JIWAJI UNIVERSITY, GWALIOR
SCHOOL OF STUDIES IN PHYSICS

M.Sc. Program

Programme Outcomes (POs)

The present course is aimed to prepare the students for teaching and research in the modern and challenging areas of Physics. The course is so tailored that it provides on one hand the basic understanding of the emerging areas of Physics and on the other it lays emphasis on their application in research and technology. The faculty members are also committed to address the needs of individual student and encourage them to develop their potential to contribute in the development of Nation.

Our distinguishing features are:

- Developing acquaintance in the current areas of research
- Transferring Computational knowledge based on density functional theory.
- Transferring experimental knowledge related to synthesis and characterization of materials

Programme Specific Outcomes (PSOs)

The pass out students

- acquire ability to design mathematical thought to solve even basic problems.
- acquire ability for mathematical ability to implement new ideas.
- acquire global level research opportunities for doctoral and post-doctoral studies.
- may utilize their true potential to qualifying NET/GATE/SLET for future academic contribution.
- may utilize their true potential to pass state civil services and other competitive examinations.
- acquire ability to engage themselves to transfer their knowledge in the broadest context of socio-technological changes.

After the award of Ph.D. degree

- A students will be able to join any post of teaching/research.
- he will be able to contribute as post doctoral fellow in an organization

First Semester (July - December 2020)

Note: Each course shall be of 100 Marks out of which 40 marks are allotted to internal assessment and 60 marks for End semester examination. Minimum pass marks are 14 for the internal assessment and 21 for the University End Semester Examination. 25% of the syllabus in each paper shall be covered through ICT.

		Inter-nal	End Sem.Exam	Max. Marks	Credits
PT – 101	METHODS IN MATHEMATICAL PHYSICS			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT – 102	CLASSICAL MECHANICS			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT – 103	ELECTROMAGNETISM & NON-LINEAR OPTICS			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT – 104	SEMICONDUCTOR ELECTRONICS			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PL – 105	GENERAL PHYSICS LAB. I			100	3
	Seminar/Internal test/Viva-voce/Practical Record	40			
	End semester examination		60		
PL – 106	GENERAL PHYSICS LAB. II			100	3
	Seminar/Internal test/Viva-voce/Practical Record	40			
	End semester examination		60		
PA– 107	Assignment on an assigned topic	100		100	2
PV - 108	Comprehensive viva-voce	100		100	4
			Total	800	24

II Semester (January - June 2021)

Note: Each course shall be of 100 Marks out of which 40 marks are allotted to internal assessment and 60 marks for End semester examination. Minimum pass marks are 14 for the internal assessment and 21 for the University End Semester Examination. 25% of the syllabus in each paper shall be covered through ICT.

		Inter-nal	End Sem. Exam	Max. Marks	Credits
PT – 201	CLASSICAL ELECTRODYNAMICS AND ANTENNAE PHYSICS			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT – 202	NON-RELATIVISTIC QUANTUM MECHANICS			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT -203	BASIC ELEMENTS OF SOLID STATE PHYSICS			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT – 204	NUMERICAL COMPUTATIONAL METHODS			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PL – 205	GENERAL Physics LAB. I			100	3
	Seminar/Internal test/Viva-voce/Practical Record	40			
	End semester examination		60		
PL – 206	ELECTRONICS LAB. II			100	3
	Seminar/Internal test/Viva-voce/Practical Record	40			
	End semester examination		60		
PA - 207	Report based on participation in Yoga Classes/ Physical Education/ Study tour arranged by the Department.	100		100	2
PV - 208	Comprehensive viva-voce	100		100	4
			Total	800	24

Note: Students are required to complete one available course of 8-12 weeks “online learning through SWAYAM” during second and / or third semester. They have to submit the pass certificate issued by the course coordinator of that SWAYAM course in the beginning of the fourth semester.

III SEMESTER (July - December 2021)

Note: Each course shall be of 100 Marks out of which 40 marks are allotted to internal assessment and 60 marks for End semester examination. Minimum pass marks are 14 for the internal assessment and 21 for the University End Semester Examination. 25% of the syllabus in each paper shall be covered through ICT.

		Inter-nal	End Sem. Exam	Max. Marks	Credits
PT – 301	QUANTUM MECHANICS AND APPROXIMATIONS			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT – 302	ATOMIC PHYSICS AND MOLECULAR SPECTROSCOPY			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT -303	CONDENSED MATTER PHYSICS			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT – 304	MICROWAVE AND OPTICAL COMMUNICATION			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT – 305	MATERIALS SCIENCE – I			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT – 306	ASSEMBLY LANGUAGE AND Python PROGRAMMING			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PL – 307	GENERAL Physics LAB. I			100	3
	Seminar/Internal test/Viva-voce/Practical Record	40			
	End semester examination		60		
PL – 308	ELECTRONICS LAB. II			100	3
	Seminar/Internal test/Viva-voce/Practical Record	40			
	End semester examination		60		
PL – 309	MATERIAL SCIENCE LABORATORY			100	3
	Seminar/Internal test/Viva-voce/Practical Record	40			
	End semester examination		60		
PL – 310	COMPUTER SCIENCE LABORATORY			100	3
	Seminar/Internal test/Viva-voce/Practical Record	40			
	End semester examination		60		
PA – 311	Assignment on an assigned topic	100		100	2
PV – 312	Comprehensive viva-voce	100		100	4
	Total			800	24

Note: (1) Out of PT-304, PT-305, and PT-306 anyone paper is to be opted by the student. Similarly, out of PL-8, PL-9, and PL-10 only one laboratory experiment / Projects will be issued automatically related to that optional course.

IV SEMESTER (January - June 2022)

Note: Each course shall be of 100 Marks out of which 40 marks are allotted to internal assessment and 60 marks for End semester examination. Minimum pass marks are 14 for the internal assessment and 21 for the University End semester examination. 25% of the syllabus in each paper shall be covered through ICT.

