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Ref. No..... Date .....

Semester-I (2022-23 Batch)

(SYLLABUS WITH EFFECT FROM THE ACADEMIC SESSION 2022-2023)

	Course Code	Course Title	Course wise Class (L+T+P)	Credit
Semester I	PHY-H-CC-T- 01	Mathematical Physics-I	Core (60L)	4
	PHY-H-CC-P- 01		Core (60P)	2
	PHY-H-CC-T-02	Mechanics	Core (60L)	4
	PHY-H-CC-P-02		Core (60P)	2
	PHY-H-GE-T- 01	Mechanics/ Thermal Physics and Statistical Mechanics	Generic Elective (60L)	4
	PHY-H-GE-P- 01		Generic Elective (60P)	2

B.Sc (Hons)

PHY-H-CC-T-01: MATHEMATICAL PHYSICS-I

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F. M. = 75 (Theory - 40, Internal Assessment - 15) Internal Assessment : Class Attendance (Theory) - 05, Theory (Class Test/ Assignment/ Tutorial) - 05, Practical (Sessional Viva-voce) - 05] Theory: 60 Lectures

Unit	Topic	Teacher	Lecture
1.	Calculus: Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). First Order Differential Equations and Integrating Factor.	Sourav Karar	10
2.	Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral	Sourav Karar	5

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3.	Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.	Sourav Karar	6
4.	Vector Calculus: 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	Sourav Karar	7
5.	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 proof)	Sourav Karar	10
6.	Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.	Sourav Karar	4
7.	Matrices: Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew- Hermitian Matrices. Singular and NonSingular matrices. Orthogonal and Unitary Matrices. Trace of a Matrix. Eigen-values and Eigenvectors (Degenerate and nondegenerate). Cayley-Hamiliton Theorem. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary homogeneous Differential Equations. Functions of a Matrix	Sourav Karar	6
8.	Introduction to probability: Independent random variables: Sample space and Probability distribution functions. Binomial, Gaussian, and Poisson distribution with examples. Mean and variance.	Sourav Karar	5
9.	Dirac Delta function and its properties: Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.	Sourav Karar	2

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PHY-H-CC-P-01: MATHEMATICAL PHYSICS-I Practical – 20 marks (Lab. Note Book - 05, Viva-Voce-05, Experiment -10) 60 Lectures

Unit	Topic	Teacher	Lecture
1.	Introduction and Overview Computer architecture and organization, memory and Input/output devices Basics of scientific computing Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow-emphasize the importance of making equations in terms of dimensionless variables, Iterative methods Errors and error Analysis Truncation and round off errors, Absolute and relative errors, Floating point computations.	Sayan Das	10
2.	Introduction to programming in Python/Fortran/Matlab/C/C++: Introduction to programming, constants, variables and data types, dynamical typing, operators and expressions, modules, I/O statements, iterables, compound statements, indentation in python, the if-elif-else block, for and while loops, nested compound statements, lists, tuples, dictionaries and strings, basic ideas of object-oriented programming. Introduction to plotting graphs with Matplotlib/Gnuplot/Origin/Excel Basic 2D and 3D graph plotting - plotting functions and datafiles, fitting data using gnuplot's fit function, polar and parametric plots, modifying the appearance of graphs, Surface and contour plots, exporting plots	Sayan Das	20
3.	Programs: Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search, Factorial of a number, sum of a power series e.g. sin, cosine, exponential series etc. Random number generation Area of circle, area of square, volume	Sayan Das	30

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	of sphere, value of pi (π), Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods Solution of linear and quadratic equation, solving ɵ = tan ɵ, I = I0{sinα/α}2 , in optics Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation Evaluation of trigonometric functions e.g. sinɵ, cosɵ, tanɵ etc. Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method Given Position with equidistant time data to calculate velocity and acceleration and vice versa. Find the area of B-H Hysteresis loop. Monte-Carlo integration Curve fitting, Least square fit, Goodness of fit, standard deviation Ohms law to calculate R, Hooke's law to calculate spring constant		

PHY-H-CC-T-02: MECHANICS

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75(Theory - 40, Internal Assessment - 15) Internal Assessment : Class Attendance (Theory) - 05, Theory (Class Test/ Assignment/ Tutorial) - 05, Practical (Sessional Viva-voce) - 05]

Unit	Topic	Teacher	Lecture
1.	Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Review of Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Momentum of variable-mass system: motion of rocket.	Nashiruddin Ahammed	8
2.	Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. 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.	Nashiruddin Ahammed	8
3.	Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.	Nashiruddin Ahammed	2

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4.	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. Euler's Equation. Bernoulli's Theorem	Nashiruddin Ahammed	2
5.	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). Physiological effects on astronauts.	Nashiruddin Ahammed	15
6.	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.	Nashiruddin Ahammed	10
7.	Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics 11 in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.	Nashiruddin Ahammed	5
8.	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. Four Vectors (definition and examples only).	Sayan Das	10

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PHY-H-CC-P-02: MECHANICS Practical - 20 marks

(Lab. Note Book - 05, Viva-Voce-05,Experiment -10) 60 Lectures

1.

Unit	Topic	Teacher	Lecture
1.	Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.	Nashiruddin Ahammed	6
2.	To study the random error in observations.	Nashiruddin Ahammed	6
3.	To determine the height of a building using a Sextant.	Nashiruddin Ahammed	6
4.	To determine the value of g using Kater's Pendulum.	Nashiruddin Ahammed	6
5.	. To determine g and velocity for a freely falling body using Digital Timing Technique	Nashiruddin Ahammed	6
6.	To determine the Young's Modulus of the material of a bar by flexure method	Nashiruddin Ahammed	6
7.	To determine the Modulus of Rigidity of a Wire by - Dynamic Method	Nashiruddin Ahammed	6
8.	To determine the elastic Constants of a wire by Searle's method.	Nashiruddin Ahammed	6
9.	To determine the value of g using Bar Pendulum	Nashiruddin Ahammed	6
10	To draw the frequency - resonance length curve of a sonometer wire and to determine an unknown frequency of a tuning fork	Nashiruddin Ahammed	6

Generic Elective

PHY-H-GE-T-01: MECHANICS

(Credits: Theory-04, Practicals-02) F.M. = 75 (Theory - 40, Practical - 20, Internal Assessment - 15) Internal Assessment [Class Attendance (Theory) - 05, Theory (Class Test/ Assignment/

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Tutorial) - 05, Practical (Sessional Viva-voce) - 05] Theory: 60 Lectures

Unit	Topic	Teacher	Lecture
1.	Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. (4 Lectures) Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. (6 Lectures) Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass. (10 Lectures) Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets. (6 Lectures) Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum. (5 Lectures).	Nashiruddin Ahammed	31
2.	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. Basic idea of global positioning system (GPS). Weightlessness. Physiological effects on astronauts	Nashiruddin Ahammed	9
3.	Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations	Nashiruddin Ahammed	3
4.	Elasticity: Hooke's law - Stress-strain diagram - Elastic moduliRelation 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-Y, η and σ by Searle's method	Nashiruddin Ahammed	7
5.	Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts.	Sayan Das	10

