গড়গাঁও মহাবিদ্যালয়

GARGAON COLLEGE

TEACHING PLAN
DEPARTMENT OF PHYSICS
JULY 2021 - JUNE 2022

GARGAON COLLEGE
TEACHING PLAN

Course: B. Sc.

Session: Odd semester 2021

Subject: Physics

Name of the Teacher: DILIP BORDOLOI

Designation: Associate Professor

Methods to be applied: Lecture, Assignment and test, Seminar Presentation/Group Discussion/Micro Teaching.

Teaching Materials: Board and Marker, ICT tools like Projector, online platform like Google meet, zoom, Google Classroom etc.

Paper Code/ Title	Allotted Unit/ Topic	No. Of Class required	Detail of the topic to be taught
C2: Mechanics	**Fundamentals of Dynamics**	**6**	Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable-mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.
	Work and Energy	**4**	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.
		3	**Collisions:** Elastic and inelastic collisions between particles. Centre of Mass and laboratory frame
	Rotational Dynamics	**12**	Angular momentum of particles and system of particles, Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.
	Elasticity	**2**	Relation between Elastic constants. Twisting torque on a Cylinder or Wire.
GE-1: Mechanics	**Elasticity**	**8**	Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion–Torsional pendulum-Determination of Rigidity modulus and moment of inertia- q, η and σ by Searles method.

	Special Theory of Relativity:	**7**	Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities
C6: Thermal Physics	**Zeroth and First Law of Thermodynamics**	**8**	Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.
	Second Law of Thermodynamics	**10**	Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.
	Entropy	**7**	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.
GE-3: Thermal Physics and Statistical Mechanics	**Laws of Thermodynamics: Thermodynamic Description of system**:	**22**	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 changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.
DSE1: Classical Dynamics	**Special Theory of Relativity**	**33**	Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time -dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation.

			Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.
	Fluid Dynamics	**10**	Density ρ and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation, qualitative description of turbulence, Reynolds number.

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C-3: Electricity and Magnetism	**Electrical Circuits**	**4**	AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.
	Network theorems	**4**	Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.
	Ballistic Galvanometer:	**3**	Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.
C4: Waves and Optics	**Fresnel Diffraction**	**7**	Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a

			slit and a wire.
	Holography	**3**	Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.
GE-2: Electricity and Magnetism	**Electromagnetic Induction:**	**6**	Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.
	Maxwell`s equations and Electromagnetic wave propagation	**10**	Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.
C8: Mathematical physics-III	**Integrals Transforms**	**15**	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.
	Laplace Transforms	**15**	Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to 2nd order Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits, Coupled differential equations of 1st order. Solution of heat flow along infinite bar using Laplace transform.
GE-4: Wave and Optics	**Diffraction**	**14**	Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.
C13: Electromagnetic Theory	**EM Wave Propagation in Unbounded Media:**	**10**	Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.

	EM Wave in Bounded Media	**10**	Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence)
	Optical Fibres	**3**	Numerical aperture , Step and Graded Indices (Definitions only), Single and Multimode fibres (Concepts and Definition Only).
C14: Statistical Mechanics	**Bose-Einstein Statistics:**	**13**	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.
	Fermi-Dirac Statistics	**15**	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.

(Dilip Bordoloi)

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C-2: Mechanics	**i. Fluid Motion**		Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube
	ii. 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).
	iii. 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
	iv. Non-Inertial Systems:		Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems
C-7: Digital Electronics	**i. 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
	ii. 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 ICs.
	iii. 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.

	iv. 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.
	v. Data processing circuits		Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders
	vi. Arithmetic Circuits		Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.
	vii. 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.
	viii. Timers		IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.
	ix. Shift registers		Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).
C-12: Solid State Physics	**i. 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.
	ii. 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
	iii. 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
DSE-1: Classical Dynamics	**i. Classical Mechanics of Point Particles**		Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyroradius and gyrofrequency, motion in crossed electric and magnetic fields. Generalized coordinates and velocities, Hamilton's principle, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such as coupled oscillators Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, solution of Hamilton's equation for Simple Harmonic Oscillations; particle in a central force field-conservation of angular momentum and energy.
	ii. Small Amplitude Oscillations		Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.

GE-1: Mechanics	**i. 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.
	ii. Oscillations		Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations.
GE-3: Thermal Physics and Statistical Mechanics	**iii. 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.

