MUGBERIA GANGADHAR MAHAVIDYALAYA

P.O.-BHUPATINAGAR, Dist.-PURBA MEDINIPUR, PIN.-721425, WEST BENGAL, INDIA
NAAC Re-Accredited B+ Level Govt. aided College
CPE (Under UGC XII Plan) & NCTE Approved Institutions
DBT Star College Scheme Award Recipient

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Department of Physics

Syllabus distribution for Physics Hons, GE and B.Sc Pure Pass

Physics (Hons)					
Course	Course content/Syllabus	Credit/ Marks	Allotted Teachers	Class allotted per week	Total class
SEMESTER I					
C1T	**Mathematical Physics** **Calculas** Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor andbinomial series (statements only). First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers. **Introduction to Probablity** Independent random variables: Probability distribution functions; binomial, Gaussian, and Poisson, with examples. Mean and variance. Dependent events: Conditional Probability. Bayes' Theorem and the idea of hypothesis testing.	04	Dr. Wadut Shaikh	02	(04*15) =60

	Vector Calculas Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields. Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vectoridentities. Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs). **Orthogonal Curvilinear Coordinates** Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian **Dirac Delta functionandits properties** Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.		Gourcha nd Manna	02	
C1P	**Mathematical Physics Lab** Introduction and Overview of Computer architecture and organization Basics of scientific computing Errors and error Analysis Introduction to plotting graphs with Gnuplot Introduction to programming in python Basic Programs Random number generation Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secantmethods Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation oflinear interpolation Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods	02	Dr. Wadut Shaikh	04	(04*15) =60
C2T	**Mechanics** **Fundamentals of Dynamics** Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of	04	Debasish Das	01	(04*15) =60

	variable- mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. **Work and Energy** Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Qualitative study of one dimensional motion from potential energy curves. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non- conservative forces. Law of conservation of Energy. **Collisions** Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames **Rotational Dynamics** Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.				
	Elasticity Relation between Elastic constants. Twisting torque on a Cylinder or Wire. **Fluid Motion** Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. **Gravitation and Central Force Motion** Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). **Oscillations** SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.		Arpita Das	02	

	Non-Inertial Systems Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems. **Special Theory of Relativity** Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum.		Sourav Panda	01	

C2P	**Mechanics Lab** **General Topic** Discussion on random errors in observations. **List of Practical** 1. Measurements of length (or diameter) using vernier caliper, screw gauge and travellingmicroscope. 2. To study the random error in observations. 3. To determine the height of a building using a Sextant. 4. To study the Motion of Spring and calculate, (a) Spring constant, (b) g and (c) Modulus of rigidity. 5. To determine the Moment of Inertia of a Flywheel. 6. To determine g and velocity for a freely falling body using Digital Timing Technique 7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method). 8. To determine the Young's Modulus of a Wire by Optical Lever Method. 9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle. 10. To determine the elastic Constants of a wire by Searle's method. 11. To determine the value of g using Bar Pendulum. 12. To determine the value of g using Kater's Pendulum.	02	Gourcha nd Manna	04	(04*15) =60

SEMESTER II					
C3T	**Electricity and Magnetism** **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. **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.	04	Debasish Das	01	(04*15) =60
	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 asa 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. **Magnetic Properties of Matter** Magnetization vector (M). Magnetic Intensity (H).Magnetic Susceptibility andpermeability. Relation between B, H, M. Ferromagnetism. B-H curve and hysteresis. **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. ChargeConservation and Displacement current		Arpita Das	02	
	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 Network theorems		Sourav Panda	01	

	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				
C3P	**Electricity and Magnetism (Lab)** Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses. **List of Practical** 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) Anti- resonant frequency and (b) Quality factor Q.	02	Sourav Panda	04	(04*15) =60

C4P	**Waves and Optics** **Superposition of Collinear Harmonic oscillations** Linearity and Superposition Principle. Superposition of two collinear oscillations having 1.) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. **Superposition of two perpendicular Harmonic Oscillations** Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequencyand their uses.	04	Dr. Wadut Shaikh	01	(04*15) =60
	Wave Motion Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves **Velocity of Waves** Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. **Superposition of Two Harmonic Waves** Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves. **Wave Optics** Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.		Rupam Mal	02	
	Interference Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. **Interferometer** Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3)		Gourchand Manna	01	

	Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer. **Diffraction and Holography** Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only) Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire. Holography: Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.				
C4P	**Wave and Optics Lab** **List of Practical** 1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law. 2. To investigate the motion of coupled oscillators. 3. To study Lissajous Figures. 4. Familiarization with: Schuster`s focusing; determination of angle of prism. 5. To determine refractive index of the Material of a prism using sodium source. 6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source. 7. To determine the wavelength of sodium source using Michelson's interferometer. 8. To determine wavelength of sodium light using Fresnel Biprism. 9. To determine wavelength of sodium light using Newton's Rings. 10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film. 11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source usingplane diffraction grating. 12. To determine dispersive power and resolving power of a plane diffraction grating.	02	Gourcha nd Manna	04	(04*15) =60