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PHY-H-GE-P-01: MECHANICS

Practical - 20 marks (Lab. Note Book - 05, Viva-Voce-05,Experiment -10) 60 Lectures

Unit	Topic	Teacher	Lecture
1.	Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.	Nashiruddin Ahammed	6
2.	To study the random error in observations.	Nashiruddin Ahammed	6
3.	To determine the height of a building using a Sextant.	Nashiruddin Ahammed	6
4.	To determine the value of g using Kater's Pendulum.	Nashiruddin Ahammed	6
5.	. To determine g and velocity for a freely falling body using Digital Timing Technique	Nashiruddin Ahammed	6
6.	To determine the Young's Modulus of the material of a bar by flexure method	Nashiruddin Ahammed	6
7.	To determine the Modulus of Rigidity of a Wire by - Dynamic Method	Nashiruddin Ahammed	6
8.	To determine the elastic Constants of a wire by Searle's method.	Nashiruddin Ahammed	6
9.	To determine the value of g using Bar Pendulum	Nashiruddin Ahammed	6
10	To draw the frequency - resonance length curve of a sonometer wire and to determine an unknown frequency of a tuning fork	Nashiruddin Ahammed	6

CORE COURSE (GENERAL/PASS IN PHYSICS)

PHY-G-CC-T-01: MECHANICS

(Credits: Theory-04, Practicals-02) F.M. = 75 (Theory - 40, Practical – 20, Internal Assessment – 15) Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

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Unit	Topic	Teacher	Lecture
1.	Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. (4 Lectures) Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. (6 Lectures) Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass. (10 Lectures) Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets. (6 Lectures) Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum. (5 Lectures).	Nashiruddin Ahammed	31
2.	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. Basic idea of global positioning system (GPS). Weightlessness. Physiological effects on astronauts	Nashiruddin Ahammed	9
3.	Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations	Nashiruddin Ahammed	3
4.	Elasticity: Hooke's law - Stress-strain diagram - Elastic moduliRelation 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-Y, η and σ by Searle's method	Nashiruddin Ahammed	7
5.	Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts.	Sayan Das	10

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PHY-G-CC-P-01: MECHANICS

Unit	Topic	Teacher	Lecture
1.	Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.	Nashiruddin Ahammed	6
2.	To study the random error in observations.	Nashiruddin Ahammed	6
3.	To determine the height of a building using a Sextant.	Nashiruddin Ahammed	6
4.	To determine the value of g using Kater's Pendulum.	Nashiruddin Ahammed	6
5.	. To determine g and velocity for a freely falling body using Digital Timing Technique	Nashiruddin Ahammed	6
6.	To determine the Young's Modulus of the material of a bar by flexure method	Nashiruddin Ahammed	6
7.	To determine the Modulus of Rigidity of a Wire by - Dynamic Method	Nashiruddin Ahammed	6
8.	To determine the elastic Constants of a wire by Searle's method.	Nashiruddin Ahammed	6
9.	To determine the value of g using Bar Pendulum	Nashiruddin Ahammed	6
10	To draw the frequency - resonance length curve of a sonometer wire and to determine an unknown frequency of a tuning fork	Nashiruddin Ahammed	6

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Semester-III

(SYLLABUS WITH EFFECT FROM THE ACADEMIC SESSION 2018-2019)

Honours

Course Code	Course Title	Course Nature	Credit
PHY-H-CC-T-05	Mathematical Physics-II	Core (60L)	4
PHY-H-CC-P-05		Core (60P)	2
PHY-H-CC-T-06	Thermal Physics	Core (60L)	4
PHY-H-CC-P-06		Core (60P)	2
PHY-H-CC-T-07	Digital Systems and Applications	Core (60L)	4
PHY-H-CC-P-07		Core (60P)	2
PHY-H-GE-T-03	Digital, Analog Circuits and Instrumentation/ Elements of Modern Physics	Generic Elective(60L)	4
PHY-H-GE-P-03		Generic Elective(60P)	2
PHY-H-SEC-T-01	Physics Workshop Skills/ Computational Physics Skills/ Electrical Circuits & Network Skills/ Basic Instrumentation Skills	Skill Enhancement (30L)	2
Total	**5 courses**	**Total**	**26**

PHY-H-CC-T-05: MATHEMATICAL PHYSICS-II

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75(Theory - 40, Internal Assessment – 15) Internal Assessment : Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

Unit	Topic	Teacher	Lecture

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1	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.	Sayan Das	14
2	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 and Orthogonality.	Sayan Das	24
3	Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).	Sayan Das	4
4	Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error.	Sayan Das	4
5	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.	Sayan Das	14

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PHY-H-CC-P-05: MATHEMATICAL PHYSICS-II

Practical – 20 marks (Lab. Note Book – 05, Viva-Voce-05,Experiment -10)

Unit	Topic	Teacher	Lecture
1	Introduction to Numerical computation numpy, scipy/Matlab/Octave/ Scilab	Sayan Das	20
2	Curve fitting, Least square fit, Goodness of fit, standard deviation	Sayan Das	4
3	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	Sayan Das	6
4	Solution of ODE First order Differential equation Euler, modified Euler and Runge-Kutta second order methods Second order differential equation ,Fixed difference method	Sayan Das	30

PHY-H-CC-T-06: THERMAL PHYSICS

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75(Theory - 40, Internal Assessment – 15) Internal Assessment : Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) –

05, Practical (Sessional Viva-voce) - 05]

Unit	Topic	Teacher	Lecture

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1	Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroeth 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 Coefficient.	Nasiruddin Ahammed	8
2	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.	Nasiruddin Ahammed	10
3	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 Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.	Nasiruddin Ahammed	7

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4	Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables.Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free 26 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.	Nasiruddin Ahammed	7
5	Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp[1]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.	Nasiruddin Ahammed	7
6	Kinetic Theory of Gases Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of	Nasiruddin Ahammed	7
	Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.		
7	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.	Nasiruddin Ahammed	4

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8	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.	Nasiruddin Ahammed	10

PHY-H-CC-P-06: THERMAL PHYSICS

Practical – 20 marks (Lab. Note Book – 05, Viva-Voce-05,Experiment -10

Unit	Topic	Teacher	Lecture
1	To determine Mechanical Equivalent of Heat, J, by Callender and 27 Barne's constant flow method	Nasiruddin Ahammed	20
2	To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.	Nasiruddin Ahammed	10
3	To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT)	Nasiruddin Ahammed	10
4	To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.	Nasiruddin Ahammed	20

PHY-H-CC-T-07: DIGITAL SYSTEMS AND APPLICATIONS

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75(Theory - 40, Internal Assessment – 15) Internal Assessment: Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

