THIRD YEAR
Distribution of marks for the session 2013-2014 ; 2014-2015

Course Code	Course Title	Marks	Time In hours	Credits
PHYS-301	Optics (5 Questions)	100	4	4
PHYS-302	Atomic and Molecular Physics (2+3) Questions	100	4	4
PHYS-303	Quantum Mechanics-I (5 Questions)	100	4	4
PHYS-304	Electronics (5 Questions)	100	4	4
PHYS-305	Solid State Physics-I (5 Questions)	100	4	4
PHYS-306	Nuclear Physics-I (5 Questions)	100	4	4
PHYS-307	Physics Practical-III	250	18	10
PHYS-308	Sessional	75	-	3
PHYS-309	Viva Voce	75	-	3
	Total	**1000**		**40**

SYLLABUS

PHYS 301: OPTICS

5 Questions x 20 100 Marks 4 hours 4 Credits

1. **Nature of light:** Velocity of light, Optical theories, wave front, Huygen's principle, explanation of Laws of reflection and refraction from wave theory, Spectrometer, Telephotography.
2. **Interference:** Introduction, Young's experiment, Bi-prism, Newton's Ring, Michelson's Interferometer, Fabry-Parot Interfero-meter.
3. **Diffraction:** Introduction, Fresnel and Fraunhofer classes of diffraction, single slit, double slit, plane difraction gratings; Zone plate.
4. **Polarisation:** Introduction, Polarization by reflection; Crystals, Double refraction: plane, circular and elliptic polarization. Nicole prism, Polarimeters.
5. **Principle of holography:** The hologram, reconstruction of the image, Theory and some distinguishing characteristics of holography, practical application, and advances in holography and its application.
6. **Non Linear and Fiber optics**: Introduction, Second Harmonic Generation, Surface Structure, Surface Second harmonic Generation. Nonlinear Photorefractive Crystals, Photorefractive effect, Hologram formation, Photorefractive materials, Optical Fiber, Fiber-Optic components, Non linear effects in Optical Fiber, Fiber fabrication, Properties of Cables.

(60 Lectures)

REFERENCES

1. Jenkins and White	Fundamentals of Optics
2. Ghatak	Introduction to Optics
3. Born & Wolf	Principles of Optics
4. Deodhar	Introduction to Optics
5. B. B. Laud	Laser and Non-linear Optics
6. Ajoy Ghatak	Fiber Optics and Lasers

PHYS 302: ATOMIC AND MOLECULAR PHYSICS

(2+3) Questions x 20 100 Marks 4 hours 4 Credits

Atomic Physics

1. **Discharge of electricity through gases:** Motion of charged particles in electric and magnetic fields; Determination of e/m and charge of the electron; positive ray analysis and mass-spectrography.
2. **Structures of atom:** Alpha particle scattering; Bohr model: Franck-Hertz experiment; Sommerfeld model; Vector atom model; Stern-Gerlach experiment; Pauli exclusion principle & periodic table.
3. **Quantum effects:** Thermionic emission, photo-electric effect., Compton effect, pair production and annihilation.
4. **Atomic spectra:** Hydrogen spectra, spectra of many electron atom; Fine structure and hyperfine structure, Zeeman effect; Paschen-Back effect for one and two electron systems.
5. **X-ray spectra, scattering of X-rays:** Absorption of X-rays; continuous and characteristic X-rays; Moseley's law. X-ray diffraction. **(35 Lectures)**

Molecular Physics

1. **Molecular rotation and spectra:**

Molecular bonds; Molecular rotations; Classification of molecules according to their axes of rotations; Rotational energy levels; rigid rotor model of a diatonic molecule; Rotation about the bond axis; Selection rules for transitions; Rotational spectra ;Non-rigid rotor model; Centrifugal distortion; Intensities of spectral lines; Line and band spectra; Stark effect; Isotope effect in molecular rotation; Applications of rotational energy: Microwave oven

2. **Vibrational states and spectra:**

Parabolic potential energy approximation; Vibrational energy levels; Vibrational transitions and spectra; Rotational-vibrational spectra; The Born-Oppenheimer approximation.

