Syllabus for Undergraguate Programme

Bachelor of Science in Physics

Manipur University, Canchipur

Imphal-795003

PHY – 101: MECHANICS   75 marks

Fundamentals of Dynamics

Dynamics of a single particle, Dynamics of a system of particles, Center of mass, Conservation of momentum of variable mass system, Motion of rocker, Work-energy theorem, Potential energy diagram, Stable and unstable equilibrium, Conservative and non-conservative forces, Force as gradient of potential energy.   **10 marks**

Rotational Dynamics

Angular momentum of a particle and system of particles, Torque, Conservation of angular momentum, Rotation about a fixed axis, Moment of inertia, its calculation for rectangular, spherical and cylindrical bodies; Kinetic energy of rotation.   **15 marks**

Gravitation and Central Force Motion

Law of gravitation, Inertial and gravitational mass and their equivalence, potential energy and field due to spherical shell and solid sphere, Self-energy, Motion of a particle under central force field, Angular momentum conservation, one body problem, two body problem and its reduction to one body problem and its solution. The energy equation and energy diagram.

15 marks

Oscillatory motion

Motion of simple and compound pendulum, Loaded spring, energy considerations, time average of energy, Damped harmonic oscillator, Resonance of a highly damped system, Free oscillations of system with one degree of freedom, Linearity and superpositions of particle, superposition of (i) two and (ii) N colinear harmonic oscillations, beats.

15 marks

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 and time dilation, relativistic transformation of velocity, frequency and wave number, Velocity dependence of mass and equivalence of mass and energy, Relativistic Doppler effect, Relativistic kinematics, Transformation and energy and momentum.

20 marks

Suggested books:

1. An introduction to mechanics by Daniel Kleppner, Robert J Kolenkow (McGraw-Hill,1973)
2. Berkeley Physics Course Vol 1 Mechanics: Charles Kittel, Walter Knight, Malvin
3. Ruderman, Carl Helmholz, Burton Moyer (Tata McGraw-Hill, 2007)
4. Mechanics: D S Mathur(S. Chand & Company Limited, 2000)
5. The Physics of wave and oscillations: N K Bajaj (Tata McGraw-Hill, 1988)
6. Berkeley Physics Course Vol 3 Waves: Franks Crawford (Tata McGraw-Hill, 2007)

Laboratory:

1. Determination of 'g' by using a compound pendulum (bar with holes)
2. Determination of moment of inertia of a body by using a torsion pendulum
3. Determination of frequency of a tuning fork by means of a sonometer
4. Determination of 'g' by Kater's pendulum
5. Determination of surface tension of a given liquid by capillary rise method and verification of Jurin's law
6. Determination of coefficient of viscosity of water by Poiseuille's method
7. Verification of Stock's law and determination of coefficient of viscocityof a liquid
8. Determination of Young's modulus by Searle's method
9. Determination of rigidity modulus by statical method

Semester II

PHY-202: THERMAL PHYSICS AND OPTICS 75 Marks

Thermodynamics

First and Second laws of thermodynamics, Carnot theorem, Thermodynamic scale of temperature, Entropy, Entropy of a mixture, Third law of thermodynamics, Thermodynamic potential: Enthalpy Gibbs and Helmholtz functions, First and second order phase transitions, Chemical potential, Maxwell's relations and their applications, Clausius-Clapeyron's equation, Ehrenfest's equation, Joule-Thomson effect and its theory, Magnetic cooling by adiabatic demagnetization, approach to absolute zero.