		Inter-nal	End Sem. Exam	Max. Marks	Credits
PT – 401	NUCLEAR PHYSICS			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT – 402	STATISTICAL MECHANICS			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT – 403	INSTRUMENTATION			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT – 404	INTEGRATED ELECTRONICS			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT – 405	MATERIALS SCIENCE – II			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PT – 406	COMPUTER APPLICATIONS IN PHYSICS			100	3
	Internal assessment test/seminar/assignment	40			
	End semester examination		60		
PL – 407	GENERAL LAB/PROJECT			100	3
	Seminar/Internal test/Viva-voce/Practical Record	40			
	End semester examination		60		
PL – 408	ELECTRONICS LABORATORY LECTRONICS LAB. II			100	3
	Seminar/Internal test/Viva-voce/Practical Record	40			
	End semester examination		60		
PL – 409	MATERIAL SCIENCE LABORATORY			100	3
	Seminar/Internal test/Viva-voce/Practical Record	40			
	End semester examination		60		
PL – 410	OMPUTER SCIENCE LABORATORY			100	3
	Seminar/Internal test/Viva-voce/Practical Record	40			
	End semester examination		60		
PA – 411	Report based on participation in Yoga Classes/ Physical Education/ Study tour arranged by the Department.	100		100	2
PV – 412	Comprehensive viva-voce	100		100	4
PS - 413	Online learning through SWAYAM	100		100	4
			Total	900	28

Note: Out of PT-404 to PT-406, only one paper is to be opted by the student in consultation with the physics faculty and corresponding laboratory out of PL408-PL4l0 be allotted automatically to the student.

First Semester (July - December 2020)

PT – 101 METHODS IN MATHEMATICAL PHYSICS

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course Outcomes:

After learning this paper student will be

- *able to define general tensor, state quotient law and Christoffel symbols*
- *able to differentiate a function of complex variable, will be familiar with contour integration, expansion of a complex function and evaluation of residue at a pole*
- *familiar with Fourier and Laplace transformations and their applications*
- *to obtain series solution of differential equation and will be familiar with Legendre and Hermit polynomials*

Unit – I Tensor Analysis

Definition of Tensor and its rank, Transformation laws of covariant, contravariant and mixed tensors, Fundamental Operations with tensors (addition, subtraction and multiplication), Inner and outer product, Contraction of tensors, Associated tensors, Christoffel symbols, covariant differentiation of tensor

Unit – II Elements of Complex Variable

Functions of a complex variable, the derivative and the Cauchy-Riemann differential equations, line integrals of complex functions, Cauchy's integral theorem, Cauchy's integral formula, Taylor's series, Laurent's series, residues; Cauchy's residue theorem, singular points of an analytic function, evaluation of residues, Jordon-Lemma, evaluation of definite integrals,.

Unit – III Theory of Fourier and Laplace Transforms

Fourier series analysis, evaluation of constants, Fourier sine, cosine and complex transforms, transforms of derivatives, Convolution theorem, Parseval's relation, Momentum representation: Examples from optics, Electromagnetism and quantum mechanics, Laplace transforms(LT) of simple function and derivatives, LT and solution of simple differential equations, convolution theorem.

Unit – IV Special Functions

General form of second order homogeneous differential equation: ordinary points, regular and irregular points, the point at infinity; Indicial equation, Series solution of differential equations, Generating functions and recurrence relations, orthogonality and Rodrigue's formula of Legendre, Hermite and Laguerre polynomials, and Bessel functions.

BOOKS RECOMMENDED

1) Applied Mathematics for Engineers and Physicist: Pipes
2) Mathematical Physics: Harper
3) Advanced Engineering Mathematics: Kreyszig
4) Schaum Series for Transforms, Complex Variables and Tensors
5) Mathematical Methods: Arfken
6) Elements of Complex variables: Churchill

PT – 102 CLASSICAL MECHANICS

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course Outcomes:

After learning this paper student will be

- *familiar with the application of Lagrangian formulation*
- *familiar with the variational principle, central force problem, virial theorem*
- *familiar with small oscillations and rotation of rigid body*

Unit – I Lagrangian Mechanics

Mechanics of a particle, Mechanics of a system of particles, Constraints, Generalised coordinates, De Alembert's principle and Lagrangian equations, Lagrangian for a charged partcle in an electromagnetic field, application of Lagrangian formulation for (a) cylinder of radius a rolling down on an inclined plane, (b) Simple pendulum

Unit – II Variational Principle

Hamilton's principle, some techniques of the calculus of variation, application to (a) geodesics in a plane (b) minimum surface of revolution, Derivation of Lagrange's equation from Hamilton's principle. Hamilton function and conservation of energy, canonical transformation, Hamiltons equations, application of Hamiltons equations for hrmonic oscillator

Unit – III Two body central force problem and scattering

Reduction of two body central force problem to the equivalent one body problem, The equation of motion and the first integrals, Classification of orbits, the virial theorem, the Kepler problem, scattering in a central force field, Rutherford scattering, transformation of the scattering problem to laboratory coordinates.

Unit – IV Small oscillations and dynamics of rigid body

Formulation of the problem, the eigen value equation, frequencies of free vibration, free vibration of a linear tri atomic molecule, transition from a discrete to a continuous system, the Lagrangian formulation for continuous system.

Hamilton equations of motion, Hamilton’s equation from variational principle, equation of canonical transformation

BOOKS RECOMMENDED

1. Classical Mechanics: Goldstein.
2. Classical Mechanics: Takwale
3. Classical Mechanics : J C Upaddhya

PT – 103 ELECTROMAGNETISM AND NON-LINEAR OPTICS

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course Outcomes:

After learning this paper student will be

- *familiar with Maxwell's equations and will be able to obtain solutions of various problems with the help of Maxwell's equations .*
- *able to differentiate isotropic and non isotropic mediums.*
- *familiar with the non-linear optics*

Unit – I Application of Maxwell Equations

Maxwell's equation, Field energy, Poynting theorem, plane wave solution of Maxwell's equations, Reflection and Refraction at a plane boundary of dielectrics, Polarization by reflection and total internal reflection, Waves in a conducting medium, Reflection and refraction by the ionosphere.

Unit – II Electromagnetic Waves in Anisotropic Medium

The dielectric tensor of an anisotropic medium, structure of a monochromatic plane wave in an anisotropic medium: The phase velocity and the ray velocity, Geometrical constructions for determining the velocities of propagation and directions of vibrations, optical properties of uniaxial and biaxial crystals: The optical classification of crystals, E.M. wave propagation in uniaxial crystals.