3. **Electronic states and spectroscopy:**

Spin multiplicity and spin correlation; Singlet, doublet and triplet states; Singlet oxygen formation and photosensitization; Electronic transitions; Fermi's golden rule; Electronic spectra: The Jablonski diagram; Fluorescence; fluorescent lamp; Phosphorescence; Luminescence; Thermo- luminescence and its applications (e.g. TLD); Photoelectron spectroscopy; Franck- Condon principle

4. **Raman effect**

Reyleigh and Raman scattering; Quantum theory and the classical interpretation of the Raman effect; Stokes and anti-Stokes radiation; Intensity and polarization of Raman lines; Depolarization factor; Applications **(25 Lectures)**

REFERENCES

1.	Richtmyer, Kennard & Cooper	Introduction to Modern Physics
2.	J.B. Rajam	Atomic Physics
3.	Segre	Nuclei and Particles
4.	A. Beiser	Concepts of Modern Physics
5.	G. Herzberg	Molecular Spectra and Molecular Structure
6.	J. C. Slater	Quantum Theory of Molecules and Solids, Vol. I: Electronic Structure of Molecules
7.	L. Pauling	The Nature of the Chemical Bond
8.	G. Aruldhas	Molecular Structure and Spectroscopy
9.	Colin N. Banwell & Elaine M. Mc. Cash	Fundamentals of Molecular Spectroscopy
10.	P. S. Sindhu	Fimdamentals of Molecular Spectroscopy.

PHYS 303: QUANTUM MECHANICS-I

5 Questions x 20 **100 Marks** **4 hours** **4 Credits**

1. The origins of quantum theory: Experimental observations (black body radiation, atom model, photoelectric effect etc.) and difficulties in classical theory, quantization of physical quantities, basic postulates of quantum mechanics.

2. Wave nature of matter: Wave particle duality; De Broglie hypothesis; wavelength and velocity, phase and group velocity of matter wave, wave packet, the Heisenberg uncertainty relation and applications.

3. The Schrödinger wave equation: The development of wave function and its interpretation, normalization of wave function, probability and current densities, expectation values of dynamical variables, the Ehrenfest theorem.

4. Fourier techniques and momentum representation: Fourier analysis of wave function, Fourier integral theorem, parseval's formula, coordinate and momentum representation of wave function; significance, Schrödinger equation in momentum representation, momentum wave function for free particle and particle in a box, box normalization, Dirac delta normalization.

5. Operators: Eigenfunctions and eigenvalues of operators; expansion in eigenfunctions; orthogonality of eigenfunctions; commuting operators and observables, uncertainty relations (derivation only).

6. One dimensional problem with Schrödinger equation: Free particle in Q.M., particle in a potential (step, square well, etc.) barrier, reflection and transmission co-officients energy levels calculation, tunneling through a potential barrier, the linear harmonic oscillator.

7. The Schrödinger equation in three dimensions: Separation in Cartesian and polar coordinates, central force problem, the free particle and free particle in a box, three dimensional square well potential and harmonic oscillator.

8. The hydrogen atom: Schrödinger equation for hydrogen atom, solution in spherical co-ordinate, energy levels, spherical harmonics. **(60 Lectures)**

REFERENCES

1. Schiff	Quantum Mechanics
2. Matthews	Quantum Mechanics
3. Mandle	Quantum Mechanics
4. Dicke& Wittke	Introduction to Quantum Mechanics
5. A.M.H. Rashid	Quantum Mechanics
6. Merzbacher	Quantum Mechanics
7. Powell & Crasemann	Quantum Mechanics
8. A. Beiser	Concept of modern Physics

PHYS-304: ELECTRONICS

5 Questions x 20 100 Marks 4 hours 4 Credits

1. a. **Electron Emission:** Types of emission; thermionic emission, Richardson-Dushman equation, Child's Law for rectangular parallel electrodes.

   b. **Electron Tubes:** study of vacuum tubes: Diode & triode their operation, parameters and characteristics.

   c. **Gas Tubes**: Ionisation, Cold-cathode gas diode, hot-cathode gas diode and hot-cathode gas triode (Thyratron) their operation, parameters and characteristics, effect of gas on thermionic diode.

   d. **Cathode-Ray Tube**: Operation, electrostatic deflection sensitivity, magnetic deflection sensitivity and application.

2. Semiconductor Diodes : Types of semiconductor, doping, formation of n and p types, p-n junction diode, its characteristics, barrier voltage across p-n junction, junction capacitance, avalanche and Zener breakdown, different types of diodes: Zener diode, Tunnel diode, LED, Baractor, solar cell.

3. Rectifiers and power supply: Half and full wave rectifiers; their operation, mathematical expressions for(average value of current, rms value of current, power, ripple factor, efficiency, TUF), harmonics, smoothing circuits, filter circuits: series inductor, shunt capacitor, LC and π- filters, voltage regulator.

4. Transistor and its characteristics: p-n-p and n-p-n transistors; transistor as circuit element, load line analysis, static current-voltage characteristics of CB, CE and CC transistors, transistor biasing, transistor as an amplifier; transistor equivalent circuit using h-parameter, DC bias and stability.

