **CO3** | Design circuit which uses Op-Amp to compare two signals and also design the Schmitt circuit using Op-Amp. | | | |
| | | **CO4** | Study transistor Wein bridge oscillator and observe the effect of variation in R & C on oscillator frequency and compare with theoretical value | | | |
| | | **CO5** | Study transistor phase shift oscillator and observe the effect of variation in R & C on oscillator frequency and compare with theoretical value. | | | |
| | | **CO6** | Classify circuits, working principle, waveforms and application of Astable, Monostable and Bistable multivibrator (Using IC555). | | | |
| | | **CO7** | Classify transistorized circuits and applications in designing of Astable, Monostable and Bistable multivibrator (Using transistors). | | | |
| | | **CO8** | Building on the basic understanding of how light interacts with semi-conductor materials by comparing the characteristics of an LED and photodiode. | | | |

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| | | **TITLE** | **CODE** | **T/P/R** | **TYPE** | **CREDIT** |
| **SECOND YEAR** | **SEMESTER - IV** | **Atomic and Molecular Physics** | **B011001T** | **THEORY** | **CORE** | **04** |
| | | **CO1** | Understanding of Hydrogen-spectra, alkali spectra, alkaline earth spectra and their fine structures based on Vector atom model (Spin-Orbit interaction energy) . | | | |
| | | **CO2** | Detailed exploration of Coupling schemes, Normal and Anomalous Zeeman Effect, Paschen-Back effect, Stark effect, Hyperfine structure, Isotope effect in atomic spectra, distinction between Isotope effect, hyperfine structure and Lamb Shift. | | | |
| | | **CO3** | Brief explanation of Pure Rotational spectra, Vibrational spectra, Rotational- Vibrational spectra of diatomic linear and symmetric top molecules, Raman Spectra is done in this section. | | | |
| | | **CO4** | Study of electronic Spectra of Diatomic molecules, spatial and temporal Coherence, He-Ne gas laser, ruby laser, uses of lasers in Raman spectroscopy, Principle of Electron Spin Resonance (E.S.R), Nuclear Magnetic Resonance (N.M.R) and their applications is done in this section. | | | |
| | | **Nuclear Physics II** | **B011002T** | **THEORY** | **CORE** | **04** |
| | | **CO1** | Understand the Nuclear two-body problem, Simple theory of deuteron, Spin dependence and non-central feature of nuclear forces, Charge symmetry and charge independence of nuclear forces, Meson theory of nuclear forces, Partial wave analysis. | | | |
| | | **CO2** | Gain insights on Low energy n-p scattering, Low energy p-p scattering, Existence of two nucleon bound system, Scattering length and effective range theory. | | | |
| | | **CO3** | Appreciate and understand liquid drop model, Magic numbers and evidence of shell structure, Extreme single particle shell model, Predictions of spin, parity and electromagnetic moments, Nilsson Model (Qualitative), Collective model. | | | |
| | | **CO4** | Be familiar with Rotational and Vibrational Hamiltonian, Energy levels and band structure due to single particle; Vibrational and rotational behaviour of different nuclei. | | | |
| | | **CO5** | Classification of elementary particles Exact conservation laws, Approximate conservation laws: Isospin and Isospin wave functions for pion-nucleon system, strangeness, parity, time reversal and charge conjugation, CP violation. | | | |
| | | **CO6** | Get a thorough understanding of Eight fold way, Quarks, Quark-Quark interaction, SU(3) quark model, Gellmann-Nishijima formula, Magnetic dipole moment of baryons, Masses of hadrons. Basic ideas about the standard model. Mass generation. | | | |
| | | **Electronics-II** | **B011003T** | **THEORY** | **ELECTIVE** | **04** |
| | | **CO1** | Understand and analyze various analog continuous wave modulation and demodulation techniques including AM, FM and PM. Analyze various power, voltage, and current calculations in AM/FM systems | | | |
| | | **CO2** | Understand various aspect of amplitude modulation in different domains. Learn block diagram of AM transmitter, suppression of carrier methods and to distinguish various analog modulation techniques. Discuss various types of SSB and explain their advantages | | | |
| | | **CO3** | Evaluate modulation index, bandwidth, and power requirements for various analog modulation schemes. Understand and analyze various analog continuous wave modulation and demodulation techniques. Analyze various analog pulse modulation and demodulation techniques including AM, FM and PM. | | | |
| | | **CO4** | Understand the basic principles, benefits, and drawbacks of digital baseband and bandpass communication systems. Analyze various digital pulse modulation and demodulation techniques including PAM, PWM, and PPM. Understand the concept of sampling, quantization and coding. | | | |
| | | **CO5** | Learn the progression of PCM, Differential PCM, Delta Modulation, Adaptive Delta modulation. Understand the concept of baseband transmission and various line coding formats used in digital communication systems. | | | |