Unit	Topic	Teacher	Lecture

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1	Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.	Sayan Das	3
2	Integrated Circuits (Qualitative treatment only): Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital LCS.	Sayan Das	3
3	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.	Sayan Das	6
4	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.	Sayan Das	6
5	Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.	Sayan Das	4
6	Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.	Sayan Das	5
7	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.	Sayan Das	6
8	Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.	Sayan Das	3
9	Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-inSerial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).	Sayan Das	2

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10	Counters(4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.	Sayan Das	4
11	Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map	Sayan Das	6
12	Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI.	Sayan Das	8
13	Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions.	Sayan Das	4

PHY-H-CC-P-07: DIGITAL SYSTEMS AND APPLICATIONS

Practical – 20 marks (Lab. Note Book – 05, Viva-Voce-05,Experiment -10)

Unit	Topic	Teacher	Lecture
1	To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.	Sayan Das	4
2	To test a Diode and Transistor using a Multimeter.	Sayan Das	4
3	To design a switch (NOT gate) using a transistor.	Sayan Das	4
4	To verify and design AND, OR, NOT , XOR and using NAND gates.	Sayan Das	4
5	5. To design a combinational logic system for a specified Truth Table.	Sayan Das	6

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6	6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.	Sayan Das	4
7	7. To minimize a given logic circuit.	Sayan Das	4
8	8. Half Adder, Full Adder and 4-bit binary Adder.	Sayan Das	4
9	9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.	Sayan Das	6
10	10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.	Sayan Das	6
11	11. To build JK Master-slave flip-flop using Flip-Flop ICs	Sayan Das	6
12	Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI. (8	Sayan Das	4
13	Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions.	Sayan Das	4

Generic Elective Papers (GE)

PHY-H-GE-T-02: THERMAL PHYSICS AND STATISTICAL MECHANICS

(Credits: Theory-04, Practicals-02) F.M. = 75 (Theory - 40, Practical – 20, Internal Assessment – 15)
Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

Unit	Topic	Teacher	Lecture

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1	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 and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law and Entropy, Carnot's cycle & theorem, Entropy	Nasiruddin Ahammed	22
	changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero		
2	Thermodynamical Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Clausius[1]Clapeyron Equation, Expression for (CP - CV), CP/CV, TdS equations.	Nasiruddin Ahammed	10
3	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	Nasiruddin Ahammed	10
4	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.	Nasiruddin Ahammed	6
5	Statistical Mechanics: Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Phase space - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics.	Nasiruddin Ahammed	12

PHY-H-GE-CC-P-02: THERMAL PHYSICS

Practical – 20 marks (Lab. Note Book – 05, Viva-Voce-05,Experiment -10

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Unit	Topic	Teacher	Lecture
1	To determine Mechanical Equivalent of Heat, J, by Callender and 27 Barne's constant flow method	Nasiruddin Ahammed	20
2	To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.	Nasiruddin Ahammed	10
3	To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT)	Nasiruddin Ahammed	10
4	To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.	Nasiruddin Ahammed	20

CORE COURSE (GENERAL/PASS IN PHYSICS)

PHY-G-CC-T-03: MATHEMATICAL PHYSICS-III

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75(Theory - 40, Internal Assessment – 15) Internal Assessment : Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) – 05

Unit	Topic	Teacher	Lecture
1	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	Sayan Das	30
	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.		

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2	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.	Sayan Das	15
3	Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.	Sayan Das	15

PHY-G-CC-P-03: MATHEMATICAL PHYSICS-III

Practical – 20 marks (Lab. Note Book – 05, Viva-Voce-05,Experiment -10)

Unit	Topic	Teacher	Lecture
1	Solving differential Equation	Sayan Das	40
2	Nth root of unity	Sayan Das	10
3	Dirac delta functions	Sayan Das	10

PHY-G-SEC-T-01: COMPUTATIONAL PHYSICS SKILLS (Credits: 02)

F.M. = 50 (Theory - 40, Internal Assessment – 10) Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05]

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Unit	Topic	Teacher	Lecture
1	Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of linux as an Editor. Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a	Sayan Das	10
	finite series, calculation of sin(x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal		
2	Scientific Programming: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and NonExecutable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.	Sayan Das	10

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3	Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DOENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.	Sayan Das	10

Semester-V

(SYLLABUS WITH EFFECT FROM THE ACADEMIC SESSION 2018-2019)

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Honours

Course Code	Course Title	Course Nature	Credit
PHY-H-CC-T-11	Quantum Mechanics & Applications	Core (60L)	4
PHY-H-CC-P-11		Core (60P)	2
PHY-H-CC-T-12	Solid State Physics	Core (60L)	4
PHY-H-CC-P-12		Core (60P)	2
PHY-H-DSE-T-01	Advanced Mathematical Physics I/Advanced Mathematical Physics II/Classical Dynamics/Applied Dynamics	Discipline Specific Elective (60L+60P)	6
PHY-H-DSE-P-01			
PHY-H-DSE-T-02	Nuclear and Particle Physics/Astronomy and Astrophysics/Atmospheric Physics/Earth Physics	Discipline Specific Elective (60L+60P)	6
PHY-H-DSE-P-02			
Total	**4 courses**	**Total**	**24**

PHY-H-CC-T-11: QUANTUM MECHANICS AND APPLICATIONS

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75(Theory - 40, Internal Assessment – 15) Internal Assessment : Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

Unit	Topic	Teacher	Lecture

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1	Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; 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 Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.	Sayan Das	6
2	Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms 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 wavefunction; Position-momentum uncertainty principle.	Sayan Das	10
3	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; Hermite polynomials; ground state, zero point energy & uncertainty principle.	Sayan Das	12

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4	Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d,..shells.	Sayan Das	10
5	Atoms in Electric & Magnetic Fields: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.	Sayan Das	8
6	Atoms in External Magnetic Fields:- Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).	Sayan Das	4
7	Many electron atoms: Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral 39 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.).	Sayan Das	10

PHY-H-CC-P-11: QUANTUM MECHANICS AND APPLICATIONS

Unit	Topic	Teacher	Lecture
1	Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:	Sayan Das	20
2	Solve the s-wave radial Schrodinger equation for an atom, for the screened coulomb potential	Sayan Das	20
3	Solve the s-wave radial Schrodinger equation for a particle of mass m For the anharmonic oscillator potential	Sayan Das	20

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PHY-H-CC-T-12: SOLID STATE PHYSICS (Credits: Theory-04, Practicals-02)

Theory: 60 Lectures F.M. = 75(Theory - 40, Internal Assessment – 15) Internal Assessment : Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

Unit	Topic	Teacher	Lecture
1	Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis - Central and NonCentral 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.	Nasiruddin Ahammed	12
2	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	Nasiruddin Ahammed	10
3	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.	Nasiruddin Ahammed	8
4	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.	Nasiruddin Ahammed	8
5	Ferroelectric Properties of Materials: Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.	Nasiruddin Ahammed	6