5. Amplifier Fundamentals: Tuned and untuned transistors, direct coupled, RC coupled, transformer coupled, circuits; single and double tuned amplifiers, Class A, AB, B, C amplifiers, push-pull amplifier.

6. Feed back circuits and Oscillators: Feed back concept, types of feedback, criteria for oscillations, tank circuit, frequency response, stability, Nyquist criterion, study of R-C, phase-shift, Hartley, Colpitt and Crystal oscillators.

7. Modern semiconductor devices: FET, JFET, MOSFET, UJT and SCR (Thyristor): structure operation and common characteristics, uses; DIAC, TRIAC : structure and common characteristics. **(60 Lectures)**

REFERENCES

1. Millman & Halkias	Integrated Electronics
2. Gupta & Kumar	Handbook of Electronics
3. B.L. Thereja	Basic Electronics
4. V. K. Mehta	Principles of Electronics

PHYS-305: SOLID STATE PHYSICS-I

5 Questions x 20 100 Marks 4 hours 4 Credits

1. Crystal Structure: Periodic arrays of atoms: Symmetry operations, point group, space group, unit cells, Bravais lattice, Miller indices: spacing of planes; Simple crystal structures: packing fractions.

2. Crystal Diffraction: The incident beams, X-rays, Neutrons, Electrons; Bragg's law; Experimental diffraction methods; derivation of scattered amplitude by Laue method; reciprocal lattice; Brillouin zone; Ewald construction; geometrical structure factor, atomic form factor.

3. Classification of Crystal: Crystal of inert gases (Vander Waals interaction, Repulsive interaction, equilibrium lattice constants ; cohesive energy, compressibility & bulk modulus); ionic crystals (Electrostatic energy, evaluation of Madelung constant, Bulk modulus); Covalent Crystals, Hydrogen-bonded crystals and Metal crystals.

4. Lattice Vibrations and Phonons : The concept of the lattice mode of vibration; Elastic vibrations of continuous media; vibrations of one dimensional monatomic linear lattice Vibrations of one dimensional diatomic lattice; quantization of lattice vibration; infrared absorption; concept of phonons; phonon momentum; inelastice scattering of photons, X-rays and neutrons by phonons; localised phonons.

5. Thermal Properties of Solids: Specific heats of solids; breakdown of classical theory ; Einstein theory; Debye theory and its modification by Born; Gruneisen constant, Anharmonic crystal interaction ; thermal expansion; thermal conductivity; thermal resistivity, Umklapp process.

6. Free Electron Theory of Mettles: Conduction electrons; the free electron model; Fermi-Dirac distribution- Fermi function, Fermi energy, Quantum theory of free electrons in a box ; Free electron gas in one and three demensions; Wiedeann-Franz law; Thermionic emission from metals; Hall effect in metals ; failures of the free electron theory.

7. Electric Properties of Solids: Dielectic and Ferroelectric properties of solids; Dielectric constant and polarizability; Liddane- Sachs- Teller relation ; Dielectric relaxation time ; Dipole theory of ferro-electricity; Antiferro electricity ; Piezo electricity.

8. **<u>Magnetic properties of materials</u>:** Concepts of Magnetism, Diamagnetism, paramagnetism, ferromagnetism, Antiferro-magnetism, diamagnetic susceptibility, paramagnetic susceptibility ; Langevin dia and paramagenetism. (**60 Lectures)**

<u>REFERENCES</u>

1. C. Kittel	Introduction to Solid State Physics
2. A.J. Dekker	Solid State Physics
3. J.P. Srivastava	Elements of Solid State Physics
4. Saxena, Gupta & Saxena	Fundamentals of Solid State Physics
5. M.A. Omar	Elementary Solid State Physics
6. A.Rao	A First course in Solid State Physics
7. M J Buerger	Elementary Crystallography

<u>PHYS- 306 : NUCLEAR PHYSICS -I</u>

5 Questions x 20   100 Marks   4 hours   4 Credits

1. <u>General Properties of Nuclei</u>: Introduction, Rutherford's α-particle scattering, Nuclear mass, mass defect and packing fraction, Nuclear force and binding energy, Nucleon separation energy, Nuclear density & radius, Nuclear spin, parity and statistics, Electric and magnetic moments of nuclei, Isotopes, Magic and Mirror nuclei.

2. <u>Radioactivity</u> : Discovery of radioactive, Radioactive decay law, half-life and mean life, Units of radioactivity, Successive disintegrations and equilibrium, Natural radioactivity series.

