Lesson Plan - Honours (AY 2019-20)

Name: Dr. Pratibha Pal

Department: Physics

Year	Paper	Unit	Topic	No. of lectures	Session
Sem I	CC2		**6. Elasticity** a) Relation between Elastic constants. Twisting Torque on a cylinder or wire. Bending of a beam. Internal bending moment. Elastic Potential Energy. **7. Fluid Motion** a) Kinematics of Moving Fluids: Idea of compressible and incompressible fluids, equation of Continuity; Streamline and Turbulent Flow, Reynold's Number.	**8 Lectures** **6 Lectures**	**July to Pre-Puja**
			7. Fluid Motion (Contd.) Euler's equation. The special case of Fluid statistics F = grad P. Simple applications. b) Poiseuille's equation for flow of a viscous liquid through a Capillary Tube.	**4 Lectures** **3 Lectures**	**Post-Puja to End Sem**
Sem II	CC4		***1. Oscillations*** a) 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. ***2. Superposition of Harmonic Oscillations*** a) 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 oscillations having 1) equal phase difference and 2) equal frequency difference. ***3. Wave motion*** a) Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane progressive waves. Wave equation. Particle and wave velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. b) Water Waves: Ripple and Gravity Waves. ***4. Velocity of Waves*** a) Velocity of Transverse Vibrations of Stretched Strings. b) Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. ***5. Superposition of Harmonic Waves*** a) Standing waves in a String. Fixed and Free Ends. Analytical Treatment. 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. b) Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. c) Superposition of N Harmonic Waves. Phase and Group Velocities.	**8 Lectures** **8 Lectures** **7 Lectures** **5 Lectures** **8 Lectures**	**Jan-June**

Year	Paper	Unit	Topic	No. of lectures	Session
Sem III	**CC6**		**1. Introduction to Thermodynamics** a) Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, ZerothLaw of Thermodynamics & Concept of Temperature. Concept of Work & Heat, State Functions, Internal Energy and First Law of Thermodynamics. Its differential form, 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. b) Second Law of Thermodynamics: Reversible and Irreversible processwith 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. c) Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to PerfectGas Scale. d) Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature-Entropy diagrams for Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. **2. Thermodynamic Potentials** **a)** 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 **b)** Maxwell's Thermodynamic Relations. **c)** Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of C_p-C_v, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. Joules 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.	**8 Lectures** **6 Lectures** **4 Lectures** **8 Lectures** **6 Lectures** **2 Lectures** **4 Lectures** **3 Lectures**	**July to Pre-Puja** **Post-Puja toEnd Sem**

Year	Paper	Unit	Topic	No. of lectures	Session
Sem IV	**CC9**		**Elements of Modern Physics** **Unit 1.** a) Blackbody Radiation, Planck's quantum, Planck's constant. Photo- electric effect and Compton scattering - light as a collection of pho- tons. Davisson-Germer experiment. De- Broglie wavelength and matter waves. Wave-particle duality. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Probability interpretation: Normalized wave functions as probability amplitudes. b)Two-Slit experiment with photons and electrons. Linear superposition principle as a consequence. c) Position measurement- gamma ray microscope thought experiment. Heisenberg uncertainty principle (Statement with illustrations). Impossibility of a particle following a trajectory. **Unit 2** a) Postulates of Quantum Mechanics: States as normalized vectors (normalized wave functions). Dynamical variables as linear Hermitian operators. Predictions of quantum mechanics from solving the eigen- value equation for the observables. Illustration using two and three level systems. Expectation values of observables. b) Time evolution: Schrodinger equation for non-relativistic particles. Stationary states. Solution of Schrodinger's equation using expansion in stationary states. Time evolution of expectation values. c) Application to one dimensional systems. Particle moving in one dimension: Position, Momentum and Energy operators. Probability and probability current densities in one dimension. Boundary conditions on wave functions. Ehrenfest theorem. Particle in a one dimensional infinitely rigid box: energy eigen-values and eigen-functions, normalization. Quantum dot. Quantum mechanical scattering and tunneling in one dimension across a step potential & rectangular potential barrier. d) Simultaneous measurements: Compatible and incompatible observables and their relation to commutativity. Heisenberg's uncertainty relation for a pair of incompatible observables. Complete and incom- plete measurements - degeneracy. Illustration of the ideas using the Angular momentum operators.	**8 Lectures** **2 Lectures** **4 Lectures** **6 Lectures** **3 Lectures** **6 Lectures** **4 Lectures**	**Jan - June**

			Unit 3 a) 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. b) Nature of nuclear force, NZ graph. c) Nuclear Models: Liquid Drop model. semi-empirical mass formula and binding energy. Nuclear Shell Model. Magic numbers. **Unit 4** a) 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. b) Fission and fusion: mass de cit, relativity and generation of energy. Fission - nature of fragments and emission of neutrons. Nuclear re- actor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions)	**3 Lectures** **1 Lecture** **3 Lectures** **5 Lectures** **5 Lectures**	
Sem IV	**PHSA-SECB-TH**		**Renewable Energy and Energy Harvesting** **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. **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, at 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.	**Lectures 6** **Lectures 6**	**Jan - June**

