

DEBRA THANA S.K.S. MAHAVIDYALAYA (Autonomous)



Debra, Paschim Medinipur, West Bengal
Department Of Physics

Proposed Curriculum & Syllabus (draft)
(w.e.f. Academic Year 2024-2025)

Based on
Curriculum & Credit Framework for Undergraduate
Programmes (CCFUP), 2024 & NEP, 2020

**BACHELOR OF SCIENCE (HONOURS) MAJOR IN PHYSICS
(Under CCFUP, 2024)**

Level	YR.	SEM	Course Type	Course Code	Course Title	Credit	L-T-P	Marks			
								CA	ESE	TOTAL	
B.Sc. (Hons.)	2 nd	III	SEMESTER-III								
			Major-3	PHSHMJ03	T:Mathematical Physics II	4	3-1-0	15	60	75	
			Major-4	PHSHMJ04	T: Thermal Physics P: Practical	4	3-0-1	15	60	75	
			SEC	PHSSEC03	Advance Python Programming & Introduction to Latex	3	0-0-3	10	40	50	
			AEC	AEC03	Communicative English -2 (<i>common for all programmes</i>)	2	2-0-0	10	40	50	
			MDC	MDC03	Multidisciplinary Course -3 (<i>to be chosen from the list</i>)	3	3-0-0	10	40	50	
			Minor-3 (Disc.-I)	PHSMIN03	T: Thermal Physics & Statistical Mechanics P: Practical	4	3-0-1	15	60	75	
		Semester-III Total						20			375
		IV	SEMESTER-IV								
			Major-5	PHSHMJ05	T:Electronics I ; P: Practical	4	3-0-1	15	60	75	
			Major-6	PHSHMJ06	T: Electricity & Magnetism P: Practical	4	3-0-1	15	60	75	
			Major-7	PHSHMJ07	T:Quantum Mechanics I ; P: Practical	4	3-0-1	15	60	75	
			AEC	AEC04	MIL-2 (<i>common for all programmes</i>)	2	2-0-0	10	40	50	
			Minor-4 (Disc.-II)	PHSMNI04	T: Thermal Physics & Statistical Mechanics P: Practical	4	3-0-1	15	60	75	
			Summer Intern.	INT	Internship/ Apprenticeship - activities to be decided by the Colleges following the guidelines to be given later	4	0-0-4	-	-	50	
		Semester-IV Total						24			400
		TOTAL of YEAR-2						44			775

MJ = Major, MI = Minor Course, SEC = Skill Enhancement Course, AEC = Ability Enhancement Course, MDC = Multidisciplinary Course, CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical, MIL = Modern Indian Language

MAJOR (MJ)

MJ-3: Mathematical Physics II
MJ-3T: Mathematical Physics II (Theory)

Credits 04 (Full Marks: 75)
Credits 04 [50L+10T]

Matrices:

Transformation of a matrix. Similarity transformation. Invariance of trace and determinant under similarity transformation. Transformation of basis. Commuting operators and simultaneous eigenvectors for non-degenerate and degenerate eigenvalues. Diagonalization of matrices. Solutions of coupled linear ordinary homogeneous differential equations. Functions of a matrix, *e.g.*, exponential and trigonometric functions. (4 L+1T)

Partial Differential Equations Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation. (2L+1T)

Dirac Delta function and its' properties: Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function(2 L+1T)

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Power series solution of 2nd order differential equation. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Multipole expansion in Electrostatics. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions ($J_0(x)$ and $J_1(x)$) and Orthogonality. (8 L+1T)

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singularity and types of singularities, branch points and branch cuts (definitions only). Cauchy's Integral theorem, Cauchy's Integral formula (proof not required). Simply and multiply connected region. Taylor's and Laurent expansions (statements only). Residues and Residue Theorem. Applications in solving simple Definite Integrals. (13 L+1T)

Integrals Transforms:

Fourier Transforms: Fourier Integral theorem(Statement only). Fourier Transform. Fourier sine and cosine transform, Examples. Fourier transform of single pulse, trigonometric, exponential and Gaussian functions. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). One dimensional Wave Equations. (5 L+1T).

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and

Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to 2nd order Differential Equations: Coupled differential equations of 1st order. Solution of heat flow along semi infinite bar using Laplace transform. (5L+1T)

Transformation of Co-ordinates and fundamentals of Tensors. Einstein's Summation Convention. Relation between Direction Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Invariant Tensors : Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors.

Cartesian Tensors: Vector Algebra and Calculus using Cartesian Tensors : Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. Tensor notation of Laplacian operator. Proof of Vector Identities involving scalar and vector products and vector identities involving Del operator under Tensor notation. Isotropic Tensors (Definition only). Tensorial Character of Physical Quantities. Moment of Inertia Tensor. Stress and Strain Tensors : Symmetric Nature. Elasticity Tensor. Generalized Hooke's Law.

