DEPARTMENT OF PHYSICS, OSMANIA UNIVERSITY, HYDERABAD
M. Sc. (Physics) and M.Sc. (Appl. Electronics) Courses under CBCS
(with effect from the academic year 2022 –2023)

Semester-I

S.No.	Sub. Code	Paper No.	Subject	Instructions/ week	Credits
			THEORY		
01	PAE 101T	I	Mathematical Physics	3	3
02	PAE 102T	II	Classical Mechanics	3	3
03	PAE 103T	III	Quantum Mechanics - I	3	3
04	PAE 104T	IV	Electronics	3	3
			PRACTICALS		
05	PAE 151P+152P	V & VI	C – Programming lab & Electronics lab	8	4
06	PAE 153P+154P	VII & VIII	Heat & Acoustics lab & Optics lab	8	4
			Total		20

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DEPARTMENT OF PHYSICS, OSMANIA UNIVERSITY, HYDERABAD
Semester- I Syllabus M.Sc. (Physics)

PAE 101 T **Paper –I: Mathematical Physics**

UNIT –I: (15Hrs)

Linear Differential equations with variable coefficients:Legendre's Differential equation;The Power series Solution–LegendreFunctions of the first and second kind –Generating Function-Rodrigue's formula– Orthogonal Properties – Recurrence Relations.

Bessel's Differential Equation: Power series Solution –Bessel Functions ofFirst and Second kind-Generating Function –Orthogonal Properties –Recurrence Relations; Elements of complex analysis.

UNIT –II: (15Hrs)

Beta and Gamma functions – Properties and their relations; **Hermite Differential Equation:** Power series Solution–Hermite polynomials –Generating Function-Orthogonality –Recurrence relations -Rodrigues formula.

Laguerre Differential equations: The Power series Solution–Generating Function- Rodrigue's formula– Recurrence Relations,Orthogonal Properties- Integral representation of Laguerre differential equations; Green's function. Partial differential equations (laplace, wave and heat equations in two and three dimensions).

UNIT –III: (15Hrs)

Fourier Transform: Introduction, Infinite Fourier Sine and Cosine transforms–-Fourier Sine and Cosine transform of derivatives-Finite Fourier transforms – Applications of Fourier Transforms; **Laplace Transform:** Introduction, Properties of Laplace transformsInverse Laplace transform and its properties –Inverse Laplace theorem –Convolution theorem.

Matrices– eigen values- eigen vectors -Characteristic equation of a matrix- Cayley Hamilton theorem; **Tensors** –Order and rank of the tensors –transformation laws of covariant, contra-variant and mixed tensors – properties of tensors: Addition, subtraction and multiplication of tensors, Outer and inner products- contraction of tensors and quotient law

Reference Books:

1. Applied Mathematics for Engineers and Physicists –Louis A Pipes and Lawrence R. Harvill.
2. Mathematical Physics –AK Ghatak, IC Goyal and SL Chua-Macmillan India Ltd.
3. Vector and Tensor Analysis –Schaum Series.
4. Mathematical Physics –SatyaPrakash

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DEPARTMENT OF PHYSICS, OSMANIA UNIVERSITY, HYDERABAD

Semester- I Syllabus M.Sc. (Physics)

PAE 102 T **PAPER-II: CLASSICAL MECHANICS**

UNIT- I (15 Hrs)

Inertial Frames and Galilean Transforms, Non-Inertial Frames, Pseudo Forces, Rotational Frames, Rotational Transforms and Conservation Theorems, Rotations in terms of Euler Angles-Euler's Equation of motion for a Rigid body

Minkowski space, Space-Time diagrams, World point, World line – relativistic motion and Lorentz transforms as rotation in four-space, Four velocity, Energy-momentum vectors with few examples

UNIT- II (15 Hrs)

Constraints, Generalized Coordinates, Principle of Virtual work, D'Alembert's Principle, Lagrange's equation from D'Alembert's Principle, Examples of Lagrangian Equations: Simple Pendulum, Compound Pendulum, Spherical Pendulum, L-C circuit, Velocity dependent potentials- Lagrangian for a charged particle in Electromagnetic field.