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C-4: Wave and Optics	**i. Superposition of Collinear Harmonic oscillations**		Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.
	ii. Superposition of two perpendicular Harmonic Oscillations		Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their use.
	iii. 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.
	iv. 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.
	v. 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.
GE-2: Electricity and Magnetism	**i. Electrostatics**		Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.
C-10: Analog system and Applications	**i. Semiconductor Diodes**		P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current Flow Mechanism in Forward and Reverse Biased Diode.
	ii. Two-terminal Devices and their Applications		(1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell.
	iii. Bipolar Junction transistors		n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.
	iv. 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.
	v. Coupled amplifiers		Two stage RC coupled Amplifier and its frequency response.

	vi. Feedback in Amplifiers		Effect of positive and negative feedback on Input impedence, Output impedence, Gain , Stability, Distortion and noise.
DSE-3: Nuclear and Particle Physics	**i. 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.
	ii. 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.
	iii. Radioactivity decay		(a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) □-decay: energy kinematics for □-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion.
	iv. 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).

(Diganta Konwar)

H.O.D. Physics

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C-1 : Mathematical Physics-1	i. Recapitulation of vectors	**5**	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.
	ii. Vector Differentiation	**8**	Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities.
	iii. Vector Integration	**14**	Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).
GE-1: Mechanics	**i. Vectors**	**3**	Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.
	ii. Ordinary Differential Equations	**7**	1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.
C-6: Thermal Physics	**i. Thermodynamic Potentials**	**7**	Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations .
	ii. Maxwell's Thermodynamic Relations	**7**	Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.
	iii. Distribution of Velocities	**7**	Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's

			Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.
	iv. Molecular Collisions	**4**	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.
	v. Real Gases	**10**	Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule- Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule- Thomson Cooling.
GE-3: Thermal Physics and Statistical Mechanics	**i. Statistical Mechanics:**	**12**	Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics.
C-11: Quantum Mechanics and Applications.	**i.** Time dependent Schrodinger equation	**6**	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.
	ii. Time independent Schrodinger equation	**10**	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.
	iii. General discussion of bound states in an arbitrary potential	**12**	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 eigen functions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle.
	iv. Quantum theory of	**10**	time independent Schrodinger equation in spherical polar coordinates; separation of variables for second

	hydrogen-like atoms		order partial differential equation; angular momentum operator & quantum numbers; Radial wave functions 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.
	v. Atoms in Electric & Magnetic Fields:	**8**	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.
	vi. Atoms in External Magnetic Fields	**4**	Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).
	vii. Many electron atoms:	**10**	Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms-L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali atoms (Na etc.)

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C-3: Electricity and Magnetism	**i. Electric Field al**	**6**	Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

	ii. Electric Potential	**6**	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.
	iii. Electrostatic energy	**10**	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.
	iv. Dielectric Properties of Matter	**8**	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.
GE-2: Electricity and Magnetism	**i. Vector Analysis**	**12**	Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).
C-8: Mathematical Physics- III	**i.** Complex Analysis.	**30**	Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.
GE-4: Wave and Optics	**i. Sound**	**10**	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.
C-13: electromagnetic Theory	**i. Polarization of Electromagnetic Waves**	**12**	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

C-14: Statistical Mechanics	**i. Classical Statistics**	**18**	Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature
	ii. Classical Theory of Radiation:	**9**	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.
	iii. Quantum Theory of Radiation:	**5**	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.

(Guna Kanta Sonowal)

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TEACHING PLAN & LESSON PLAN
GARGAON COLLEGE, SIMALUGURI-785686, SIVASAGAR, ASSAM
SESSION- 2021-2022

TEACHING PLAN

2021-22

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TEACHING PLAN & LESSON PLAN

GARGAON COLLEGE, SIMALUGURI-785686, SIVASAGAR, ASSAM

SESSION- 2021-2022

TEACHING PLAN FOR ODD SEMESTER

Semester	First Semester (Honours)
Paper Code/Title	**Paper Code:** C2 **Paper Title:** Mechanics
Allotted Unit/Topic	Fundamentals of Dynamics, Work and Energy, Collisions, Rotational Dynamics, Elasticity.
Number of Classes	17
Details of the topic	**Fundamentals of Dynamics:** Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable-mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. **Work and Energy:** Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. 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. **Collisions:** Elastic and inelastic collisions between particles. Centre of Mass and laboratory frame. **Rotational Dynamics:** Angular momentum of particles and system of particles, Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. **Elasticity:** Relation between Elastic constants. Twisting torque on a Cylinder or Wire.
Teaching Tools	• Board and Marker • ICT tools like Projector, online platform like Google Classroom, Google Meet etc.
Evaluation Process	• Sessional Examination • Unit Test • Google Class Room Quiz • Seminar Presentation/Group Discussion
Semester	First Semester (Generic)

