Programme Code:	M.Sc. PHY			**Programme Title:**	Master of Physics	
Course Code:	23PPS101			**Title**	**Batch:**	2023– 2025
				Core I: Mathematical Physics	**Semester:**	I
Lecture Hrs./Week or Practical Hrs./Week	5	**Tutorial Hrs./Sem.**	-		**Credits:**	4

Units	Content	Hrs
Unit I	**SPECIAL FUNCTIONS** Legendre differential equations and Legendre functions - Generating function of Legendre polynomial - Orthogonal properties of Legendre's polynomials - Recurrence formulae for Pn(x) - Bessel's differential equations: Bessel's functions of first kind - To solve J1/2(x), J-1/2(x), J3/2(x) and J-3/2(x) - Recurrence formulae for Jn(x) - Generating function of Jn(x) - Hermite differential equation & Hermite polynomials - Generating function of Hermite polynomials - Recurrence formulae for Hermite polynomials	13
Unit II	**COMPLEX VARIABLES** Analytic function: definition – The necessary and sufficient conditions for f(z) to be analytic: Cauchy Riemann Differential equations in polar form – Cauchy's integral theorem(Cauchy proof only) - Cauchy's integral formula - Taylor's series and Laurent's series - Singularities of an analytic function - Residues and their evaluation - Cauchy Residue theorem - Evaluation of definite integrals of certain important real integrals	13
Unit III	**LAPLACE & WAVE EQUATIONS** Solution of Laplace's equation in Cartesian coordinates - Examples of Two dimensional steady flow of heat - Solution of Laplace's equation in two dimensional cylindrical coordinates – Problems - Solution of Laplace's equation in Spherical polar coordinates – Problems – Diffusion equation or Fourier equation of heat flow - Solution of heat flow equation –Variable linear flow- Problems	13
Unit IV	**FOURIER INTEGRAL AND TRANSFORMATIONS** Fourier Integral– Fourier's Transform: Infinite Fourier sine and cosine transforms - Properties of Fourier's Transform: Addition theorem, Similarity theorem, Shifting property, Modulation theorem- Convolution theorem and Parseval's theorem – Problems – Finite Fourier sine and cosine transforms - Problems – Simple application of Fourier transform: Evaluation of integrals	13
Unit V	**TENSORS, BETA AND GAMMA FUNCTIONS** n- dimensional space- Superscripts and Subscripts- Transformation of co-ordinates – Indicial convention- Summation convention – Dummy and real indices -Kronecker delta symbol -Generalised Kronecker delta - Scalars,contravariant and covariant vectors- Tensors of higher ranks - Algebraic operations oftensors – Quotient law - Symmetric and skew symmetric tensors - Beta and Gamma functions: Symmetry property of beta function – Evaluation of beta function – Transformation of beta function - Evaluation of Gamma function - Transformation of Gamma function – Relation between beta and gamma function.	13
	Total Contact Hrs	**65**

ProgrammeCode:	M.Sc.PHY			**Programme Title:**	MasterofPhysics	
CourseCode:	23PPS102			**Title**	**Batch:**	2023– 2025
				Core II: Classical Mechanics	**Semester:**	I
LectureHrs./Week **PracticalHrs./Week**	5	**TutorialHrs./Sem.**	-		**Credits:**	4

Units	Content	Hrs
Unit I	**LAGRANGIAN FORMALISM** Constraints and Degrees of freedom - Generalized coordinates: Generalized Displacement, Velocity, Acceleration, Momentum, Force & Potential - Variational techniques and Euler's Lagrange differential equation - Hamilton's Variational principle - Lagrange's equation of motion from Hamilton's principle - Deduction of Newton's second law of motion from Hamilton's principle - Applications of Lagrange's equation of motion**:** Linear harmonic oscillator - Simple pendulum - Isotropic oscillator – Particle moving under central force - *Conservation theorems: Cyclic coordinates - Conservation of Linear momentum - Conservation of energy*	13
Unit II	**HAMILTONIAN FORMALISM** Phase space - Hamiltonian - Hamilton's canonical equation of motion -Significance of H - Deduction of canonical equation from Variational principle -Applications of Hamilton's equation of motion**:** Simple pendulum - Particle in a central field of force – Hamiltonian of a Charged particle in an electromagnetic field - Principle of least action and proof - Canonical transformations - Generating function and different forms – Poisson brackets**:** Definition - Equation of motion in Poisson bracket form - Angular momentum and Poisson bracket relations	13
Unit III	**HAMILTON JACOBI THEORY** Hamilton Jacobi method**:** H J partial differential equation - Solution of H J equation – Discussion on Hamilton's principle function - Solution of harmonic oscillator problem by H J method - Particle falling freely - H J equation for Hamilton's characteristic function - Kepler's problem solution by H J method - Action and Angle variables – Solution of harmonic oscillator problem by action angle variable method	13
UnitIV	**RIGID BODY DYNAMICS** Generalisedco ordinates for rigid body motion – Euler's theorem – Euler's angles - Rotational kinetic energy of a rigid body - Equations of motion for a rigid body_ Euler's equations : Lagrange's method – Equation of motion about fixed axis - The motion ofsymmetric top under the action of gravity- Force free motion of symmetrical rigid body.	13
Unit V	**MECHANICS OF SMALL OSCILLATIONS** Stable & Unstable equilibrium –Two coupled oscillators-Formulation of the problem : Lagrange's equations for small oscillations - Properties of T,V and ω - Normal coordinates & normal frequencies of vibration - Systems with few degrees of freedom : Free vibrations of linear triatomic molecule	13
	TotalContactHrs	**65**