Unit - III Electromagnetic Wave Interactions

E.M. wave propagation in biaxial crystals Refraction in crystals: double refraction, internal and external conical refraction, Acoustic-optic interaction: Raman-Nath theory of ultrasonic diffraction of E.M. waves, magneto-optic interaction: Faraday effect, Linear electro-optic effect, Index ellipsoid of KDP or lithium niobite in an electric field. interaction with matter: normal and anomalous dispersion

Unit -IV Nonlinear Optics

Nonlinear optical media, Second order nonlinear optics, Second harmonic generation, The electro-optics effect, Three-wave mixing, Third order nonlinear optics, Third harmonic generation and self phase modulation, four wave mixing, optical phase conjugation. Raman gain

Books Recommended

1. Introduction of electrodynamics: Griftith
2. Foundation of electromagnetic Theory: Reitz, Millford and Christy.
3. Electromagnetic waves and radiation systems: Jordan and ballman
4. Classical electrodynamics: Jackson
5. Optical Electronics; Ghatak and Tyagarajan
6. Photonics: Saleh and Teich

PT – 104 SEMICONDUCTOR ELECTRONICS

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course Outcomes:

After learning this paper student will be

- able to analyze various electronic circuits.
- Familiar with power amplifier and RC oscillators
- Able to design circuit for a particular wave shape
- Able to understand differential and operational amplifier, and their applications.

Unit-I Biasing Techniques and Linear Amplifier

Continuity equation and its application to p-n junction under forward and reverse bias, Solution of Continuity equation for reversed and forward biased abrupt p-n junctions, Derivation of Einstein's equation, Load line for a transistor, Location of Q-point for the bipolar transistor, variation of bias current, Fixed and emitter feedback bias, , Stability index, Stabilization against variation in I_{CO}, V_{BE} and β (beta), RC coupled CE amplifier, its frequency response and gain frequency plot, Gain band product,

Unit – II Power Amplifier and Oscillators

Operating conditions for power amplifier, power relations, The ideal transformer, voltage limitations of the transformer, non-linear distortion, Idea of inter-modulation distortion, The class A power amplifier, The push-pull amplifier, Feedback requirements of oscillations, Basic oscillator analysis, Hartley and Colpitt oscillators, Piezo-electric and RC oscillators.

Unit – III Wave Shaping Circuits

Introduction to wave shaping, types of wave shaping circuits, Linear and non-linear wave shaping, Clipper circuits(positive, negative and Biased clippers), Two level slicing circuits, Relaxation oscillator, Multivibrator circuits(monostable, Bistable and Astable circuits) and their analysis.

Unit – IV Differential and Operational Amplifiers(ICT Based Unit)

Differential amplifier, Differential amplifier circuit configuration, Dual input balanced output differential amplifier, Voltage gain, differential input resistance, inverting and non-inverting inputs, CMRR, Operational amplifier, input offset voltage, input offset currents, input bias currents, differential input resistance, input capacitance, offset voltage supply, rejection ratio, Ideal OP Amp, equivalent circuit of an OP Amp, ideal voltage transfer curve, inverting, dual and non-inverting amplifier,

BOOKS RECOMMENDED

1. Electronics Fundamentals and Application: J.D. Ryder
2. Solid State Electronic Devices: B.G.Streetman
3. Electronic Principals: Malvino
4. Principals of Microwave: Atwarter
5. Electromagnetic Wave and Radiating System: Jorden and Ballmon
6. Electronic Devices and Circuits: Millman and Halkius

II Semester (January - June 2021)

PT–201 CLASSICAL ELECTRODYNAMICS, PLASMA ANDANTENNAE PHYSICS

Max. Marks: 40 (internal) + 60 (University Examination)

Course outcomes:

After learning this paper student will be

- *Familiar with the terms related to radiation from a single particle.*
- *Familiar with the theory of wave propagation and plasma physics*
- *Able to use different type of antenna for different purposes.*

UNIT - I Dipole Radiation

Maxwell's equations in terms of scalar and vector potential, Gauge transformations: Lorentz gauge and Coulomb gauge, Retarded potentials, Radiation from oscillating electric and magnetic dipoles with simple applications.

UNIT - II Radiation from a Point Charge

Lienard - Wiechart potentials, Fields due to point charge in uniform and accelerated motions, Power radiated by a point charge (in non relativistic limit), Radiation reaction: Abraham Lorentz formula, Physical origin of the radiation reaction.

UNIT - III Plasma physics and Wave Propagation

Definition of plasma, Plasma fusion and confinement by Magnetic mirrors, Kink and Sausage instability, Motion of charged particle in E and B fields, Gravitational field, time varying fields, Phase velocity, Group velocity, Cutoff and resonance for electromagnetic wave propagating parallel and perpendicular to the magnetic field., Idea of fusion reactors

UNIT - IV Antenna Arrays

Two element array, Horizontal pattern in broadcast array, Linear array, Multiplication of patterns, Binomial arrays, Antenna gain, Effective area, Antenna terminal Impedance, Mathematics of linear arrays, antenna synthesis, Tchebyscheff distribution, Idea of super directive arrays, Radiation from current sheet.

Books Recommended:

1. Classical Electrodynamics by J.D. Jakson
2. E.M. Waves and Radiating systems by Jorden and Ballman
3. Introduction to Classical Electrodynamics by Griffth
4. Controlled thermonuclear reaction, by S Glastone
5. Plasma Physics by F F Chen

PT – 202 NONRELATIVISTIC QUANTUM MECHANICS

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *Familiar with the fundamentals of quantum mechanics.*
- *Able to apply quantum mechanics to find solution of problems in 3-D.*
- *Familiar with the matrix formulation of quantum mechanics.*
- *Able to apply approximations to obtain quantum mechanical solutions.*

Unit – I Fundamentals

Correspondence principle, Complementarity Principle, Uncertainty principle, Schrödinger wave equation, Separation of the time dependent wave equation, Eigenfunctions and eigenvalues, Stationary states, Probability density, Normalization of wavefunction, Expectation value of an observable, Ehrenfest's theorem, Free particle solution,

Boundary and Continuity conditions, One-dimensional step potential (finite and infinite), Particle in a one-dimensional square potential well (finite and infinite), The rectangular potential barrier, parity of wave function, Orthonormality, Schmidt orthogonalization, Schwarz inequality, Linear harmonic oscillator. Dynamical variables as operators, Hermitian operators and their properties,