General Tensors Transformation of Co-ordinates. Minkowski Space. Contravariant & Covariant Vectors. Contravariant, Covariant and Mixed Tensors. Kronecker Delta and Permutation Tensors. Algebra of Tensors. Sum, Difference & Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Metric Tensor. (8L+2T)

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Parseval Identity and its application to summation of infinite series. (4L+1T)

Suggested Readings:

Mathematical Physics-

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
2. Introduction to Mathematical Physics, Charlie Harper, 1978, PHI Learning Pvt. Ltd.
3. Mathematical methods in the Physical Sciences, M. L. Boas, 2005, Wiley.
4. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press.
5. Fourier Analysis by M.R. Spiegel, 2004, TataMcGraw-Hill.
6. Differential Equations, George F. Simmons, 2006, TataMcGraw-Hill.
7. Differential Equations, S.L. Ross, 2007, Wiley.
8. Fourier Series and Boundary Value Problems, J.W. Brown and R.V. Churchill, 2017, Mc-Graw Hill Education.
9. Mathematical Physics, P.K. Chattopadhyay, 2014, New Academic Science.
10. Fundamentals of Mathematical Physics, A B Gupta, 2024, Books & Allied.

MJ-4: Thermal Physics
MJ-4T: Thermal Physics

Credits 04 (Full Marks: 75)
Credits 03 [45L]

Introduction to Thermodynamics:

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_p and C_v , Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient. (7 L)

Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature-Entropy diagrams for Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. (8 L)

Thermodynamic Potentials

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations. (8L)

Maxwell's Thermodynamic Relations

Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of $C_p - C_v$, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. (7L)

Kinetic Theory of Gases:

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance. (8L)

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V

Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule- Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule- Thomson Cooling. (7 L)

Reference Books

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
- Thermodynamics and an introduction to thermostatics, H. B. Callen, 1985, Wiley.

MJ-4P: Thermal Physics Lab:

Credits: 01

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine the coefficient of thermal conductivity of Cu by Searle's Apparatus
4. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
5. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
6. To determine the temperature co-efficient of resistance by Platinum resistance thermometer
7. To study the variation of thermo emf. across two junctions of a thermocouple with temperature.

Reference Books

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.

MJ-5: Electronics I
MJ-5T:Electronics I

Credits 04 (Full Marks: 75)
Credits 03 (45L)

Semiconductor Diodes:

P and N type semiconductors. Energy Level Diagram. Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift & Diffusion Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current Flow Mechanism in Forward and Reverse Biased Diode.(3L)

Two-terminal Devices and their Applications

Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter Zener Diode and Voltage Regulation. (4L)

Bipolar Junction transistors:

n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β . Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions. (4L)

Field Effect transistors:

Basic principle of operations of JFET & MOSFET . (4L)

Amplifiers

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. Frequency response of a CE amplifier.

Coupled Amplifier: Two stage RC-coupled amplifier. (4L)

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators. (4L)

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. (2L)

Applications of Op-Amps: Linear - (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator. Non-linear – (1) inverting and non-inverting comparators, (2) Schmidt triggers. Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation) (4L)

Digital Systems and Applications:

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. (4L)

Boolean algebra De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. (4L)

Dataprocessingcircuits:

Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. (2L)

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. (3L)

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) FlipFlops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK FlipFlop. (3L)

Reference Books

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
3. Solid State Electronic Devices, B.G. Streetman & S.K. Banerjee, 6th Edn.,2009, PHI Learning
4. Electronic Devices & circuits, S. Salivahanan & N.S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
5. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
6. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
7. Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer
8. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
9. Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning
10. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India
11. Digital Principles and Applications, A.P. Malvino, D. P. Leach and Saha, 7th Ed., 2011, Tata McGraw
12. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt.Ltd.
13. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
14. Digital Electronics G K Kharate ,2010, Oxford University Press
15. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHILearning
16. Logic circuit design, Shimon P. Vingron, 2012, Springer.
17. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
18. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill

MJ-5P: Electronics I- LAB**Credits 01**

1. To study the V-I characteristics Zener diode and its use as voltage regulator.
2. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
3. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
4. To design a Wien bridge oscillator for given frequency using an op-amp.
5. To design a phase shift oscillator of given specifications using BJT.
6. To study the Colpitt's oscillator.

7. To design an inverting amplifier using Op-amp (741) for dc voltage of given gain
8. To design inverting and an non-inverting amplifier using Op-amp (741) and study its frequency responses
9. To add two dc voltages using Op-amp in inverting and non-inverting mode.
10. To investigate the use of an op-amp as an Integrator and a Differentiator.
11. To verify and design AND, OR, NOT and XOR gates using NAND gates and design a switch (NOT gate) using a transistor.
12. To design a combinational logic system for a specified Truth Table.
13. Half Adder, Full Adder and 4-bit binary Adder.
14. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
15. To build JK Master-slave flip-flop using Flip-Flop ICs
16. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.

Reference Books

1. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
4. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
5. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
6. Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson

MJ-6: Electricity and Magnetism**Credits 04 (Full Marks: 75)****MJ-6T: Electricity and Magnetism**

Credits 03 [45L]

Electric Field and Electric Potential:

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Uniqueness theorem (statement). Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

(10L)

Dielectric Properties of Matter:

Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D . Relations between E , P and D . Gauss' Law in dielectrics.