15 marks

Kinetic theory of Gases and Radiation

Derivation of Maxwell's law of distribution of velocities, Mean free path, Transport phenomena, viscosity, conduction, diffusion and Brownian motion, Equation of state for ideal gases, Equation of state for real gases, Deviation from ideal gas equation, the virial equation, Derivation of Van-der-Waal's equation, Critical constants and law of corresponding states, Blackbody radiation, Wien's displacement law , Rayleigh-Jeans' law and ultraviolet catastrophe, derivation of Plank's radiation law 20 marks

Interference and Diffraction:

Interference in thin films, Fringes of equal thickness and equal inclination, Theory of Newton's rings, Michelson's interferometer and Febri-Perot interferometer, Difference between interference and diffraction, Theory of plane diffraction grating, Resolving power and dispersive power of a plane diffraction grating, Fresnel's integrals, Cornu's spiral, Fresnel diffraction pattern at a straight edge   **20 marks**

Polarization

Polarization by reflection, double refraction. Wave surface as uniaxial crystal, production and detection of elliptically and circularly polarized light, Babinets' compensation theory and uses, optical activity and polarimeter.   **20 marks**

Elements of Quantum Optics:

Stimulated emission, population inversion, mechanism of population inversion, spontaneous and stimulated inversion, Einstein's coefficients, Threshold condition for laser action, He-Ne laser, Ruby laser, application of lasers, Elements of second harmonic generation.   **10 marks**

Suggested Books:

1. A treatise on heat: including kinetic theory of gases, thermodynamics and recent.
2. Advances in statisncal thermodynamics: MeghnadSaha, B.N.Srivastava (Indian Press,1958)
3. Heat and thermodynamics:anintermediatetextbook;MarkWaldo Zemansky,RichardDittman (McGraw-Hill,1981)
4. Thermodynamics,kinetic theory , and staticalthermodynamics:FrancisW.Sears& Gerhard L. Salinger.(Narosa,1986)
5. Fundamentals of optics: Francis Arthur Jenkins and Harvey Elliott White (McGraw-Hill, 1976)
6. Optics:AjoyGhatak (Tata Mc Graw Hill,2008)
7. 7.A Textbook of Light:B Ghosh and K .G.Mazumdar.(5th Edition) Sreedhar Publishers, Kolkata.
8. Thermal Physics-P K Chakrabarti, 0New Central Book Agency 2006,Kolkata.

LABORATORY: **25 marks**
1. To construct athermocouple with the elements supplied and todetermine the melting point of the given substance and the thermoelectric power.
2. Determination of J by Callendar and Barne,s method.
3. Determination of co-effcient of linear expansion of a mertallic rod by optical lever method.
4. Verification of Newton,s law of cooling.
5. Determination of apparent expansion of a liquid by weight thermometer method.

6. Determination of frequency of a tuning fork by Melde,s method.
7. Determination of thermal conductivity of a metallic rod by Searle,s method.
8. Determination of the refractive index of the give liquid with help of a plane mirror convex lens and a spherometer.
9. Determination of the refractive index of a given liquid by travelling microscope method.

Semester - III

PHY --303: ELECTRICTY AND MAGNETISM   75 marks

Vector and scalar fields
Fields-scalar and vector,examples, directional derivative and gradient ofa vector field, flux and divergence of a vector field, circulation and curl of a vector field, algebra of the del operator and Laplacian operator, Gauss's theorem, Stoke's theorem and Green theorem.
15 marks

Electric field
Electric field and electric lines, Gauss,s Law and applications, electrostatics of conductor, Electric potential, multipole moments and multipole expansion, force ,torque and energy of a dipole in an external electric field, Poisson,s and Laplace,s equations, uniqueness theorem, solution to Laplace,s equations in spherical coordinates, zonal harmonics, conducting sphere in uniform electric field   Electrostatic energy,system of point charges, system of continuous charge distribution, spherically symmetric charge distributions,charged capacitors   Dielectric properties of matter, polarization, electric field caused by polarized matter, Gauss's law in a dielectric, boundary conditions on E and D, capacitors filled with dielectric, dielectric sphere in a uniform electric field, Clausius-Mosseti equation
20 marks

Magnetic Field
Magnetic field, magnetic force between currents and definition of B, divergence and curl of B, Ampere's circuital law, magnetic scalar and vector potentials, calculation of B for a straight wire, a circular loop and a solenoid, field of a dipole, force, torque and energy of a dipole in an external field, magnetic moment, Lorentz force, magnetic field energy
Magnetic properties of matter, magnetization, magnetic field caused by magnetized matter, field equation in a magnetized matter, Ampere's law in a magnetized matter, boundary conditions on B and H, magnetic cell, magnetic circuits, hysteresis and B-H curve
20 marks

