COURSE HANDOUTS

B.Sc (General) Courses in Physics

Semester I, III and V, 2021-2022

Mechanics (PHSGCOR01T, PHSHGEC01T)

1st semester, 2021-2022

About the Course

- Name of the Course : Mechanics
- Nature of the Course : Core Course/Generic Elective
- Code of the Course : PHSGCOR01T/PHSHGEC01T (Theory), PHSGCOR01P/PHSHGEC01P (Laboratory)
- Credit point : 4 (Theory) + 2 (Laboratory)
- Class Hours : 60 (Theory) + 60 (Laboratory)

Course Description

This is a freshmen level course on Newtonian mechanics, general properties of matter and special theory of relativity. In the laboratory. the students will get hands on learning experience of the concepts that are taught in the theory classes. Emphasis will be given on laboratory techniques such as accuracy of measurements and data analysis.

Course Outcomes

CO1 : Comprehend basic vector calculus – products, derivatives and integration of vectorial quantities.

CO2 : Learn how to solve first order and second order homogeneous and inhomogeneous ordinary differential equations.

CO3 : Understand Newtonian mechanics and frames of reference. Understand the conservation laws in motion of a point particle or system of particles. Understand rotational motion - angular velocity and angular momentum, torque, conservation of angular momentum.

CO4 : Learn Newtonian theory of gravitation, Kepler's laws. Acquire basic idea of statellites in circular orbits and GPS.

CO5 : Understand simple harmonic motion and the properties of systems executing such motions.

CO6 : Acquire knowledge about elasticity – Hooke's law, relation between elastic constants, Poisson's ratio, work done in stretching and work done in twisting a wire - bending of beam.

CO7 : Acquire basic idea of special theory of relativity and relativistic effects on the motion of an object.

CO8 : Acquire hands on training experience to verify concepts learned in the theory.

Relationship to other courses

- Assumed knowledge : Grasp over 10 + 2 level physics and mathematics
- Pre-requisite : Freshmen course
- Follow up Course : None

Faculty : Purnendu Chakraborty, Raghunath Bera, Priyanka Chowdhury, Paramita Mallick

Course Schedule (PHSGCOR01T, PHSHGEC01T)

Faculty	Class Timing			Google Classroom Code
Purnendu Chakraborty	Friday	13:00 – 14:00	Room No. 116	xz435fg
Raghunath Bera	Thursday	14:00 – 15:00	Room No. 111	2k6ltu3
Priyanka Chowdhury	Tuesday	14:00 – 15:00	Physics Lab.	2zdc3qi
Paramita Mallick	Wednesday	14:00 – 15:00	Physics Lab.	75jzueo

Course Schedule (PHSGCOR01P, PHSHGEC01P)

Faculty	Class Timing			Google Classroom Code
Priyanka Chowdhury	Tuesday	15.00 – 17.00	Physics Lab.	2zdc3qi
	Friday	14.00 – 16.00	Physics Lab.	
Paramita Mallick	Wednesday	15.00 – 17.00	Physics Lab.	75jzueo
	Saturday	14.00-16.00	Physics Lab.	

Course Outline

Unit 1 – Mathematical Methods
Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. Ordinary Differential Equations: 1 st order homogeneous differential equations. 2 nd order homogeneous and inhomogeneous differential equations with constant coefficients.
Unit 2 – Particle Dynamics
Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass. Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets. Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum
Unit 3 – Gravitation
Gravitation: Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).
Unit 4 – Oscillations
Oscillations: Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. Forced harmonic oscillations, resonance.
Unit 5 – Elasticity
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.- Bending of beam.
Unit 6 - Special Theory of Relativity
Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Relativistic Doppler Effect.
Reference Books
1. Classical Mechanics. T.W.B. Kibble and F.H. Berkshire, 2004, Imp. Col. Press, World Scientific. 2. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill. Classical Dynamics of Particles and Systems. S.T. Thornton and J. B. Marion, 2009, Brooks, Cole. 3. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill. 4. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley. 5. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley 6. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill. 7. Classical Mechanics and General Properties of Matter. S.N. Maiti and D.P. Raychaudhuri, New Age

8. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
9. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
10. Special Relativity (MIT Introductory Physics). A.P. French, 2018, CRC Press.
11. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
12. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.