Year	Paper	Unit	Topic	No. of lectures	Session
Sem IV	**PHSA-SECB-TH**		**Wind Energy harvesting** Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. **Ocean Energy** Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.	**Lectures 3** **Lectures 4**	**Jan - June**
III Year (1+1+1)	**VI**	**I**	**NUCLEAR & PARTICLE PHYSICS I** ***1.Bulk properties of nuclei*** Nuclear mass, charge, size, binding energy, spin and magnetic moment. Isobars, isotopes and isotones; mass spectrometer (Bainbridge). ***2. Nuclear structure*** Nature of forces between nucleons, nuclear stability and nuclear binding, the liquid drop model 11 (descriptive) and the Bethe-Weizsacker mass formula, application to stability considerations, extreme single particle shell model (qualitative discussion with emphasis on phenomenology with examples). ***3. Unstable nuclei*** **(a) Alpha decay** : alpha particle spectra – velocity and energy of alpha particles. Geiger-Nuttal law. **(b) Beta decay** : nature of beta ray spectra, the neutrino, energy levels and decay schemes, positron emission and electron capture, selection rules, beta absorption and range of beta particles, Kurie plot.	**5+ 1(Tutorial)** **9 + 2 (Tutorial)** **3+1 (Tutorial)** **4 + 1 (Tutorial)**	**July to Pre-Puja**
			(c)Gamma decay : gamma ray spectra and nuclear energy levels, isomeric states. Gamma absorption in matter – photoelectric process, Compton scattering, pair production (qualitative).	**4+ 1(Tutorial)**	

Year	Paper	Unit	Topic	No. of lectures	Session
			NUCLEAR & PARTICLE PHYSICS II ***1. Nuclear reactions*** Conservation principles in nuclear reactions. Q-values and thresholds, nuclear reaction cross-sections, examples of different types of reactions and their characteristics. Bohr's postulate of compound nuclear reaction, Ghoshal's experiment. ***2. Nuclear fission and fusion*** Discovery and characteristics, explanation in terms of liquid drop model, fission products and energy release, spontaneous and induced fission, transuranic elements. Chain reaction and basic principle of nuclear reactors. Nuclear fusion: energetics in terms of liquid drop model. ***3. Elementary particles*** (a) Four basic interactions in nature and their relative strengths, examples of different types of interactions. Quantum numbers – mass, charge, spin, isotopic spin, intrinsic parity, hypercharge. Charge conjugation. Conservation laws. (b) Classifications of elementary particles – hadrons and leptons, baryons and mesons, elementary ideas about quark structure of hadrons – octet and decuplet families.	**5 + 1 (Tutorial)** **5 + 1 (Tutorial)** **3 + 1 (Tutorial)** **4 + 1 (Tutorial)**	**Post-Puja to Winter vacation.**
III (1+1 +1)	**VI**	**I**	**NUCLEAR & PARTICLE PHYSICS II** ***4. Particle Accelerator and Detector*** Cyclotron – basic theory, synchrotron, GM counter ***5. Nuclear Astrophysics*** Primordial nucleosynthesis, energy production in stars, pp chain, CNO cycle. Production of elements (qualitative discussion)	**3 + 1 (Tutorial)** **6 + 1 (Tutorial)**	**Post-Winter Vacation to Test examination**

Lesson Plan - General

Name:

Dr. Pratibha Pal

Department: Physics

Year	Paper	Unit	Topic	No. of lectures	Session
1st Sem (CBCS)	GE1/CC1		**Elasticity** a) Hooke's Law: Stress-Strain diagram. Elastic moduli-relation between elastic constants- Poisson's Ration-expression for Poisson's ratio in terms of elastic constants. b) Twisting couple on a cylinder - determination of Rigidity modulus by static torsion. Torsional pendulum. c) Bending of beam. d) Work done in stretching and work done in twisting a wire.	**7 Lectures** **4 Lectures** **3 Lectures** **3 Lectures**	**July to Pre-Puja** **Post Puja to End Sem**
Sem III (CBCS)	GE3/CC3		**1. Laws of Thermodynamics** a) 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: Relation between C_p and C_v, work done during Isothermal and Adiabatic Processes. Compressibility and Expansion coefficients , Reversible and Irreversible Processes, Second Law and Entropy. Carnot's cycle, Carnot's theorem. Entropy changes in reversible and irreversible processes. Entropy-Temperature diagrams, Third Law of Thermodynamics, unattainability of absolute zero. **2. Thermodynamic Potentials** a) Enthalpy, Gibb's, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thomson effect, Clausius-Clayperon Equation. Expression for (C_p - C_v), C_p /C_v , TdS equations.	**12 Lectures** **4 Lectures**	**July to Pre-Puja** **Post Puja to End Sem**

Year	Paper	Unit	Topic	No. of lectures	Session
Sem IV **(CBCS)**	**GE4/CC4**		**1. Superposition of Two Collinear Harmonic oscillations:** **a)** Linearity and Superposition Principle. Superposition of two collinear oscillations having 1) equal frequencies and 2) different frequencies (Beats). **2. Superposition of Two Perpendicular Harmonic oscillations:** a) Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequency and their uses. **3. Wave Motion - General** a) Transverse waves on a string. Travelling and standing waves on a string. Normal modes of a string. Group velocity, Phase Velocity. Plane waves, Spherical wave, Wave Intensity. **4. Sound** a) Review of SHM, damped and forced vibrations-resonance. Fourier's Theorem - Applications to Saw tooth and square wave. Intensity and loudness of sound - Decibel-Intensity levels. Musical notes-Musical scale. Acoustics of buildings : reverberation and time reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time- acoustics aspects of halls and auditoria.	**4** **2** **4** **6**	**Jan - June**
3rd year (1+1+1)	**IVA**	**II**	**2. Conventional energy sources *:*** thermal power plant, relevance of Rankinecycle (qualitative discussion), steam turbine, hydro-electric power plant - - basic principle.	**6**	**July to Pre-Puja**
		II	**3. Non-conventional energy** sources: solar, wind, tidal, geothermal,and biogas sources, elementary idea of production and uses.	**6**	**Post-Puja to Winter vacation.**

Lesson Plan - Honours

(AY 2019-2020)