3. <u>Nuclear reaction</u> : Types of nuclear reactions, Conservation laws, Q-value, thres hold energy, Nuclear collisions in laboratory and centre of mass system, reaction cross sections.

4. <u>Alpha-decay</u>: Properties of α particles, Energies of α-particle, α-particle spectra and nuclear energy levels, Absorption of α-particles-range, stopping power, straggling, Range-energy relationship, Geiger-Nuttal rule, Theory of α-decay.

5. <u>Beta decay</u> : Types of β-decay, end point energy of β-particle spectra, Fermi theory of β-decay, Kurie plot, selection rules, Absorption of β-particles, Range-energy relationship.

6. <u>Gamma Decay</u>: Origin of γ -decay, interaction of γ- rays with matter, γ -ray spectra and nuclear energy levels, attenuation of γ - rays, Internal conversion.

7. <u>Detection of Nuclear Radiation</u>: Ionization of gases by charged & uncharged particles, Ionization chamber, Proportional counter, GM counter.

60 Lectures

<u>REFERENCES</u>

1. E.B. FAUL	Nuclear Physics and Partite Physics
2. Blatt & Weisskopf	Nuclear Physics
3. I. Kaplan	Nuclear Physics
2. Halliday	Nuclear Physics
3. Burcham	Nuclear Physics
4. Green	Nuclear Physics
5. Elton	Nuclear Physics

6. A. Islam wbDwK¬qvi wdwR· (Nuclear Physics in Bangla)
7. H. M. Sengupta wbDwK¬qvi wdwR·

PHYS 307: PHYSICS PRACTICAL-III

250 Marks **18 hours** **10 Credits**

Each student is to perform **3 experiments one from each of 3 groups** listed below : Each of the experiment shall be **of 6 hours duration**.

Marks distribution:

(i) Class performance including Lab Note Book	= 70
(ii) 3 experiments each of 6 hours duration (3x6)	= 180
Total	**= 250**

Marks distribution for each of the 6-hours experiment

(i) Theory	= 10
(ii) Procedure + Data collection	= 24
(iii) Calculations + Result	= 10
(iv) Discussion	= 06
(v) Viva on experiment	= 10
Total	**= 60**

LIST OF EXPERIMENTS

GROUP- A: OPTICS

1. Determination of wavelength of Na light by Newton's rings.
2. Determination of wavelength by Biprism.
3. Determination of Specific rotation of sugar solution by polarimeter.
4. Refractive index of prism material and liquid by spectrometer.
5. Determination of wavelength of spectral lines from gas discharge tube.
6. Calibration of a spectrometer.
7. Determination of Cauchy's constants.
8. Detection of an unknown radical by means of (a) deviation spectrograph and (b) concave grating.
9. Study of absorption spectra by means of ultra violet spectroscopy.
10. Drawing of the emission curve by means of infrared spectroscopy.
11. Determination of (a) Separation of "D1" & "D2" lines of sodium and (b) refractive
12. index of air by means of Michelson's interferometer.

GROUP-B: MODERN PHYSICS

1. Determination of ionisation potential and critical potential.
2. Determination of energy of alpha particles.
3. Determination of planck's constant by photocell.
4. To demonstrate the random nature of the emission of particles from a radioactive source and to introduce statistical methods of predicting and interpreting the results of radioactivity measurements.
5. Radioactivity experiments with scalers or ratemeters.
6. To find the value of e/m for an electron.
7. Determination of e by Millikan's method.
8. Study of Franck-Hertz experiment.
9. Study of Zeeman effect.

10. Determination of Rydberg Constant using spectrometer.
11. Variation of electron wavelength with anode voltage.

GROUP-C: ELECTRONICS

1. Plotting the characteristic curve for diode valve.
2. Plotting the characteristic curve of a triode valve.
3. Construction of a radio receiver and study its performance.
4. Construction of a radio transmitter and study its performance.
5. Determination of frequency response characteristics of RC circuits by cathode ray oscilloscope.
6. To construct a power supply and to find out the efficiency and ripple factor of (a) a half wave rectifier and (b) a full wave rectifier.
7. To draw the response curve of a R-C coupled amplifier.
8. To draw transistor characteristics curves and determine the various parameters.
9. To draw the characteristics curves of a semiconductor diode and determine its static and dynamic resistances.
10. To draw the characteristic curves of a FET.
11. Familiarization of an oscilloscope (b) calibration of a cathode ray tube for both a.c and d. c. sources. (c) Measurement of an unknown frequency and phase angle between two a.c. sources using cathode ray tube.
12. Construction and study of an audio amplifier.
13. Construction and study of Hartley oscillator.
14. Design of half adder and full adder.