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| | | **CO6** | Understand and remember the concept of amplitude shift keying modulation and demodulation. Analyze the frequency shift keying modulator, coherent and non-coherent frequency shift keying detectors. Provide detail on the various schemes used to transmit digital signals, including FSK, PSK, BPSK, QPSK, DPSK, MSK and QAM. | | | | |
| | | **Laser Physics and Applications** | | **B011006T** | **THEORY** | **ELECTIVE** | **04** |
| | | **CO1** | Understand interactions of atoms and molecules with light, absorption and spontaneous and stimulated emission in two level system, the effects of homogeneous and inhomogeneous line broadening, and the conditions for laser amplification. | | | | |
| | | **CO2** | Realize three and four-level laser system, the simple homogeneous laser and its output behaviour and optimal operating conditions. | | | | |
| | | **CO3** | Learn operations and basic properties of the most common laser types, He-Ne, carbon-dioxide, ruby, neodymium-YAG, semiconductor diode, dye, excimer and knowledge of other main laser types. | | | | |
| | | **CO4** | Realize laser applications in industry and manufacturing, the use of lasers in medicine, laser applications in science and technology, and the use of lasers in defense and military. | | | | |
| | | **CO5** | Develop an understanding of optical fiber communication link, structure, propagation and transmission properties of an optical fiber. | | | | |
| | | **CO6** | Understand the different kind of losses, signal distortion in optical wave guides and other signal degradation factors. Also learn the different techniques to manufacture optical fibers. | | | | |
| | | **Physics of Nanomaterials** | | **B011007T** | **THEORY** | **ELECTIVE** | **04** |
| | | **CO1** | Understand the fundamental principles of solid-state physics, including crystal structures, band theory, and density of states in bands, and apply this knowledge to explain the behavior of materials at the nanoscale. | | | | |
| | | **CO2** | Analyze the quantum nature of nanomaterials and their optical properties, including surface plasmon resonance in metal nanoparticles and the variation of density of states and band gap with dimensionality, and apply this knowledge to design new materials for renewable energy applications. | | | | |
| | | **CO3** | Evaluate the different methods of nanofabrication, including top-down and bottom-up approaches, lithography, etching, and chemical synthesis, and assess their advantages and limitations for producing different types of nanomaterials. | | | | |
| | | **CO4** | Develop skills in the characterization of nanomaterials using a range of techniques, including X-ray and electron diffraction, microscopy, and spectroscopy, and apply these techniques to identify the structure, particle size, crystallography, and surface structures of different nanomaterials. | | | | |
| | | **CO5** | Demonstrate an understanding of the properties of one-dimensional and two-dimensional electron systems, including quantum confinement, and apply this knowledge to design new materials with novel electronic and optical properties. | | | | |
| | | **CO6** | Critically analyze the role of scattering mechanisms in the diffusive transport of electrons in nanomaterials, and identify strategies for optimizing the transport properties of different materials for specific applications. | | | | |
| | | **CO7** | Evaluate the properties of carbon nanostructures, including fullerenes, carbon nanotubes, and graphene, and assess their potential for use in renewable energy applications, such as solar cells and energy storage devices. | | | | |
| | | **CO8** | Apply the principles of solid-state physics, quantum mechanics, and nanofabrication to design new nanomaterials with specific properties, and evaluate their potential for use in a range of applications, including renewable energy, electronics, and biomedical devices. | | | | |
| | | **Practical – Electronics-II** | | **B011009P** | **PRACTICAL** | **CORE** | **04** |
| | | **CO1** | Learn implementation of Binary to Gray code converter and vice-versa, BCD to 7-segmant using logic gates. | | | | |

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| | | **CO2** | Understand how a Multiplexers routes the data from many sources to one destination and demultiplexer redistributes data back from one source to many destinations. | | | |
| | | **CO3** | Learn to design 4-bit synchronous and asynchronous counters and evaluate their operation with their respective truth tables. | | | |
| | | **CO4** | Understand the fundamentals of sampling and the translation of signals form the digital to analog and analog to digital domains, like 4 Bit R-2R ladder DAC and 4 Bit Counter type ADC. | | | |
| | | **CO5** | Evaluate the performance of analog and digital modulation - demodulation techniques, such as AM, FM and PAM. | | | |
| | | **CO6** | Implement analog and digital pulse modulation and demodulation methods, like PCM. | | | |
| | | **CO7** | Learn how 4-bit data can be store and then retrieve from 4-bit memory address in RAM. | | | |
| | | **CO8** | Develop and test assembly language programs to use instructions of 8085, such as addition, subtraction, multiplication and division. | | | |
| | | **Research Project** | | **B011010R** | **RESEARCH** | **PROGRESSIVE** | **08** |
| | | **CO1** | Learn to investigate the problem's design or strategy using available methodology or by developed methodology. | | | |
| | | **CO2** | Learn data collection and analysis, as well as implementation and validation of results and outcomes. | | | |
| | | **CO3** | Understand how to reach to the findings and making logical recommendations. | | | |
| | | **CO4** | By compilation of dissertation, students will be able to report the research in a scholarly fashion appropriate to the disciplinary area in the form of dissertation or research report. | | | |
| | | **CO5** | Learn how to analyze and present qualitative and quantitative data, improve critical thinking abilities, and showcase improved writing abilities. | | | |