Course Calendar (PHSGCOR01T/PHSHGEC01T)

Purnendu Chakraborty			
Unit	Topic	Class Hours	Month
1	**Mathematical Methods**	**10**	
1A	Vectors : Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.	4	October November
1B	Ordinary Differential Equations : 1st order homogeneous differential equations. 2nd order homogeneous and inhomogeneous differential equations with constant coefficients.	5	November December
	1st Class Test	1	December
2C	**Particle Dynamics**	**6**	
2C	Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum.	5	December, January
	2nd Class Test	1	January

Raghunath Bera			
Unit	Topic	Class Hours	Month
3	**Gravitation**	**8**	
3A	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).	4	October November
3B	Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).	3	November December
	1st Class Test	1	December
5	**Elasticity**	**8**	
5A	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.	2	December
5B	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.	3	December, January
5C	Bending of beam.	2	January
	2nd Class Test	1	January

Priyanka Chowdhury			
Unit	Topic	Class Hours	Month
2	**Particle Dynamics**	**8**	
2A	Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.	7	October, November, December
	1st Class Test	1	December
4	**Oscillations**	**6**	
4A	Oscillations: Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages.	2	December
4B	Damped oscillations. Forced harmonic oscillations, resonance.	3	January
	2nd Class Test	1	January

Paramita Mallick			
Unit	Topic	Class Hours	Month
6	**Special Theory of Relativity**	**7**	
6A	Special Theory of Relativity : Constancy of speed of light. Postulates of Special Theory of Relativity.	2	October, November
6B	Length contraction. Time dilation. Relativistic addition of velocities.	4	November, December
	1st Class Test	1	December
2B	**Particle Dynamics**	**7**	
2B	Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.	6	December, January
	2nd Class Test	1	January

Assessment of students

Internal assessment of the students will be done through class tests.

Thermal Physics and Statistical Mechanics (PHSGCOR03T, PHSHGEC03T)

3rd Semester, 2021-2022

About the Course

- Name of the Course : Thermal Physics and Statistical Mechanics
- Nature of the Course : Core Course
- Code of the Course : PHSGCOR03T (Theory), PHSGCOR03P (Laboratory)
- Credit point : 4 (Theory) + 2 (Laboratory)
- Class Hours : 60 (Theory) + 60 (Laboratory)

Course Description

This course is designed to get a fundamental understanding of Heat and Thermodynamics. The laws related to behavior of a thermal system, the thermodynamic potentials and the thermodynamic variables are to be discussed. The ideas about theory of Blackbody radiation will be introduced here along with the concept of Statistical Mechanics.

Course Outcomes

On successful completion of this core course students will -

CO1 : Understand the zeroth, first and second laws of thermodynamics, the nature of thermodynamic properties of matter like internal energy, entropy, specific heats, temperature.

CO2 : Understand reversible and irreversible process, conversion between heat and work, Carnots's Theorem.

CO3 : Understand thermodynamic potentials, Free energy, Maxwell's relations, Clausius Clapeyron equation.

CO5 : Acquire knowledge in the kinetic theory of gases, velocity distribution laws, molecular collisions, the process of thermal conductivity, viscosity and diffusion in gases.

CO7 : Acquire knowledge on the blackbody radiation, different laws relating to radiation, Planck's Law.

CO8 : Understand identical particles and indistinguishability, derivation of Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics and their applications in different physical systems.

CO9 : Verify concepts learned in theoretical course through hands on experiments to measure coefficient of thermal conductivity, thermo-emf and mechanical equivalent of heat by using platinum resistance thermometer, thermocouple and diode sensors.

Relationship to other courses

- **Assumed knowledge**: Basic ideas of thermal processes
- **Prerequisite**: None.