Programme Code:	M.Sc. PHY			**Programme Title:**	Master of Physics	
Course Code:	23PPS103			**Title**	**Batch:**	2023– 2025
				Core III: Statistical Mechanics	**Semester:**	I
Lecture Hrs./Week or Practical Hrs./Week	5	**Tutorial Hrs./Sem.**	-		**Credits:**	4

Units	Content	Hrs
Unit I	**CONCEPTS OF STATISTICAL MECHANICS** Phase space – Number of phase cells in given energy range of harmonic oscillator and three dimensional free particle - Volume in Phase space – Ensembles – Micro, Canonical ensemble – Canonical ensemble – Grand canonical – ensemble – Uses of ensemble – Liouvilles theorem - Postulate of equal a priori probability – Statistical equilibrium – Thermal equilibrium - Mechanical equilibrium – Particle equilibrium – Thermo dynamical quantities : entropy – enthalpy – Helmholtz free energy – Gibb's free energy - Chemical potential - Connection between statistical and thermo dynamical quantities	13
Unit II	**CLASSICAL STATISTICS** Microstates and Macro states – Division of phase space into cells - Classical Maxwell Boltzmann distribution law – Most probable speed , Mean speed , Mean square speed , Root mean square speed - Principle of equipartition energy – Gibbs paradox – Partition function and its correlation with thermodynamic quantities. Partition function and their properties, effect of shifting zero level of energy on partition function, mean energy, specific heat, entropy -comparison of ensemble – *Equipartition theorem from canonical distribution*	13
Unit III	**QUANTUM STATISTICS** Transition from classical statistical Mechanics to Quantum Statistical Mechanics – Indistinguishability in quantum statistics – Statistical weight or a priori probability – Matrices – The density matrix – Postulates – Condition for statistical equilibrium – Identical particles and symmetry requirement – Bose - Einstein distribution law – Fermi – Dirac distribution law - Maxwell Boltzmann statistics - Evaluation of Constant α & β - Results of all three statistics	13
Unit IV	**APPLICATION OF QUANTUM STATISTICS** Photon gas - Black body radiation and Planck radiation – Specific heat of solids – Einstein theory – Debye theory – Bose Einstein condensation – Liquid Helium - Electron Gas – Free electron model and electronic emission – Pauli's theory of Para magnetism – *White dwarfs*	13

Unit V	**TRANSPORT PROPERTIES** Brownian movement – Onsager solutions – Fluctuations : Energy, Pressure volume, enthalpy – phase transition – First and second order phase transitions - Ising model – Bragg William approximation – One dimensional Ising model	13
	Total Contact Hrs	**65**

Programme Code:	M.Sc. PHY			**Programme Title:**	Master of Science	
Course Code:	23PPS204			**Title**	**Batch:**	2023 – 2025
				Core IV: Quantum Mechanics I	**Semester:**	II
Lecture Hrs./Week	5	**Tutorial Hrs./Sem.**			**Credits:**	4

Units	Content	Hrs
Unit I	**BASIC AND GENERAL FORMALISM OF QUANTUM MECHANICS** Schrodinger Equation: Generalization to three dimension, operator correspondence - Max Born physical interpretation of the wave function - Conservation of probability- Ehrenfest theorem - Linear vector space: linear vector space - basis function - Hilbert space - Eigen function and Eigen values - Self Adjoint operator (Hilbert Space) Schwartz inequality - Operators and Linear operator - Completeness and Normalization of eigenfunctions - Gram Schmidt orthogonalisation procedure - Postulates of Quantum mechanics - Matrix representation of an operator - Column representation of wave function - Normalization and orthogonality of wave function in Matrix form - Change of basis, Similarity and Unitary transformation - Dirac's Notation- Equations of Motion; Schrodinger, Heisenberg and Dirac representation-Equationsofmotion-Schrodinger,HeisenbergandDirac representation.	13
Unit II	**APPLICATIONS OF SCHRODINGER EQUATION TO THREE DIMENSIONAL PROBLEMS** Schrödinger's equation in Cartesian and polar coordinates - Particle moving in a spherically symmetric potential - Equations and Solutions of φ, θ and R - The rigid rotator with free axis -Eigen function for the rotator - Rigid rotator in a fixed plane - Motion of a particle in a three dimensional square well Potential - Three dimensional harmonic oscillator - The hydrogen atom: Equations andSolutions of φ, θ and R.	13
Unit III	**ANGULAR MOMENTUM AND IDENTICAL PARTICLES** Algebra of the angular momentum vector components - Ladder operators - Eigen value spectrum and Matrix representation - Angular momentum operator- Addition of two angular momenta and CG coefficients - Application to two electron systems - Parity operator, Symmetric and Antisymmetric wave functions for a system of nidentical particles - *Pauli's exclusion principle.*	13
Unit IV	**TIME INDEPENDENT PERTURBATION THEORY** Perturbation theory for a system with Non-degenerate energy Levels - effect of electric field on the ground state of Hydrogen (Stark effects in Hydrogen) - *Ground state of Helium* - Degenerate energy levels - Effect of electric field on n = 2 state of Hydrogen - Variation method - The Hellmann Feynman theorem - Estimation of Ground state of Helium - WKB approximation - Connection Formula -Validity -*Alpha emission.*	13
Unit V	**SCATTERING THEORY**	13

