ACADEMIC CALLENDAR FOR EVEN SEMESTERS

(2^{ND}, 4^{TH} & 6^{TH} SEMESTERS)

1. SEMESTER – 2 (HONOURS)

Name of the Teacher	Topics
Dr.Mukul Kr. Mitra	Diffraction of Light: 1. Fraunhofer Diffraction: a) Single slit, b) Circular aperture, c) Resolving power of a telescope, d) Double slit, e) Multiple slits, f) Diffraction grating, g) Resolving power of grating, h) Rayleigh criterion for resolution. 2. Fresnel's Diffraction: a) Half period zone, b) Explanation of rectilinear propagation of light, c) Zone plate, c) Fresnel's integral.
Dr.Anindya Sarkar	Wave Optics: 1. **Electromagnetic nature of light:**a) Definition and properties of wave front. Huygens Principle, (b) Temporal and Spatial Coherence, c) Interference: Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. d) 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, 2. **Interferometers:**(a) 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.
Prof.Souvik Prasad	Waves (Theory) 1. **Oscillations**: a) Differential equation of Simple Harmonic Oscillation and its solution. Kinetic energy, potential energy, totalenergy 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 Two Collinear Harmonic oscillations having equal frequencies and different frequencies(Beats). (b) Superposition of Two Perpendicular Harmonic Oscillation for phase difference = 0, $_2$, π : Graphical and Analytical Methods, Lissajous Figures with equal and unequal frequency and their uses. 3. **Wave motion**: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Traveling) Waves. WaveEquation for travelling waves . Particle and Wave Velocities. (Solution of spherical wave equation may be assumed) 4. **Superposition of Harmonic Waves:**(a) Velocity of Transverse Vibrations of Stretched Strings, Standing (Stationary) Waves in a String: Fixed andFree Ends. Analytical Treatment. Changes with respect to Position and Time. Energy of Vibrating String. Transferof Energy. Normal Modes of Stretched Strings. (form of the solution of wave equation may be assumed). Pluckedand Struck Strings.(b) Superposition of N Harmonic Waves. Phase and Group Velocities.
Dr.Nilormi Biswas	**The Magnetostatic Field:** (a) Biot-Savart's law. Application of Biot-Savart's law to determine the magnetic field of a straight conductor, circular coil. Force on a moving point charge due to a magnetic field: Lorentz force law. Force between two straight current carrying wires. (b) Divergence of the magnetic field and its solenoidal nature. Magnetic vector

	potential, calculation for simple cases. (c) Curl of the magnetic field. Ampere's circuital law. Its application to (1) Infinite straight wire, (2) Infinite planar surface current, and (3) Infinite Solenoid. **<u>Magnetic properties of matter</u> :** (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 $\vec{H}$. Relation between $\vec{B}$, $\vec{H}$ and $\vec{M}$. Linear media. Magnetic Susceptibility and Permeability. Boundary conditions for $\vec{B}$ and $\vec{H}$. Brief introduction of dia-, para- and ferro-magnetic materials. B-H curve and hysteresis. **<u>Electro-magnetic induction</u>** : 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.
Prof.ChinmaySikdar	**<u>Method of Images</u>** : a) 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. b)Electrostatic Energy : Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Energy per unit volume in electrostatic field.**<u>Electrical circuits</u>** : a) 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.
Prof. Lucky Dildar	2.1.1 Electricity and Magnetism (Theory) 1. **<u>Dirac delta function and it's properties</u>** : a) Dirac delta function: definition of Dirac delta function. Delta function as limit of different representations. b) Properties of delta function. c) Three dimensional delta function. Proof of the relation $\nabla \cdot (\frac{\hat{r}}{r^2}) = 4\pi\delta^3(\vec{r})$. 2. **<u>Electrostatics</u>** : (a) Coulombs law, principle of superposition, electrostatic field. 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. 3. **<u>Dielectric properties of matter</u>** : a) Electric dipole moment, electric potential and field due to an electric dipole, force and Torque on a dipole. b) Electric Fields inside matter, Electric Polarisation, bound charges, displacement density vector, relation between $\vec{E}$, $\vec{P}$ and $\vec{D}$. c) Gauss's theorem in dielectrics, linear Dielectric medium, electric susceptibility and permittivity. d) Electrostatic boundary conditions for $\vec{E}$ and $\vec{D}$.