Theory of small oscillations, stable, unstable and neutral equilibrium, Free vibrations of a Linear Triatomic molecule, Eigen value equations, Principal axis transformation-Frequencies and Normal modes

UNIT- III (15 Hrs)

Euler-Lagrange Equations, Hamilton's Principle, Lagrange equation from Hamilton's principle, Principle of Least Action, Examples of Hamilton equations – motion of a particle in a central force field, projectile motion of a body, charged particle moving in a electromagnetic field, Cyclic coordinates and Conservation theorems.

Canonical coordinates and canonical transformations, Conditions for the transformations to be canonical, Generating functions, Lagrange and Poisson brackets, Hamilton's equations in Poisson bracket form, Hamilton-Jacobi equation, Harmonic oscillator by Hamilton-Jacobi method.

Reference Books:

1. Classical Mechanics by H. Goldstein, Poole &Safko (Pearson 2002)
2. Classical Mechanics by J.C. Upadhyaya (Himalaya Publishing House)
3. Introduction to Classical Mechanics by Takwale&Puranik (TMH)
4. Classical Mechanics by Rana&Joag (TMH)
5. Classical Mechanics of particles and Rigid Bodies by Kiran C Gupta (New Age International Publishers)
6. Lagrangian and Hamiltonian Mechanics by Calkin (Allied Publishers 2000)
7. Lagrangian Dynamics by D.A. Wells (Schaum's series 1967)

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DEPARTMENT OF PHYSICS, OSMANIA UNIVERSITY, HYDERABAD
Semester- I Syllabus M.Sc. (Physics)

PAE 103 T **Paper –III: Quantum Mechanics- I**

UNIT –I (15 **Hrs**):

Fundamentals of Quantum Mechanics: Linear Vector space, Dirac's Ket and Bra notation.Eigen equation, Eigenkets and Eigenvalues –Degenerate and non-degenerate states.Operators,Hermitian operators and their properties-Commuting and non-commuting operators. Matrix representations of vectors and operators – Observable and expectation value of an observable - Parity operator, Projection operator, the number operator and its significance.

UNIT –II (15 **Hrs**):

Exactly solvable and Symmetry problems: The Schrodinger, Heisenberg and interactionpictures. Linear harmonic oscillator- Solution by operator method.Hydrogen atom- Solution of the radial part of the Schrodinger equation.
Space and time displacements –Unitary operators of space and time displacements and equations of motion.Space inversion and unitary inversion operator - Intrinsic parity.Time reversal operator – anti-linear operator.

UNIT –III (15 **Hrs**):
Angular Momentum: Orbital Angular Momentum, Commutation Relations involving: $\mathbf{L}^2$, $\mathbf{L}_x$,$\mathbf{L}_y$, $\mathbf{L}_z$ –Eigenvalues and Eigen functions of $\mathbf{L}^2$ – Generalized angular momentum, J.Commutation relations between $\mathbf{J}^2$ and components of **J**, $\mathbf{J}_+$ and $\mathbf{J}_-$. Eigen values of $\mathbf{J}^2$ and $\mathbf{J}_z$. Matrix representation for $\mathbf{J}^2$ and $\mathbf{J}_z$. Spin angular momentum - Pauli spin matrices and their properties. Addition of angular momenta - Clebsch-Gordon coefficients- Recursion relations-C-G coefficients for $\mathbf{J}_1 = \frac{1}{2}$, $\mathbf{J}_2 = \frac{1}{2}$, and $\mathbf{J}_1 = \frac{1}{2}$, $\mathbf{J}_2 = 1$, as examples.