	Scattering amplitude and scattering cross section - Integral equation in terms of Green's function - Born approximation and its validity - Application to screened coulomb potential - Partial wave analysis - Optical theorem -Application to low energy two nucleon scattering.	
	Total Contact Hrs	**65**

ProgrammeCode:	M.Sc.PHY			**Programme Title:**	MasterofPhysics	
CourseCode:	23PPS205			**Title**	**Batch:**	2023 – 2025
				Core V: Electromagnetic theory & Electrodynamics	**Semester:**	II
LectureHrs./Week or PracticalHrs./Week	5	**TutorialHrs./Sem.**	-		**Credits:**	4

Units	Content	Hrs
Unit I	**ELECTROSTATICS AND MAGNETOSTATICS** Concept of charge - Coulomb's law - Gauss law - Multipole expansion of charge distribution - Dielectric and its polarization - Electric displacement D - Polarization of non-polar molecules – Lorentz equation for molecular field - ClaussiusMossotti relation - Polarisation of polar molecules-Langevin equation-Debye relation and molecular structure - Current density - Ampere's law of force - BiotSavart law - Ampere's circuital law - Magnetic scalar and vector potential - Application to magnetic dipole	13
Unit II	**FIELD EQUATION AND CONSERVATION LAWS** Equation of continuity - Displacement current **D** - Maxwell's equations - Energy in electromagnetic field - Poynting vector - Momentum in electromagnetic fields – Electromagnetic potential **A** and φ - Maxwell's equations in terms of electromagnetic potential - Concept of Gauge - Lorentz Gauge - Coulomb Gauge - *Retarded potential – LienardWiechart potentials*	13
Unit III	**PLANE ELECTROMAGNETIC WAVES PROPAGATION** EM waves in free space –Propagation of E.M waves in Isotropic dielectrics Propagation of E.M waves in Anisotropic dielectrics - Propagation of E.M waves in conducting media - Propagation of E.M waves in ionized media –The dynamic value of conductivity	13
UnitIV	**INTERACTION OF E.M.W WITH MATTER ON MICROSCOPIC SCALE** Scattering and Scattering parameters- Scattering by a free electron (Thomson scattering)- Scattering by a bound electron (Rayleigh scattering) **INTERACTION OF E.M.W WITH MATTER ON MACROSCOPIC SCALE** Boundary conditions - Reflection and Refraction of EM waves - Fresnel's formula – Brewster's law and polarization of E.M.W - Total internal reflection - Reflection from a metallic surface - Propagation of EM waves between conducting planes	13
Unit V	**RELATIVISTIC ELECTRODYNAMICS 1** Four vectors and tensors - Transformation equations for □ and***J*** - Transformation equation for ***A*** and φ - Electromagnetic field tensor - Transformation equation for ***E*** and ***B*** - Covariance of Maxwell's equations : Four vector form & four tensor form – *Covariance and transformation law of Lorentz force*	13
	TotalContactHrs	**65**

Programme Code:	M.Sc. PHY			**Programme Title:**	Master of Science	
Course Code:	23PPS206			**Title**	**Batch:**	2023-2025
				Core VI: Condensed Matter Physics	**Semester:**	II
Lecture Hrs./Week or Practical Hrs./Week	5	**Tutorial Hrs./Sem.**	-		**Credits:**	4