***** For further details please see the syllabus*. ****

2. SEMESTER – 4 (HONOURS)

<table>
<tr><th>Name of the Teacher</th><th>Topics</th></tr>
<tr><td>Dr.Mukul Kr. Mitra</td><td>Mathematical Physics III (Theory)
1. <u>Complex Analysis</u> :
(a) Brief Revision of Complex Numbers and their Graphical Representation. b) Euler's formula, Roots of Complex Numbers. c) Functions of Complex Variables. d) Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. e) Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. f) Cauchy's Inequality. g) Cauchy's Integral formula. Simply and multiply connected region. h) Laurent and Taylor's expansion. I) Residues and Residue Theorem. Application in solving Definite Integrals. Only single valued integrals; simple poles on and off the real axis.
2. <u>Variational calculus in Physics</u>:
a) Functionals. Basic ideas of functionals. b) Extremization of action as a basic principle in mechanics. c) Lagrangianformulation. d) Euler's equations of motion for simple systems: harmonic oscillators, simple pendulum, spherical pendulum, coupled oscillators. e) Cyclic coordinates. f) Symmetries and conservation laws. g) Legendre transformations and the Hamiltonian formulation of mechanics. h) Canonical equations of motion. i) Applications to simple systems.</td></tr>
<tr><td>Dr.Anindya Sarkar</td><td><u>Analog Electronics</u>

<u>Amplifiers</u> :
a) Transistor amplifier; CB, CE and emitter follower circuit and their uses. Load Line analysis of Transistor amplifier. b) Classification of Class A, B & C Amplifiers with respect to placement to Q point. c) Frequency response of a CE amplifier. d) The role of series and parallel capacitors for cut off frequencies. e) The idea about the value of coupling and bypass capacitor with respect to lower cut-off frequencies. f) Miller capacitance and its role in higher cut-off frequency.
<u>Feedback amplifiers and OPAMP</u> :
(a) Effects of Positive and Negative Feedback. b) Voltage series, current series, voltage shunt and current shunt feedback and uses for specific amplifiers. c) Estimation of Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise for voltage series feedback (d) Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) e) Open-loop and Closed-loop voltage Gain. f) Frequency Response. CMRR. g) Slew Rate and concept of Virtual ground.
<u>Application of OPAMP</u>:
a) D.C. Application:
• Inverting and non-inverting amplifiers
• Inverting and non inverting Adder
HONOURS: SEMESTER 4. CC 8, CC 9, CC 10, SEC B 38
• Differentiator as Subtractor
• Logarithmic & anti logarithmic amplifiers
• Error amplifier
– Comparator
– Schmidt Trigger
A.C. Application:
• Differentiator
• Integrator
<u>Multivibrator</u>:</td></tr>
</table>