Name: GAYATRI PAL

Department: PHYSICS

Year	Paper	Unit	Topic	No. of lectures	Session
1st Sem (CBCS)	CC2		**1. Fundamentals of Dynamics** **a) Review of Newton's Laws**: Mechanistic view of the Universe. Concepts of Inertial frames, force and mass. Solution of the equations of motion (E.O.M.) in simple force fields in one, two and three dimensions using Cartesian, cylindrical polar and spherical polar coordinate systems.	**5**	**July to Pre-Puja**
			b) Dynamics of systems of particles: Difficulty of solving the E.O.M. for systems of particles. Newton's third Law. External and Internal forces. Momentum and Angular Momentum of a system. Torque acting on a system. Conservation of Linear and Angular Momentum. Centre of mass and its properties. Two-body problem.	**5**	
			c) Variable- mass system: motion of rocket.	**2**	
			2. Work and Energy a) **Work - Kinetic Energy Theorem**. Conservative Forces: Force as the gradient of a scalar field - concept of Potential Energy. Other equivalent definitions of a Conservative Force. Conservation of Energy.	**5**	
			b) **Qualitative study of one dimensional** motion from potential energy curves. Stable and Unstable equilibrium.	**3**	
			c**) Energy of a system of particles**.	**2**	
			3. Gravitation and Central Force Motion a)Central Force. Reduction of the two body central force problem to a one-body problem. Setting up the E.O.M. in plane polar coordinates.	**4**	**Post-Puja to End Sem**
			b)Differential equation for the path. Motion under an Inverse-square force. Newton's Law of Gravitation. Inertial and gravitational mass. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).	**5**	
			c)Gravitational potential energy. Potential and field due to spherical shell and solid sphere.	**3**	

Year	Paper	Unit	Topic	No. of lectures	Session
2nd Sem (CBCS)	**CC3**		**The Magnetostatic Field** a) Biot-Savart's law. Force on a moving point charge due to a magnetic field: Lorentz force law. Application of Biot-Savart's law to determine the magnetic field of a straight conductor, circular coil. Force between two straight current carrying wires. b) Divergence of the magnetic field - its solenoidal nature. Magnetic vector potential. c) Curl of the magnetic field. Ampere's circuital law. Its application to Infinite straight wire, (2) Infinite planar surface current, and (3) Solenoid. **Magnetic properties of matter.** a) Potential and field due to a magnetic dipole. Magnetic dipole moment. Force and torque on a magnetic dipole in a uniform magnetic field. b) Magnetization. Bound currents. The magnetic intensity - H. Relation between B, H and M. Linear media. Magnetic Susceptibility and Permeability. Brief introduction of dia-, para- and ferro-magnetic materials. B-H curve and hysteresis. **Electro-magnetic induction** a) Ohms law and definition of E.M.F. Faraday's laws of electromagnetic induction, Lenz's law. Self-Inductance and Mutual Inductance. Reciprocity Theorem. Introduction to Maxwell's Equations. Charge conservation. Displacement current and resurrection of Equation of Continuity. b) Energy stored in magnetic field.	**5** **2** **4** **4** **5** **5** **2**	**Jan - June**

Year	Paper	Unit	Topic	No. of lectures	Session
Sem 3 **(CBCS)**	**CC7**		1. **Integrated Circuits** 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. **2. 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. 3. **Boolean algebra** De Morgan's Theorems. Boolean Laws. Simpli cation of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equiva- lent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. **4. Data processing circuits** Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. **5. Circuits** Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.	**6** **8** **6** **4** **4**	**July to Pre-Puja**

Year	Paper	Unit	Topic	No. of lectures	Session
Sem 3 (CBCS)	**CC7**		6. **Sequential Circuits:** SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around condi- tions in JK Flip-Flop. M/S JK Flip-Flop. **7. Timers** IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. **8. 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). **9. Counters (4 bits)** Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. **10. Computer Organization** Input/Output Devices. Data storage (idea of RAM and ROM). Com- puter memory. Memory organization & addressing. Memory Inter- facing. Memory Map.	**6** **5** **5** **4** **4**	**Post Puja to End Sem**
Sem 4 (CBCS)	**CC9**		**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 Re- verse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current Flow Mecha- nism in Forward and Reverse Biased Diode.	**8**	**Jan - June**

Year	Paper	Unit	Topic	No. of lectures	Session
Sem 4 (CBCS)	**CC9**		**2. Two-terminal Devices and their Applications.** Rectifier Diode: Half-wave Recti ers. Centre-tapped and Bridge Full-wave Recti ers, Calculation of Ripple Factor and Recti cation E ciency, C- lter. Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell. **3.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. **4.Field Effect transistors Basic principle of operations only.** **5.Amplifiers** Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. Frequency response of a CE amplifier. Coupled Amplifier: Two stage RC-coupled amplifier. Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators. Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. Applications of Op-Amps: Linear - (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator. Non-linear (1) inverting and non-inverting comparators,	**5** **5** **2** **10**	**Jan - June**

			(2) Schmidt triggers. Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation)		
Year	**Paper**	**Unit**	**Topic**	**No. of lectures**	**Session**
3 Hons	**5**	**II**	**ATOMIC PHYSICS** **Atomic Spectrum** Good quantum numbers, and selection rules. Stern-Gerlach experiment andspin as an intrinsic quantum number. Incompatibility of spin with classical ideas. Bohr-Sommerfeld model. Fine structure. Study of fine structure by Michelson interferometer. **Vector atom model** Magnetic moment of the electron, Lande g factor. Vector model – space quantization. Zeeman Effect : Explanation from vector atom model. **Many electron model** Pauli exclusion principle, shell structure. Hund's rule, spectroscopic terms of many electron atoms in the ground state. **Molecular spectroscopy** Diatomic molecules – rotational and vibrational energy levels. Basic ideas about molecular spectra.Raman effect and its application to molecular spectroscopy (qualitative discussion only). **Laser Physics** Population inversion, Einstein's A and B	**8** **5** **3** **4**	**July to Pre-Puja**