Units	Content	Hrs
Unit I	**GEOMETRY OF CRYSTALS** Lattice parameter and space lattice – The Basics and crystal structure – Unit cells and lattice parameters – Crystal systems – Bravais space lattices- Metallic crystal structures- Directions, Planes and miller indices-Important features of miller indices of crystal planes- Separation between lattice planes in a cubic crystals - Crystal bonding – Primary bonds – Covalent, Metallic, Ionic bonding - Van der Waals bond – Hydrogen bond (formation & properties) – Bond energy of NaCl molecule – Calculation of Lattice energy of ionic crystal – Calculation of Madelung constant of ionic crystals-Reciprocal lattice – Concept of reciprocal lattice - Properties of reciprocal lattice – X-ray diffraction – Bragg's law – Bragg's X-ray spectrometer – Powder crystal methods – Ewalds construction – Experimental methods. *Point defects, Dislocations and Color centers(Basic ideas only)*	13
Unit II	**LATTICE VIBRATIONS OF SOLIDS &THERMAL PROPERTIES** One line of atoms – the linear diatomic lattice – Quantization of lattice vibrations – Experimental determination of dispersion relation - Inelastic scattering of neutrons - The specific heat – Lattice specific heat – Classical theory - Einstein theory – The Debye theory – Born's modification – Thermal conductivity – Lattice thermal conductivity – Phonon mean free path – The Umklapp processes	13
Unit III	**FREE ELECTRON THEORY AND BAND THEORY OF SOLIDS** Classical free electron theory of Drude-Lorentz – Sommerfeld quantum theory (Energy levels in one and three dimensions) – Fermi Dirac distribution – Density of states – Fermi energy – Wave functions in a periodic lattice and the Bloch theorem – Behaviour of an electron in a periodic potential (Kronig Penney model) – Brillouin zone – Number of possible wave functions in a band - Motion of electrons in one dimensional periodic potential (crystal momentum, velocity, effective mass, negative effective mass and holes)	13
Unit IV	**FERRO ELECTRIC AND MAGNETIC PROPERTIES OF SOLIDS** Ferroelectric crystals – Properties of Rochelle salt and $BaTiO_3$ - Polarization Catastrophe – Ferroelectric domains –Piezoelectricity – Langevin's theory of Diamagnetism and Para magnetism – Quantum theory of Diamagnetism and Para magnetism – Cooling by adiabatic demagnetization - Weiss theory of Ferromagnetism - Ferromagnetic domains – Neel model of Anti ferromagnetism – Neel model of Ferrimagnetism	13

Unit V	**SUPERCONDUCTORS** Mechanism of Superconductors – Effects of magnetic field – Critical current – Meissner effect – Type I and Type II Superconductors - London equations - Thermodynamics of Superconductors - BCS theory - Quantum tunneling - Josephson's tunneling - Theory of AC & DC Josephson effect - High temperature Superconductors	13
	Total Contact Hrs	**65**

Programme Code:	M.Sc. PHY			**Programme Title:**	Master of Science	
Course Code:	23PPS2E2			**Title**	**Batch:**	2023 – 2025
				Core Elective II: Electronic Communications and Cyber security	**Semester:**	II
Lecture Hrs./Week	5	**Tutorial Hrs./Sem.**			**Credits:**	4

Units	**Content**	**Hrs**
Unit I	**ANALOG COMMUNICATION** Power and energy in a signal-model of communication system- modulation and frequency translation - Amplitude Modulation**:** DSB-SC, SSB, VSB and conventional AM - Superhetrodyne AM receiver - Frequency Modulation**:** Modulation index, spectrum and bandwidth, direct generation and demodulation, superhetrodyne FM receiver - Noise**:** noise power spectral density, white, thermal and shot noise, equivalent noise temperature - Signal to noise ratio and noise figure	13
Unit II	**PULSE MODULATION AND DIGITAL COMMUNICATION** Pulse Modulation: Sampling theorem, informal justification, pulse amplitude modulation, time division multiplexing and pulse time modulation - Pulse code Modulation: Quantization Error, bandwidth, companding and delta modulation - Data Transmission: Base band and radio frequency transmission, FSK and PSK - Information Theory:	13

	Rate and measurement, channel capacity, Noisy and noiseless channel - *Shannon's theorem*	
Unit III	***MICROWAVE SYSTEMS*** Microwaves - Multicavity klystron - Reflex klystron - Magnetron - Travelling wave tube **Radar and Television** Elements of a Radar System-Radar Equation-Radar Performance Factors-Radar Transmitting Systems- Radar Antennas-Duplexers-Radar Receivers and Indicators-Pulsed Systems-Other Radar Systems- Colour TV Transmission and Reception	13
Unit IV	**CYBER SECURITY AND CRYPTOGRAPHY** Overview of Cyber Security: Confidentiality, Integrity and Availability. Threats: Malicious Software (Viruses, Trojans, Root kits, Worms, Botnets), Memory exploits (Buffer Overflow, Heap Overflow, Integer Overflow, Format String). *Cryptography – Authentication, Password System – Windows Security.*	13
Unit V	**NETWORK SECURITY** Network Security – Network Intrusion, Deduction and Prevention Systems, Firewalls. Software Security: Vulnerability Auditing, Penetration Testing, Sandboxing, Control Flow Integrity. Web Security: User Authentication. Legal and Ethical Issues: Cybercrime, Intellectual Property Rights, Copyright, Patent, Trade Secret, Hacking and Intrusion, Privacy, Identity Theft.	13
	Total Contact Hrs	**65**