	a) Transistor as a switch, Explanation using CE output characteristics. Calculation of component values for apractical transistor switch. b) Transistor switching times, use of speed up capacitor (Physical explanation only)Construction and operation, using wave shapes of collector coupled Bistable, MonostableandAstableMultivibratorcircuits, Expression for time period. **Oscillators**: a) Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, b) WeinBridge oscillator, determination of feedback factor and frequency of oscillation. c) Reactive network feedback oscillators: Hartley's &Colpitt's oscillators. Relaxation oscillator using OPAMP.
Prof.Souvik Prasad	**Special theory of Relativity** : (a) Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. b) Lorentz Transformations. c) Simultaneity and order of events. Lorentz contraction. Time dilation. d) Relativistic transformation of velocity. Relativistic Dynamics. e) Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. **Transformation of Energy and Momentum** : (a) A short introduction to 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 convention →diag(1,-1,-1,-1).) (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. Mathematical Physics III (Practical) 1. Exploring Gaussian Integrals and the delta function 3 Lectures + 8 Classes • Numerically handling improper integrals over infinite intervals • Numerically verifying the Gaussian integral result $\int_{-\infty}^{\infty} \exp\left(-ax^2 + bx + c\right) = \sqrt{\frac{\pi}{a}} \exp\left(\frac{b^2}{4a} + c\right)$ • Verifying that the convolution of two Gaussian function is a Gaussian • Verifying that $\int_{a-x_1}^{a+x_2} \delta(x-a) f(x)\, dx = f(a)$ using different limiting representation of $\delta(x)$. 2. Solution of Differential Equation 3 Lectures + 6 Classes First order and 2nd order ODE by scipy.integrate.odeint(). 3. Special functions 3 Lectures + 6 Classes Use of special functions taken from scipy.special. Plotting and verification of the properties of special functions. Orthogonality relations and recursion relations. Examples, (a) $zJ'_{\nu}(z) + \nu J_{\nu}(z) = zJ_{\nu-1}(z)$ (b) $\left(1-x^2\right)P'_n(x) + (n+1)\, xP_n(x) - (n+1)P_{n+1}(x)$ (c) $\int_{-\infty}^{\infty} P_n(x)\, P_m(x)\, dx = \frac{2}{2n+1}\delta_{mn}$ *HONOURS: SEMESTER 4. CC 8, CC 9, CC 10, SEC B* 36 **Solution of some basic PDEs**:

	(a) Boundary value problems. Finite discrete method with fixed step sizes. Idea of stability. Application to simple physical problems. (b) Laplace equation $\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} = 0$, on a square grid with specified potential at the boundaries. (c) Wave equation in 1+1 dimension: $\frac{\partial^2 \phi}{\partial t^2} = \lambda \frac{\partial^2 \phi}{\partial x^2}$. Vibration of a string with ends fixed with given initial configurations: $\phi(x, 0)$ and $\frac{\partial \phi}{\partial t}(x, 0)$. (d) Heat equation in 1+1 dimension, $\frac{\partial u}{\partial t} = \alpha \frac{\partial^2 u}{\partial x^2}$ with specified value of temperature at the boundaries with given initial temperature at the boundaries with given initial temperature profile. **<u>Fourier Series</u>**: a)Evaluate the Fourier coefficients of a given periodic function using scipy.integrate.quad(). Examples: squarewave, triangular wave, saw-tooth wave. Plot to see a wave form from scipy.signal and the constructed series along with.
Dr.Nilormi Biswas	<u>Quantum Mechanics (Theory)</u> **<u>Wavepacket description</u>** : a)Description of a particle using wave packets. b) Spread of the Gaussian wave-packet for a free particle in one dimension. c) Fourier transforms and momentum space wavefunction. d) Position-Momentum uncertainty. **<u>General discussion of bound states in an arbitrary potential</u>** : a)Continuity of wave function, b) boundary condition and emergence of discrete energy levels. c) Application to one dimensional square well potential of finite depth. **<u>Quantum mechanics of simple harmonic oscillator</u>** : a)Setting up the eigenvalue equation for the Hamiltonian. Energy levels and energy eigenfunctions in terms of Hermite polynomials (Solution to Hermite differential equation may be assumed). Ground state, zero point energy & uncertainty principle. **<u>Quantum theory of hydrogen-like atoms</u>** : a)Reduction of a two body problem to a one body problem. b) The time independent Schrodinger equation fora particle moving under a central force, c) the Schrodinger equation in spherical polar coordinates. Separation of variables. d) Angular equation and orbital angular momentum. e) Spherical Harmonics (Solution to Legendre differential equation may be assumed). Radial equation for attractive coulomb interaction - Hydrogen atom. f) Solution for the radial wavefunctions (Solution to Laguerre differential equation may be assumed). g) Shapes of the probability densities for ground & first excited states. h) Orbital angular momentum quantum numbers l and m; s, p, d shells.
Prof.ChinmaySikdar	<u>Analog Electronics</u> **<u>Circuits and Network</u>** : a)Discrete components, Active & Passive components, Ideal Constant voltage and Constant current Sources. b) Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits. **<u>Semiconductor Diodes and application</u>** : (a) P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. b) PN Junction Fabrication (Simple Idea). c) Barrier Formation in PN Junction Diode. d) Static and Dynamic Resistance.