Electromagnetic induction
Electromagnetic induction, Faraday's law of induction, curl E, self and mutual inductance, reciprocity theorem, energy stored in a coil

Alternating current and transient phenomena, A C circuit, mean value of current and voltage, skin effect, power factor, A C in L-R, C-R, L-C-R circuits, series and parallel resonance, transient growth and decay of currents in L-R, C-R, L-C-R circuits, oscillatory discharge

Maxwell's equations, the equations and their physical meanings and the respective laws, equation of continuity, wave equation for E and B, plane wave solutions, transverse nature of electromagnetic wave, flow of electromagnetic power and the pointing theorem

20 marks

Suggested books:
1. Introduction to electrodynamics: David J. Griffiths, 3rd edition (Benjamin Cummings, 1998).
2. Elements of electromagnetics: Mathew N O Sadiku (Oxford university press)
3. Electricity and magnetism: Edward M. Purcell (McGraw Education), 1980)
4. Electricity and magnetism: D C Tayal (Himalaya Publishing house, 1988)
5. Electricity and Magnetism: D Chattopadhyay an P Rakshit

Laboratory:
1. Determination of the horizontal component of earth's magnetic fieldand the magnetic moment of the magnet with the help of a deflection magnetometer
2. Determination of self-inductance by Rayleigh's method
3. Determination of frequency of A C mains with the help of sonometer
4. Determination of capacitance by de Sauty's bridge
5. Determination of refractive index of a prism by using a sonometer
6. Determination of capacitance by using ballistic galvanometer
7. Determination of ECE of copper
8. To convert the given galvanometer in to an ammeter and calibrate it with the help of copper voltameter

Semester IV

PHY – 404: ATOMIC AND NUCLEAR PHYSICS   **75 marks**

Mass Spectrograph and x-ray

Atomic masses; Bainbridge and Aston mass spectrograph, X-Rays: Continuous and characteristic x-rays; Mosley's law; absorption of x-ray and absorption spectra, x-ray diffraction and Bragg's law; measurement of x-ray wave length.   **10 marks**

Atomic Spectra

Hydrogen spectrum, Bohr's theory, Sommerfeld's modification of Bohr's theory and relativistic correction, vector model of atom, electron spin, Pauli's exclusion principle,

periodic table of element; spin-orbit interaction – fine structure of hydrogen, spectra of alkali elements selection rules, L-S and J-J coupling schemes; Zeeman effect.   **20 marks**

Radioactivity

Law of radioactive decay and halflife, radioactive series; theory of successive transformations; secular and transient equilibrium; Carbon dating, artificial radioactivity; radioisotopes and their uses; radiation hazards; theory of alpha decay; beta decay and neutrino hypothesis; gamma decay.   **10 marks**

Particle accelerator: Linear accelerator, Cyclotron; Betatron; Synchrotron

Nuclear detector: Proportional counter, GM counter, Cloud chamber, Bubble chamber, scintillation counter, Nuclear emulsion   **10 marks**

Nuclei and their properties: Rutherford's theory of alpha particle scatteringand its experimental verification; Charge mass, size, constituents, spin and parity of nuclei; nuclear stability and binding energy; nuclear moments- electric dipole moment, electric quadrupole moment and magnetic moment, nuclear forces.   **5 marks**

Nuclear models: Liquid drop model, semi-empirical mass formula and its applications, shell model.   **10 marks**

Nuclear reactions: Q-value of a reaction; kinematics of nuclear reactions;types of nuclear reactions; cross sections of nuclear reactions; nuclear fission- elementary theory of nuclear fission, energy and mass distribution of fission fragments, fission neutrons, four factor formula, nuclear reactor and its types, breeder reactor; nuclear fusion reaction in the sun; controlled nuclear fusion.   **10 marks**