Reference Books:

1. Quantum Mechanics by L.I. Schiff
2. A Text book Quantum Mechanics: PM Mathews and K Venkateshan (TMH)
3. Quantum Mechanics by Ghatak and Lokanathan (Macmillan)
4. Quantum Mechanics by E Merzbacher (John Wiley)
5. Quantum Mechanics by Aruldhas (New Age International)
6. Modern Quantum Mechanics by Sakurai (Addison Wesley)

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DEPARTMENT OF PHYSICS, OSMANIA UNIVERSITY, HYDERABAD
Semester- I Syllabus M.Sc. (Physics)

PAE 104 T **Paper – IV: Electronics**

UNIT – I: (15 **Hrs)**

Regulated Power Supply: Basic Principle of regulated power supply, fixed IC voltage regulators using IC 78XX and 79XX, variable IC regulators with LM723

Feed back in Amplifiers: The concept of feedback, Positive and Negative feedback – feedback gain- Advantages ofNegative feedback in amplifiers,

Oscillators: Barkhausen Criterion, RC oscillators: Phase shift Oscillator,Wein Bridge Oscillator, LC Oscillators: Hartley and Collpitts Oscillators.

UNIT – II: (15 **Hrs)**

Operational Amplifiers: Characteristics of Ideal operational Amplifier, Block diagram ofan IC operational Amplifier, Analysis of inverting amplifier, Non-inverting amplifier, Integrator, Differentiator, summing amplifier, Difference amplifier, Comparator, Logarithmic amplifier and exponential amplifier, Square wave, Rectangular wave and Triangular wave generators.

Timer IC 555: Working of IC 555, Astable Multi-vibrator with IC 555.

UNIT – III: (15 **Hrs)**

Logic Circuits: Min terms and Max terms, simplification of Boolean equations- sum of products and product of sums- Karnaugh Maps (upto 4 variables), Multiplexer (16:1) and De-multiplexer (1:4)

Flip –Flops: RS, D, JK and M/S JK flip flops with their truth tables, timing diagrams.

Counters: Asynchronous and Synchronous Counters, Modulus N Counter, Decade Counter using IC7490.

Microprocessor: Introduction to Microprocessors –Architecture of 8085microprocessor, Instruction set: Data transfer instructions, Arithmetic Logic and Branch operations, Interrupts, Simple Assembly language programming: 8-bit addition, 8-bit subtraction, 8-bit multiplication.

Reference Books. :

1. Integrated Electronics –Millman and Halkias.
2. Microelectronics –Millman & Grabel.
3. Digital principles and applications- Malvino and Leech
4. Operational amplifier –Gayakwad
5. Principles of Digital Electronics –Gothman
6. Digital Principles and Applications Computer Electronics –Malvino.
7. Microprocessors Architecture, Programing and Application with the 8085 / 8080 – Gaonkar
8. Pulse Digital & Switching Waveforms by Millman and Taub, TMH 2001.
9. Fundamentals of electronics by JD Ryder, Wiley.

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Semester-II

S.No.	Sub. Code	Paper No.	Subject	Instructions/ week	Credits
			THEORY		
01	PAE 201T	I	EM Theory	3	3
02	PAE 202T	II	Statistical Mechanics	3	3
03	PAE 203T	III	Quantum Mechanics - II	3	3
04	PAE 204T	IV	General Solid State Physics	3	3
			PRACTICALS		
05	PAE 251P+252P	V & VI	C – Programming lab & Electronics lab	8	4
06	PAE 253P+254P	VII & VIII	Heat & Acoustics lab & Optics lab	8	4
			Total		20

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DEPARTMENT OF PHYSICS, OSMANIA UNIVERSITY, HYDERABAD
Semester- II Syllabus M.Sc. (Physics)

PAE 201 T **Paper – I: Electromagnetic Theory**

UNIT – I: (15 Hrs)

Electro-Static Potentials and Maxwell's Field Equations:

Special techniques forcalculating electrostatic potential : Poisson's and Laplace's equations-Solutions of Laplace's equations for electrostatic potential in Cartesian, spherical and cylindrical coordinates-Multi-pole expansion of the energy of a system of charges in an electrostatic field-The scalar and vector magnetic potentials. Derivation of Maxwell's equations-General wave equation-Gauge transformations-Lorentz and Coulomb gauges-Momentum, angular momentum and free energies of electromagnetic field-Poynting Theorem (work energy theorem in electrodynamics).