	e) Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. f) Derivation for Barrier Potential, g) Barrier Width and Current for Step Junction. (h) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, i) Calculation of Ripple Factor and Rectification Efficiency, j) L and C filter. Circuit and operation of clipping and clamping circuit. (k) Principle and structure of - • LEDs • Photodiode • Solar Cell • Varactor diode **Bipolar Junction transistors and biasing** : (a) n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. b) Physical Mechanism of Current Flow. Current gains α and β, Relations between them. c) Active, Cut-off and saturation Regions. DC Load line and Q-point. (d) Transistor Biasing and Stabilization Circuits; Fixed Bias, collector to base bias, emitter or self bias, e) voltageDivider Bias. f) Transistor as 2 port Network. g) h-parameter Equivalent Circuit. h) Analysis of a single-stage CE amplifierusing Hybrid Model. i) Input and Output Impedance. **Field Effect transistors**: a)JFET and MOSFET (both depletion and enhancement type) as a part of MISFET. b) Basic structure & principleof operations and their characteristics. c) Pinch off, threshold voltage and short channel effect. **Regulated power supply**: a)Load regulation and line regulation. b) Zener diode as a voltage regulator. c) The problem with the zener regulatorcircuit. d) Requirement of feedback and error amplifier. e) Study of series regulated power supply using pass and error transistor assisted by zener diode as a reference voltage supplier.
Prof. Lucky Dildar	Quantum Mechanics (Theory) **Generalized Angular Momenta and Spin** : (a) Generalized angular momentum. Electron’s magnetic Moment and Spin Angular Momentum. J = L + S. b) Gyromagnetic Ratio and Bohr Magneton and the g factor. c) Energy associated with a magnetic dipole placed in magnetic field. d) Larmor’s Theorem. e) Stern-Gerlach Experiment. (f) Addition of angular momenta - statement only. Allowed values of angular momentum. **Spectra of Hydrogen atom and its fine structure** : (a) Formula for first order nondegenerate perturbative correction to the eigenvalue statement only. (b) Spin-orbit interaction and relativistic correction to the kinetic energy and Darwin term. (c) Fine structure of the hydrogen atom spectrum (No rigorous derivation is required). **Atoms in Electric & Magnetic Fields** : (a) Zeeman Effect: Normal and Anomalous Zeeman Effect (Formula for first order perturbative correction to the eigenvalue to be assumed). (b) Paschen Back effect & Stark effects (Qualitative Discussion only). **Many electron atoms** : (a) Identical particles. b) Symmetric & Antisymmetric Wave Functions. c) Pauli’s Exclusion Principle. d) Hund’s Rule. e) Periodic table. (f) Fine structure splitting. L-S and J-J coupling scheme. g) Spectral Notations for Atomic States and Termsymbols. h) Spectra of Alkali Atoms (Na etc.).