Unit - II Three-dimensional Systems

Particle in a three-dimensional box, The Dirac delta-function, , Central force problem in three dimensions, Separation of the wave equation, Bound states in a three-dimensional square potential well, Solution for *1=0*, Interior and exterior solutions for arbitrary *'l'*, The hydrogen atom wave functions, Energy levels, Degeneracy Energy eigenvalues of a three-dimensional harmonic oscillator, Energy eigenvalues of (a) plane rigid rotator (b) 3-D rigid rotator, Partial wave expansion of a free particle wave function. angular momentum operators, orbital angular momentum, Commutation relations, Eigenfunctions and Eigenvalues of L^2 and L_z

Unit - III Matrix Theory

Hilber Space, Linear Vector Space, dimensions and basis, operators, commutator algebra, derivation of uncertainty relation through operators, postulates of quantum mechanics.

Matrix formulation of quantum theory (representation in discrete basis) – matrix representation of vector and operators, Bra and Ket notations, projection operators, matrix theory of Linear harmonic oscillator, matrices for *a, x, p* and H

Angular momentum: Matrix formulation of angular momentum, matrices for $\mathbf{J}^2$ and $\mathbf{j}_z$, addition of two angular momentum.

Spin-Pauli spin matrices and their algebra.

Unit - IV Approximation Methods

Formulation of variational approximation method, application of variational method: (1) ground state of helium atom, (2) Zero point energy of Simple Harmonic Oscillator. The WKB approximation, Application of WKB approximation: (1) Connection formulas for penetration though a barrier, (2) bound energy levels in a potential well.

Books Recommended:

1. Intro. to quantum mechanics David j Griffith
2. Quantum Mechanics: L.I. Schiff.
3. Quantum Mechanics: J.T. Powell and Crasemann
4. Quantum Mech. & Field Theory By " B. K. Agrawal.
5. Quantum Mechanics A. K. Ghatak & S.Loknathan
6. Intro. to quantum mechanics by *Pauling & Wilson*

PT – 203 BASIC ELEMENTS OF SOLID STATE PHYSICS

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *Familiar with various structures of lattice*
- *Familiar with lattice dynamics and will be Able to calculate thermal parameters.*
- *Able to write equation of states and obtain electron energy bands.*
- *Familiar with the general properties of semiconductors and their types.*

Unit – I Crystal Structure

A review of concepts of space and crystal lattice, Primitive vectors and cells; Symmetry elements, Miller indices for planes and axes, Space groups and point groups, Bragg's law, Construction of reciprocal lattice, reciprocal lattice vectors, Brillion zones, Reciprocal lattice of SC, BCC and FCC, Structure and atomic factors

Unit – II Lattice Dynamics and Thermal Properties

Vibrations of one dimensional monoatomic and diatomic lattices, Quantization of lattice vibrations, Phonon momentum, Qualitative description of phonons in three dimensional lattice, phonon density of states, Einstein and Debye models of lattice specific heat, Anharmonic effects in crystals: thermal expansion of solids, Equation of states of solids, Phonon-phonon interaction and thermal conductivity

Unit – III Electronic Energy Bands

A brief review of properties of free electron gas, Hall effect and quantised Hall effect, The periodic potential, Bloch theorem and Born-von Kramer boundary conditions, Fermi surface, Electron density of states, Kroning-Penny model, Equation for electron wave in a periodic potential: solution of central equation, approximate solution near zone boundary, Construction of Fermi surfaces, The tight binding approximation for bond structure, Orthoganalized Plane-Wave (OPW) method and idea of pseudopotential.

Unit – IV Elements of Semiconductor Physics

Examples of semiconductors, Typical band structure of a semiconductor, Effective mass in solids, Number of carriers in thermal equilibrium, Intrinsic (non-degenerate) semiconductors, Extrinsic semiconductors, Effect of doping, Impurity levels, Population of impurity levels, Fields and carrier densities in equilibrium, p-n junctions, Elementary picture of rectification by p-n junction.

BOOKS RECOMMENDED

1. Introduction to solid state physics: Kittel
2. Solid State Physics: Ashcroff and Mermin
3. An introduction to x-ray crystallography: woolfson
4. Solid state Physics: Azaroff
5. Intermediate quantum theory of crystalline solids: Aniamalu
6. Solid state Physics: Epifanov

PT – 204 NUMERICAL COMPUTATIONAL METHODS

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *Able to define what is numerical solution?*
- *Able to obtain numerical solution of single or a set of linear equations.*
- *Able to calculate the amount of errors involved in numerical calculations.*
- *Able to obtain numerical solutions of integrals and differential equations.*
- *Familiar with least square fit and integrations.*

In this paper, derivation of formula, algorithm for writing program and application will be taught.

Unit – I Numerical Solutions of nonlinear and a set of linear equations.

Concept of numerical solution, Numerical solutions of Transcendental equations: Iterative method, Bisection method, False Position and Newton Raphson method; Numerical solutions of simultaneous linear equations: Gauss Elimination and Gauss Seidel method,

Unit – II Least Square Fits and Error Analysis

Concept of best fit and least square fit. Linear regression of a function (based on the least Square fit) related to one variable, Linear regression based on two variable. Non-linear regression: Polynomial fit, exponential function fit; Error analysis: Basic concepts of errors and their types with special reference to numerical methods

Unit – III Interpolation, Numerical Integration

Introduction to interpolation, equally spaced argument data and unequally spaced argument data; Forward, Backward and Central difference operators and their symbolic relation with shift operator, forward difference table, Newton 's forward and backward interpolation, Gauss central difference interpolation formula, Lagrange interpolation formula. Numerical solution of integrals: Trapezoidal formula and Simpson 1/3 rule

Unit – IV Numerical Solution of Differential Equations

Ordinary differential equation, solution of ordinary differential equation: Picard's method, Euler method, second orders Runge-Kutta method, fourth order Runge-Kutta method. Numerical solution of second order differential equation with reference to Schrodinger equation.