Faculty : Mahuya Chakrabarti and Paramita Mallick

Course Schedule (PHSGCOR03T/PHSHGEC03T)

Teacher	Timetable			Google Classroom Code
Mahuya Chakrabarti	Tuesday	12:00 – 13:00	Room No 111	bhjjumi
	Friday	16:00 – 17:00	Room No 111	
Paramita Mallick	Tuesday	15:00 – 16:00	Room No 111	xodduif
	Saturday	13:00 – 14:00	Room No 111	

Course Schedule: PHSGCOR03P (Laboratory)

Teacher	Timetable			Google Classroom Code
Mahuya Chakrabarti Paramita Mallick	Tuesday	12:00 – 13:00	Physics Laboratory	bhjjumi
	Thursday	12:00 – 13:00	Physics Laboratory	

Course Outline

Unit 1 : Introduction to Thermodynamics
Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law and Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.
Unit 2 : Thermodynamic Potentials
Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications – Joule Thompson Effect, Clausius- Clapeyron Equation, Expression for (CP – CV), CP/CV, TdS equations.
Unit 3 : Kinetic Theory of Gases
Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.
Unit 4 : Theory of Radiation
Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.
Unit 5 : Statistical Mechanics
Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, 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.
Reference Books
1. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford Univ Press. 2. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill. 3. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press. 4. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications 5. Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill 6. Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears and G.L. Salinger. 1988, Narosa 7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole. 8. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.

Course Calendar

Paramita Mallick			
Unit	Topic	Class Hours	Month
1	**Laws of Thermodynamics**	**22**	
1A	Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes.	6	September
1B	Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes.	6	September October
	First class test	1	October
1C	Second law and Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams.	5	November
1D	Third law of thermodynamics, Unattainability of absolute zero.	3	November December
	Second class test	1	December
2	**Thermodynamic Potentials**	**10**	
2A	Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for $(C_P – C_V)$, C_P/C_V, TdS equations.	10	December January

Mahuya Chakrabarti			
Unit	Topic	Class Hours	Month
3	**Kinetic Theory of Gases**	**10**	
3A	Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order)	6	September
3B	Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case)	3	September October
	1^{st} Class Test	1	October
4	**Theory of Radiation**	**6**	
4A	Blackbody radiation, Spectral distribution, Concept of Energy Density,	3	October
4B	Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan-Boltzmann Law and Wien's displacement law from Planck's law.	2	November
	2^{nd} class test	1	November

5	**Statistical Mechanics**	**12**	
5A	Phase space, Macrostates and Microstate, Entropy and Thermodynamic probability	4	November December
5B	Maxwell-Boltzmann law - distribution of velocity - Quantum statistics (qualitative discussion only)	2	December
5C	Fermi-Dirac distribution law (statement only) electron	2	December
5D	Bose-Einstein distribution law (statement only), photon gas as an example of Bose gas- comparison of three statistics.	3	December January
	3rd Class Test	1	January

Evaluation of students :

Internal evaluation of the students will be done through class tests only.

Perspective of Modern Physics (PHSGDSE02T)
5^{th} semester, 2021-2022

About the Course

- Name of the Course : Perspectives of Modern Physics
- Nature of the Course : Department Specific Elective
- Code of the Course : PHSGDSE02T
- Credit point : 6

Course description

Elements of Modern Physics is an introductory course to give students an understanding of relativistic dynamics, quantum theory of light, wave function description, wave particle duality, atomic and nuclear Physics.

Course Outcomes

On successful completion of this core course students will :

CO1 : Acquire knowledge on Lorentz transformation, velocity addition; know the concept of relativistic mass, and momentum, two body elastic collisions.

CO2 : Gain knowledge on limitations of classical theory of electromagnetic radiation, Planck's law of black body radiation, Photoelectric effect, Compton's scattering, Rutherford's model of atomic structure. Bohr's model

CO3 : Be familiar with De Broglie's hypothesis Wave particle duality, Davisson-Germer experiment, Bohr's quantization postulate for stationary orbits, Heisenberg Uncertainty principles.

CO4 : Gather knowledge on wave functions, linear superposition principle of wave functions, Schrödinger equation for non-relativistic particles, momentum and energy operators, stationary states, probability and probability current densities in one dimension.

CO5 : Know about application of Schrödinger equation in one dimensional infinitely rigid box and a rectangular potential barrier, energy eigenvalues and eigenfunctions, quantum dot, quantum mechanical scattering and tunneling across a step potential and across.