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6	Elementary band theory: Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient. \	Nasiruddin Ahammed	10
7	42 Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation)	Nasiruddin Ahammed	6

PHY-H-CC-P-12: SOLID STATE PHYSICS

Practical – 20 marks (Lab. Note Book – 05, Viva-Voce-05,Experiment -10)

Unit	Topic	Teacher	Lecture
1	To measure the Dielectric Constant of a dielectric Materials with frequency	Nasiruddin Ahammed	30
2	To measure the resistivity of a semiconductor (Ge) with temperature by fourprobe method (room temperature to 150 °C) and to determine its band gap	Nasiruddin Ahammed	30

PHY-H-DSE-T-01: CLASSICAL DYNAMICS

(Credits: Theory-05, Tutorials-01) Theory: 75 Lectures F.M. = 75 (Theory - 60, Internal Assessment – 15) Internal Assessment [Class Attendance – 05, Class Test/ Assignment/ Tutorial – 10]

Unit	Topic	Teacher	Lecture
1	Classical Mechanics of Point Particles: Generalised coordinates and velocities. Hamilton's Principle, Lagrangian and Euler-Lagrange equations. Applications to simple systems such as coupled oscillators. Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, particle in a central force field. Poisson brackets. Canonical transformations	Sayan Das	22

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2	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 & twin paradox. Four-vectors: space-like, time-like & light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energymomentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of fourmomentum. Relativistic kinematics. Application to two-body decay of an unstable particle. The Electromagnetic field tensor and its transformation under Lorentz transformations: relation to known transformation properties of E and B. Electric and magnetic fields due to a uniformly moving charge. Equation of motion of charged particle & Maxwell's equations in tensor form. Motion of charged particles in external electric and magnetic fields	Sayan Das	38
3	Electromagnetic radiation: Review of retarded potentials. Potentials due to a moving charge: Lienard Wiechert potentials. Electric & Magnetic fields due to a moving charge: Power radiated, Larmor's formula and its relativistic generalisation.	Sayan Das	15

PHY-H-DSE-T-02: NUCLEAR AND PARTICLE PHYSICS

(Credits: Theory-05, Tutorials-01) Theory: 75 Lectures F.M. = 75 (Theory - 60, Internal Assessment – 15) Internal Assessment [Class Attendance – 05, Class Test/ Assignment/ Tutorial – 10]

Unit	Topic	Teacher	Lecture

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1	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.	Sourav Karar	10
2	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.	Sourav Karar	12
3	Radioactivity decay:(a) Alpha decay: basics of a-decay processes, theory of a- emission, Gamow factor, Geiger Nuttall law, a-decay spectroscopy. (b) (3-decay: energy kinematics for (3- decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion	Sourav Karar	9
4	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).	Sourav Karar	8
5	Nuclear Astrophysics: Early universe, primordial nucleosynthesis (particle nuclear interactions), stellar nucleosynthesis, concept of gamow window, heavy element production: r- and s- process path.	Sourav Karar	5
6	107 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	Sourav Karar	6

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7	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 (concept of charge carrier and mobility), neutron detector.	Sourav Karar	6
8	Particle Accelerators: Accelerator facility available in India: Van-de Graff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.	Sourav Karar	5
9	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	Sourav Karar	14
	charm, concept of quark model, color quantum number and gluons.		

(GENERAL/PASS IN PHYSICS)

PHY-G-DSE-T-01 Electricity and magnetism

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75 (Theory - 40, Internal Assessment - 15) Internal Assessment : Class Attendance (Theory) - 05, Theory (Class Test/ Assignment/ Tutorial) - 05, Practical (Sessional Viva-voce) - 05]

Unit	Topic	Teacher	Lecture

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1.	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. (6 Lectures) 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.(6 Lectures) 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. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. (10 Lectures)	Sourav Karar	22
2.	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.	Sourav Karar	8
3.	Magnetic Field: Magnetic force between current elements and definition of Magnetic Field B. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. 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 and permeability. Relation between B, H, M. B-H curve and hysteresis	Sourav Karar	12
4.	Transients: Growth and decay of currents and voltages in L-R, CR and L-C-R circuits; electrical oscillations in L-C circuits. (2 Lectures) 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. (4 Lectures) Network	Sourav Karar	15

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	theorems: Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuit		
5.	Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.	Sourav Karar	3

PHY-G-DSE-P-01 Electricity and magnetism

Practical - 20 marks (Lab. Note Book - 05, Viva-Voce-05,Experiment -10) 60 Lectures

Unit	Topic	Teacher	Lecture
1.	Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances and (e) Checking electrical fuses.	Sourav Karar	12
2.	To study the characteristics of a series(a) RC Circuit.	Sourav Karar	12
3.	To determine an unknown Low Resistance using Potentiometer. 4. To determine an unknown Low Resistance using Carey Foster's Bridge.	Sourav Karar	12
4.	. 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	Sourav Karar	12
5.	To study the characteristics of a series LR Circuit.	Sourav Karar	12

PHY-G-SEC-T-03: RADIATION SAFETY

(Credits: 02) F.M. = 50 (Theory - 40, Internal Assessment – 10) Internal Assessment [Class Attendance

(Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05] Theory: 30 Lectures

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Unit	Topic	Teacher	Lecture
1	Basics of Atomic and Nuclear Physics: Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, The composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission.	Sayan Das	6
2	Interaction of Radiation with matter: Types of Radiation: Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, Interaction of Photons - Photo electric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, Interaction of Charged Particles: Heavy	Sayan Das	7
	charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), Interaction of Neutrons- Collision, slowing down and Moderation.		
3	Radiation detection and monitoring devices: Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). Radiation detection: Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors (Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry.	Sayan Das	7

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4	Radiation safety management: Biological effects of ionizing radiation, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Subcritical system (ADS) for waste management.	Sayan Das	5
5	Application of nuclear techniques: Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime detection, Mining and oil. Industrial Uses: Tracing, Gauging, Material Modification, Sterization, Food preservation.	Sayan Das	5

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Semester-II (2022-23 Batch)
(SYLLABUS WITH EFFECT FROM THE ACADEMIC SESSION 2022-2023)
Honours

Semester II	PHY-H-CC-T-03	Electricity and Magnetism	Core (60L)	4
	PHY-H-CC-P-03		Core (60P)	2
	PHY-H-CC-T- 04	Waves and Optics	Core (60L)	4
	PHY-H-CC-P- 04		Core (60P)	2
	PHY-H-GE-T-02	Electricity and Magnetism/ Waves and Optics	Generic Elective (60L)	4
	PHY-H-GE-P- 02		Generic Elective (60P)	2
	AECC-2	Bengali / English communication	Ability Enhancement Compulsory (30L)	2
	Total	**4 courses**	**Total**	**20**