***** For further details please see the syllabus*. ****

3. SEMESTER – 6 (HONOURS)

Name of the Teacher	Topics
Dr.Mukul Kr. Mitra	Electromagnetic Theory (Theory) **Maxwell Equations :** (a) Review of Maxwell's equations. b) Vector and Scalar Potentials. c) Gauge Transformations: Lorentz and Coulomb Gauge. d) Boundary Conditions at Interface between Di_erent Media. e) Wave Equations. Plane Waves in Dielectric Media. f) Poynting Theorem and Poynting Vector. g) Electromagnetic (EM) Energy Density. h) Physical Concept of Electromagnetic Field Energy Density, i) Momentum Density and Angular Momentum Density. **EM Wave Propagation in Unbounded Media :** (a) Plane EM waves through vacuum and isotropic dielectric medium, b) transverse nature of plane EM waves, c) refractive index and dielectric constant, wave impedance. d) Propagation through conducting media, relaxation time, skin depth. e) Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, f) refractive index, skin depth, application to propagation through ionosphere. **EM Wave in Bounded Media :** (a) Boundary conditions at a plane interface between two media. Re-_ection& Refraction of plane waves at plane interface between two dielectric media-Laws of Re_ection& Refraction. b) Fresnel's formulae for perpendicular & parallel polarization cases, Brewster's law. Re- ection& Transmission coe_cients. c) Total internal re_ection, evanescent waves. Metallic re_ection (normal Incidence). **Electromagnetic origin of Wave Optics** (a) Kirchho_'s Integral Theorem, Fresnel-Kirchho_'s Integral formula. (Qualitative discussion only) (b) Description of Linear, Circular and Elliptical Polarization. Origin of Double-Refraction: Propagation of E.M. Waves in Anisotropic Media. c) Symmetric Nature of Dielectric Tensor. d) Fresnel's Formula. **Polarization in uniaxial crystals :** (a) Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. b) Double Refraction. c) Polarization by Double Refraction. d) NicolPrism. e) Ordinary & extraordinary refractive indices. f) Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. g) Production &analysis of polarized light. h) Babinet Compensator and its Uses. i) Rotatory polarization. (j) Optical Rotation. Biot's Laws for Rotatory Polarization. k) Fresnel's Theory of optical rotation. l) Calculation of angle of rotation. m) Experimental verification of Fresnel's theory. n) Specific rotation. o) Laurent's half-shade and biquartzpolarimeters.
Dr.Anindya Sarkar	Statistical Mechanics (Theory) **Bose-Einstein Statistics**: (a) B-E distribution law. b) Thermodynamic functions of a strongly Degenerate Bose Gas, c) Bose Einstein condensation, properties of liquid He (qualitative description), d) Radiation as a photon gas and Thermodynamic functions of photon gas. e) Bose derivation of Planck's law. **Fermi-Dirac Statistics**: (a) Fermi-Dirac Distribution Law. b) Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, c) Fermi Energy, Electron gas in a Metal, d) Specific Heat of Metals.

Prof.Souvik Prasad	**Statistical Mechanics (Practical)** **List of Practicals** : 1. Computational analysis of the behavior of a collection of particles in a boxthat satisfy Newtonian mechanics and interact via the Lennard-Jones potential,varying the total number of particles N and the initial conditions: (a) Study of local number density in the equilibrium state (i) average; (ii) fluctuations (b) Study of transient behavior of the system (approach to equilibrium) (c) Relationship of large N and the arrow of time (d) Computation of the velocity distribution of particles for the systemand comparison with the Maxwell velocity distribution (e) Computation and study of mean molecular speed and its dependenceon particle mass (f) Computation of fraction of molecules in an ideal gas having speednear the most probable speed 2. Computation of the partition function Z (_) for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and afiniite number of non-interacting particles N under Maxwell-Boltzmann,Fermi-Dirac and Bose-Einstein statistics: (a) Study of how Z (_), average energy hEi, energy _uctuation_E, specific heat at constant volume Cv, depend upon the temperature, totalnumber of particles N and the spectrum of single particle states. (b) Ratios of occupation numbers of various states for the systems consideredabove (c) Computation of physical quantities at large and small temperature Tand comparison of various statistics at large and small temperatureT. 3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature. 4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distributionfunction, (c) Debye distribution function for high temperature and lowtemperature and compare them for these two cases. 5. Plot the following functions with energy at different temperatures (a) Maxwell-Boltzmann distribution (b) Fermi-Dirac distribution (c) Bose-Einstein distribution
Prof. Lucky Dildar	**Statistical Mechanics (Theory)** **Classical Statistical Mechanics :** (a) Macrostate& Microstate, Elementary Concept of Ensemble and Ergodic Hypothesis. Phase Space. (b) Microcanonical ensemble, Postulate of Equal a-priori probabilities. c) Boltzmann hypothesis: Entropy and Thermodynamic Probability. (d) Canonical ensemble, Partition Function, e) Thermodynamic Functions of an Ideal Gas, f) Classical Entropy Expression, g) Gibbs Paradox. (h) Sackur Tetrode equation, i) Law of Equipartition of Energy (with proof) - Applications to Specific Heat and its Limitations. j) Thermodynamic Functions of a Two-Energy Level System. k) Negative Temperature. (l) Grand canonical ensemble and chemical potential. **Classical Theory of Radiation :** (a) Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. b) Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. c) Wien's Displacement law. Wien's Distribution Law. Rayleigh-Jean's Law. d) Ultraviolet Catastrophe. **Quantum Theory of Radiation :** (a) Spectral Distribution of Black Body Radiation. b) Planck's Quantum Postulates. c) Planck's Law of Blackbody Radiation: Experimental Verification. d) Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.