ProgrammeCode:	M.Sc.PHY			**ProgrammeTitle:**	MasterofPhysics	
CourseCode:	23PPS2N1			**Title**	**Batch:**	2023 – 2025
				Non Major Elective: Non Conventional Energy Sources	**Semester:**	II
LectureHrs./Week or PracticalHrs./Week	1	**TutorialHrs./Sem.**	-		**Credits:**	2

Units	**Content**	**Hrs**
Unit I	**SOLAR ENERGY** Solar radiation at the earth surface – Physical principles of the conversion of solar radiation into heat – Solar water heating – Solar cooking	3

Unit II	**WIND ENERGY** Wind energy conversion – Site selection consideration – Basic components of a wind energy conversion system (WECS) – *Advantages and disadvantages of WECS.*	2
Unit III	**OCEAN ENERGY** Ocean thermal energy conversion (OTEC) – Methods of ocean thermal energy power generation – Closed cycle OTEC system – Open cycle OTEC system.	2
UnitIV	**GEOTHERMAL ENERGY** A typical geothermal field – Estimates of Geothermal power – Nature of Geothermal fields – Geothermal sources – Advantages and disadvantages of Geothermal energy – *Applications of Geothermal Energy.*	3
Unit V	**CHEMICAL ENERGY** Fuel cells – Design, principle and operation of a fuel cell – Classification of fuel cells – Types of fuel cells – Advantages and disadvantages of fuel cell	3
	TotalContactHrs	**13**

Programme Code:	M.Sc. PHY			**Programme Title:**	Master of Science	
Course Code:	23PPS1E1			**Title**	**Batch:**	2023 – 2025
				Core Elective I- Applied Electronics	**Semester:**	I
Lecture Hrs./Week	5	**Tutorial Hrs./Sem.**	-		**Credits:**	5

Units	**Content**	**Hrs**
Unit I	**SEMICONDUCTOR DEVICES AND AMPLIFIERS** Semiconductor: Basic ideas- CE transistor characteristics - JFET, Depletion MOSFET and Enhancement MOSFET - Characteristics - UJT and Relaxation Oscillator - SCR & SCR as a switch - Principle of amplification - Classification of amplifiers - Common base, Common emitter RC coupled amplifiers and Frequency response - Hybrid parameters and Small signal analysis - Emitter follower - *Concept of Power amplification & Classification of Power amplifiers* - Transformer coupled class A Power amplifier –Calculation of Efficiency - Class B Push pull amplifier - Complementary symmetry Push pull amplifier – Efficiency calculation - Biasing of FET amplifier - Common source	13

	FET amplifier - Common drain FET amplifier.	
Unit II	**FEEDBACK AMPLIFIER & OSCILLATORS** Concept of Feedback - Negative feedback - Forms of negative feedback - *Effect of negative feedback on bandwidth, distortion, noise and stability* - Positive feedback - Barkhausen criterion - Generation of sinusoidal waves by a tuned LC circuit - Classification of oscillators - Hartley oscillator - Colpitts oscillator - Phase shift oscillator– Frequency calculation - Astable, Monostable and Bistable Multivibrators .	13
Unit III	**OPERATIONAL AMPLIFIER-I** Ideal Op Amp - Inverting Op Amp - Non inverting Op Amp - Voltage follower circuits-- Voltage to current converter - Sample and hold circuit-- Logarithmic amplifier-Constant current source using Op Amp- Realization of constant – current source – Comparators – window detector circuits – Schmitt Trigger	13
Unit IV	**OPERATIONAL AMPLIFIER-II** Differential amplifier – Common mode and Differential mode – Common Mode Rejection Ratio(CMRR)- Differential Amplifier circuits – Common Mode operation – Differential Mode operation –Characteristics of the nonideal Operational amplifier – Frequency compensation-Practical Operational amplifier.	13
Unit V	**RADIOMETRY AND PHOTOMETRY** Radiometric and photometric flux,Efficacy ,Radiometric and photometric Energy,Radiometric and photometric intensity (Definition only) – Common Radiant Profiles – Optical transfer function and Numerical aperture **DISPLAY DEVICES & DETECTORS** Light Emitting Diode: Construction – Electrical and Optical Characteristics – Electroluminescent Source: Electroluminescent lighting panel and Display – Classifications and Characteristics of radiation detectors – Detector Noise – Thermal Detectors: Thermocouple- Pyroelectric detectors – External Photo effect Photoelectric Detectors: Photomultiplier, Internal Photo effect Photoelectric Detectors: Photoconductors	13
	Total Contact Hrs	**65**

Programme code:	MSc	**Programme Title :**	Master of Science	
Course Code:	22PPS310	**Title**	**Batch :**	2022-2024
		Core X: Molecular Spectroscopy	**Semester**	III
Hrs/Week:	5		**Credits:**	4