Books suggested:
1. Atomic and Nuclear Physics: Gopalakrishnan (McMillan)
2. Concept of Modern physics: A Beiser
3. Concept of Nuclear Physics: Bernard L Cohen
4. Nuclear Physics: S N Ghosal
5. Nuclear Physics: D C Tayal

Laboratory:
1. To draw the (i-D) curve for a prism using a spectrometer and to find the minimum deviation using sodium light
2. To draw (i-D) curve for a prism using a spectrometerand to find the refractive index of the prism using sodium light (angle of the given prism)

3. Determination of radius of curvature of a convex lens using by Newton's ring method
4. Determination of dispersive power of a prism for sodium light using a spectrometer
5. Determination of width of a single slit of from a diffraction pattern and verification of the value by means of a travelling microscope
6. Determination of wavelength of sodium light using a plane transmission grating
7. Determination of internal resistance of a cell using a potentiometer
8. To measure current in an external circuit with the help of a potentiometer
9. Calibration of an ammeter with the help of a potentiometer

Semester V

PHY -505: ELECTRONICS   100 marks
Basic circuit analysis
Circuit models, Kirchoff's law, single equation loop, node pair circuit, voltage and current divider riles, principle of superposition, Thevenin and Norton's theorem, two-port analysis of and electrical network   **10 marks**

Semiconductor diodes
p-n junction diodes, I-V characteristics, application in the rectifiers, clippers and limiters, Zener diode and it's applications   **10 marks**

Bi-junction polar transistors (BJT)
p-n-p and n-p-n structures, active and saturation region, characteristics of BJT, common-emitter input and output characteristics, z and h parameter, common-base configuration, output characteristics, two-port analysis of a transistor using zand h parameter, load line concept, emitters follower, biasing method, stability factor, low frequency model
Derivation of current gain, input resistance, voltage gain and output resistance of CB, CE amplifier configuration (for small signals) and the CE configuration with an emitter resistor (also for small signals), bypassing of the emitter resistor with a bypass capacitor.
                                    30 marks

Field effect transistor (FET)
Classification of various type of FETS, constructional detail of junction field-effect transistor, drain characteristics of JFET, biasing of JFET, operating region, pinch-off voltage, idea of metal-oxide-semiconductor-field-effect-transistor (MOSFET).   **10 marks**

Amplifier
Resistance-capacitance and transformer couple amplifier, power amplifier-class A, B, AB and C operations, Concept of negative and positive feedback, representation of a single loop negative feedback amplifier, transfer gain with feedback, merits and demerits of

negative feedback, Differential amplifier, principle of operational amplifier, transfer characteristics, offset parameter, differential gain, CMR, inverting and non-inverting operational amplifier, operational amplifier adder, differentiator, integration, applications of operational amplifiers. **25 marks**

Oscillator
Wave-form generation: Barkhausen criterion. RC oscillator, Wien Bridge oscillator, phase shift oscillator **5 marks**

Digital circuits
Binary system, Boolean algebra, NOR, NAND gates, half and full adders, minimization of Boolean expressions using K- map **10 marks**

Suggested books:
1. Digital principles and applications: Donald P. Leach & Albert Paul Malvino, (Glencoe, 1995)
2. Electronic Principles: Albert Paul Malvino (Tata McGraw Hill)
3. Basic electronics and linear circuits: N. N. Bhargava, D. C. Kulshreshtha and S. C. Gupta (Tata McGraw Hill, 2006)
4. Integrated electronics: Milliman and Halkias
5. Electronics: D Chattopadhyay and P. C. Rakshit

PHY -506: MATHEMATICAL PHYSICS **100 marks**
Complex variables and functions of a complex variable
Complex numbers and their graphical representation, modulus and argument of a complex number, function of a complex variable, continuity and derivative, Cauchy-Reimann condition, analytic functions, integration of a function of a complex variable, Cauchy's theorem, Cauchy's integral formula, Tylor's series for an analytic function, Laurent series, singularities and their classification, residue and the residue theorem, evaluation of definite integrals **35 marks**