BOOKS RECOMMENDED

1. Numerical Computational methods by Patil and Verma
2. Numerical Analysis: Rajaraman
3. Computer programming by S.S. Sastri
5. Numerical methods : Balaguruswami

III SEMESTER (July - December 2021)

PT – 301 QUANTUM MECHANICS AND APPROXIMATIONS

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *Able to apply approximation methods to find quantum mechanical solution.*
- *Familiar with the problems related to identical particles in energy calculations*
- *Familiar with theory of scattering*
- *Able to apply relativistic quantum mechanics to solve problems.*

Unit- I Approximation methods

Formulation of first order time independent perturbation theory for degenerate levels, Application to First order Stark effect in hydrogen like atoms, Fine structure splitting of atomic energy levels, Zeeman effect with and without electron spin.

Time dependent perturbation theory, first order transition probability, constant perturbation, harmonic perturbation, Fermi Golden Rules, Atom in a radiation field, Einstein's *A* and *B* coefficients, Plane electromagnetic waves, Electric dipole transitions, selection rules.

Unit - II Identical Particles

Indistinguishabelity, Exchange degeneracy, Symmetric and antisymmetric wlave functions for many particle systems, Spin and statistics, Computation of interaction energy for two-particle systems, Exchange interaction, Application to ground state of a helium-like atom, Structure of wave function lor excited states of a helium-like atom, Pauli exclusion principle (qualitative), Collisions of identical particles Allowed states of 2-particle systems.

Unit - III Scattering theory

Scattering cross section, Laboratory and center-of-mass coordinate systems, Transformation of variables from one system to another, Asymptotic behaviour, Scattering by spherically symmetric potentials, Partial waves and phase shifts, Partial wave expansion of differential cross section, Total cross section, Ramsauer – Townsend effect Scattering by a perfectly rigid sphere, Scattering *by* a square potential well, Green's functions in scattering theory, Born approximation, Application to scattering by (i) a square potential well (ii) Yukawa potential, Hypergeometric functions, Scattering in a Coulomb field (separation in parabolic coordinates), Rutherford formula.

Unit - IV Elements of relativistic quantum mechanics

Klein - Gordon equation, Free particle solutions, Dirac equation for a free particle, Free particle solution, Negative energy, Hole theory, Reduction of Dirac equation into covariant form, Gamma matrices and their algebra, Existence of spin, Electromagnetic potentials in Dirac equation, Existence of magnetic moment.

Books Recommended:

1. Quantum Mechanics: L.I. Schiff
2. Quanrum Mechanics: J.L. Powell and Crasmann
3. Introduction to Quantum Mechanics: Pauling and Wilson
4. Quantum Mechanics and Field Theon: B. K Agrawal
5. Quantum Mechanics: A.K Ghatak and S. Loknathan
6. The Principles of Quantum Mechanics: Dirac.
7. Practical Quantum Mechanics: Flugge.

PT – 302 ATOMIC PHYSICS AND MOLECULAR SPECTROSCOPY

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *Able to draw energy levels for atoms.*
- *Familiar with various types of electron coupling in atoms*
- *Familiar with interaction of electromagnetic radiation with matter.*
- *Able to differentiate between rotational, vibrational and ro-vib spectra.*

Unit – I Atomic Physics I

Quantum states of one electron atom, atomic orbitals, Hydrogen spectrum, spectra of alkali elements, spin orbit (l-s) interaction and fine structure of alkali spectra, normal and anomalous Zeeman effect, Paschen back effect, Stark effect; two electron system, equivalent and non equivalent electrons, Pauli's exclusion principle, interaction energy, L-S and J-J coupling, Hyperfine structure, line broadening mechanisms.

Unit – II Atomic Physics II

Ionization of matter by charge particles, interaction of electromagnetic radiation with matter, stopping power and range, photo electric effect, Compton effect and pair production, radiation detection, gas filled counters, solid state counters, scintillation counter, photomultiplier tube, Cerenkov detector, nuclear emulsions, Betatron, electron synchrotron and proton synchrotron.

Unit III Rotational Spectra

Type of molecules: Linear, non-linear, symmetric top, asymmetric top, spherical top; rotational spectra of diatomic molecules as a rigid rotator, energy level diagram and spectra, rotational spectra of non rigid rotator, energy level diagram and spectra, intensity of rotational lines, applications of rotational spectra and pure rotational Raman spectra.

Unit – IV Vibrational and Vibrational-rotational Spectra

Vibrational energy of diatomic molecules, diatomic molecule as a simple oscillator, its energy level diagram and spectrum, Morse potential energy curve, molecules as vibrating rotator, vibration spectrum of diatomic molecules, PQR branches, infrared spectrometry, vibrational Raman spectroscopy, structure determination from Raman and IR spectroscopy.

BOOKS RECOMMENDED

1. Introducttion to Atomic Physics: H.E.White
2. Fundamentals of Molecular spectroscopy: C.N.Banwell and E.M.McCash
3. Spectra of diatomic molecules: Herzberg
4. Spectroscopy Vol.I&II: Walker and Straughen
5. Nuclear Physics: Kaplan

PT – 303 CONDENSED MATTER PHYSICS – II

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *Familiar with point defects in alloys.*
- *Familiar with magnetic properties of solids.*
- *Able to realize superconductivity in solids.*

Unit – I Point Defects and Alloys

Lattice vacancies, Interstials and their thermodynamical calculations, Features of point defects, Color centres, Formation of alloys, Order-disorder transformation, Elementary theory of order

Unit – II Dielectric and Ferroelectric

Static polarization: various types of polarization, Local fields, Clausius-Mossotti relation, Time dependent polarization and dielectric relation, Lyddane-Sachs-Teller relation, Ferroelectric crystals, Classification of ferroelectric crystals, polarization catastrophe, First and second order phase transitions, Idea of antiferroelectricity, Piezo-electricity and ferroelectricity

Unit – III Magnetic Properties of Solids

Quantum theory of paramagnetism, Electrostatic origins of magnetic interactions. Singlet and triplet states and idea of calculation of singlet-triplet splitting. Exchange integral and Heissenberg interaction, derivation of the Spin or Heisenberg Hamiltonian. Ground state of the Heisenberg Ferromagnet and Spin Waves, Magnon dispersion relation. Idea of Antiferromagnetic and Ferrimagnetic orders, Anisotropy energy, Bloch Walls, Idea of ferrites

Unit – IV Superconductivity

Concept of superconducting state, Thermodynamical properties of superconductors, London's equation and penetration depths, Magnetic properties and critical magnetic fields, Meissner effect, Flux quantization, Coherence length, Ginzburg-Landau theory, elements of BCS theory of superconductivity, Isotpe effect, DC and AC Josephson tunneling. Description and working of SQUID. A qualitative description of high Tc superconductivity in ceramic oxides.