Unit	Content	Hrs
I	**MOLECULAR SYMMETRY & GROUP THEORY** Group - Group Multiplication table - Classes - Symmetry elements and Symmetry operations –Symmetry planes and reflections - Invertion centre - Proper axes and proper rotations - Improper axes and improper rotations - Point groups - A systematic procedure for symmetry classification of molecules - Representations of a group - The Great Orthogonality theorem and its consequences - *Character tables*	13
II	**MICROWAVE SPECTROSCOPY** Rotation of molecules – Rigid Diatomic molecule – Intensities of spectral lines - Effect of isotopic substitution –Non rigid rotator – Spectrum of non rigid rotator – Polyatomic molecules: Linear molecules - Symmetric top molecules - Techniques and Instrumentation.	13
III	**IR SPECTROSCOPY** Vibrating diatomic molecule: Energy of a diatomic molecule – Simple harmonic oscillator - Diatomic Vibrating Rotator - Vibrations of Polyatomic molecules: Fundamental vibrations and their symmetry – Overtone and combination of frequencies - Fourier transform IR spectroscopy **RAMAN SPECTROSCOPY** Quantum theory of Raman Effect - Classical theory of Raman effect: Molecular polarizability - Pure Rotational Raman spectra: Linear molecules – Symmetric top molecules - Vibrational Raman spectra: Raman activity of vibrations- Rule of Mutual Exclusion – Overtone and combination of vibrations - Structure determination from Raman & IR spectroscopy - Techniques & Instrumentation	13
IV	**RESONANCE SPECTROSCOPY** Magnetic properties of Nuclei - Resonance condition - Bloch equations and their Steady State solutions - Chemical shift – NMR instrumentation - Applications: NMR imaging - *Concept and theory of Electron Spin Resonance –* ESR spectrometer	13

V	**NQR, MOSSBAUER AND ELECTRONIC SPECTROSCOPY** Quadruple nucleus – Principle of NQR – Transitions for axially and non axially symmetric systems: Frequencies of transitions – Half Integral Spins – Integral Spins – NQR Instrumentation – Regenerative continuous wave oscillator method - Applications: Chemical bonding -Halogen quadrupole resonance - Principle and theory of Mossbauer Effect - Mossbauer instrumentation - Applications - Electronic spectroscopy - Vibrational coarse structure of electronic spectra - Frank Condon principle - Fortrat parabole	13
Total contact hours		65

Programme Code:	MSC	**Programme Title:**	Master of Science	
Course Code:	22PPS311	**Title**	**Batch:**	2022 - 2024
		Core XI: Condensed Matter Physics	**Semester:**	III
Hrs/Week:	5		**Credits:**	4

Unit	Content	Hrs
I	**GEOMETRY OF CRYSTALS** Lattice parameter and space lattice – The Basics and crystal structure – Unit cells and lattice parameters – Crystal systems – Bravais space lattices- Metallic crystal structures- Directions, Planes and miller indices-Important features of miller indices of crystal planes-Separation between lattice planes in a cubic crystals - Crystal bonding – Primary bonds – Covalent, Metallic, Ionic bonding - Van der Waals bond – Hydrogen bond (formation & properties) – Bond energy of NaCl molecule – Calculation of Lattice energy of ionic crystal – Calculation of Madelung constant of ionic crystals-Reciprocal lattice – Concept of reciprocal lattice - Properties of reciprocal lattice – X-ray	13

	diffraction – Bragg's law – Bragg's X-ray spectrometer – Powder crystal methods *Point defects, Dislocations and Color centers(Basic ideas only)*	
II	**LATTICE VIBRATIONS OF SOLIDS &THERMAL PROPERTIES** One line of atoms – the linear diatomic lattice – Quantization of lattice vibrations – Experimental determination of dispersion relation - Inelastic scattering of neutrons - The specific heat – Lattice specific heat – Classical theory - Einstein theory – The Debye theory – Born's modification – Thermal conductivity – Lattice thermal conductivity – Phonon mean free path – The Umklapp processes	13
III	**FREE ELECTRON THEORY AND BAND THEORY OF SOLIDS** Classical free electron theory of Drude-Lorentz – Sommerfeld quantum theory (Energy levels in one and three dimensions) – Fermi Dirac distribution – Density of states – Fermi energy – Wave functions in a periodic lattice and the Bloch theorem – Behaviour of an electron in a periodic potential (Kronig Penney model) – Brillouin zone – Number of possible wave functions in a band - Motion of electrons in one dimensional periodic potential (crystal momentum, velocity, effective mass, negative effective mass and holes)	13
IV	FERRO ELECTRIC AND MAGNETIC PROPERTIES OF SOLIDS Ferroelectric crystals – Properties of Rochelle salt and $BaTiO_3$ - Polarization Catastrophe – Ferroelectric domains –Piezoelectricity – Langevin's theory of Diamagnetism and Para magnetism – Quantum theory of Diamagnetism and Para magnetism – Cooling by adiabatic demagnetization - Weiss theory of Ferromagnetism - Ferromagnetic domains – Neel model of Anti ferromagnetism – Neel model of Ferrimagnetism	13