Special functions
Gamma functions, recurrence relations, Beta function and recurrence relations, relation between gamma and beta function
Legendre, Hermite and Laguerre polynomials and associated Legendre functions, differential equations and series solutions, generating functions, recurrence relations, orthogonality relations
Bessel differential equation, generating function, recurrence relation, zeroes of the Bessel function, orthogonality relation, series expansion of a function in terms of a complete set of orthogonal functions **30 marks**

Partial differential equations

Vibration of stretched string, derivation of the equation and its solution under various initial conditions, vibration of rectangular and circular membranes, heat conduction; derivation of the equation, solution for the temperature in a finite rod, semi infinite rod, the classical wave equation and the Laplace equation **20 marks**

Fourier Series

Orthogonality of the sine and cosine functions, Fourier series of a function, Fourier series expansion of a periodic function, Parseval's theorem, sine and cosine series

15 marks

Suggested Books

1. Advanced Engineering Mathematics by Erwin Kreyszing
2. Mathematical methods for Physicists by G. Arfken and Weber
3. Mathematical Physics by A K Ghatak, I Goyal and Chu
4. Applied Mathematics for Engineers and Physicists by L A Pipes and L R Harvell
5. Complex variables (Schaum Series): M Spiegel

PHY – 507 (P): Laboratory   **100 marks**

1. To draw the characteristics of a transistor in the CE and CB configurations
2. To draw the resonance curve of series and parallel LCR circuit and to determine the Q- factor
3. Determination of the constant of a ballistic galvanometer by using a standard capacitor
4. To construct two input OR and AND logic gates using p-n junction transistors and to verify their truth table
5. To study the performance of NOT circuit using transistors
6. To draw the characteristics of a Zener diode an to study its use as a voltage regulator
7. To study solid state half-wave and full-wave rectifiers and to determine the ripple factor and percentage of regulation and different types of filters
8. To plot the frequency response of an R-C coupled amplifier (i) without feedback and (ii) with negative feedback and to determine the bandwidth in each case
9. Determination of self-inductance by Anderson's method
10. Determination of mutual inductance by using a Ballistic Galvanometer and to draw the M.O. curve
11. Determination of the band gape of a p-n junction diode (germanium)

PHY – 608: QUANTUM MECHANICS **100 marks**

Origin of the Quantum theory

Blackbody-radiation spectrum and Plank's hypothesis, Einstein's idea and the photoelectric effect, Compton effect, Frank-Hertz experiment

Stability of the atom, Bohr's postulate of angular momentum quantization and the Bohr atom model, Bohr-Sommerfeld quantization rule

De-Broglie wave and wave particle duality, Davison Germer experiment, electron diffraction and neutron diffraction

Development of Quantum mechanics: Wave behavior of matter, two slit experiment with electron (thought experiment), Superposition, description in terms of probability and need for probability amplitude, wave packet, Heisenberg's uncertainty principle (thought experiment and application), Bohr's complimentary principle, Bohr's correspondence principle. **30 marks**

Basic Postulates and formalism

Schrodinger equation, wave function as probability amplitude and dynamical variables as operators, probability conservation and normalization of wave function, conditions for physical acceptance of wave function, equation of continuity (differential probability conservation)

Eigenvalue and eigenfunction of a dynamical variable, Hermiticity and reality of the eigenvalues, physical meaning of eigenvalues of a dynamical variable, superposition of wave functions and the expectation postulate, expectation value and Ehrenfest's theorem, the commutator and the quantum analogue of the classical equation of the motion, constants of the motion.

The fundamental commutator, commutator algebra, precise definition of uncertainly and the uncertainly relation (statement). **30 marks**

Stationary state and energy eigenstates

Stationary states, time independent Schrodinger equation, the stationary state wave functions, free particle and plane wave

Particle in a one-dimensional box

Energy eigen value and eigen functions, graphical illustrations, nodes as the energy quantum number, calculation of expectation values, qualitative estimation of the ground state energy from the uncertainty principle.