BOOKS RECOMMENDED

1. Introduction to solid state physics: Kittel
2. Solid state Physics: Ashcroft and Marmin
3. Solid State Physics: Epifanov
4. Introduction to superconductivity: Kuper
5. Intermediate quantum theory of crystalline solids: Animalu
6. Solid state Physics: Zimam

PT – 304 MICROWAVE AND OPTICAL COMMUNICATION

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *Familiar with microwave generation and propagation.*
- *Familiar with different modes of propagation and microstrip line*
- *Able to learn about optical fibers and integrated electronics.*

Unit – I Microwave Generators and Solid State Devices

Transit time effect at high frequency, failure of triodes/diodes at high frequency, concept of velocity modulation and current modulation, Klystron, Operation and characteristic, Reflex Klystron, Magnetron, Principle of operation and microwave characteristics of Gunn diode and Impatt diode

Unit – II Microwave Propagation , Components and microstrip line

Wave propagation in circular wave-guide, TE and TM modes in circular wave guides, TEM modes in circular wave guides, Cavity resonators, Wave-guide Tee's (Magic Tee), S-parameters, strip type transmission lines, symmetric strip transmission line, asymmetric transmission line

Unit – III Optical Fibres

Basic optical laws and definitions, Optical fibre modes and configuration, Modal theory for circular waveguides, Solution of wave equation for step-index optical fibres, Power flow in step index fibres, Graded index fibres, WKJ analysis of the graded index fibres. Propagation constants, wave number diagrams and graphical analysis and derivation of expression for number of propagating modes in graded index fibres

Unit – IV Integrated optics

Idea of modes in asymmetric planer wave guide, Strip waveguide, Phase modulators,Mach-Zehnder interferometer and modulator, Optical directional couplers, PIN diode photodetectors, Avalanche photodiode detectors, Idea of optical fibre communication system

BOOKS RECOMMENDED

1. Microwave devices and circuits: Lio.
2. Microwave: Atwarter.
3. Microwave Engineering: Rizzi.
4. Optical fibre communication: Kaiser.
5. Optical electronics: Ghatak.
6. An introduction to optical fibres : Cherian.

PT – 305 MATERIALS SCIENCE – I

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *Able to classify materials in different categories*
- *Able to realize the concept of phase transition in materials.*
- *Familiar with the laws of diffusion in materials*
- *Familiar with the elastic and inelastic properties of materials..*

Unit - I Classification of Materials

Types of materials: Crystalline, Polycrystalline, Amorphous (Introduction and their structure), Elementary idea of polymers (structure and properties) methods of polymerization, Glasses: Structure and properties, Type of Glasses, Fracture in glasses, Composite Materials: Introduction, their types and properties, Different types of bonding, Medalung energy for ionic crystal.

Unit - II Phase Transitions

Thermodynamics of phase transformation, Free-energy calculation, I and II order transformation, Hume-Rothery rule, solid solution and types of solid solutions, Phase rule, One-, Two- component systems, Eutectic and peritectic phase diagrams, Lever rule, Phase diagrams of Mg-Al, Fe-C Kinetics of transformation, Homogeneous and heterogeneous nucleation, Growth kinetics.

Unit - III Diffusion in Materials and Microscopy

Mechanism of diffusion, Energy of formation and motion, long distance motion, Rate theory of diffusion, Einstein relation (relation between diffusivity and mobility), Fick's laws of diffusion and solution of Fick's second law, Kirkendal effect, Experimental determination of Diffusion coefficient.

Unit - IV Elastic and inelastic Behaviour

Atomic models for elastic behaviour, Elastic deformation in single crystals, Elastic anisotropy, Elastic constant and elastic moduli (Cubic system, isotropic body), Rubber like elasticity, inelastic behaviour, Thermo-elastic effect and relaxation process, Idea of viscoelastic behaviour (Spring-Dashpot model), Determination of elastic constant of cubic crystals by ultrasonic wave propagation

BOOKS RECOMMENDED

1. Materials and Engineering. Raghavan
2. Introduction to Solids Wert and Thomson
3. Introduction to solids. L.V. Azaroff
4. Diffusion kinetics for atoms in crystals: Manning
5. Elements of Solid State Physics - Ali Omar.

PT – 306 ASSEMBLY LANGUAGE AND Python PROGRAMMING

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *Able to understand elementary devices used in computer.*
- *Able to differentiate between low level language and high level languages used in computer*
- *Able to write program in assembly language.*
- *Able to write programme in Python to solve various physics problems.*

Unit – I Introduction to Computer Systems Organization, Machine representation of numbers and characters

Components of a Computer System (Processor, Memory, Input/ Output), Introduction to number systems, Number systems conversion, Representation of binary numbers, Binary arithmetic, Boolean algebra. Truth tables, Canonical forms and switching equations, Simplification approaches. Examples: decoders, encoder, multiplexers, adders, etc., Memory devices (Flip-flops, registers etc.); Synchronous Sequential Circuits, Design of Random Access Memory; ROM, PROM and EPROM

Unit – II Concept of Assembly Language, mnemonics and programming

Concept of machine language, Assembly language and assembler, Instruction set of 8085, Op-codes, Mnemonics, Instruction and data format, Addressing modes, Instruction set: data transfer group, arithmetic group, logical group, branch group and stack, I/O and machine control group. Programs based on above statements, addition and multiplication of eight bit numbers and sixteen bit numbers.