V	**SUPERCONDUCTORS** Mechanism of Superconductors – Effects of magnetic field – Critical current – Meissner effect – Type I and Type II Superconductors - London equations - Thermodynamics of Superconductors - BCS theory - Quantum tunneling - Josephson's tunneling - Theory of AC & DC Josephson effect - High temperature Superconductors	13
Total contact hours		65

Programme Code:	MSC	**Programme Title:**	Master of Science	
Course Code:	22PPS3E2	**Title**	**Batch:**	2022-2024
		Major Elective II: Thin film & Nano science	**Semester:**	III
Hrs/Week:	5		**Credits:**	5

Unit	Content	Hrs
I	**Thin film** Nature of thin film, Thermodynamics of nucleation, Film growth, Deposition parameters& grain size, Epitaxy, Incorporation of defects, Impurities in thin films. **Deposition Techniques:** Physical Vapour deposition:Thermal Evaporation, RF Sputtering, **Reactive sputtering, Chemical vapour deposition:** Pyrolysis, Chemical deposition: Chemical Bath deposition.	13

II	**Properties of thin films** **Optical properties:** Reflection, Transmission, Absorption, Energy band gap, Transition. **Electrical properties:** Sheet resistance, Measurement of sheet resistance, Temperature co-efficient of resistance (TCR), Influence of thickness on resistivity, Hall effect and Magneto resistance **Application:** ***Integrated circuits***	13
III	**Nanoscience** Introduction, Moore's laws - classification of **nanostructures** – quantum confinement- Summary of electronic properties of atoms and solids: **Isolated atom, Bonding between atoms, Giant molecular solids,** Free electron model and energy bands, Electronic conduction - How nanoscale dimension affect properties: Structural properties, Thermal properties, chemical properties, Mechanical properties, Magnetic properties, Optical properties, Electronic properties, Biological systems.	13
IV	**Structure and properties of Nanoparticles** **Nanofibers, inorganic nanotubes and nanowires,** Metal nanoclusters: Magic numbers, Geometric structure, Electronic structure, Reactivity, Magnetic properties. Semiconducting nanoparticles: Optical properties, Photo fragmentation, coulombic explosion, excitons, SET, Carbon nanostructures: Introduction- Carbon nanoclusters-carbon nanotubes-properties-Application.	13
V	**Synthesis and Characterization of Nanoparticles** **Growth mechanism : Vapour liquid solid growth(VLS), Vapour solid growth(VS)** Top down approach (Physical method): Lithography-Ball milling - Laser induced evaporation Bottom up approach (Chemical method): Sol-gel process-Self assembly-Solvo thermal process- Electro chemical synthesis -	13

	Thermolysis, **Electrospinning** Characterization: XRD – **Scanning tunneling microscopy- Atomic force microscopy-** IR and Raman spectroscopy-UV spectroscopy-Photo luminescence spectroscopy.	
	Total contact hours	65

Programme code:	MSC	**Programme Title :**	Master of Science	
Course Code:	22PPS412	**Title** Core XII: Lasers & Non-Linear Optics	**Batch :** **Semester:**	2022- 2024 IV
Hrs/Week:	5		**Credits:**	4

Unit	Content	Hrs
I	**BASIC PRINCIPLES OF LASERS** Energy levels - Thermal equilibrium - Einstein's prediction – Einstein Relations - Condition for large Stimulated emissions - Condition for light amplification - Line shape function - Population inversion - Pumping methods – Active medium – Metastable states – Pumping schemes – Optical Resonator and its Action - Line broadening - Cavity configurations - Modes - *Laser rate equations for three & four level systems*	13
II	**LASER CHARACTERISTICS** Spatial & Temporal coherence - Directionality - Monochromaticity - Intensity	13

	TYPES OF LASERS Ruby laser - Nd YAG laser - Helium Neon laser - Carbondioxide laser - Semiconductor diode laser - Excimer laser - Dye laser - Chemical laser - X ray laser - Free electron laser - Fiber laser - Color center laser	
III	**PERFORMANCE IMPROVEMENT OF LASER** Q- factor - Methods of Q switching – Cavity dumping – Techniques for mode locking - Laser amplifiers - Distributed feedback laser **APPLICATIONS OF LASER** Material processing: Surface treatments – Drilling –Cutting - Welding - Laser in Nuclear energy: Isotope separation - Laser in medicine - Laser in Defence –Holography.	13
IV	**NON-LINEAR OPTICS** Harmonic generation - Second harmonic generation - Phase matching - Third harmonic generation - Optical mixing - Parametric generation of light - Self focusing of light **MULTIPHOTON PROCESSES** Multi quantum Photo electric effect – Two photon processes (Experiments) - Three photon processes - Second harmonic generation - Parametric generation - Parametric light Oscillator - Frequency up conversion - Phase conjugate optics	13
V	**LASER SPECTROSCOPY** Rayleigh and Raman scattering - Stimulated Raman effect - Hyper Raman effect (Classical treatment) - Coherent Anti Stokes Raman Scattering - Spin flip Raman Laser - Photo acoustic Raman Spectroscopy – Brillouin scattering - Saturation absorption Spectroscopy - Doppler free two photon Spectroscopy – Modulation of an electron wave by a light wave – *Laser induced collision processes*	13
Total contact hours		65