CO6 : Gain knowledge on energy and orbital angular momentum of hydrogen and hydrogen like atoms, space quantization, orbital magnetic moment, spin Magnetic moment, Zeeman effect, Larmour Precession, spin-orbit interaction and fine-structure splitting Pauli's Exclusion Principle and Aufbau principle

CO7 : Be familiar with structure of atomic nucleus, nuclear force, binding energy curve, mass formula, radioactivity, alpha and beta decay, gamma ray emission, nuclear Fission and fusion, nuclear reactor.

CO8 : Understand generation of X-ray, Mosley's law, amorphous and crystalline solids, concept of Lattice, unit cell and basis vectors, diffraction of X-ray by crystalline solid and Bragg's law.

Faculty : Priyanka Chowdhury, Paramita Mallick

Course Schedule (PHSGDSE02T)

Faculty	Timetable			Google Classroom Code
Priyanka Chowdhury	Monday	12:00 – 13:00	Auditorium 6	dobrtlj
	Wednesday	13:00 - 14:00	Physics Laboratory	
	Thursday	11:00 - 12:00	Auditorium 6	
Paramita Mallick	Tuesday	10:00-11:00	116	dncaiyv
	Thursday	10:00 – 11.00	Auditorium 6	
	Friday	14:00-16:00	111	

Course Outline

Unit 1 – Relativistic Dynamics
Brief summary of Lorentz transformation and time dilation, length contraction, velocity addition etc. (no derivation required). Elastic collision between two particles as observed from two inertial frames with relative velocity, idea of relativistic momentum and relativistic mass. Mass-energy equivalence.
Unit 2 – Quantum Theory of Light
Review on the limitations of classical theory of electromagnetic radiation within a cavity and its solution by Planck's quantum hypothesis (no derivation required). Statement of Planck's law of black body radiation. Photoelectric effect. Einstein's postulate on light as a stream of photons. Compton's scattering and its explanation.
Unit 3 - Bohr's model
Limitations of Ruherford's model of atomic structure. Bohr's model, its successes and limitations.
Unit 4 - Wave-particle Duality
De Broglie's hypothesis – wave particle duality. Davisson-Germer experiment. Connection with Einstein'spostulate on photons and with Bohr's quantization postulate for stationary orbits. Heisenberg's uncertainty relation as a consequence of wave-particle duality. Demonstration by γ-ray microscope thought experiment. Estimating minimum energy of a confined particle using uncertainty principle.
Unit 5 - Wave-function Description
Two slit interference experiment with photons, atoms & particles; linear superposition principle of associated wave functions as a consequence; Departure from matter wave interpretation and probabilistic interpretation of wave function; Schroedinger equation for non-relativistic particles; Momentum and Energy operators; stationary states. Properties of wave function. Probability and probability current densities in one dimension.
Unit 6 - Stationary State Problems
One Dimensional infinitely rigid box, energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example. Quantum mechanical scattering and tunneling in one dimension – across a step potential and across a rectangular potential barrier.
Unit 7 – Atomic Physics
Quantization rules energy and orbital angular momentum from Hydrogen and Hydrogen like atoms (no derivation); s, p, d,shells-subshells. Space quantization. Orbital Magnetic Moment and Magnetic Energy of electron, Gyromagnetic Ratio and Bohr magneton. Zeeman effect. Electron Spin as relativistic quantum effect (qualitative discussion only), Spin Angular Momentum. Spin Magnetic Moment. Stern-Gerlach Experiment. Larmor Precession. Spin-orbit interaction. Addition of angular momentum (statement only). Energy correction due to relativistic effect and spin-orbit ineraction (statement only). Fine-structure splitting. Multi-electron atoms. Pauli's Exclusion Principle (statement only). Spectral Notations for atomic States. Aufbau principle, $n+l$ rule (qualitative discussion only). Periodic table.