			coefficients; feedback of energy on a resonator; 3-level and 4-level systems.	**3**	
Year	**Paper**	**Unit**	**Topic**	**No. of lectures**	**Session**
3rd year	**7A**	**I**	**STATISTICAL MECHANICS** **Microstates and macrostates** Classical description in terms of phase space and quantum description in terms of wave functions. Hypothesis of equal apriori probability for microstates of an isolated system in equilibrium. Interactions between two systems – thermal, mechanical and diffusive. Statistical definition of temperature, pressure, entropy and chemical potential. Partition function of a system in thermal equilibrium with a heat bath. **Classical statistical mechanics** Maxwell-Boltzmann distribution law. Calculation of thermodynamic quantities for ideal monoatomic gases. **Motivations for quantum statistics** Gibbs' paradox. Identical particle and symmetry requirement. Derivation of MB, FD and BE statistics as the most probable distri - butions (micro-canonical ensemble). Classical limit of quantum statistics. **Quantum statistical mechanics** Bose-Einstein statistics: Application to radiation – Planck's law. Rayleigh Jeans and Wien laws as limiting cases, Stefan's law. Fermi-Dirac statistics: Fermi distribution at zero and non-zero temperature Fermi energy and its expression in terms of particle density. Degenerate and non- degenerate Fermi gas. Electron specific heat of metals at low temperature. Saha equation for thermal ionization and its application to astrophysics.	**8** **3** **3** **6**	**Post-Puja to Test examination)**

General

Name: Dr. Gayatri Pal

Department: Physics

Year	Paper	Unit	Topic	No. of lectures	Session
1st Sem (CBCS)	**GE1**		**Laws of Motion:** a) Laws of Motion: Frames of reference. Newtow's laws of motion. Dynamics of system of particles. Conservation of momentum. Center of Mass.	**8**	**July to Pre-Puja**
			Work and Energy: Work- energy theorem. Conservative forces. Concept of potential energy. Conservation of Energy.	**5**	**Post-Puja to End Sem**
2nd Sem (CBCS)	**GE2**		**Magnetism** Biot-Savart's law and the Lorentz force law. Application of Biot-Savart's law to determine the magnetic eld of a straight conductor, circular coil, solenoid carrying current. Force between two straight current carrying wires. Divergence of the magnetic field. Magnetic vector potential. Curl of the magnetic field. Ampere's circuital law. Determination of the magnetic field of a straight current carrying wire. Potential and field due to a magnetic dipole. Magnetic dipole moment. Force and torque on a magnetic dipole. Magnetic fields inside matter: Magnetization. Bound currents. The magnetic intensity - H. Linear media. Magnetic susceptibility and Permeability. Brief introduction of dia-, para- and ferro-magnetic materials. **Electromagnetic Induction** **Ohms law and definition of E.M.F.** 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.	**10** **2** **4**	**Jan - June**

Year	Paper	Unit	Topic	No. of lectures	Session
2nd Sem (CBCS)	**GE2**		**Maxwell's Equations and Electromagnetic Wave Propagation** Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic eld, electromagnetic wave propagation through vacuum and isotropic di- electric medium, transverse nature of EM waves,. Polarization of E.M. waves.	**7**	**Jan - June**
3rd Sem (CBCS)	**GE3**		**Statistical Mechanics** Phase space, Macrostate and Microstate. Ensemble - Ergodic hy- pothesis. PEAP, Entropy and Thermodynamic probability - Boltz mann hypothesis. Maxwell-Boltzmann law - distribution of velocity - Quantum statistics (qualitative discussion only) - Fermi-Dirac distribution law (statement only) - electron gas as an example of Fermi gas - Bose-Einstein distribution law (statement only) - photon gas as an example of Bose gas- comparison of three statistics.	**6**	**Post Puja to End Sem**

Year	Paper	Unit	Topic	No. of lectures	Session
3	**4A**	**III**	***Feedback :*** Basic principle, positive and negative feedback, Barkhausen criterion, oscillator,	**2**	**July to Pre-Puja**
			OPAMP : characteristics, uses of OPAMP as amplifier, oscillator, and filter;	**5**	
			light-emitting diodes, 7-segment display, SCR, diac and triac.	**2**	
			. *Digital electronics :* combinational circuits --- adder and subtractor, multiplexer, demultiplexer, encoder, decoder, sequential circuits --- flip-flop, D and J-K, registers and counters.	**5**	
		III	***Instruments :*** cathode-ray oscilloscope, digital multimeter, L and C measurements.	**3**	**post-Puja to Test examination)**

Lesson Plan (AY 2019-2020)
Name:Dr. Subhendu Chandra
Department: Physics
Honours Course

Semester	Paper	Unit	Topic	No. of lectures	Session
1Hons	PHS-A-CC-1-1-TH		**Vector Algebra and Vector Calculus:** **(a)** Recapitulation of Vector Algebra. Idea of linear independence, completeness, basis and representation of vectors. Properties of vectors under rotations. Scalar product and its invariance under coordinate rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. **(b)** Vector Differentiation: Scalar and Vector fields. 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. **(c)** Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).	**8** **8** **5**	**July to Pre-Puja**
			Orthogonal Curvilinear Coordinates: **(d)** Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Spherical and Cylindrical Coordinate Systems.	**4**	**post-Puja to End Sem**
2Hons	PHS-A-CC-2-3-TH		**Electrical circuits:** AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit **Network theorems:** 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.	**5** **5**	**January to June**

3 Hons	PHS-A-CC-3-5-TH		**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 coe-cients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity. **Frobenius Method and Special Functions:** Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions (Jo(x) and J1(x))and Orthogonality.	**12** **10**	**July to Pre-Puja**
3 Hons	PHS-A-SEC-A-TH		**Basic Electricity Principles:** Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. **Understanding Electrical Circuits:** Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money	**10** **8**	