PHY-H-CC-T-03: ELECTRICITY AND MAGNETISM

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75 (Theory - 40, Internal Assessment - 15) Internal Assessment : Class Attendance (Theory) - 05, Theory (Class Test/ Assignment/ Tutorial) - 05, Practical (Sessional Viva-voce) - 05]

Unit	Topic	Teacher	Lecture

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1.	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. (6 Lectures) 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.(6 Lectures) 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. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. (10 Lectures)	Sourav Karar	22
2.	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.	Sourav Karar	8
3.	Magnetic Field: Magnetic force between current elements and definition of Magnetic Field B. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying	Sourav Karar	12
	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 and permeability. Relation between B, H, M. B-H curve and hysteresis		

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4.	Transients: Growth and decay of currents and voltages in L-R, CR and L-C-R circuits; electrical oscillations in L-C circuits. (2 Lectures) 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. (4 Lectures) Network theorems: Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuit	Sourav Karar	15
5.	Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.	Sourav Karar	3

PHY-H-CC-P-03: ELECTRICITY AND MAGNETISM

Practical - 20 marks (Lab. Note Book - 05, Viva-Voce-05,Experiment -10) 60 Lectures

Unit	Topic	Teacher	Lecture
1.	Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances and (e) Checking electrical fuses.	Sourav Karar	12
2.	To study the characteristics of a series(a) RC Circuit.	Sourav Karar	12
3.	To determine an unknown Low Resistance using Potentiometer. 4. To determine an unknown Low Resistance using Carey Foster's Bridge.	Sourav Karar	12
4.	. 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	Sourav Karar	12

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5.	To study the characteristics of a series LR Circuit.	Sourav Karar	12

PHY-H-CC-T-04: WAVES AND OPTICS

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75(Theory - 40, Internal Assessment - 15) Internal Assessment : Class Attendance (Theory) - 05, Theory (Class Test/ Assignment/ Tutorial) - 05, Practical (Sessional Viva-voce) - 05]

Unit	Topic	Teacher	Lecture
1.	Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and equal frequency differences. (5 Lectures) Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses. (2 Lectures) 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 (4 Lectures) 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.(6 Lectures)	Sayan Das	12

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2.	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	Sayan Das	7
3.	Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. (3 Lectures) 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. (9 Lectures)	Sayan Das	12
4.	Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.	Sayan Das	4
5.	Diffraction: Kirchhoff s Integral Theorem, Fresnel-Kirchhoff s Integral formula and its application to rectangular slit. (5 Lectures) Fraunhofer diffraction: Single slit. Circular aperture,	Sayan Das	20
	Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. (8 Lectures) 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. (7 Lectures)		

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PHY-H-CC-P-04: WAVES AND OPTICS

Practical - 20 marks (Lab. Note Book - 05, Viva-Voce-05,Experiment -10)

Unit	Topic	Teacher	Lecture
1.	To study Lissajous Figures.	Sayan Das	8
2.	Familiarization with: Schuster's focusing; determination of angle of prism	Sayan Das	8
3.	To determine refractive index of the Material of a prism using sodium source	Sayan Das	8
4.	To determine the dispersive power of the material of a prism using mercury source.	Sayan Das	8
5.	To determine wavelength of sodium light using Newton's Rings.	Sayan Das	8
6.	To determine dispersive power and resolving power of a plane diffraction grating.	Sayan Das	14
7.	To draw the deviation - wavelength of the material of a prism and to find the wavelength of an unknown line from its deviation.	Sayan Das	14

Generic Elective Papers (GE)

PHY-H-GE-T-02: WAVES AND OPTICS

(Credits: Theory-04, Practicals-02) F.M. = 75 (Theory - 40, Practical - 20, Internal Assessment - 15)
Internal Assessment [Class Attendance (Theory) - 05, Theory (Class Test/ Assignment/ Tutorial) - 05, Practical (Sessional Viva-voce) - 05] (60 Lectures)

Unit	Topic	Teacher	Lecture

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1.	Superposition of Two Collinear Harmonic oscillations: Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).(4 Lectures) Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses. (2 Lectures) Waves Motion- General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity.	Sayan Das	19
	Plane waves. Spherical waves, Wave intensity. (7 Lectures) 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 - Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of liquid with temperature-lubrication.		
2.	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. (6 Lectures	Sayan Das	7
3.	Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. (3 Lectures) 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 inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. (10 Lectures) Michelson's Interferometer: (1) Idea of form of fringes (no theory needed), (2) Determination of wavelength, (3) Wavelength difference, (4) Refractive index, and (5) Visibility of fringes. (3 Lectures)	Sayan Das	16

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4.	Diffraction: Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and Diffraction grating. Fresnel Diffraction: Halfperiod zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.	Sayan Das	14
5.	Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization.	Sayan Das	5

PHY-H-GE-P-02: WAVES AND OPTICS

Practical - 20 marks (Lab. Note Book - 05, Viva-Voce-05,Experiment -10) 60 Lectures

Unit	Topic	Teacher	Lecture
1	To investigate the motion of coupled oscillators	Sayan Das	4
4	To study Lissajous Figures	Sayan Das	4
5	Familiarization with Schuster's focussing; determination of angle of prism	Sayan Das	4
6	To determine the Coefficient of Viscosity of water by any method	Sayan Das	4
7	To determine the Refractive Index of the Material of a Prism using Sodium Light	Sayan Das	4
8	To determine Dispersive Power of the Material of a Prism using Mercury Light	Sayan Das	6
9	To determine the value of Cauchy Constants	Sayan Das	4
10	To determine the Resolving Power of a Prism	Sayan Das	4
11	To determine wavelength of sodium light using Fresnel Biprism	Sayan Das	4
12	To determine wavelength of sodium light using Newton's Rings	Sayan Das	4
13	To determine the wavelength of monochromatic/Laser light using Diffraction of Single Slit	Sayan Das	4
14	To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction	Sayan Das	6

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CORE COURSE (GENERAL/PASS IN PHYSICS)

PHY-G-CC-T-04: WAVES AND OPTICS

(Credits: Theory-04, Practicals-02) F.M. = 75 (Theory - 40, Practical – 20, Internal Assessment – 15)
Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05

Unit	Topic	Teacher	Lecture
1.	Superposition of Two Collinear Harmonic oscillations: Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).(4 Lectures) Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses. (2 Lectures) 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. (7 Lectures) 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 - Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of liquid with temperature-lubrication.	Sayan Das	19
2.	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. (6 Lectures	Sayan Das	7

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3.	Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. (3 Lectures) 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 inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of	Sayan Das	16
	wavelength and refractive index. (10 Lectures) Michelson's Interferometer: (1) Idea of form of fringes (no theory needed), (2) Determination of wavelength, (3) Wavelength difference, (4) Refractive index, and (5) Visibility of fringes. (3 Lectures)		
4.	Diffraction: Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and Diffraction grating. Fresnel Diffraction: Halfperiod zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.	Sayan Das	14
5.	Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization.	Sayan Das	5