SEMESTER III					
C5T	**Mathematical Physics-II** **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. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity. **Frobenius Method and Special Functions** Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions (Jo(x) and J1(x))and Orthogonality.	04	Dr. Wadut Shaikh	02	(04*15) =60
	Some Special Integrals Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). **Variational calculus in physics** Functionals. Basic ideas of functionals. Extremization of action as a basic principle in mechanics. Lagrangian fomulation. Euler's equations of motion for simple systems: harmonics oscillators, simple pendulum, spherical pendulum, coupled oscillators. Cyclic coordinates. Symmetries and conservation laws. Legendre transformations and the Hamiltonian formulation of mechanics. Canonical equations of motion. Applications to simple systems. **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.		Rupam Mal	02	
C5P	**Mathematical Physics II Lab** **Introduction to Numerical computation using numpy and scipy** Introduction to the python numpy module. Arrays in numpy, array operations, array item selection, slicing, shaping arrays. Basic linear algebra using the linalg submodule. Introduction to online graph plotting using matplotlib. Introduction to the scipy module. Uses in	02	Dr. Wadut Shaikh	04	(04*15) =60

optimization and solution of differential equations. Introduction to OCTAVE (if time permits)

Curve fitting, Least square fit, Goodness of fit, standard deviation
Ohms law to calculate R, Hooke's law to calculate spring constant

Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems

Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)

Generation of Special functions using User defined functions

Generating and plotting Legendre Polynomials Generating and plotting Generating and Bessel function

Solution of ODE First order Differential equation Euler, modified Euler and Runge- Kutta second order methods Second order differential equation Fixed difference method

First order differential equation

1. Radioactive decay
2. Current in RC, LC circuits with DC source
3. Newton's law of cooling
4. Classical equations of motion Second order Differential Equation
5. Harmonic oscillator (no friction)
6. Damped Harmonic oscillator
7. Over damped
8. Critical damped
9. Oscillatory
10. Forced Harmonic oscillator
11. Transient and Steady state solution
12. Apply above to LCR circuits also
13. Solve $x^2\frac{d^2y}{dx^2} - 4x(1+x)\frac{dy}{dx} + 2(1+x)y = x^3$ with the boundary condition at $x = 1, y = \frac{1}{2}e^2, \frac{dy}{dx} = -\frac{3}{2}e^2 - 0.5$, in the range 1≤x≤3. Plot y and $\frac{dy}{dx}$ against x in the given range in the same graph.

Partial differential equations

1. Wave equation
2. Heat equation
3. Poisson equation
4. Laplace equation

C6T	Thermal Physics **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 CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient. 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. **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	04	Debasish Das	02	(04*15) =60
	Maxwell's Thermodynamic Relations Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. **Kinetic Theory of Gases** Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of		Arpita Das	02	

	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. Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 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.				
C6P	**Thermal Physics Lab** **List of Practical** 1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flowmethod. 2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus. 3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method. 4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method. 5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT). 6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions. 7. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature	02	Arpita Das	04	(04*15) =60
C7T	**Digital Systems and Applications** Integrated Circuits Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI	04	Sourav Panda	04	(04*15) =60

	and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital lCs. **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. **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. **Data processing circuits** Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. **Circuits** Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip- Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip- Flop. **Timers** C 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. **Shift registers** Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-outShift Registers (only up to 4 bits). **Counters (4 bits)** Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. **Computer Organization** Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map				
C7P	**Digital Systems and Applications Lab** **List of practical** 1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO. 2. To test a Diode and Transistor using a Multimeter.	02	Sourav Panda	04	(04*15) =60

	3. To design a switch (NOT gate) using a transistor. 4. To verify and design AND, OR, NOT and XOR gates using NAND gates. 5. To design a combinational logic system for a specified Truth Table. 6. To convert a Boolean expression into logic circuit and design it using logic gate ICs. 7. To minimize a given logic circuit. 8. Half Adder, Full Adder and 4-bit binary Adder. 9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C. 10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates. 11. To build JK Master-slave flip-flop using Flip-Flop ICs 12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram. 13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs. 14. To design an astable multivibrator of given specifications using 555 Timer. 15. To design a monostable multivibrator of given specifications using 555 Timer.				
SEC1T	**Electrical Circuits and Network Skills** **Basic Electricity Principles** Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. **Understanding Electrical Circuits** Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three- phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money. **Electrical Drawing and Symbols** Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. **Generators and Transformers** DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation oftransformers.	02	Rupam Mal	02	(02*15) =30