			Electrical Drawing and Symbols: a) Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. **Generators and Transformers:** (a) DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. **Electric Motors:** (a) Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor **Solid-State Devices:** (a) Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources.	**5** **3** **5** **2**	
3 Hons	PHS-A-CC-3-5-TH		**Variational calculus in physics:** Functionals. Basic ideas of functionals. Extremization of action as a basic principle in mechanics. Lagrangianfomulation. Euler's equations of motion for simple systems: harmonics oscillators, simple pendulum, spherical pendulum, coupled oscillators. Cyclic coordinates.Symmetries and conservation laws. Legendre transformations and the Hamiltonian formulation of mechanics. Canonical equations of motion. Applications to simple systems	**8**	**Post-Puja to End Sem**
3 Hons	PHS-A-SEC-A-TH		**Electrical Protection:** (a) Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection.Page 97 Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device) **Electrical Wiring:** (a) 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.	**6** **10**	

4 Hons	PHS-A-CC-4-8-TH		**Integrals Transforms:** (a) 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. **Introduction to probability:** (a) Independent random variables: Sample space and Probability distribution functions. Binomial, Gaussian, and Poisson distribution with examples. Mean and variance.	**10** **5**	

Year	Paper	Unit	Topic	No. of lectures	Session
3Hons	**V**	**II**	**Crystal Structure:** Crystalline and amorphous solids, translational symmetry. Elementary ideas about crystal structure, lattice and bases, unit cell, reciprocal lattice, fundamental types of lattices, Miller indices, lattice planes, simple cubic, f.c.c. and b.c.c. lattices. Laue and Bragg equations. Determination of crystal structure with X-rays. **Structure of solids:** Different types of bonding- ionic, covalent, metallic, van der Waals and hydrogen. Band theory of solids,Periodic potential and Bloch theorem, Kronig-Penny model, energy band structure. Band structure in Conductors, direct and indirect semiconductors and insulators (qualitative discussions); free electron theory of metals, effective mass, drift current, mobility and conductivity, Wiedemann-Franz law. Hall effect in metals: Phenomenology and implication.	**10+3** **15+2**	**July to Pre-Puja**
			Dielectric properties of materials: Electronic, ionic and dipolar polarizability, local fields, induced and oriented polarization– molecular field in a dielectric; Clausius-Mosotti relation.	**4**	

			Magnetic properties of materials: Dia, para and ferro-magnetic properties of solids. Langevin's theory of diamagnetism and paramagnetism. Quantum theory of paramagnetism, Curie's law. Ferromagnetism: spontaneous magnetization and domain structure; temperature dependence of spontaneous magnetisation;Curie-Weisslaw, explanation of hysteresis. **Lattice vibrations:** Elastic and atomic force constants; Dynamics of a chain of similar atoms and chain of two types of atoms; optical and acoustic modes; interaction of light with ionic crystals. Einstein's and Debye's theories of specific heats of solids. **Superconductivity:** Introduction (Kamerlingh-Onnes experiment), effect of magnetic field, Type-I and type-II superconductors, Isotope effect. Meissner effect. Heat capacity. Energy gap. Ideas about High-Tc superconductors.	**11+3** **5+2** **4+1**	**Post-Puja to Test examination**

General Course

Semester	Paper	Unit	Topic	No. of lectures	Session
1 General	PHS-G-CC-1-1-TH		**Mathematical Methods** (a) Vector Algebra: Vectors as directed line segments. Addition of vectors and multiplication by a scalar. Scalar and vector products. Basis and representation of vectors. (b) Vector Analysis: Derivatives of a vector with respect to a parameter. Gradient, divergence and Curl.	**5** **5**	**July to Pre-Puja**
			Vector Analysis (Continued) Vector integration, line, surface and volume integrals of vector fields. Gauss'-divergence theorem and Stoke's theorem of vectors (Statement only)	**5**	**Post Puja to End Sem**
2 General	PHS-G-CC-2-2-TH		**1. Essential Vector Analysis** (a) Vector Algebra: Addition of vectors and multiplication by a scalar. Scalar and vector products of two vectors. (b) Vector Analysis: Gradient, divergence and Curl. Vector integration, line, surface	**5**	**August to Pre-Puja**

			and volume integrals of vector fields. Gauss'divergence theorem and Stoke's theorem of vectors (Statement only) and their significances. **2. Electrostatics** (a) Coulombs law, principle of superposition, electrostatic field. Electric field and charge density, surface and volume chargev density, charge density on the surface of a conductor. Force per unit area on the surface. (b) Electric dipole moment, electric potential and field due to an electric dipole, force and Torque on a dipole. Electric Fields inside matter, Electric Polarisation, bound charges, displacement density vector, linear Dielectric medium, electric Succeptibility and Permittivity (c) Divergence of the Electrostatic field, flux, Gauss's theorem of electrostatics, applications of Gauss theorem to find Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Gauss's theorem in dielectrics. (d) Curl of the Electrostatic Field. Conservative nature of electrostatic field, Introduction to electriostatic potential, Calculation of potential for linear, surface and volume charge distributions, potential for a uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Energy per unit volume in electrostatic field.	**7** **8** **`10**	
			Electric Fields inside matter: Electric Polarisation. Bound charges. Displacement vector. Gauss's theorem in dielectrics. Linear Dielectric medium. Electric Succeptibility and Permittivity. Parallel plate capacitor completely filled with dielectric. **Linear Network:** Impedance of L, C, R and their combinations. Thevenin& Norton's Theorem. Maximum power transfer theorem and superposition theorem. Anderson's bridge.	**10** **6**	**Post Puja to End Sem**

Year	Paper	Unit	Topic	No. of lectures	Session
3 General	**IVA**	**IV**	**Communications:** Propagation of electromagnetic waves in atmosphere, various layers of atmosphere, ground andsky waves. **Transmission of electromagnetic waves:**Amplitude and frequency modulation, calculation ofpower in amplitude modulation, sideband generation in frequency modulated wave; demodulation, linear diode detector, detection of FM waves, signal-to-noise ratio.	**2** **5**	**July to Pre-Puja**
		IV	**Transmission through media:**coaxial cables, optical fibre --- cladding, energy loss, band width and channel capacity, information carrying capacity of lightwaves (qualitative); satellitecommunication, microwave link --- modem and internet	**5**	**post-Puja to Test**