PHY-G-CC-T/P-04: Waves and Optics:

Practical - 20 marks (Lab. Note Book - 05, Viva-Voce-05,Experiment -10) 60 Lectures

Unit	Topic	Teacher	Lecture
1	To investigate the motion of coupled oscillators	Sayan Das	4
4	To study Lissajous Figures	Sayan Das	4
5	Familiarization with Schuster's focussing; determination of angle of prism	Sayan Das	4
6	To determine the Coefficient of Viscosity of water by any method	Sayan Das	4
7	To determine the Refractive Index of the Material of a Prism using Sodium Light	Sayan Das	4

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8	To determine Dispersive Power of the Material of a Prism using Mercury Light	Sayan Das	6
9	To determine the value of Cauchy Constants	Sayan Das	4
10	To determine the Resolving Power of a Prism	Sayan Das	4
11	To determine wavelength of sodium light using Fresnel Biprism	Sayan Das	4
12	To determine wavelength of sodium light using Newton's Rings	Sayan Das	4
13	To determine the wavelength of monochromatic/Laser light using Diffraction of Single Slit	Sayan Das	4
14	To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction	Sayan Das	6

Semester-IV

(SYLLABUS WITH EFFECT FROM THE ACADEMIC SESSION 2018-2019)

Honours

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Course Code	Course Title	Course Nature	Credit
PHY-H-CC-T-08	Mathematical Physics III	Core (60L)	4
PHY-H-CC-P-08		Core (60P)	2
PHY-H-CC-T-09	Elements of Modern Physics	Core (60L)	4
PHY-H-CC-P-09		Core (60P)	2
PHY-H-CC-T-10	Analog Systems and Applications	Core (60L)	4
PHY-H-CC-P-10		Core (60P)	2
PHY-H-GE-T-04	Solid State Physics/ Quantum Mechanics/ Nuclear and Particle Physics	Generic Elective(60L)	4
PHY-H-GE-P-04		Generic Elective(60P)	2
PHY-H-SEC-T -02	Renewable Energy & Energy harvesting/ Radiation Safety/ Technical Drawing/ Applied Optics/ Weather Forecasting	Skill Enhancement (30L)	2
Total	**5 courses**	**Total**	**26**

PHY-H-CC-T-08: MATHEMATICAL PHYSICS-III

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75(Theory - 40, Internal Assessment – 15) Internal Assessment : Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) – 05

Unit	Topic	Teacher	Lecture

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1	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.	Sayan Das	30
	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.		
2	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.	Sayan Das	15
3	Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.	Sayan Das	15

PHY-H-CC-T-08: MATHEMATICAL PHYSICS-III

Practical – 20 marks (Lab. Note Book – 05, Viva-Voce-05,Experiment -10)

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Unit	Topic	Teacher	Lecture
1	Solving differential Equation	Sayan Das	40
2	Nth root of unity	Sayan Das	10
3	Dirac delta functions	Sayan Das	10

PHY-H-CC-T-09: ELEMENTS OF MODERN PHYSICS

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75(Theory - 40, Internal Assessment – 15

Unit	Topic	Teacher	Lecture
1	Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson[1]Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with	Sourav Karar	14
	electrons. Probability. Wave amplitude and wave functions.		
2	Position measurement- gamma ray microscope thought experiment; Wave[1]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.	Sourav Karar	5

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3	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.	Sourav Karar	10
4	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	Sourav Karar	10
5	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.	Sourav Karar	8
6	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.	Sourav Karar	8
7	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).	Sourav Karar	3
8	Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three[1]Level and Four-Level Lasers. Ruby Laser and He-Ne Laser	Sourav Karar	4

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PHY-H-CC-P-09: ELEMENTS OF MODERN PHYSICS

Practical – 20 marks (Lab. Note Book – 05, Viva-Voce-05,Experiment -10)

Unit	Topic	Teacher	Lecture
1	Measurement of Planck's constant using black body radiation and photo-detector	Sourav Karar	20
2	Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light	Sourav Karar	20
3	To determine work function of material of filament of directly heated vacuum diode	Sourav Karar	20

PHY-H-CC-T-10: ANALOG SYSTEMS AND APPLICATIONS

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75(Theory - 40, Internal Assessment – 15) Internal Assessment : Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

Unit	Topic	Teacher	Lecture
1	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. (10	Sayan Das	

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2	Two-terminal Devices and their Applications: (1) Rectifier Diode: Half[1]wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell. (6	Sayan Das	
3	Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of 36 CB, CE and CC Configurations. Current gains a and P Relations between a and p. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions. (6	Sayan Das	
4	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. (10	Sayan Das	
5	Coupled Amplifier: RC-coupled amplifier and its frequency response. (4	Sayan Das	
6	Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. (4	Sayan Das	
7	Sinusoidal Oscillators: Barkhausen's Criterion for selfsustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators. (4	Sayan Das	

8	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. (4	Sayan Das	

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9	Applications of Op-Amps: (1) Inverting and noninverting amplifiers, (2) Adder, (3)Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator. (9	Sayan Das	
10	Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation) (3	Sayan Das	

PHY-H-CC-P-10:ANALOG SYSTEMS AND APPLICATIONS

Practical – 20 marks (Lab. Note Book – 05, Viva-Voce-05,Experiment -10) 60 Lectures

Unit	Topic	Teacher	Lecture
1	To study V-I characteristics of PN junction diode, and / Light emitting diode.	Sayan Das	15
2	To study the V-I characteristics of a Zener diode and its use as voltage regulator	Sayan Das	15
3	study the characteristics of a Bipolar Junction Transistor in CE configuration.	Sayan Das	15
4	To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.	Sayan Das	15

PHY—H-SEC-T-02: RENEWABLE ENERGY AND ENERGY HARVESTING

(Credits: 02) F.M. = 50 (Theory - 40, Internal Assessment – 10) Internal Assessment [Class Attendance

(Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05

Unit	Topic	Teacher	Lecture

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1	Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.	Sayan Das	3
2	Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.	Sayan Das	6
3	82 Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind	Sayan Das	3
	turbines, Power electronic interfaces, and grid interconnection topologies.		
4	Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.	Sayan Das	3
5	Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. (2	Sayan Das	2
6	Geothermal Energy: Geothermal Resources, Geothermal Technologies.	Sayan Das	2
7	Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.	Sayan Das	2
8	Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power	Sayan Das	4

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9	Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications (2	Sayan Das	2
10	Carbon captured technologies, cell, batteries, power consumption	Sayan Das	2
11	Environmental issues and Renewable sources of energy, sustainability.	Sayan Das	1

Generic Elective Papers (GE)

PHY-H-GE-T-04: NUCLEAR AND PARTICLE PHYSICS

(Credits: Theory-05, Tutorials-01) F.M. = 75 (Theory - 60, Internal Assessment – 15)