Unit – III Introduction to Python programming

How to begin with Python, standard syntax, case sensitivity, output and input statements, defining class, declaring variables, keywords, method, control statements : if, if-else-if, for loop; iteration statements: while, do—while, scope and life time of variable, operators, ; break, continuous and return statements, introduction to constructors,

Unit – IV Python programming for numerical computational methods

Solutions of transcendental equations: Bi-section method and Newton's Raphson Method.
Solutions of a set of linear equations: Gauss elimination method.
Forward and backward interpolation methods: Newton's and Gauss central methods.
Numerical integrations: Trapezoidal formula, Simpson's rule and Monte Carlo method.
Solution of differential equations: Runge-Kutta method

BOOKS RECOMMENDED

1. Microprocessor programming kit manual
2. Introduction to Microprocessor by Mathur
3. Numerical computational method by Patil and Verma
4. Java-the complete reference by Herbert Schildt
5. Intel 8080/8085 assembly language programming manual

IV SEMESTER (January - June 2022)

PT – 401 NUCLEAR PHYSICS

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *Familiar with two body problems with examples from nuclear physics.*
- *Familiar with different nuclear models and their applications.*
- *familiar with nuclear reactions.*

Unit –I Two body Problems

Binding energies and the Saturation of nuclear forces, Charge independence of nuclear force, The ground state of the deuteron (central forces), Comparison with experimental data on deuteron, Spin dependence of nuclear force, Tensor force, Neutron-proton scattering at low energies (below 10MeV), Cross-section, Laboratory and center of mass coordinate systems, Scattering length, Spin dependence of nuclear force, Singlet and triplet potentials, Effect of chemical binding, Coherent scattering of neutrons by protons (scattering by ortho- and para-hydrogen), Proton-Proton scattering at low energies (elementary theory), Exchange forces (elementary Yukawa theory).

Unit –II Nuclear Models

Liquid drop model, Semi empirical mass formula, Isobaric mass parabolae, Nuclear fission, The mass and energy distributions of the fission products, The energy release in fission, Application of liquid drop model to fission, Magic numbers, Single particle model of the nucleus, Spin-orbit coupling, Application to prediction of spin and magnetic moments (Schmidt values).

Unit - III Nuclear Decay

Beta particle spectra, The continuous spectrum, Neutrino hypothesis, Fermi theory of beta-decay (non-relativistic), Kurie plots, Comparative half lives, Allowed and forbidden transitions, Selection rules, Symmetry laws and the non-conservation of parity in beta-decay, Gamma transitions, Multipole moments (mathematical results of theory to be assumed), Selection rules, Internal conversion (qualitative only), Nuclear isomerism

Unit - IV Nuclear Reactions

Conservation laws for nuclear reactions, Q-value, The compound nucleus, Independence hypothesis, Resonances, Single level Breit-Wigner formula, Direct reaction (introductory ideas about stripping and pick-up reactions),

Books Recommended:

1. Nuclear physics: Kaplan
2. Nuclear physics: Enge
3. Nuclear physics: Evans
4. Nuclear physics: Blatt and Wisskopf

PT – 402 STATISTICAL MECHANICS

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *Familiar with micro-canonical, canonical and grand canonical ensembles.*
- *Familiar with the application of above concept to solve problems.*
- *familiar with the fluctuations in ensembles.*

Unit – I Micro canonical Ensemble

Concept of phase spaces, Liouville's theorem, Concept of Gibb's ensembles: micro canonical ensemble, canonical and grand canonical ensembles, Thermo-dynamical potential functions and their relations, Partition function of micro-canonical ensembles and its application to (a) classical ideal gas (b) Gibb's paradox, Sackur Tetrode equation.

Unit – II Canonical Ensemble

Canonical ensemble, Maxwell Boltzmann distribution, Maxwell's distribution of velocities and speeds, Boltzmann energy equipartition theorem, Rotational and vibrational partition function, Their application to diatomic molecules.

Unit – III Grand Canonical Ensemble

Grand canonical partition function, Derivation of Bose Einstein statistics, Weak and strong degeneracy, Applications of Bose Einstein statistics to Bose Einstein condensation and phase transition, Thermo-dynamical properties of an ideal Bose Einstein gas, Liquid helium and its properties, Two fluid model for liquid helium .

Grand canonical partition function and derivation of Fermi Dirac statistics (FD), FD degeneracy of electron gas in metals,

Unit – IV Fluctuations

Elementary discussion of fluctuations, Fluctuations in ensembles: (Microcanonical, canonical, grand canonical), One-dimensional random walk problem, Brownian motion, Electrical noise: (Nyquist theorem).

BOOKS RECOMMENDED

1. Statistical Mechanics: ESR Gopal
2. Statistical Mechanics: Huang
3. Statistical Mechanics: Mendle

PT – 403 INSTRUMENTATION

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *Familiar with different devices used in temperature measurement.*
- *Familiar with the methods of crystal growth and characterization*
- *familiar with the instruments used in biomedical.*
- *familiar with the high resolution spectroscopy.*

Unit – I Measurement of Temperature

Temperature scales, mechanical temperature sensors, liquid filled sensors, platinum resistance thermometer, principle and construction of resistance thermometer circuits, thermistors and its measuring circuits, thermocouple and its circuits, solid state sensors, temperature measurement by radiation methods, optical pyrometers.

Unit – II X-Rays and Crystal Growth Techniques

X-ray spectrum, X-ray generating equipment, monochromators, powder and single crystal diffractometer, X-ray absorption meter, basic properties and uses of ESCA,
Theories of crystal growth, Growth of Single crystals from melt, Czocharlski method, Concept of annealing and quenching, Thin film deposition, Vacuum evaporation and chemical vapour deposition

Unit – III Elements of high-resolution spectroscopy

Principles of Mossbauer spectroscopy, applications of Mossbauer spectroscopy: chemical shift, quadrupole effects, effect of magnetic field; spin resonance spectroscopy: nature of spinning particles, interaction between spin and magnetic field, Larmor precession; introduction to magnetic resonance spectroscopy and its applications.

Unit – IV Biomedical Instrumentation (ICT based Unit)

Electrocardiography, ECG amplifiers, electrodes and leads, ECG recorder principles, types of ECG recorders, measurement of blood flow, magnetic blood flow recorder, ultrasonic blood flow meter, principles of ultrasonic measurement, ultrasonic imaging

BOOKS RECOMMENDED:

1. Instrumentation devices and systems: G.S.Rangan et al
2. Handbook of X-ray: Kelbel
3. Biomedical Instrumentation: L.Cromwell et al

PT – 404 INTEGRATED ELECTRONICS

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *Able to identify materials for integrated circuits.*
- *Familiar with the technology used in Integrated circuit fabrication.*
- *familiar with the instruments and methods used in preparing thin films.*
- *familiar with the fabrication technology related to the electronic devices.*

Unit – I Materials for Integrated Circuits

Electronic grade Silicon, Purification of metallurgical grade Silicon, Float zone crystal growing method, Czochralski method, Silicon lapping and polishing and Wafer preparation, Vapor phase epitaxy, Liquid phase epitaxy, Oxidation: thermal, dry and wet, Plasma oxidation.