Lesson Plan - Honours (AY 2019-20)
Name: Dr. Shinjinee Das Gupta
Department: Physics

Year/ Semester	Paper	Unit	Topic	No. of lectures	Session
Sem I	**PHS-A-CC-1-1-TH**		**First Order and Second Order Differential equations:** First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. **Calculus of functions of more than one variable:** Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers. **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 Non-Singular matrices. Orthogonal and Unitary Matrices. Trace of a Matrix. Inner Product. Eigen-values and Eigenvectors. Cayley- Hamiliton Theorem.	**Lectures 10** **Lectures 8** **Lectures 12**	**July to Pre-Puja**
Sem I	**PHS-A-CC-1-1-TH**		**Matrices contd.** Diagonalization of Matrices. Solutions of Coupled Linear Ordinary Differential Equations. Functions of a Matrix.	**Lectures 6**	**Post-Puja to End Sem Exam**

Year	Paper	Unit	Topic	No. of lectures	Session
Sem II	**PHS-A-CC-2-4-TH**		**Wave Optics:** Electromagnetic Nature of Light. Definition and properties of wavefront. Huygen's Principle. Temporal and Spatial coherence. **Interference** Division of amplitude and wavefront. Young's double slit experiment. Llyod's mirror and Fresenl's Biprism. Phase change on reflection and Stokes' treatment. Interference in Thin Films: parallel and wedge shaped films. Fringes of equal inclination and fringes of equal thickness. Newton's rings: measurement of wavelength and refractive index. **Interferometer** a) Michelson Inteferometer: 1) Idea of form of fringes, 2) Determination of wavelength, 3) Wavelength difference, 4) Refractive Index and 5) Visibility of fringes. b) Fabry-Perot interferometer. **Diffraction** a) Fraunhofer diffraction: Single slit. Circular apertures. Resolving power of a Telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. b) Fresnel Diffraction : Fresnel's Assumptions. Fresnel's Half-period zone for plane wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple foci of a Zone Plate, Fresnel's Integrals, Fresnel's diffraction pattern of a straight edge, a slit and a wire.	**Lectures 3** **Lectures 10** **Lectures 6** **Lectures 10** **Lectures 10**	**Jan - June**

Year	Paper	Unit	Topic	No. of lectures	Session
Sem III	PHS-A-CC-3-6-TH		**Kinetic Theory of Gases** a) **Distribution of velocities:** Maxwell's velocity distribution law and its experimental verification. Doppler broadening of spectral lines and Stern's experiment. Mean, RMS and most probable speeds. Degrees of Freedom. Law of equi partition of energy (detailed derivation not required). Specific heats of gases. b) **Molecular collisions:** Mean free path. Collision probability. Estimation of Mean Free Paths. Transport Phenomena in Ideal gases: 1) Viscosity, 2) thermal conduction and 3) diffusion. Brownian Motion and its significance. **c)Real Gases:** Behavior of Real gases: Deviations from Ideal gas equation. Virial equation. Andrew's experiment of 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. **Conduction of Heat** a) Thermal conductivity, diffusivity. Fourier's equation for heat conduction – its solution for rectilinear flow of heat.	**Lectures 8** **Lectures 10** **Lectures 8** **Lectures 3**	**July to Pre-Puja**
Sem III	PHS-A-CC-3-5-TH		**Some Special Integrals** a) Beta and Gamma functions and Relation between them. Expressions of integrals in terms of Gamma functions. Error functions (Probability Integral). **Partial differential equations** a) 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 a vibrational mode of stretched strings, rectangular and circular membranes. Diffusion equation.	**Lectures 5** **Lectures 10**	**Post Puja to End Sem**

Year	**Paper**	**Unit**	**Topic**	**No. of lectures**	**Session**
Sem IV	**PHS-A-CC-4-8-TH**		**SPECIAL THEORY OF RELATIVITY** a) Michelson-Morley experiment and its outcome. Postulates of special theory of relativity. Lorentz transformation. Simultaneity and order of events. Lorentz contraction, Time dilatation, Relativistic transformation of velocities. Relativistic dynamics : variation of mass with velocity. Massless particle. Mass-energy equivalence. Transformation of energy and momentum. b) Relativity in Four vector notation: Four Vectors, Lorentz transformation and invariant interval, space-time diagrams. Proper time and proper velocity. Relativistic energy and momentum - Four momentum. Conservation of four momentum and applications to collisions. Minkowski Force.	**Lectures 15** **Lectures 15**	**Jan - June**
Sem IV	**PHS-A-CC-4-9-TH**		**Lasers:** Einstein 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.	**Lectures 10**	**Jan - June**
Sem IV	**PHS A-SEC B-TH**		**Renewable Energy and Energy Harvesting** **Geothermal Energy :** Geothermal resources, Geothermal technologies. **Hydro Energy:** Hydropower resources, Hydropower technologies, environmental impacts of hydropower sources. **Piezoelectric Energy Harvesting:** **a)** Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity. Piezoelectric parameters and modeling of piezoelectric generators, Piezoelectric Energy Harvesting applications and Human power. **Electromagnetic Energy Harvesting** a) Linear Generators, physics mathematical models, recent applications. b) Carbon capture technologies, cell, batteries, power consumption. c) Environmental issues and Renewable sources of energy, sustainability.	**Lectures 2** **Lectures 3** **Lectures 6** **Lectures 6**	**Jan - June**