TEACHING PLAN & LESSON PLAN

GARGAON COLLEGE, SIMALUGURI-785686, SIVASAGAR, ASSAM

SESSION- 2021-2022

Paper Code/Title	**Paper Code:** GE-1 **Paper Title:** *Mechanics*
Allotted Unit/Topic	Laws of motion.
Number of Classes	10
Details of the topic	**Laws of motion:** Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.
Teaching Tools	• Board and Marker • ICT tools like Projector, online platform like Google Classroom, Google Meet etc.
Evaluation Process	• Sessional Examination • Unit Test • Google Class Room Quiz • Seminar Presentation/Group Discussion
Semester	Third Semester (Honours)
Paper Code/Title	**Paper Code:** C-V **Paper Title:** Mathematical Physics-II
Allotted Unit/Topic	Theory of Errors, Partial Differential Equations.
Number of Classes	21
Details of the topic	**Theory of Errors:** Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. Least-squares fit. Error on the slope and intercept of a fitted line. **Partial Differential Equations:** Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation.
Teaching Tools	• Board and Marker • ICT tools like Projector, online platform like Google Classroom, Google Meet etc.
Evaluation Process	• Sessional Examination • Unit Test • Google Class Room Quiz • Seminar Presentation/Group Discussion
Semester	Third Semester (Honours)

TEACHING PLAN & LESSON PLAN

GARGAON COLLEGE, SIMALUGURI-785686, SIVASAGAR, ASSAM

SESSION- 2021-2022

Paper Code/Title	**Paper Code:** C-VII **Paper Title:** Digital Systems and Applications.
Allotted Unit/Topic	Computer Organization, Intel 8085 Microprocessor Architecture, Introduction to Assembly Language.
Number of Classes	18
Details of the topic	**Computer Organization:** Input/ Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map. **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. **Introduction to Assembly Language:** 1 byte, 2 byte & 3 byte instruction.
Teaching Tools	• Board and Marker • ICT tools like Projector, online platform like Google Classroom, Google Meet etc.
Evaluation Process	• Sessional Examination • Unit Test • Google Class Room Quiz • Seminar Presentation/Group Discussion
Semester	Third Semester (Generic)
Paper Code/Title	**Paper Code:** GE-3 **Paper Title:** Thermal Physics and Statistical Mechanics.
Allotted Unit/Topic	Thermodynamic Potentials.
Number of Classes	10
Details of the topic	**Thermodynamic Potentials:** Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - JouleThompson Effect, Clausius-Clapeyron Equation, Expression for (CP – CV), CP/CV, TdS equations.
Teaching Tools	• Board and Marker • ICT tools like Projector, online platform like Google Classroom, Google Meet etc.
Evaluation Process	• Sessional Examination • Unit Test • Google Class Room Quiz • Seminar Presentation/Group Discussion

TEACHING PLAN & LESSON PLAN

GARGAON COLLEGE, SIMALUGURI-785686, SIVASAGAR, ASSAM

SESSION- 2021-2022

Semester	Fifth Semester (Honours)
Paper Code/Title	**Paper Code:** DSE-2 **Paper Title:** Astronomy and Astrophysics
Allotted Unit/Topic	Astronomical Scales, Basic concepts of positional astronomy, Astronomical techniques, Physical principles, Galaxies, Large scale structure & expanding universe.
Number of Classes	50
Details of the topic	**Astronomical Scales:** Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature. **Basic concepts of positional astronomy**: Celestial Sphere, Geometry of a Sphere, Spherical Triangle Astronomical Coordinate Systems, Geographical Coordinate Systems, Horizon System, Equatorial System, Diurnal Motion of the Stars, Conversion of Coordinates. Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Calendar. Basic Parameters of Stars: Determination of Distance by Parallax Method; Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus; Determination of Temperature and Radius of a star; Determination of Masses from Binary orbits; Stellar Spectral Classification, Hertzsprung-Russell Diagram. **Astronomical techniques:** Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes). **Physical principles:** Gravitation in Astrophysics (Virial Theorem, Newton versus Einstein), Systems in Thermodynamic Equilibrium. **Galaxies:** Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies (The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and Gas). Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo) The Milky Way Galaxy, Gas and Dust in the Galaxy, Spiral Arms. **Large scale structure & expanding universe**: Cosmic Distance Ladder (An Example from Terrestrial Physics, Distance Measurement using Cepheid Variables), Hubble's Law (Distance- Velocity Relation), Clusters of Galaxies (Virial theorem and Dark Matter).
Teaching Tools	• Board and Marker

	• ICT tools like Projector, online platform like Google Classroom, Google Meet etc.
Evaluation Process	• Sessional Examination • Unit Test • Google Class Room Quiz • Seminar Presentation/Group Discussion