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SEMESTER – 2 (GENERAL)

Name of the Teacher	Topics
Dr.Mukul Kr. Mitra	Electricity and Magnetism (Theory) **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. c) Vector integration, line, surface and volume integrals of vector fields. d) Gauss'divergence theorem and Stoke's theorem of vectors (Statement only) and their significances. **Electrostatics**: (a) Coulombs law, principle of superposition, electrostatic field. Electric field and charge density, surface andvolume 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. c) Electric Fields inside matter, Electric Polarisation, bound charges, displacement density vector, linear Dielectricmedium, electric Succeptibility and Permittivity. (d) Divergence of the Electrostatic field, flux, Gauss's theorem of electrostatics, applications of Gauss theoremto 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. (e) Curl of the Electrostatic Field. Conservative nature of electrostatic field, Introduction to electriostaticpotential, Calculation of potential for linear, surface and volume charge distributions, potential for a uniformlycharged spherical shell and solid sphere. Calculation of electric field from potential. Energy per unit volume inelectrostatic field.
Dr.Nilormi Biswas	**Magnetism** : (a) Introduction of magnetostatics through Biot-Savart's law. Application of Biot Savart's law to determine the magnetic field of a straight conductor, circular coil, solenoid carrying current. Force between two straight current carrying wires. Lorentz force law. (b) Divergence of the magnetic field, Magnetic vector potential. (c) 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. (d) 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** : Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. **Electrodynamics** : Maxwell's Equations, Equation of continuity of current, Displacement current, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, Poynting vector, decay of charge in conducting medium.

SEMESTER – 4(GENERAL)

Name of the Teacher	Topics
Dr.Anindya Sarkar	**<u>Introduction to wave Optics</u>** : Definition and Properties of wave front. Huygens Principle, Electromagnetic nature of light. **<u>Interference</u>** : Superposition of two waves with phase difference, distribution of energy, formation of fringes, visibility of fringes. Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stoke's treatment. Interference in Thin Films: parallel and wedgeshaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. Michelson's Interferometer (a) Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength dierence, Refractive index. **<u>Diffraction</u>** : (a) Fraunhofer diffraction Single slit; Double Slit. Multiple slits and Diffraction grating. (b) Fresnel Diffraction: Half-period zones. Zone plate. **<u>Polarization</u>** : Transverse nature of light waves. Plane polarized light, production and analysis. Circular and elliptical polarization. **<u>Optical activity</u>**.
Prof.Souvik Prasad	SEC B -1 (Technical Skill) Arduino (Project type) **<u>Introduction to Arduino</u>** : Brief history of the Arduino; open-source electronics prototyping. **<u>Basic ideas</u>** : Basic ideas of Arduino, Familiarize the Arduino board, Setting up the arduino board. Installation of IDE in PC/ laptop for Arduino programming(Sketch) **<u>Arduino Programming</u>**: (a) Program structure: data types, variables and constants, operators, control statements, loops, functions, string. (b) Interfacing: serial communication, digital and analog input/output, getting input from sensors(e.g. temperature sensor,ultrasonic sensor etc)
Prof.ChinmaySikdar	Waves and Optics (Theory) **<u>Accoustics</u>** : (a) Review of SHM, damped & forced vibrations: amplitude and velocity resonance. Fourier's Theorem and its application for some waveforms e.g., Saw tooth wave, triangular wave, square wave. Intensity and loudness of sound. Intensity levels, Decibels. **<u>Superposition of vibrations</u>** : (a) Superposition of Two Collinear Harmonic oscillations having equal frequencies and different frequencies (Beats). (b) Superposition of Two Perpendicular Harmonic Oscillation for phase difference $\delta = 0,\ _2\ , \pi$: Graphical andAnalytical Methods, Lissajous Figures with equal and unequal frequency and their uses.