Year	Paper	Unit	Topic	No. of lectures	Session
III (1+1+ 1)	**V**	**II**	**1. Time dependent and time independent Schrodinger equation** Eigenstates, normalization and orthonormality. **2. Simple applications of Quantum Mechanics** One dimensional potential well and barrier, boundary conditions, bound and unbound states. Reflection and transmission coefficients for a rectangular barrier in one dimension – explanation of alpha decay. Free particle in one dimensional box, box normalization, momentum eigenfunctions of a free particle. Linear harmonic oscillator, energy eigenvalues from Hermite differential equation, wave function for ground state, parity of wave function. **3. Schrodinger equation in spherical polar coordinates** Angular momentum operators and their commutation relations; eigenvalues and eigenfunctions of L^2 and Lz; theorem of addition of angular momenta [statement with examples]. The hydrogen atom problem – stationary state wavefunctions as simultaneous eigenfunctions of H, L^2, and Lz; radial Schrodinger equation and energy eigenvalues [Laguerre polynomial solutions to be assumed]; degeneracy of the energy eigenvalues.	**Lectures 6+ 2 (Tutorial)** **Lectures 15+ 3 (Tutorial)** **Lectures 13+ 3 (Tutorial)**	**July to Pre-Puja**

Year	Paper	Unit	Topic	No. of lectures	Session
III (1+1+ 1)	**V**	**I**	**SPECIAL THEORY OF RELATIVITY** 1. Introduction Galilean transformation and invariance of Newton's laws of motion, non-invariance of Maxwell's equations. Michelson-Morley experiment and explanation of the null result. 2. Special Theory of Relativity Concept of inertial frame. Postulates of special theory; simultaneity; Lorentz transformation along one of the axes – length contraction, time dilatation and velocity addition theorem, Fizeau's experiment. Four vectors. Relativistic dynamics : variation of mass with velocity; energy momentum relationship. 3. Vectors and Tensors Covariant and contravariant vectors. Contraction. Covariant, contravariant, and mixed tensors of rank-2, transformation properties. The metric tensor (flat space-time only). Raising and lowering of indices with metric tensors. (Consistent use of any one convention --- diag (-1,1,1,1) or diag (1,-1,-1,-1).) Example of common four-vectors: position, momentum, derivative, current density, four-velocity. 4. Invariant intervals Concept of space-time: Euclidean and Minkowski. Invariant intervals in 1+1 and 3+1 dimensions (use Minkowski space-time). Space like, time-like and light like four vectors. Light cone. Causality and simultaneity in different frames.	**Lectures 4 + 1 (Tutorial)** **Lectures 10+ 2 (Tutorial)** **Lectures 6+ 1 (Tutorial)** **Lectures 5+1 (Tutorial)**	**Post-Puja to Winter vacation/Test**

General Course

Year/ Semester	Paper	Unit	Topic	No. of lectures	Session
Sem I	**PHS-G-CC-1-1-TH**		**Viscosity** (a) Rate ow of liquid in a capillary tube - Poiseuille's formula. **Surface Tension** Synclastic and anticlastic surface - Excess of pressure - Application to spherical drops and bubbles - variation of surface tension with temperature. **Gravitation** (a) Motion of a particle in a central force eld. Conservation of angular momentum leading to restriction of the motion to a plane and constancy of areal velocity. Newton's Law of Gravitation. Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits.	**Lectures 12**	**July to Pre-Puja**
Sem I	**PHS-G-CC-1-1-TH**		**Gravitation contd.** Basic idea of global positioning system (GPS). Weightlessness.	**Lectures 2**	**Post-Puja to End Sem Exam**
Sem III	**PHS-G-CC-3-3-TH**		**Kinetic Theory of Gases** a) Derivation of Maxwell's law of distribution of velocities and its experimental verification. Mean free path (Zeroth order). Transport Phenomena in Ideal gases: 1) Viscosity, 2) thermal conduction and 3) diffusion. Law of equi-partition of energies (no derivation) and its application to specific heat of gases, mono-atomic and diatomic gases. **Theory of Radiation** a) Blackbody radiation, Spectral distribution, Concept of energy density, derivation of Planck's Law, Deduction of Wien's distribution Law, Rayleigh-Jean's Law , Stefan-Boltzmann Law and Wien's displacement Law from Planck's Law.	**Lectures 12** **Lectures 8**	**July to Pre-Puja** **Post-Puja to End Sem Exam**

Sem IV	**PHS-G-CC-4-4-TH**		**Wave Optics:** Electromagnetic Nature of Light. Definition and properties of wavefront. Huygen's Principle. **Interference** Division of amplitude and wavefront. Young's double slit experiment. Llyod's mirror and Fresenl's Biprism. Phase change on reflection and Stokes' treatment. Interference in Thin Films: parallel and wedge shaped films. Fringes of equal inclination and fringes of equal thickness. Newton's rings: measurement of wavelength and refractive index. **Michelson's Interferometer** 1) Idea of form of fringes, 2) Determination of wavelength, 3) Wavelength difference, 4) Refractive Index and 5) Visibility of fringes. **Diffraction** a) Fraunhofer diffraction: Single slit. Double slit. Multiple slits. Diffraction grating. b) Fresnel Diffraction : Half-period zones. Zone Plate. Fresnel's diffraction pattern of a straight edge, a slit and a wire. **Polarization** Transverse nature of light waves. Plane polarized light - production and analysis. Circular and elliptical polarization. Optical activity.	**Lectures 2** **Lectures 8** **Lectures 2** **Lectures 8** **Lectures 6**	**Jan - June**
III (1+1+1)	**IVA**	**I**	**<u>Pumps, gauges and engine</u>** 1. **Production and measurement of high vacuum** : Rotary and diffusion pump, Mcleod, Pirani, and Penning gauges.	**Lectures 8 + 2 (Tutorial)**	**July to Pre-Puja**