UNIT – II: (15 Hrs)

Propagation of Plane Electromagnetic Waves:

Electromagnetic (EM) waves inunbounded media-EM wave equation for a homogeneous isotropic dielectric medium-Propagation of plan EM waves in free space-Propagation of EM waves in homogeneous isotropic dielectric medium- Energy transmitted by a plane EM wave-Propagation of EM wave in conducting medium- Attenuation and Skin effect-Energy transmitted –Polarization of EM wave.Propagation of EM waves inbounded media-Boundary conditions for **E,D,B** and **H** – Reflection and Refraction of plane EM waves at plane interface between two dielectrics

UNIT – III: (15Hrs)

Interaction of Electromagnetic Waves with Matter:

Laws of reflection and refraction-Fresnel's relations- Reflection (R) and Transmission(T) coefficients -Brewster's angle-Total internal reflection-Reflection and Refraction of plane EM waves at plane interface between non-conducting and conducting medium-Metallic reflection and its applications – Dispersion in non-conductors –Normal and anomalous dispersion.

Electromagnetic radiation: Inhomogeneous wave equation for potentials-Retarded potentials, Oscillating electric dipole radiation-Oscillating magnetic dipole radiation-Radiation from center-fed linear antenna, Lienard-Wiechert potentials

Reference Books:

1. Classical Electrodynamics by SP Puri, Tata McGraw-Hill Publishing Co., Ltd (2000).
2. Introduction to Electrodynamics by DJ Griffiths, Prentice- Hall of India (1998).
3. Electricity and Magnetism by MH Nayfeh and MK Brussel, John Wiley and Sons (1985).
4. Classical Electrodynamics by JD Jackson, John Wiley and Sons (1999).
5. Foundations of Electromagnetic Theory by JR Rietz, FJ Milford and Christy, Narosa Publishing house (1986)
6. Engineering Electromagnetics by WH Hayt and JA Buck Tata Mc-Graw Hill (2001)
7. Electromagnetic waves and Radiating systems by EC Jordan and KG Balmain, Prentice Hall (1968)

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DEPARTMENT OF PHYSICS, OSMANIA UNIVERSITY, HYDERABAD
Semester- I Syllabus M.Sc. (Physics)

PAE 202 T **Paper – II: Statistical Mechanics**

UNIT – I: (15 Hrs)

Relation between thermodynamics and statistical mechanics- Micro states and macro states of a system – Phase space- Ensembles – Mean values and ensemble average – Density distribution in phase space- Liouville's theorem. Apriori probability postulate – Micro canonical, canonical and grand canonical ensembles –Quantization of phase space. Entropy and Probability.Entropy of a perfect gas using micro canonical ensemble - Gibbs paradox-Sackur.-Tetrode equation.Equipartition theorem.

UNIT – II: (15 Hrs)

Canonical ensemble- Partition function-Ideal gas, Grand canonical ensemble-Partition function-Ideal gas.Partition function and thermodynamic quantities-Translational, rotational and vibrational partition functions.Ideal Bose-Einstein gas-Energy and pressure of the gas.Bose-Einstein condensation-Liquid Helium, Two Fluid model-Phonons, super fluidity.Ideal Fermi-Dirac gas-Energy and pressure of the gas. White dwarfs.

UNIT – III : (15 Hrs)

Fluctuation-mean square deviation-Fluctuations in energy, volume and concentration. Brownian motion- Classification of phase transition-Phase transitions of first and second kind: Ising model, Bragg-Williams approximation-One dimensional Ising model an application to ferromagnetic systems-Order-Disorder transition.

Reference Books:

1. Statistical Mechanics by SatyaPrakash and JP Agarwal (Pragati Prakashan-2002)
2. Statistical Mechanics by Gupta and Kumar (PragathiPrakashan -2002)
3. Statistical Mechanics by BK Agarwal and M Eisner (New Age International)
4. Statistical Mechanics by RK Srivastava and J Ashok (Prentice Hall, India)
5. Introduction to phase transitions and critical Phenomena HE Stanley (Clarendon Press, Oxford).
6. Heat and Thermodynamics by Zemansky (TMH).