Unit	Topic	Teacher	Lecture
1	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.	Sourav Karar	10
2	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.	Sourav Karar	12
3	Radioactivity decay:(a) Alpha decay: basics of a-decay processes, theory of a- emission, Gamow factor, Geiger Nuttall law, a-decay spectroscopy. (b) (3-decay: energy kinematics for (3- decay, positron emission, electron	Sourav Karar	9
	capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion		

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4	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).	Sourav Karar	8
5	Nuclear Astrophysics: Early universe, primordial nucleosynthesis (particle nuclear interactions), stellar nucleosynthesis, concept of gamow window, heavy element production: r- and s- process path.	Sourav Karar	5
6	107 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	Sourav Karar	6
7	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 (concept of charge carrier and mobility), neutron detector.	Sourav Karar	6
8	Particle Accelerators: Accelerator facility available in India: Van-de Graff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.	Sourav Karar	5
9	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.	Sourav Karar	14

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CORE COURSE (GENERAL/PASS IN PHYSICS)

PHY-G-CC-T-04: STATISTICAL MECHANICS

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75(Theory - 40, Internal Assessment – 15) Internal Assessment : Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) – 05

Unit	Topic	Teacher	Lecture
1	Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal	Nasiruddin Ahammed	18
	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.		
2	Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure 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.	Nasiruddin Ahammed	9
3	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.	Nasiruddin Ahammed	5

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4	Bose-Einstein Statistics: B-E 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.	Nasiruddin Ahammed	13
5	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. (15	Nasiruddin Ahammed	15

PHY-G-CC-P-04: STATISTICAL MECHANICS

Practical – 20 marks (Lab. Note Book – 05, Viva-Voce-05,Experiment -10)

Unit	Topic	Teacher	Lecture
1	Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.	Nasiruddin Ahammed	12
2	Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room	Nasiruddin Ahammed	12
3	Plot Maxwell-Boltzmann distribution function versus temperature.	Nasiruddin Ahammed	12
4	Plot Fermi-Dirac distribution function versus temperature.	Nasiruddin Ahammed	12
5	Plot Bose-Einstein distribution function versus temperature	Nasiruddin Ahammed	12

PHY-G-SEC-T-02 : ELECTRICAL CIRCUITS & NETWORK SKILLS (Credits: 02)

F.M. = 50 (Theory - 40, Internal Assessment – 10) Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05]

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Unit	Topic	Teacher	Lecture
1	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.	Sourav Karar	3
2	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.	Sourav Karar	4
3	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.	Sourav Karar	4
4	Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers	Sourav Karar	3
5	Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.	Sourav Karar	4
6	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	Sourav Karar	3

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7	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)	Sourav Karar	4
8	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.	Sourav Karar	5

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Semester-VI

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Honours

Course Code	Course Title	Course Nature	Credit
PHY-H-CC-T-13	Electro-magnetic Theory	Core (60L)	4
PHY-H-CC-P-13		Core (60P)	2
PHY-H-CC-T-14	Statistical Mechanics	Core (60L)	4
PHY-H-CC-P-14		Core (60P)	2
PHY-H-DSE-T -03	Medical Physics/Nano Materials and Applications/Communication Electronics/Digital Signal Processing	Discipline Specific Elective (60L+60P)	6
PHY-H-DSE-P-03			
PHY-H-DSE-T-04	Biophysics/	Discipline Specific	6

PHY-H-CC-T-13: ELECTROMAGNETIC THEORY

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75(Theory - 40, Internal Assessment – 15) Internal Assessment : Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

Unit	Topic	Teacher	Lecture

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1	Maxwell Equations: Review of 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. (12	Sourav Karar	30
2	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. (10	Sourav Karar	30
3	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	Sourav Karar	10
	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)		
4	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	Sourav Karar	12

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5	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.	Sourav Karar	5

PHY-H-CC-P-13: ELECTROMAGNETIC THEORY

Practical – 20 marks (Lab. Note Book – 05, Viva-Voce-05,Experiment -10)

Unit	Topic	Teacher	Lecture
1	To verify the law of Malus for plane polarized light.	Sourav Karar	20
2	To determine the specific rotation of sugar solution using Polarimeter.	Sourav Karar	20
3	To determine the Boltzmann constant using V-I characteristics of PN junction diode.	Sourav Karar	20

PHY-H-CC-T-14: STATISTICAL MECHANICS

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures F.M. = 75(Theory - 40, Internal Assessment – 15) Internal Assessment : Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) – 05

Unit	Topic	Teacher	Lecture

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1	Classical Statistics: Macrostate & Microstat s, Elementary Concept of Ensemble, Phase Spa ce, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partiti on Function, Thermodynamic Functions of an Id eal Gas, Classical Entropy Expression, Gibbs Para lox, Sackur Tetrode equation, Law of Equipartitio i of Energy (with proof) - Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.	Nasiruddin Ahammed	18
2	Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pu e temperature dependence. Kirchhoff s law.	Nasiruddin Ahammed	9
	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.		
3	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.	Nasiruddin Ahammed	5
4	Bose-Einstein Statistics: B-E 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.	Nasiruddin Ahammed	13

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5	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. (15	Nasiruddin Ahammed	15

PHY-H-CC-P-14: STATISTICAL MECHANICS

Practical – 20 marks (Lab. Note Book – 05, Viva-Voce-05,Experiment -10)

Unit	Topic	Teacher	Lecture
1	Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.	Nasiruddin Ahammed	12
2	Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room	Nasiruddin Ahammed	12
3	Plot Maxwell-Boltzmann distribution function versus temperature.	Nasiruddin Ahammed	12
4	Plot Fermi-Dirac distribution function versus temperature.	Nasiruddin Ahammed	12
5	Plot Bose-Einstein distribution function versus temperature	Nasiruddin Ahammed	12

PHY-H-DSE-T-03: DIGITAL SIGNAL PROCESSING

(Credits: Theory-04, Practicals-02) F.M. = 75 (Theory - 40, Internal Assessment – 15) Theory: 60

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Lectures Internal Assessment : Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]