Lesson Plan - Honours
(AY 2019-20)
Name: Kathakali Biswas
Department:Physics

Honors Course

Semester	paper	Unit	Topic	No. of lectures	Session
I	PHS-A-CC-1-1-TH		**Recapitulation:** Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves.	**Lectures 7**	**July to Pre-Puja**
	PHS-A-CC-1-1-TH		**Convergence of infinite series:** Convergence of power series . Idea of interval of convergence . Different convergence tests of power series: D'alembert's ratio test, Cauchy's root test, Integral test. Alternating series test. Absolute and conditional convergence. Taylor series of one variable, Maclaurin series. Approximation errors.	**Lectures 3**	**Post-Puja to End Sem Exam**
	PHS-A-CC-1-2-TH		**Rotational Dynamics:**(a) The Rigid Body: Constraints defining the rigid body. Degrees of freedom for a rigid body; (b) Relation between Angular momentum and Angular Velocity: Moment of Inertia Tensor. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies.	**Lectures 8**	**July to Pre-Puja**
	PHS-A-CC-1-2-TH		**Rotational Dynamics Contd. :** (c) Equation of motion for rotation about a fixed axis. Principal Axes transformation. Transformation to a body fixed frame. E.O.M for the rigid body with one point fixed (Euler's equations of motion). Torque free motion.Kinetic energy of rotation.	**Lectures 4**	**Post-Puja toEndSemExam**
II	PHS-A-CC-2-3-TH		**Electrostatics :** (a)Coulombs law, principle of superposition, electrostatic field.	**Lectures 12**	**Jan-June**

			Electric field and charge density, surface and volume charge density, charge density on the surface of a conductor. Force per unit area on the surface. (b) Divergence of the Electrostatic field, flux, Gauss's theorem of electrostatics, applications of Gauss theorem to find Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. (c) Curl of the Electrostatic Field. Conservative nature of electrostatic field, Introduction to electrostatic potential, Calculation of potential for linear, surface and volume charge distributions, potential for a uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. **Dielectric properties of matter:** Electric dipole moment, electric potential and field due to an electric dipole, force and Torque on a dipole. Electric Fields inside matter, Electric Polarisation, bound charges, displacement density vector, relation between$\vec{E}$, $\vec{P}$ and $\vec{D}$. Gauss's theorem in dielectrics, linear Dielectric medium, electric succeptibility and permittivity. Electrostatic boundary conditions for $\vec{E}$ and $\vec{D}$. **Method of Images:** Laplace's and Poisson equations. Uniqueness Theorems. Method of Images and its application to: Plane Infinite metal sheet, Semi-infinite dielectric medium and metal Sphere. **Electrostatic Energy:** Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Energy per unit volume in electrostatic field.	**Lectures 6** **Lectures 4** **Lectures 3**	

Semester	paper	Unit	Topic	No. of lectures	Session
IV	**PHS-A-CC-4-8-TH**		**Complex Analysis:** (a) Brief Revision of Complex Numbers. and their Graphical Representation. Euler's formula, 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.	**Lectures 20**	**Even Sem**

Year	paper	Unit	Topic	No. of lectures	Session
III (1+1+1)	**V**	**II**	**Central force problem:** Motion under central force; Nature of orbits in an attractive inverse square field; Kepler's laws of planetary motion. Rutherford scattering as an example of repulsive potential. **Mechanics of Ideal Fluids:** Streamlines and flowlines; Equation of continuity; Euler's equation of motion; Streamline motion - Bernoulli's equation and its applications. Definition of Newtonian and non-Newtonian fluids.	**Lectures 13+3(Tutorial)**	**July to Pre-Puja**
			Lagrangian and Hamiltonian formulation of Classical Mechanics: Generalised coordinates, constraints and degrees of freedom; D'Alembart's principle; Lagrange's equation for conservative systems (from D'Alembert's principle; variational principle not required) and its application to simple cases; Generalised momentum; Idea of cyclic coordinates, its relation with conservation principles; Definition of Hamiltonian, Hamilton's equation (derivation by Legendre transformation) and its application to simple cases.	**Lectures 12+2(Tutorial)**	**Post-Puja to Winter vacation /Test**

Year	paper	Unit	Topic	No. of lectures	Session
III (1+1+1)	**VIIA**	**I**	**Generalization of Ampere's Law:** Displacement Current, Maxwell's Field Equations, Wave equation for electromagnetic (EM) field and its solution – plane wave and spherical wave solutions, transverse nature of field, relation between E and B; energy density of field, Poynting vector and Poynting's theorem, boundary conditions. **EM Waves in an isotropic dielectric**: Wave equation, reflection and refraction at plane boundary, reflection and transmission coefficients, Fresnel's formula, change of phase on reflection, polarization on reflection and Brewster's law, total internal reflection. **EM waves in conducting medium:** Wave equation in conducting medium, reflection and transmission at metallic surface – skin effect and skin depth, propagation of E-M waves between parallel and conducting plates – wave guides (rectangular only).	**Lectures 19**	**July to Pre-Puja**
			Dispersion: Equation of motion of an electron in a radiation field : Lorentz theory of dispersion – normal and anomalous; Sellmeier's and Cauchy's formulae, absorptive and dispersive mode, half power frequency, band width. **Scattering:** Scattering of radiation by a bound charge, Rayleigh's scattering (qualitative ideas), blue of the sky, absorption.	**Lectures 6+5(Tutorial)**	**Post-Puja to Winter vacation/Test**

General Course

Semester	paper	Unit	Topic	No. oflectures	Session
I	**PHS-G-CC-1-1-TH**		**Oscillations:** Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. Forced oscillations with harmonic forces. Compound pendulum.	**Lectures 9**	**July to Pre-Puja**
			Rotational Motion: Rotation of a rigid body about a fixed axis. Angular velocity and angular momentum. Moment of Inertia. Torque. Conservation of angular momentum.	**Lectures 10**	**Post-Puja toEnd SemExam**

Year	paper	Unit	Topic	No. oflectures	Session
III (1+1+1)	**IVA**	**I**	**Engines :** Heat engines, thermal efficiency, indicated Horse-power and brake Horse-power, Otto 22 cycle and Diesel cycle, four-stroke petrol and diesel engines, calculation of efficiency and comparison.	**Lectures** 10	**Post-Puja to Winter vacation/Test**