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Semester- I Syllabus M.Sc. (Physics)

PAE 203 T **Paper – III: Quantum Mechanics – II**

UNIT – I (15 **Hrs**):
Scattering Theory:
Kinematics of Scattering Process: differential and total cross-section -Asymptotic form ofscattering wave function. Scattering amplitude by Green's method. The Born approximationmethod, screened Coulomb potential and square well potential as examples - Partial waveanalysis and phase shift- Optical Theorem- Relationship between phase shift and Potential.Scattering by Hard sphere.

UNIT – II (15 **Hrs**):
Approximation Methods:
Time independent perturbation theory, Examples of harmonic and an-harmonic Oscillators.Degenerate case- Stark effect for H-atom for n=2 level. Variation Method - Helium atom groundstate. WKB approximation method - connection formulae.Time dependent perturbation theory, Transition probability- Selection rules for transition.Constant perturbation.Transition probability to closely spaced levels- Fermi's golden rule.Harmonic perturbation- Transition probability rate.

UNIT – III (15 **Hrs**):
Relativistic Quantum Mechanics:
Klein –Gordon Equation, Plane wave solution and Equationof continuity, Probability density- Dirac Equation, alpha, beta- matrices, Plane wave solution,Significance of negative energy states. Spin of Dirac particle, Relativistic particle in centralpotential –Total Angular Momentum. Particle in a magnetic field – Spin Magnetic moment,properties of gamma matrices- Dirac's equation in covariant form.

Reference Books:

1. Quantum Mechanics by LI Schiff
2. A Text book Quantum Mechanics by PM Mathews and K Venkateshan (TMH)
3. Quantum Mechanics by Ghatak and Lokanathan (Macmillan)
4. Quantum Mechanics by E Merzbacher (John Wiley)
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Semester- I Syllabus M.Sc. (Physics)

PAE 204 T **Paper – IV: General Solid State Physics**

UNIT – I : (15Hrs)

Crystal Structure and Growth: Introduction to crystal structures (Crystal translational vectors, unit cell, Bravaislattices, Crystal systems, Miller indices, Symmetry operations), Point groups, Space groups and their notation. Bragg's law, Atomic structure factor, Geometrical structure factor and Debye Waller factor, Concept of reciprocal lattice, Concept and construction of Brillouin zones, Experimental methods of X-ray diffraction– Laue and Powder methods, Determination of unit cell parameters of a cubic crystal, Elements of electron and neutron diffraction.

Crystal growth from solution and melt, growth fromvapour phase, Experimental techniques of growth from melt.

UNIT – II: (15Hrs)

Crystal Imperfections: Classification of imperfections, Schottky and Frenkel defects, expression for their equilibrium concentrations in metals and Ionic crystals, Colour centers and their models, Dislocations-Edge and Screw dislocations, Dislocation multiplication, Grain boundaries.

Thermal Properties: Elastic waves in one dimensional array ofidentical atoms, Vibrational modes of a diatomic linear lattice and dispersion relations, Acoustic and Optical modes, Infrared absorption in ionic crystals, Phonons and verification of dispersion relation in crystal lattices. Lattice heat capacity- Einstein and Debye theories, Lattice thermal conductivity –Phonon mean free path, Origin of thermal expansion and Gruneisen relation.

UNIT – III: (15Hrs)

Band theory: Introduction to band theory, Bloch theorem, Behavior of electron in periodic potentials, Kronig- Penny model, E vs. K relation, Density of states in a band, Effective mass of an electron, Negative effective mass and concept of hole, Distinction between metals, semiconductors and Insulators.

Semiconductors: Intrinsic and extrinsic semiconductors, Fermi level, Expressions for electron and hole concentrations in Intrinsic and extrinsic semiconductors. Measurements of band gap by infrared absorption in semiconductors, Hall-effect.

Reference Books:

1. Crystallography and Solid State Physics – A.R. Verma and O.N. Srivastava
2. Solid State Physics – A.J. Decker, Macmillian Indian Ltd, 2003.
3. Introduction to Solid State Physics – C. Kittel, John Wiley Sons Inc, New York
4. Solid State Physics- RL Singhal, KedarNath&Ramnath& Co, 2006
5. Elements of Solid State Physics – J.P. Srivastava, Prentice Hall India, 2006.
6. Elements of Solid State Physics -- Ali Omar, Pearson Education Inc, 2002.

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