	Vibrations in String : (a) Wave equation in streched string and its solutions. Boundary conditions for plucked and struck strings. Expression of amplitude for both the cases (no derivation), Young's law, Ideal of harmonics. Musical scales and notes.

SEMESTER – 6(GENERAL)

Name of the Teacher	Topics
Dr.Anindya Sarkar	DSE B (2) Nuclear & Particle Physics (Theory) **General Properties of Nuclei** : (a) 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. **Nuclear Models** : (a) Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies. (b) Evidence for nuclear shell structure - nuclear magic numbers. Basic assumptions of shell model, concept of nuclear force. 3. Radioactivity 12 Lectures (a) α decay: basics of α decay processes. Theory of α emission, Geiger Nuttall law, α decay spectroscopy. (b) β decay: energy and kinematics of β decay, positron emission, electron capture, neutrino hypothesis. (c) γ decay: Gamma ray emission & kinematics, internal conversion.
Prof.Souvik Prasad	**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. **Detector for Nuclear Radiations** : Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector. **Particle Accelerators** : Accelerator facility available in India, Different type of accelerators • Van-de Graaf generator (Tandem accelerator) • Linear accelerator • Cyclotron • Betatron • Synchrotrons **Particle Physics** : Fundamental particles and their families. Fundamental particle interactions and their basic features. Symmetries and Conservation Laws, Baryon number, Lepton number, Isospin, Strangeness and Charm. Quark model, Quark structure of hadrons. **Tutorial**: In tutorial section, problems in the theory classes should be discussed. Problems and solutions regarding the theory course may be discussed.
Prof.ChinmaySikdar	DSE B (1) Digital Electronics (Theory) **Integrated Circuits**: Principle of Design of monolithic Chip. Advantages and drawbacks of ICs. Scale of

	integration: SSI, MSI, LSIand VLSI (basic idea and definitions only w.r.t. micron/submicron feature length). **Number System**: Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. Signed and unsigned number representation of binary system. Binary addition, Representation of negative number. 1's Complement and 2's Complement method of subtraction. **Digital Circuits**: (a) Difference between Analog and Digital Circuits. (b) AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND and NOR Gates as UniversalGates. XOR and XNOR Gates. De Morgan's Theorems. (c) Switching algebra, Simplification of logical expression using switching Algebra. Fundamental Products andsum term (p term and s term). Minterms and Maxterms. Conversion of a Truth Table into an algebraic expression *GENERAL: SEMESTER 6. DSE B, SEC B (SAME AS SEMESTER 4)* in (1) Sum of Products form and (2) Product of sum term form. Implementation of a truth table by NAND orNOR gate. Simplification of algebraic expression from truth table using Karnaugh Map. **Data processing circuits**: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. **Sequential Circuits**: Introduction to Next state present state table, excitation table and truth table for Sequential circuits. SR, D,and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race conditionin SR and Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop, T type FF. **Registers and Counters**: (a) 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). (b) Counters (4 bits): Asynchronous counters: ripple counter, Decade Counter. Synchronous Counter, Ringcounter.

N.B.: ***Minor modification of the Academic Calendar may be made considering the SEC subject***.