Unit - II Integrated circuit fabrication technology

Optical lithography, photo mask, photo resist and process of lithography, idea of electron beam and X-ray lithography, Fabrication of monolithic diodes, fabrication of integrated transistors, Idea of buried layer, fabrication, Monolithic circuit layout design rules, isolation method, Monolithic FET, MOS FET processing, advantages and limitations of MOS devices.

Unit - III Growth of Thin Films

Evaporation theory, physical vapour deposition method, design construction of high vacuum coating unit, flash electron beam evaporation system, idea of DC sputtering system, idea of thick film circuits.

Unit - IV Diffusion and Ion Implantation

Doping by diffusion, Idea of diffusion profile, Error function and Gaussian profile methods, Ion implantation, advantages and disadvantages of ion implantation, Neutron doping, Basic monolithic integrated circuit, Fabrication of integrated and thin film resistor and capacitors: their equivalent circuits, Integrated inductor.

Books Recommended:

1. Fundamentals of Electronics: Millman and Halkias
2. Fundamentals of Electronics. Botkar

PT – 405 MATERIALS SCIENCE – II

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *well acquaintance with dislocations in materials and plastic deformation.*
- *able to obtain results related to the transport properties of solids. .*
- *familiar with the electronic properties of materials in magnetic field*
- *familiar with the many electrons problem related to solids.*

Unit – I Dislocation and Plastic Deformation of Materials

Concept of dislocation, Dislocation of Movement, Stress field and strain energy of a dislocation, Forces on dislocation and between dislocations, Homogeneous nucleation of dislocations, Typical tensile stress-strain curve, Strength of a material, Work hardening by impurity atoms, yield drops, Shear strength of perfect and real solids, Creeps and their mechanism, Toughness, Fatigue, Methods of observing dislocations (their introduction, merits and demerits).

Unit – II Transport Properties of Solids

Electrical conductivity of metals and alloys, Extrinsic, intrinsic semiconductors and amorphous semiconductors, Scattering of electrons by phonons, impurity, etc, Relaxation time, Carrier mobility and its temperature dependence, Mathiesson's rule for resistivity, temperature dependence of metallic resistivity.

Unit- III Degradation of materials, electronic properties in magnetic field

Mechanism of oxidation, Oxidation-resistant materials, Corrosion and protection against it. Experimental methods in Fermi surface studies. Classical theory of magneto-conductivity, Cyclotron resonance, k-space analysis of motion in uniform magnetic field, de Hass von Alphon effect, Ultrasonic attenuation and skin effect.

Unit-IV Many Electron Problem in Solids

Interacting electron gas; concept of many electron system, Thomas-Fremi Theory, Hartree and Hartree-Fock approximation. Application of HF theory to free electrons, Correlation energy, Lindhardt theory and Thomas-Fermi theory of screening, Plasma oscillations in free electron gas, Dielectric function of an electron gas in random phase approximation, strongly interacting Fermi system, Idea of Landau's quasi-particle theory of Fermi liquid, Interaction of electron with acoustic and optical phonon, Polarons,

BOOKS RECOMMENDED

1. Introduction to Dislocations: Hull
2. Material Science and Engineering: Raghwan
3. Solid Slate Physics: Ashcroft and Mormin
4. Introduction to Solid Slate Physics - Kittel
5. Introduction to Superconductivity - Roseinnes and Rhodrick
6. Quantum theory of Solids -Kittel
7. Theoretical Solid State Physic - Huang.

PT – 406 COMPUTER APPLICATIONS IN PHYSICS I

Max. Marks: 40 (internal) + 60 (University Examination)
Pass Marks: 14 (internal) + 21 (University Examination)

Course outcomes:

After learning this paper student will be

- *well acquaintance with raster and random scan graphics.*
- *Able to view 2-D graphics output from different angles.*
- *familiar with the 3-D graphics.*
- *Able to write program to implement different computational technique.*

Unit – I Raster and random scan graphics

Types of graphic devices, difference between random and raster scan graphics; display technology- cathode ray displays, flat screen displays, raster coordinate system, display of line on raster/random scan, display of natural modes, Cell encoding, Frame buffers, Raster addressing, Line and character display,

Unit – II Computer Graphics in 2-D and 2-D Transformation

DDA Line drawing Algorithms, Bresenham's line drawing algorithms, Bresenham's circle drawing algorithm, Transformation of points, Lines and objects, Homogeneous coordinate systems and transformation matrices for various operations, Sequential transformations, Viewport planning, Window clipping, Window to Viewport mapping, Physical device coordinates, Zooming

Unit – III Computer Graphics in 3-D and 3-D Transformation

3-D transformations: Translational, Rotational and Scaling; Clipping in three-dimension,
3-D viewing transformation, 3-D drawing: direct projection, quadratic surfaces, removing hidden surfaces, drawing a cube and a sphere

Unit – IV Simulation Programms with graphics display

Knowledge about inputs, formula to be used and outputs related to following problems for writing computer programs: Results may be displayed in the form of table or plots:

(1) Curve fitting over a set of data- (Least square fit/ Spline function/, Bezier curves)
(2) Charging of capacitor through resister.
(3) Discharging of capacitor through resister.
(4) Showing resonance in LC circuit.
(5) Application of trapezoidal formula and Simpson's 1/3 rule.
(6) Numerical solution to simultaneous set of linear equations using
    (i) Gauss elimination method.
    (ii) Gauss Seidel method.
(7) Numerical solution of Schrodinger equation for
    (i) 1-D Potential well problem
    (ii) Interaction between two charged particles
    (iii)Simple harmonic oscillator)

BOOKS RECOMMENDED

1. Computer graphics by S.Harrington
2. Computer graphics by D.Hearn and P.M.Baker
3. Procedural elements for computer graphics by D.F.Rogers
4. Numerical Computational methods by Patil and Verma
5. Computer graphics by Newman
6. Computer graphics by Asthana and Sinha