Unit 8 – Nuclear Physics
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. Binding energy curve. Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay, beta decay, gamma emission – basic characteristics. Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Basic principle of a nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and basic principle of thermonuclear reactions
Unit 9 - X-ray and Crystal Structure of Solids
Generation of X-ray. Mosley's law, explanation from Bohr's theory. Amorphous and crystalline solids. Lattice structure of crystalline (no categorisation required). Unit cell and basis vectors of a lattice. Diffraction of X-ray by crystalline solid. Bragg's law.
Reference Books
1. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles. R. Eisberg and R. Resnick, 1985, Wiley. 2. Perspectives of Modern Physics. A. Beiser, 1969, McGraw-Hill. 3. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill 4. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education. 5. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning. 6. Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill

Course Calendar

Priyanka Chowdhury			
Unit	Topic	Class Hour	Month
1	**Relativistic Dynamics**	**8**	
1A	Brief summary of Lorentz transformation and time dilation, length contraction, velocity addition etc. (no derivation required).	3	September
1B	Elastic collision between two particles as observed from two inertial frames with relative velocity, idea of relativistic momentum and relativistic mass. Mass-energy equivalence.	5	September
3	**Bohr's model**	**4**	
	Limitations of Rutherford's model of atomic structure. Bohr's model, its successes and limitations.	4	September
	1st Class Test	1	September
8	**Nuclear Physics**	**15**	
8A	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. Binding energy curve.	5	October
8B	Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay, beta decay, gamma emission – basic characteristics.	5	October November
8C	Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Basic principle of a nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and basic principle of thermonuclear reactions.	5	November
9	**X-ray and Crystal Structure of Solids**	**10**	
9A	Generation of X-ray. Mosley's law, explanation from Bohr's theory.	2	November December
9B	Amorphous and crystalline solids. Lattice structure of crystalline (no categorisation required). Unit cell and basis vectors of a lattice.	4	December
9C	Diffraction of X-ray by crystalline solid. Bragg's law.	4	December
	2nd Class Test	1	December

Purnendu Chakraborty			
Unit	Topic	Class Hour	Month
2	**Quantum Theory of Light**	**5**	
2A	Review on the limitations of classical theory of electromagnetic radiation within a cavity and its solution by Planck's quantum hypothesis. Statement of Planck's law of black body radiation.Photoelectric effect. Einstein's postulate on light as a stream of photons. Compton's scattering and its explanation.	5	September
4	**Wave Particle Duality**	**6**	
	De Broglie's hypothesis – wave particle duality. Davisson-Germer experiment. Connection with Einstein's postulate on photons and with Bohr's quantization postulate for stationary orbits. Heisenberg's uncertainty relation as a consequence of wave-particle duality. Demonstration by γ-ray microscope thought experiment. Estimating minimum energy of a confined particle using uncertainty principle.	6	September
5	**Wave-function Description**	**6**	
	Two slit interference experiment with photons, atoms & particles; linear superposition principle of associated wave functions as a consequence; Departure from matter wave interpretation and probabilistic interpretation of wave function; Schroedinger equation for non-relativistic particles; Momentum and Energy operators; stationary states. Properties of wave function. Probability and probability current densities in one dimension.	6	October
6	**Stationary State Problems**	**6**	
	One dimensional infinitely rigid box, energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example. Quantum mechanical scattering and tunneling in one dimension – across a step potential and across a rectangular potential barrier.	5	October November
	First Class Test	1	November
7	**Atomic Physics**	**15**	
7A	Quantization rules energy and orbital angular momentum from Hydrogen and Hydrogen like atoms; s, p, d shells-subshells. Space quantization. Orbital Magnetic Moment and Magnetic Energy of electron, Gyromagnetic Ratio and Bohr magneton. Zeeman effect.	6	November December
	Electron Spin as relativistic quantum effect, Spin Angular Momentum. Spin Magnetic Moment. Stern-Gerlach Experiment. Larmor Precession. Spin-orbit	4	

	interaction.		
	Multi-electron atoms. Pauli's Exclusion Principle (statement only). Spectral Notations for atomic States. Aufbau principle, n+l rule (qualitative discussion only). Periodic table.	4	December
	Second class test	**1**	December

Evaluation : Continuous internal assessment (CIE) will be done through class tests.