TEACHING PLAN FOR EVEN SEMESTER

Semester	Second Semester (Honours)
Paper Code/Title	**Paper Code:** C4 **Paper Title:** *Wave and Optics*
Allotted Unit/Topic	Wave and Optics, Interference, Interferometer, Diffraction, Fraunhofer Diffraction.
Number of Classes	26
Details of the topic	**Wave and Optics:** Electromagnetic nature of light, definition and properties of wave front, Huygens principle, Temporal and Spatial coherence. **Interference:** Division of amplitude and wavefront, Young's double slit experiment, Lloyd's Mirror and Fresnel's Biprism, Phase change on reflection: Stokes' treatment, Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes), Newton's Rings: Measurement of wavelength and refractive index. **Interferometer:** Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4)Refractive Index, and (5) Visibility of Fringes. Fabry Perot interferometer. **Diffraction:** Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only) **Fraunhofer Diffraction:** Single slit. Circular aperture, Resolving Power of a telescope, Double slit, Multiple slits, Diffraction grating. Resolving power of grating.
Teaching Tools	• Board and Marker • ICT tools like Projector, online platform like Google Classroom,

	Google Meet etc.
Evaluation Process	• Sessional Examination • Unit Test • Google Class Room Quiz • Seminar Presentation/Group Discussion
Semester	Second Semester (Generic)
Paper Code/Title	**Paper Code:** GE-4 **Paper Title:** *Electricity and Magnetism*
Allotted Unit/Topic	Magnetism
Number of Classes	10
Details of the topic	**Magnetostatics:** Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferro-magnetic materials.
Teaching Tools	• Board and Marker • ICT tools like Projector, online platform like Google Classroom, Google Meet etc.
Evaluation Process	• Sessional Examination • Unit Test • Google Class Room Quiz • Seminar Presentation/Group Discussion
Semester	Forth Semester (Honours)
Paper Code/Title	**Paper Code:** C-IX **Paper Title:** Elements of Modern Physics
Allotted Unit/Topic	Size structure of atomic nucleus, Radioactivity, Fission and Fusion, Lasers.
Number of Classes	21
Details of the topic	**Size structure of atomic nucleus:** 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. **Radioactivity:** stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay;Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation : electron-positron pair creation by gamma photons in the vicinity of a nucleus.

	Fission and Fusion: 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). **Lasers:** Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing.
Teaching Tools	• Board and Marker • ICT tools like Projector, online platform like Google Classroom, Google Meet etc.
Evaluation Process	• Sessional Examination • Unit Test • Google Class Room Quiz • Seminar Presentation/Group Discussion
Semester	Forth Semester (Honours)
Paper Code/Title	**Paper Code:** C-X **Paper Title:** Analog Systems and Applications
Allotted Unit/Topic	Operational Amplifiers, Applications of Op-Amps., Conversion.
Number of Classes	16
Details of the topic	**Operational Amplifiers:** Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. **Applications of Op-Amps.:** (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator. **Conversion:** Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution, A/D Conversion (Successive approximation).
Teaching Tools	• Board and Marker • ICT tools like Projector, online platform like Google Classroom, Google Meet etc.
Evaluation Process	• Sessional Examination • Unit Test • Google Class Room Quiz • Seminar Presentation/Group Discussion
Semester	Forth Semester (Generic)
Paper Code/Title	**Paper Code:** GE-4

TEACHING PLAN & LESSON PLAN

GARGAON COLLEGE, SIMALUGURI-785686, SIVASAGAR, ASSAM

SESSION- 2021-2022

	Paper Title: Wave and Optics
Allotted Unit/Topic	Wave and Optics, Interference.
Number of Classes	13
Details of the topic	**Wave and Optics:** Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. **Interference:** Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index.
Teaching Tools	• Board and Marker • ICT tools like Projector, online platform like Google Classroom, Google Meet etc.
Evaluation Process	• Sessional Examination • Unit Test • Google Class Room Quiz • Seminar Presentation/Group Discussion
Semester	Sixth Semester (Honours)
Paper Code/Title	**Paper Code:** DSE-4 **Paper Title:** Nano Materials and Application
Allotted Unit/Topic	Synthesis of nanostructure materials, Characterization, Optical properties, Electron transport, Applications.
Number of Classes	40
Details of the topic	**Synthesis of nanostructure materials:** Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dot. **Characterization:** X- ray diffraction, Optical Microscopy, Scanning electron Microscopy , Transmission Electron Microscopy , Atomic Force Microscopy, Scanning Tunneling Microscopy. **Optical properties**: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging

	effects. Radiative Processes: General formalization-absorption, emission and luminescence, Optical properties of hetero structures and nano structures. **Electron transport:** Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects. **Applications:** Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron transfer devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS)
Teaching Tools	• Board and Marker • ICT tools like Projector, online platform like Google Classroom, Google Meet etc.
Evaluation Process	• Sessional Examination • Unit Test • Google Class Room Quiz • Seminar Presentation/Group Discussion

SIGNATURE