	Electric Motors Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor **Solid-State Devices** Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources **Electrical Protection** Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device) **Electrical Wiring** Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.				
	SEMESTER IV				
C8T	**Mathematical Physics III** **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. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals. **Integrals Transforms** Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.	04	Dr. Wadut Shaikh	02	(04*15) =60

	Matrices Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Upper-Triangular and Lower-Triangular Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew- Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrices. Trace of a Matrix. Inner Product. **Eigen-values and Eigenvectors** Cayley- Hamiliton Theorem. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary Differential Equations. Functions of a Matrix.		Modhumita Sahoo	02	
C8P	**Mathematical Physics III Lab** **List of practical** 1. Solve differential equations: $\frac{dy}{dx} = e^{-x} with y = 0 for x = 0$ $\frac{dy}{dx} + e^{-x} = x^2$ $\frac{d^2y}{dt^2} + 2\frac{dy}{dt} = -y$ $\frac{d^2y}{dt^2} + e^{-t}\frac{dy}{dt} = -y$ 2. Dirac Delta Function: Evaluate $\frac{1}{\sqrt{2\pi\sigma^2}}\int e^{\frac{-(x-2)^2}{2\sigma^2}}(x+3)dx$, for σ=1, .1, .01 and show it tends to 5 3. Fourier Series Program to sum $\sum_{n=1}^{\infty}(.2)^n$ Evaluate the Fourier coefficients of a given periodic function (square wave) 4. Frobenius method and Special functions: $\int_{-1}^{+1} P_n(\mu)P_m(\mu)d\mu = \delta_{n,m}$ Plot $P_n(x)$, $j_\nu(x)$ Show recursion relation 5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two). 6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program. 7. Evaluation of trigonometric functions e.g. sin θ, Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate 1/(x2+2) numerically and check with computer integration 8. Compute the nth roots of unity for n = 2, 3, and 4. 9. Find the two square roots of −5+12j. 10. Integral transform: FFT of e-x2	02	Dr. Wadut Shaikh	04	(04*15) =60
C9T	**Elements of Modern Physics** **Unit 1** Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-	04	Rupam Mal	02	(04*15) =60

	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. **Unit 2** 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; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.				
	Unit 3 One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier. Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers. **Unit 4** Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum Conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).		Gourcha nd Manna	02	

	Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing.				
C9P	**Elements of Modern Physics Lab** **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; maximumenergy 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 absorption lines in the rotational spectrum of Iodine vapour. **8.** To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet. **9.** To setup the Millikan oil drop apparatus and determine the charge of an electron. **10.** To show the tunneling effect in tunnel diode using I-V characteristics. **11.** To determine the wavelength of laser source using diffraction of single slit. **12.** To determine the wavelength of laser source using diffraction of double slits. **13.** To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating	02	Rupam Mal	04	(04*15) =60
C10T	**Analog Systems and Applications** **Semiconductor Diodes** P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current Flow Mechanism in Forward and Reverse Biased Diode.	04	Sourav Panda	02	(04*15) =60

	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. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell. **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.				
	Field Effect transistors Basic principle of operations only. **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. 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. 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. 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)		Arpita Das	02	

C10P	**Analog Systems and Applications Lab** **List of Practical** **1.** To study V-I characteristics of PN junction diode, and Light emitting diode. **2.** To study the V-I characteristics of a Zener diode and its use as voltage regulator. **3.** Study of V-I & power curves of solar cells, and find maximum power point & efficiency. **4.** To study the characteristics of a Bipolar Junction Transistor in CE configuration. **5.** To study the various biasing configurations of BJT for normal class A operation. **6.** To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias. **7.** To study the frequency response of voltage gain of a RC-coupled transistor amplifier. **8.** To design a Wien bridge oscillator for given frequency using an op-amp. **9.** To design a phase shift oscillator of given specifications using BJT. **10.** To study the Colpitt`s oscillator. **11.** To design a digital to analog converter (DAC) of given specifications. **12.** To study the analog to digital convertor (ADC) IC. **13.** To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain **14.** To design inverting amplifier using Op-amp (741,351) and study its frequency response **15.** To design non-inverting amplifier using Op-amp (741,351) & study its frequency response **16.** To study the zero-crossing detector and comparator **17.** To add two dc voltages using Op-amp in inverting and non-inverting mode **18.** To design a precision Differential amplifier of given I/O specification using Op-amp. **19.** To investigate the use of an op-amp as an Integrator. **20.** To investigate the use of an op-amp as a Differentiator. **21.** To design a circuit to simulate the solution of a 1st/2nd order differential equation.	02	Arpita Das	04	(04*15) =60

SEC2T	**Basic of Measurement** **Basic of Measurement** Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. **Electronic Voltmeter** Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance. **Cathode Ray Oscilloscope** Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only – no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working. **Signal Generators and Analysis Instruments** Block diagram, explanation and specifications of low frequency signal generators. Pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis. **Impedance Bridges & Q-Meters** Block diagram of bridge: working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges. **Digital Instruments** Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter. **Digital Multimeter** Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.	01	Dr. Wadut Shaikh	01	(01*15) =15