Programme Code:	MSC	**Programme Title:**	Master of Science	
Course Code:	22PPS413	**Title**	**Batch:**	2022-2024
		Core XIII: Nuclear & Particle Physics	**Semester:**	IV
Hrs/Week:	5		**Credits:**	4

Unit	Content	Hrs
I	**TWO BODY PROBLEM AND NUCLEAR FORCES** Deutron - Properties - Ground state of Deutron –Deutron Problem- Neutron Proton scattering at low energies - Scattering length and effective range - Spin dependence of n p forces - Tensor forces – Interpretation of high energy nucleon – nucleon scattering - Exchange forces - Nuclear forces - Properties of nuclear forces - Yukawa theory of nuclear forces	13
II	**NUCLEAR MODELS** Liquid drop model - Weizacker semi empirical mass formula - Shell model - Magic numbers - Magnetic moments and the Shell model - Prediction of angular momenta of nuclear ground states by Shell model - Collective model - Vibrational and Rotational states - *Elementary ideas of Unified and Superconductivity model*	13
III	**NUCLEAR DISINTEGRATION** Law of radioactive decay - Alpha ray emission - Gamow's theory of alpha decay - Alpha ray energies and fine structure - Alpha disintegration energy - Beta decay - Fermi's theory of beta decay - Fermi and G.T Selection rules - Parity in beta decay - Helicity - Electron capture - Gamma decay - Theory of angular correlation of successive radiation - Internal conversion - Angular momentum and Parity of excited levels	13
IV	**NUCLEAR FISSION AND FUSION REACTORS** Fission and Nuclear structure - Bohr Wheeler's theory – Classification of neutrons according to energy-energetics of fission – Controlled fission reactions – four factor formula - Fission reactors - Radioactive fission products - A natural fission reactor - Basic fusion processes - Characteristics of fusion - Solar fusion - Controlled	13

	fusion reactors – Nuclear reactions: Compound nuclear reactions – direct reactions	

Programme Code:	MSC	**Programme Title:**	Master of Science	
Course Code:	22PPS4E3	**Title**	**Batch:**	2022-2024
		Major Elective III: Microprocessor & Object-OrientedProgramming with C++	**Semester:**	IV
Hrs/Week:	5		**Credits:**	5

Unit	**Content**	**Hrs**
I	**MICROPROCESSOR FUNDAMENTALS** 8085 Microprocessor pin diagram & functions - Architecture - Addressing modes - Instruction set - Data transfer instructions - Arithmetic instructions - Logical and Branch instructions - Stack, I/O & Machine control instructions - Subroutine ,Conditional Call instructions and return instructions	13
II	**MICROPROCESSOR PROGRAMMING &MICROCONTROLLER** Steps involved in Microprocessor programming - Straight line programs -Looping programs - Mathematical programs Microcontroller – Intel 8048 Series of microcontroller: Architecture of 8048 Intel 8051 Series of microcontroller : Block diagram of 8051	13
III	**PRINCIPLES OF OBJECT-ORIENTED PROGRAMMING** Object Oriented Programming Paradigm - Basic concepts of	13

	Object Oriented Programming - Benefits of OOP **CLASSES & OBJECTS** Specifying a Class - Defining Member functions - Nesting of Member functions - Private Member functions - Arrays within a class - Memory allocation for objects- Static data members & Member functions - Arrays of Objects - Objects as function arguments - Friendly functions – Returning objects	
IV	**CONSTRUCTORS & DESTRUCTORS** Constructors - Parameterized Constructors - Multiple Constructors in a Class - Copy Constructor -Dynamic Constructor- Destructors **OPERATOR OVERLOADING** Defining Operator Overloading - Overloading Unary & Binary Operators - Overloading Binary Operators using Friends - Rules for Overloading Operators	13
V	**INHERITANCE: EXTENDING CLASSES** Defining Derived classes - Single inheritance - Making a Private Member inheritable - Multilevel inheritance - Multiple inheritance - Hierarchical inheritance - Hybrid inheritance - Virtual base classes **POINTERS &VIRTUAL FUNCTIONS** Pointers to Objects - **this** Pointer - Pointers to Derived Classes - Virtual functions - Pure virtual functions	13
Total contact hours		65

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