Unit	Topic	Teacher	Lecture
1	Classification of Signals, Transformations of the Independent Variable, Periodic and Aperiodic Signals, Energy and Power Signals, Even and Odd Signals, Discrete-Time Systems, System Properties. Impulse Response, Convolution Sum; Graphical Method; Analytical Method, Properties of Convolution; Commutative; Associative; Distributive; Shift; Sum Property System Response to Periodic Inputs, Relationship Between LTI System Properties and the Impulse Response; Causality; Stability; Invertibility, Unit Step Response.	Sayan Das	10
2	Fourier Transform Representation of Aperiodic Discrete-Time Signals, Periodicity of DTFT, Properties; Linearity; Time Shifting; Frequency Shifting; Differencing in Time Domain; Differentiation in Frequency Domain; Convolution Property. The zTransform: Bilateral (Two- Sided) z-Transform, Inverse z-Transform, Relationship Between z-Transform and Discrete-Time Fourier Transform, z-plane, Region-ofConvergence; Properties of ROC, Properties; Time Reversal; Differentiation in the zDomain; Power Series Expansion Method (or Long Division Method);AnalysisandCharacterizationofLTISystems;TransferFunctionandDifferenceEquation System. Solving DifferenceEquations	Sayan Das	10
3	Phase Delay and Group delay, Zero-Phase Filter, Linear-Phase Filter, Simple FIR Digital Filters, Simple IIR Digital Filters, All pass Filters, Averaging Filters, Notch Filters.	Sayan Das	10
4	Frequency Domain Sampling (Sampling of DTFT), The Discrete Fourier Transform (DFT) and its Inverse, DFT as a Linear transformation, Properties; Periodicity; Linearity; Circular Time Shifting; Circular Frequency Shifting; Circular Time Reversal; Multiplication Property; Parseval's Relation, Linear Convolution Using the DFT (Linear Convolution Using Circular Convolution), Circular Convolution as Linear Convolution withaliasing	Sayan Das	10

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5	Non Recursive and Recursive Structures, Canonic and Non Canonic Structures, Equivalent Structures (Transposed Structure), FIR Filter structures; Direct-Form; Cascade-Form; Basic structures for IIR systems; Direct-Form I. Finite Impulse Response Digital Filter: Advantages and Disadvantages of Digital Filters, Types of Digital Filters: FIR and IIR Filters; Difference Between FIR and IIR Filters, Desirability of Linear-Phase Filters, Frequency Response of Linear-Phase FIR Filters, Impulse Responses of Ideal Filters, Windowing Method; Rectangular; Triangular; Kaiser Window, FIR Digital Differentiators. Infinite Impulse Response Digital Filter: Design of IIR Filters from Analog Filters, IIR Filter Design by Approximation of Derivatives, Backward Difference Algorithm, Impulse Invariance Method	Sayan Das	20

PHY-H-DSE-P-03: DIGITAL SIGNAL PROCESSING

Practical – 20 marks (Lab. Note Book – 05, Viva-Voce-05,Experiment -10)

Unit	Topic	Teacher	Lecture
1	Write a program to generate and plot the following sequences: (a) Unit sample sequence o(n) , (b) unit step sequence u(n), (c) ramp sequence r(n) , (d) real valued exponential sequence x(n) = (0.8)nu(n) for 0≤n≤50	Sayan Das	20
2	Using a rectangular window, design a FIR low-pass filter with a pass-band gain of unity,cutoff frequency of 1000Hz and working at a sampling frequency of 5KHz. Take the length of the impulse response as17.	Sayan Das	20
3	Design a digital filter to eliminate the lower frequency sinusoid of x(t) = sin 7t + sin 200t. The sampling frequency is fs = 500 Hz. Plot its pole zero diagram, magnitude response, input and output of the filter.	Sayan Das	20

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PHY-H-DSE-T-04: Bio-Physics

(Credits: Theory-05, Tutorials-01) Theory: 75 Lectures F.M. = 75 (Theory - 60, Internal Assessment – 15)

Unit	Topic	Teacher	Lecture
1	Building Blocks & Structure of Living State: Atoms and ions, molecules essential for life, what is life. Living state interactions: Forces and molecular bonds, electric & thermal interactions, electric dipoles, casimir interactions, domains of physics in biology.	Nasiruddin Ahammed	18
2	Heat Transfer in biomaterials: Heat Transfer Mechanism, The Heat equation, Joule heating of tissue. Living State Thermodynamics: Thermodynamic equilibrium, fIrst law of thermodynamics and conservation of energy. Entropy and second law of thermodynamics, Physics of many particle systems, Two state systems, continuous energy distribution, Composite systems, Casimir contribution of free energy, Protein folding and unfolding.	Nasiruddin Ahammed	20
3	Open systems and chemical thermodynamics: Enthalpy, Gibbs Free Energy and chemical potential, activation energy and rate constants, enzymatic reactions, ATP hydrolysis & synthesis, Entropy of mixing, The grand canonical ensemble, Haemoglobin. Diffusion and transport Maxwell-Boltzmann statistics, Fick's law of diffusion, sedimentation of Cell Cultures, diffusion in a centrifuge, diffusion in an electric field, Lateral diffusion in membranes, Navier stokes equation, low Reynold's Number 72 Transport, Active and passive membrane transport.	Sourav Karar	20
4	Fluids: Laminar and turbulent fluid flow, Bernoulli's equation, equation of continuity, venture effect, Fluid dynamics of circulatory systems, capillary action. Bioenergetics and Molecular motors: Kinesins, Dyneins, and microtubule dynamics, Brownian motion, ATP synthesis in Mitochondria, Photosynthesis in	Sourav Karar	17
	Chloroplasts, Light absorption in biomolecules, vibrational spectra of biomolecules.		

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(GENERAL/PASS IN PHYSICS)

PHY-G-DSE-T-02: Nuclear and Particle Physics

(Credits: Theory-05, Tutorials-01) Theory: 75 Lectures F.M. = 75 (Theory - 60, Internal Assessment – 15) Internal Assessment [Class Attendance – 05, Class Test/ Assignment/ Tutorial – 10]

Unit	Topic	Teacher	Lecture
1	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.	Sourav Karar	10
2	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.	Sourav Karar	12
3	Radioactivity decay:(a) Alpha decay: basics of a-decay processes, theory of a- emission, Gamow factor, Geiger Nuttall law, a-decay spectroscopy. (b) (3-decay: energy kinematics for (3- decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion	Sourav Karar	9
4	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).	Sourav Karar	8

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5	Nuclear Astrophysics: Early universe, primordial nucleosynthesis (particle nuclear interactions), stellar nucleosynthesis, concept of gamow window, heavy element production: r- and s- process path.	Sourav Karar	5
6	107 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	Sourav Karar	6
7	Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber	Sourav Karar	6
	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 (concept of charge carrier and mobility), neutron detector.		
8	Particle Accelerators: Accelerator facility available in India: Van-de Graff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.	Sourav Karar	5
9	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.	Sourav Karar	14

PHY-G-SEC-T-04: Renewable energy

(Credits: 02) F.M. = 50 (Theory - 40, Internal Assessment – 10) Internal Assessment [Class Attendance

(Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05

Unit	Topic	Teacher	Lecture

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1	Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.	Sayan Das	3
2	Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.	Sayan Das	6
3	82 Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.	Sayan Das	3
4	Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.	Sayan Das	3
5	Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. (2	Sayan Das	2
6	Geothermal Energy: Geothermal Resources, Geothermal Technologies.	Sayan Das	2
7	Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.	Sayan Das	2
8	Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and	Sayan Das	4
	mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power		

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9	Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications (2	Sayan Das	2
10	Carbon captured technologies, cell, batteries, power consumption	Sayan Das	2
11	Environmental issues and Renewable sources of energy, sustainability.	Sayan Das	1

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