Linear harmonic oscillator

Solution of the Schrodinger equation for energy eigenvalues and eigenfunctions, calculation of expectation values and matrix elements, parity of eigenfunctions, the virial theorem.

One dimensional potential barrier

One dimensional finite potential step, stationary solutions, reflection and transmission coefficients, phenomenon of barrier penetration.

Hydrogen atom

Solution for the energy spectrum and eigenfunctions, the quantum number l, n, m, degeneracy, expectation values, the virial theorem.   **40 marks**

Suggested Books:

1. Quantum Mechanics: B H Bransden and C J Jaochain (Pearson, 2008)
2. Quantum Mechanics: EMerzbacher, (John Wiley & sons, Inc 1997)
3. Quantum Mechanics J. L. Powell & B. Crasemann (Addison-Wesley Pubs. Co., 1965)
4. Quantum Mechanics: Theory and Applications: A Ghatak& S. Loknathan 5th Edition, Macmillan India., 2004)

PHY – 609: PHYSICS OF MATERIALS   100 Marks

Crystal Structure

Crystalline and amorphous materials, lattice and unit cell, lattice translational vectors, lattice with a basis – central and noncentral unit cell, reciprocal lattice, Bravais lattice types, Brillouin zones of sc, bcc, fcc lattices, X-ray diffraction: Braggs law, X-ray scattering, atomic structurefactor and geometric structure factor

20 marks

Electrical properties of materials

Free electron model and its limitation, elementary band theory: Bloch theorem, Kronig Penney model, effective mass, concept of hole, band gaps, classification of solids, intrinsic and extrinsic semiconductors, p-type and n-type semiconductors, conductivity of semiconductors, concentration of charge carriers, Fermi level and its temperaturedependence, classical hall effect   **20 marks**

Magnetic properties of Materials

Types of magnetic materials, classical theory of diamagnetism and Paramagnetism, quantum mechanical treatment of paramegnetism, Curie law, Weiss theory of ferromagnetism, magnetic domain, soft and hard magnetic materials 20 marks

Lattice dynamics

Lattice vibrations, monoatomic and diatomiclattice vibrations, acoustic and optic modes Einstein theory of specific heat, Density of states, Debye's theory of specific heat

15 marks

Physics of low dimension

Density of states in low dimension, different types of nanomaterials, blue shifting, quantum wells, wires and application of nanoscience **10 marks**

Suggested Books
1. Solid state Physics -A J Dekkar
2. Introduction to Solid State Physics – C Kittel
3. Solid State Physics – A R Verma and O N Srivastava
4. Introduction to Nanoscience - Poole etal
5. Solid state Physics – Keer

PHY – 610: Laboratory **100 marks**
1. Determination of wavelength of monochromatic light source by using Fresnel'sbiprism
2. To draw the $(\mu - \lambda)$ curve for the material of a prism by using spectrometer and verification of dispersion formula
3. To draw the $(\mu - \lambda)$ curve for the material of a prism by using spectrometer and to determine the wavelength of the given source
4. To draw the $(D - \lambda)$ curve for a given spectrometer and hence to determine the wavelength of the unknown source
5. Determination of the grating constant by using sodium light and hence to determine the wavelength of the unknown radiation
6. To calibrate a polarimeter and to determine to determine the concentration of a given solution
7. Determination of electronic charge by Millikan's experiment
8. To study the hydrogen spectrum and to determine the Rydberg's constant with the given grating and spectrometer
9. Determination of e/m of electron by Thomson's method
10. To study the B-H curve and hysteresis loss by anchor ring method
11. To determine Planck's constant by using a photocell

Suggested Books:
1. A Handbook of Advanced Practical Physics: C R Dasgupta
2. Advanced Practical Physics: K G Mazumdar
3. Practical Physics: D Chattopadhyay and P C Rakshit
4. A textbook of Advanced Practical Physics: S K Ghosh