SEC2P	**Basic of Measurement Lab** **List of Practical** **A: The test of lab skills will be of the following test items** 1. Use of an oscilloscope. 2. CRO as a versatile measuring device. 3. Circuit tracing of Laboratory electronic equipment, 4. Use of Digital multimeter/VTVM for measuring voltages 5. Circuit tracing of Laboratory electronic equipment, 6. Winding a coil / transformer. 7. Study the layout of receiver circuit. 8. Trouble shooting a circuit 9. Balancing of bridges **B: Laboratory Exercises** 1. To observe the loading effect of a multimeter while measuring voltage across a lowresistance and high resistance. 2. To observe the limitations of a multimeter for measuring high frequency voltage andcurrents. 3. To measure Q of a coil and its dependence on frequency, using a Q- meter. 4. Measurement of voltage, frequency, time period and phase angle using CRO. 5. Measurement of time period, frequency, average period using universal counter/frequency counter. 6. Measurement of rise, fall and delay times using a CRO. 7. Measurement of distortion of a RF signal generator using distortion factor meter. 8. Measurement of R, L and C using a LCR bridge/ universal bridge. **C: Open Ended Experiments** 1. Using a Dual Trace Oscilloscope 2. Converting the range of a given measuring	01	Dr. Wadut Shaikh	02	(02*15) =30

SEMESTER V					
C11P	**Quantum Mechanics and Applications** **Schrodinger equation** Time dependent Schrodinger equation and dynamical evolution of a quantumstate; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and Energyoperators; commutator of position and momentum operators; Expectation values of position and momentum.Wave Function of a Free Particle. Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of anarbitrary wave function as a linear combination of energy eigen functions; General solution of the time dependent Schrodinger equation interms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position- momentum uncertainty principle. **General discussion of bound states in an arbitrary potential** Continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermitepolynomials; ground state, zero point energy & uncertainty principle.	04	Gourcha nd Manna	02	(04*15) =60
	Quantum theory of hydrogen-like atoms Time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angularmomentum operator & quantum numbers; Radial wave functions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angula rmomentum quantum numbers l and m;s,p,d,..shells **Atoms in Electric & Magnetic Fields** Electron angular momentum. Space quantization. Electron Spinand Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect:		Rupam Mal	02	

	Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton **Atoms in External Magnetic Fields** Normal and Anomalous ZeemanEffect. Paschen Back and Stark Effect (QualitativeDiscussiononly). **Many electron atoms** Pauli's Exclusion Principle. Symmetric & Antisymmetric WaveFunctions. Periodictable. Finestructure. Spinorbit coupling. Spectral Notations for Atomic States. Total angular momentum.Vector Model. Spin-orbit coupling in atoms - L- S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).				
C11P	**List of Practical** 1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom: $\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}[V(r) - E]$ where $V(r) = -\frac{e^2}{r}$ S wave Schrodinger equation for tnhe ground state and the first excited state of the hydrogen atom : Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 (eVÅ)1/2 , hc = 1973 (eVÅ) and m = 0.511x10 eV/c2 . 2. Solve the s-wave radial Schrodinger equation for an atom: $\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}[V(r) - E]$ where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential $V(r) = \frac{e^2}{r}e^{-r/a}$ Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 (eVÅ)1/2 , m = 0.511x106 eV/c2 , and a = 3 Å, 5 Å, 7 Å. In these units hc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases. 3. Solve the s-wave radial Schrodinger equation for a particle of mass m: $\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}[V(r) - E]$ For the anharmonic oscillator potential $V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$ for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2 , k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3}In these units, ch = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases. 4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule: $\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2\mu}{h^2}[V(r) - E]$ Where μ is the reduced mass of the two-atom system for the Morse potential $V(r) = D(e^{-2\alpha r'} - e^{-\alpha r'}), r' = \frac{r - r_0}{r}$ Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function. Take m= 940 x 10^6eV/C^2, D=0.755501eV, α=1.44, r_0=0.131349 Å	02	Dr. Wadut Shaikh	04	(04*15) =60

	Laboratory based experiments: 1. Study of Electron spin resonance- determine magnetic field as a function of the resonancefrequency 2. Study of Zeeman effect: with external magnetic field; Hyperfine splitting 3. To show the tunneling effect in tunnel diode using I-V characteristics. 4. Quantum efficiency of CCDs				
C12T	**Solid State Physics** **Crystal Structure:** Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis– Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor. **Elementary Lattice Dynamics:** Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrumin Solids. Dulong and Petit'sLaw, Einstein and Debye theories of specific heat of solids.T3 law **Magnetic Properties of Matter:** Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss'sTheory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.	04	Debasish Das	02	(04*15) =60
	Dielectric Properties of Materials Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes. **Ferro electric Properties of Materials:** Structural phase transition, Classification of crystals, Piezo electric effect, Pyro electric effect, Ferro electric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.		Arpita Das	02	

	Elementary band theory Kronig Penny model. Band Gap. Conductor, Semiconductor (PandNtype) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient. **Superconductivity** Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type Iand type II Superconductors, London's Equation and Penetration Depth. Isotopeeffect. Idea of BCS theory (Noderivation)				
C12P	**Solid State Physics Lab** **List of Practicals** 1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method) 2. To measure the Magnetic susceptibility of Solids. 3. To determine the Coupling Coefficient of a Piezoelectric crystal. 4. To measure the Dielectric Constant of a dielectric Materials with frequency 5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR) 6. To determine the refractive index of a dielectric layer using SPR 7. To study the PE Hysteresis loop of a Ferroelectric Crystal. 8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis. 9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 ^{o} C) and to determine its band gap. 10. To determine the Hall coefficient of a semiconductor sample.	02	Debasish Das	04	(04*15) =60
DSE1T	**Classical Dynamics** **Classical Mechanics of Point Particles** Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyroradius and gyrofrequency, motion in crossed electric and magnetic fields. Generalized coordinates and velocities, Recap of Lagrangian and Hamiltonian mechanics. Applications: Hamiltonian for a harmonic oscillator, solution of Hamilton's equation for Simple Harmonic Oscillations; particle in a central force field-	06	Sourav Panda	03	(06*15) =90

	conservation of angular momentum and energy. Effective potential. The Laplace- Runge-Lenz vector. **Small Amplitude Oscillations** Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.				
	Special Theory of Relativity Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle. **Fluid Dynamics** Density ρ and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation, qualitative description of turbulence, Reynolds number.		Rupam Mal	03	
DSE2T	**Nuclear and Particle Physics** **General Properties of Nuclei :** Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states. **Nuclear Models :** Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.	06	Dr. Wadut Shaikh	03	(06*15) =90

	Radioactivity decay : Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion. **Particle physics :** Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons.				
	Nuclear Reactions : Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering). **Interaction of Nuclear Radiation with matter :** Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter. **Detector for Nuclear Radiations :** Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (conceptof charge carrier and mobility), neutron detector. **Particle Accelerators :** Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.		Gourcha nd Manna	03	
SEMESTER VI					
C13T	**Electromagnetic Theory** **Maxwell Equations** Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.	04	Arpita Das	02	(04*15) =60

	EM Wave Propagation in Unbounded Media Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere. EM Wave in Bounded Media Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection &Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence).				
	Polarization of Electromagnetic Waves Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light. Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter. **Wave guides** Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission. **Optical Fibres** Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres(Concept and Definition Only).		Debasish Das	02	
C13P	**Electromagnetic Theory (Lab)** **List of Practical** 1. To verify the law of Malus for plane polarized light. 2. To determine the specific rotation of sugar solution using Polarimeter.	02	Debasish Das	04	(04*15) =60

	3. To analyze elliptically polarized Light by using a Babinet's compensator. 4. To study dependence of radiation on angle for a simple Dipole antenna. 5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating. 6. To study the reflection, refraction of microwaves. 7. To study Polarization and double slit interference in microwaves. 8. To determine the refractive index of liquid by total internal reflection usingWollaston's air-film. 9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece. 10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface. 11. To verify the Stefan`s law of radiation and to determine Stefan's constant. 12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.				
C14T	**Statistical Mechanics** **Classical Statistical Mechanics** Macrostate & Microstate, Elementary Concept of Ensemble, Microcanonical ensemble, Phase Space, Entropy and Thermodynamic Probability, Canonical ensemble, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature. Grand canonical ensemble and chemical potential.	04	Gourcha nd Manna	01	(04*15) =60
	Classical Theory of Radiation Properties of Thermal Radiation. Blackbody Radiation. Pure		Dr. Wadut	03	

	temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe. **Quantum Theory of Radiation** Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law. **Bose-Einstein Statistics:** distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law. **Fermi-Dirac Statistics:** Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.		Shaikh		
C14P	Statistical Mechanics Lab List of Practical 1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total numberof particles N and the initial conditions: a) Study of local number density in the equilibrium state (i) average; (ii) fluctuations. b) Study of transient behavior of the system (approach to equilibrium). c) Relationship of large N and the arrow of time. d) Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution. e) Computation and study of mean molecular speed and its dependence on particle mass.	02	Dr. Wadut Shaikh	04	(04*15) =60

	f) Computation of fraction of molecules in an ideal gas having speed near the mostprobable speed. 2. Computation of the partition function Z(□) for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose- Einstein statistics: a) Study of how Z(□), average energy <E>, energy fluctuation □E, specific heat at constant volume C_v, depend upon the temperature, total number of particles N and the spectrum of single particle states. b) Ratios of occupation numbers of various states for the systems considered above c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T. 3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature. 4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them forthese two cases. 5. Plot the following functions with energy at different temperatures a) Maxwell-Boltzmann distribution b) Fermi-Dirac distribution c) Bose-Einstein distribution				
DSE3T	**Communication Electronics** **Electronic communication** Introduction to communication – means and modes. Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band	04	Sourav Panda	02	(04*15) =60

	designations and usage. Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio. **Analog Modulation** Amplitude Modulation, modulation index and frequency spectrum. Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector), Qualitative idea of Super heterodyne receiver. **Analog Pulse Modulation** Channel capacity, sampling theorem, Basic Principles- PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing. **Digital Pulse Modulation** Need for digital transmission, Pulse Code Modulation, Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), and Binary Phase Shift Keying (BPSK).				
	Introduction to Communication and Navigation systems: Satellite Communication - Introduction, need, geosynchronous satellite orbits geostationary satellite advantages of geostationary satellites. Satellite visibility, transponders (C - Band), path loss, ground station, simplified block diagram of earth station. Uplink and downlink. **Mobile Telephony System** – Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only). GPS navigation system (qualitative idea only).		Debasish Das	02	
DSE3P	**Communication Electronics Lab** **List of Practical** 1. To design an Amplitude Modulator using Transistor. 2. To study envelope detector for demodulation of AM signal. 3. To study FM - Generator and Detector circuit. 4. To study AM Transmitter and Receiver. 5. To study FM Transmitter and Receiver. 6. To study Time Division Multiplexing (TDM).	02	Sourav Panda	04	(04*15) =60

	7. To study Pulse Amplitude Modulation (PAM). 8. To study Pulse Width Modulation (PWM). 9. To study Pulse Position Modulation (PPM). 10. To study ASK, PSK and FSK modulators.				
DSE4T	**Experimental Techniques** **Measurements** Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Guassian distribution. **Signals and Systems** Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise.	04	Dr. Wadut Shaikh	01	(04*15) =60
	Shielding and Grounding Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference **Transducers &industrial instrumentation(working principle, efficiency, applications)** Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector.		Rupam Mal	02	
	Digital Multimeter Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement.		Gourchand Manna	01	

	Impedance Bridges and Q-meter Block diagram and working principles of RLC Bridge. Q - meter and its working operation. Digital LCR bridge. **Vacuum Systems** Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization).				
DSE4P	**Experimental Techniques Lab** **List of Practical** 1. Determine output characteristics of a LVDT & measure displacement using LVDT 2. Measurement of Strain using Strain Gauge. 3. Measurement of level using capacitive transducer. 4. To study the characteristics of a Thermostat and determine its parameters. 5. Study of distance measurement using ultrasonic transducer. 6. Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75) 7. To measure the change in temperature of ambient using Resistance Temperature Device (RTD). 8. Create vacuum in a small chamber using a mechanical (rotary) pump and measure the chamber pressure using a pressure gauge. 9. Comparison of pickup of noise in cables of different types (co-axial, single shielded, double shielded, without shielding) of 2m length, understanding of importance of grounding using function generator of mV level & an oscilloscope. 10. To design and study the Sample and Hold Circuit. 11. Design and analyze the Clippers and Clampers circuits using junction diode	02	Rupam Mal	04	(04*15) =60

	12. To plot the frequency response of a microphone. 13. To measure Q of a coil and influence of frequency, using a Q-meter				
Generic Elective (GE) (For others department students)					
SEMESTER III					
GE3T	**Solid State Physics** **Crystal Structure** Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor. **Elementary Lattice Dynamics** Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T3 law **Magnetic Properties of Matter** Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.	04	Dr. Wadut Shaikh	02	(04*15) =60
	Dielectric Properties of Materials Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons. **Elementary band theory** Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient. **Superconductivity** Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect.		Debasish Das	02	

GE3P	**List of Practical** • Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method) • To measure the Magnetic susceptibility of Solids. • To determine the Coupling Coefficient of a piezoelectric crystal. • To measure the Dielectric Constant of a dielectric Materials with frequency • To determine the complex dielectric constant and plasma frequency of metal usingSurface Plasmon resonance (SPR) • To determine the refractive index of a dielectric layer using SPR • To study the PE Hysteresis loop of a Ferroelectric Crystal. • To study the BH curve of iron using a Solenoid and determine the energy loss. • To measure the resistivity of a semiconductor (Ge) crystal with temperature by four- probe method (room temperature to 150 oC) and to determine its band gap. • To determine the Hall coefficient of a semiconductor sample.	02	Debasish Das Rupam Mal	04	(04*15) =60
GE4T	**Electricity and Magnetism** **Vector Analysis** Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only). **Electrostatics** Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.	04	Rupam Mal	02	(04*15) =60

	Magnetism Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferro- magnetic materials.		Gourchand Manna	01	
	Electromagnetic Induction Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M oftwo coils. Energy stored in magnetic field. **Maxwell`s equations and Electromagnetic wave propagation** Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectricmedium, transverse nature of EM waves, polarization.		Debasish Das	01	
GE4P	**Electricity and Magnetism Lab** **List of Practical** **1.** To use a Multimeter for measuring a. Resistances b. AC and DC Voltages c. DC Current d. Checking electrical fuses. **2.** Ballistic Galvanometer: a. Measurement of charge and current sensitivity b. Measurement of CDR c. Determine a high resistance by Leakage Method d. To determine Self Inductance of a Coil by Rayleigh's Method. **3.** To compare capacitances using De'Sauty's bridge. **4.** Measurement of field strength B and its variation in a Solenoid (Determine dB/dx) **5.** To study the Characteristics of a Series RC Circuit. **6.** To study a series LCR circuit LCR circuit and determine its a. Resonant frequency	02	Sourav Panda Debasish Das	04	(04*15) =60

	b. Quality factor **7.** To study a parallel LCR circuit and determine its: a. Anti-resonant frequency and b. Quality factor Q **8.** To determine a Low Resistance by Carey Foster's Bridge. **9.** To verify the Thevenin and Norton theorems To verify the Superposition, and Maximum Power Transfer Theorems				
	B.Sc Pass				
	SEMESTER I				
DSC1A-C	**Mechanics** **Course Contents** **Vectors:** Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. **Ordinary Differential Equations:** 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. **Laws of Motion:** Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass. **Momentum and Energy:** Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets. **Rotational Motion:** Angular velocity and angular momentum. Torque. Conservation of angular momentum. **Gravitation:** Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).	04	Rupam Mal	02	(04*15) =60
	Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. **Elasticity:**		Sourav Panda	02	

	Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion – Torsional pendulum-Determination of Rigidity modulus and moment of inertia - q, η and σ by Searles method **Special Theory of Relativity:** Constancy of speed of light. Postulates of Special Theory of elativity. Length contraction. Time dilation. Relativistic addition of velocities.				
DSC1A-P	**Mechanics Lab** **Practical:** 1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope. 2. To determine the Height of a Building using a Sextant. 3. To determine the Moment of Inertia of a Flywheel. 4. To determine the Young's Modulus of a Wire by Optical Lever Method. 5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle. 6. To determine the Elastic Constants of a Wire by Searle's method. 7. To determine g by Bar Pendulum. 8. To determine g by Kater's Pendulum. 9. To determine **g** and velocity for a freely falling body using Digital Timing Technique 10. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g	02	Rupam Mal	04	(04*15) =60
	SEMESTER II				
DSC1B-T	**Electricity and Magnetism** **Vector Analysis**: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only). **Electrostatics:** Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem - Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric ipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation,	04	Debasish Das	02	(04*15) =60

	Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric. **Magnetism:** Magnetostatics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferro-magnetic materials. **Electromagnetic Induction:** Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field. **Maxwell`s equations and Electromagnetic wave propagation:** Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic electric medium, transverse nature of EM waves, polarization.		Gourcha nd Manna	02	
DSC1B-P	**Electricity and Magnetism** **Practical:** 1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses. 2. Ballistic Galvanometer: (i) Measurement of charge and current sensitivity (ii) Measurement of CDR (iii) Determine a high resistance by Leakage Method (iv) To determine Self Inductance of a Coil by Rayleigh's Method . 3. To compare capacitances using De'Sauty's bridge. 4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx). 5. To study the Characteristics of a Series RC Circuit. 6. To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor 7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q 8. To determine a Low Resistance by Carey Foster's Bridge. 9. To verify the Thevenin and Norton theorem	02	Gourcha nd Manna	04	(04*15) =60
	SEMESTER III				
DSC1C-T	**Thermal Physics and Statistical Mechanics** **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 CP & CV, Work	04	Debasish Das	04	(04*15) =60

	Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero. **Thermodynamic Potentials:** Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for (CP – CV), CP/CV, TdS equations. **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. **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. **Statistical Mechanics:** Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Fermi- irac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics.				
DSC1C-P	**Thermal Physics and Statistical Mechanics (lab)** **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 copper 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	02	Debasish Das	04	(04*15) =60

SEMESTER IV					
DSC1D-T	**Waves and Optics** **Superposition of Two Collinear Harmonic oscillations**: Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). **Superposition of Two Perpendicular Harmonic Oscillations**: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. **Waves Motion- General**: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity. **Fluids:** Surface Tension: Synclastic and anticlastic surface - Excess of pressure - Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature - Jaegar's method. Viscosity: Viscosity - Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of a liquid with temperature lubrication. Physics of low pressure - production and measurement of low pressure - Rotary pump - Diffusion pump - Molecular pump - Knudsen absolute gauge - penning and pirani gauge – Detection of leakage. **Sound:** Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria. **Wave Optics:** Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. **Interference:** Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal nclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. **Michelson's Interferometer:** Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index and Visibility of fringes.	04	Gourcha nd Manna	04	(04*15) =60

	Diffraction: Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. **Polarization:** Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization.				
DSC1D-P	**Waves and Optics (lab)** **Practical:** 1. To investigate the motion of coupled oscillators 2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ2 – T Law. 3. To study Lissajous Figures 4. Familiarization with Schuster`s focussing; determination of angle of prism. 5. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method). 6. To determine the Refractive Index of the Material of a given Prism using Sodium Light. 7. To determine Dispersive Power of the Material of a given Prism using Mercury Light 8. To determine the value of Cauchy Constants of a material of a prism. 9. To determine the Resolving Power of a Prism. 10. To determine wavelength of sodium light using Fresnel Biprism. 11. To determine wavelength of sodium light using Newton's Rings. 12. To determine the wavelength of Laser light using Diffraction of Single Slit. 13. To determine wavelength of (1) Sodium & (2) spectrum of Mercury light using plane diffraction Grating 14. To determine the Resolving Power of a Plane Diffraction Grating. 15. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits	02	Gourcha nd Manna	04	(04*15) =60
SEC2-T	**Basic Instrumentation Skills** **Basic of Measurement:** Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. **Multimeter:** Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. **Electronic Voltmeter:** Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity.	01	01	Dr. Wadut Shaikh	(01*15) =15

	Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. **AC millivoltmeter:** Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter**,** specifications and their significance. **Cathode Ray Oscilloscope:** Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working. **Signal Generators and Analysis Instruments:** Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis. **Impedance Bridges & Q-Meters:** Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges. **Digital Instruments:** Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter. **Digital Multimeter:** Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.				
SEC2-P	**Basic Instrumentation Skills Lab** **The test of lab skills will be of the following test items:** 1. Use of an oscilloscope. 2. CRO as a versatile measuring device. 3. Circuit tracing of Laboratory electronic equipment, 4. Use of Digital multimeter/VTVM for measuring voltages 5. Circuit tracing of Laboratory electronic equipment, 6. Winding a coil / transformer. 7. Study the layout of receiver circuit. 8. Trouble shooting a circuit 9. Balancing of bridges	01	Dr. Wadut Shaikh	02	(02*15) =30

SEMESTER V					
DSE1T	**Elements of Modern Physics** Planck's quantum, Planck's constant and light as a collection of photons; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson- Germer experiment Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra. Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle. Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wave function, probabilities and normalization; Probability and probability current densities in one dimension. One dimensional infinitely rigid box- energy eigenvalues and eigen functions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier. Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy. Radioactivity: stability of nucleus; Law of radioactive decay; Mean life & half-life; α decay; β decay - energy released, spectrum and Pauli's prediction of neutrino; γ - ray emission. Fission and fusion - mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions.	04	Rupam Mal	04	(04*15) =60
DSE1P	**Elements of Modern Physics (Practical)** **Practical:** 1. To determine value of Boltzmann constant using V-I characteristic of PN diode. 2. To determine work function of material of filament of directly heated vacuum diode. 3. To determine value of Planck's constant using LEDs of at	02	Rupam Mal	04	(04*15) =60

	least 4 different colours. 4. To determine the ionization potential of mercury. 5. To determine the wavelength of H-alpha emission line of Hydrogen atom. 6. To determine the absorption lines in the rotational spectrum of Iodine vapour. 7. To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photo-sensor and compare with incoherent source – Na light. 8. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light 9. To determine the value of e/m by magnetic focusing. 10. To setup the Millikan oil drop apparatus and determine the charge of an electron.				
SEMESTER VI					
DSE2T	**Solid State Physics** **Crystal Structure:** Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Mille Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor. **Elementary Lattice Dynamics:** Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T3 law **Magnetic Properties of Matter:** Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss. **Dielectric Properties of Materials:** Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons. **Elementary band theory:** Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient. **Superconductivity:** Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect.	04	Debasish Das	04	(04*15) =60

DSE2P	**Solid State Physics (Practical)** **Practical:** 1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method) 2. To measure the Magnetic susceptibility of Solids. 3. To determine the Coupling Coefficient of a Piezoelectric crystal. 4. To measure the Dielectric Constant of a dielectric Materials with frequency 5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR) 6. To determine the refractive index of a dielectric layer using SPR 7. To study the PE Hysteresis loop of a Ferroelectric Crystal. 8. To draw the BH curve of iron using a Solenoid and determine the energy loss from Hysteresis. 9. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four probe method (from room temperature to 150 ^{o}C) and to determine its band gap. 10. To determine the Hall coefficient of a semiconductor sample.	02	Debasish Das	04	(04*15) =60