(5L)

Magnetic Field:

Magnetic force between current elements and definition of Magnetic Field B . Biot- Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) infinite straight wire, (2) Infinite planar surface current, and (3) Solenoid. Properties of B : curl and divergence. Axial vector property of B and its consequences. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.

(12L)

Magnetic Properties of Matter:

Magnetization vector (M). Magnetic Intensity (H). Magnetic Susceptibility and permeability. Relation between B , H , M . Ferromagnetism. B - H curve and hysteresis.

(3L)

Electromagnetic Induction:

Faraday's Law. Lenz's Law. Self-Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.

(5L)

Electrical Circuits:

AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.

(5L)

Network theorems:

Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.

(5L)

Reference Books:

- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
- Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.

MJ-6P: Electricity and Magnetism Lab:

Credits: 01

List of Practicals:

1. To study the characteristics of a series RC Circuit.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Foster's Bridge.
4. To determine the resistance of a galvanometer using Thomson's method.
5. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
6. To verify the Thevenin and Norton theorems.
7. To verify the Superposition, and Maximum power transfer theorems.
8. To determine self-inductance of a coil by Anderson's bridge.
9. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
10. To study the response curve of a parallel LCR circuit and determine its (a) Antiresonant frequency and (b) Quality factor Q.

Reference Books:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- Engineering Practical Physics, S.Panigrahi and B.Mallick, 2015, Cengage Learning.
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

MJ-7: Quantum Mechanics I
MJT: Quantum Mechanics I**Credits 04 (Full Marks: 75)**
Credits 03 [45L]

Origins of Quantum Mechanics:

Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions. Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction. Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence. (10L)

Mathematical tools of Quantum Mechanics:

The linear vector Space, The Hilbert Space, Dimension and Basis of a vector space, Dirac notation, Operators, Commutation algebra, Uncertainty relation between two Operators. Eigen Value and Eigen Vector of an Operator. Matrix representation of Kets, Bras and operators. Matrix representation of Eigen value problem. Position and Momentum representation. Matrix and Wave Mechanics . (7L)

Postulates of Quantum Mechanics:

Basic postulates of Quantum Mechanics. Probability density, Superposition principle, Observables and operators, Time evolution operator, Stationary States, Schrodinger equation, Conservation of Probability, Time evolution of expectation values. Poisson Bracket and Commutators. The Ehrenfest theorem. (5L)

One dimensional Problem:

Motion of free particle: Continuous States. One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; The Finite potential barrier and well ($E > V_0$ & $E < V_0$); The tunnelling effect. The Harmonic Oscillator: Energy Eigenvalue and Energy Eigen state. Matrix representation of various operator. (8L)

Angular Momentum:

Orbital angular momentum and Spin angular momentum ; Matrix representation of Orbital and Spin angular momentum. Pauli spin matrices. Eigen value and Eigen function of different orbital and spin angular momentum operators. (5L)

Three Dimensional Problems:

Free particle in three dimensional Cartesian and Spherical Co-ordinates. Particle in three dimensional box. Three dimensional harmonic oscillator. Isotropic harmonic oscillator. The Hydrogen atom. (10L)

Reference Books

- ▶ Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- ▶ Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- ▶ Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- ▶ Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage

Learning.

- ▶ Modern Physics, G. Kaur and G.R. Pickrell, 2014, McGraw Hill
- ▶ Quantum Mechanics: Theory & Applications, A.K. Ghatak & S. Lokanathan, 2004, Macmillan

Additional Books for Reference

- ▶ Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- ▶ Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
- ▶ Quantum Physics, Berkeley Physics, Vol.4. E.H. Wichman, 1971, Tata McGraw-Hill Co.
- ▶ Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
- ▶ Six Ideas that Shaped Physics: Particle Behave like Waves, T.A. Moore, 2003, McGraw Hill

MJ-7P: Quantum Mechanics I Lab

Credits: 01

List of Practical:

1. Measurement of Planck's constant using black body radiation and photo-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
8. To setup the Millikan oil drop apparatus and determine the charge of an electron.
9. To show the tunnelling effect in tunnel diode using I-V characteristics.

Reference Books:

- ▶ Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- ▶ Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- ▶ A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal

MINOR (MI)

MI – 3/4: Thermal Physics and Statistical Mechanics

Credits 04 (Full Marks: 75)

MI – 3T/4T: Thermal Physics and Statistical Mechanics

Credits 03 [45L]

Laws of Thermodynamics:

Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between C_P and C_V , Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law and Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

(15L)

Thermodynamical Potentials:

Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for $(C_P - C_V)$, C_P/C_V , TdS equations.

(7L)

Kinetic Theory of Gases:

Derivation of Maxwell's law of distribution of velocities and its experimental verification .Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

(8L)

Theory of Radiation:

Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

(5L)

Statistical Mechanics:

Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas – comparison of three statistics.

(10L)

Reference Books:

- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill

- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears and
- G.L. Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.

MI – 3P/4P: Thermal Physics and Statistical (Lab)

Credits 01

List of Practical:

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of Cu by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.

Suggested readings:

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication

