TRIPURA UNIVERSITY

(A Central University)
Suryamaninagar-799022

SYLLABUS
OF
Physics
(Major)

Semester – I

First SEMESTER

Total Marks: 100 **Paper Name: H1**

Unit-I
Mathematical Methods in Physics

Vector: Scaler and vector fields. Differentiation of vectors.Gradient, divergence and curl, their physical meaning and application.Vector integration – line, surface and volume integration.Gauss divergence theorem, Stoke's theorem, Green's theorem and their application to simple problems.

Orthogonal curvilinear co-ordinate system:Unit vectors in such system, gradient, divergence, curl and Laplacian in orthogonal curvilinear coordinates, illustration by spherical polar and cylindrical polar co-ordinate system as special case.

Matrices: Hermitian matrices, Eigen value and eigen vector of matrix, Cayley-Hamilton theorem, diagonalization of a matrix.

Beta and gamma functions, their properties, interrelationship, their application to simple problem.

Fourier series: Statement of Dirichlet's condition, Fourier series for the expansion of some simple function. Analysis of different simple waveform with Fourier series.

Unit-II
Mechanics

Mechanics of a particle; equation of motion of a particle under time dependence force, velocity dependence force(resistive force) and their applications.

Moment of inertia, radius of gyration, parallel and perpendicular axes theorems, calculation of moment of inertia for sphere, cylinder, cone, ellipsoid, motion of a sphere and cylinder along an inclined plane.

Frames of reference, inertial and non-inertial reference frame, rotating frame of references, transformation of operation, Corioli's and centrifugal force in a rotating frame of reference, explanation of some physical phenomena from the point of view of Corioli's force.

Plane curvilinear: velocity and acceleration of particle in plane polar coordinate system (radial and transverse components of velocity and acceleration) tangential and normal component of velocity and acceleration.

Central force, conservative force and related theorems, central orbit, differential equation of motion of a particle moving under central force in plane polar coordinate system, nature of orbit in an inverse square attractive force field, areal velocity, Kepler's law of planetary motion and their application, proofs of Kepler's law consideration the inverse square law.

Unit-III
General properties of mater
(Gravitation, Elasticity, Surface tension and Viscosity)

Gauss theorem in gravitational and its application to spherical an cylindrical cases, Poisson's and Laplace's equation (derivation using divergence theorem).

Elastic moduli and their interrelation, bending moment, dispersion at the free end of a light cantilever, depression of a beam supported at the two ends and loaded at the middle, bending of beam due to its own weight (fixed at one end and supported at the two ends), torsion of a cylinder torsional oscillation, strain energy in all cases.

Fluid dynamics: derivation of equation of continuity in differential form, rigorous derivation of Bernoulli's theorem. Application of Bernoulli's theorem to Venturimeter, pitot tube, Torricelli's theorem.

Motion of viscous fluid: Poiseulli's equation for the flow of an incompressible fluid with necessary correction. Poiseulli's equation for the flow of a compressible fluid. Statement of stokes Stoke's law, equation of motion of a body through viscous medium under gravity and its solution, terminal velocity.
Surface tension: Calculation of excess pressure across a curved film with special case. Determination of surface tension using sessile drop, surface wave in a liquid.

Unit-IV
Vibration and waves

Simple Harmonic Motion (SHM); Differential equation of SHM and its solution (rigorous method), composition of SHM, Lissajou's figure, damped and forced vibrations their differential equation and solution, resonance and sharpness of resonance.
Differential equation of longitudinal plane progressive wave and its solution in one dimension, energy of waves, pressure distribution in longitudinal waves, dispersion in waves, propagation, phase velocity and group velocity on the basis of consideration of superposition of two waves.
Differential equation for transverse wave in stretched string, theories of plucked, struck and bowed string, basic principle underlying the production of combination of tone.
Acoustic of building: growth of sound intensity, reverberation time and Sabine's law. Characteristics of a good auditorium.

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Semester – II

Total Marks 100Paper Name: H2

(Theory paper H2-A = 60 marks, Practical paper H2-B = 40 marks)

Theory paper H2-A (60 marks) (48 + 12 internal)

UNIT-I: Electrostatics and Magnetostatics: (24 + 6 internal)

Gauss's theorem in electrostatics and its applications, Coulomb's theorem, mechanical force on a charged surface, energy per unit volume, Poison's equation and Laplace's equation and their solutions in the case of spherical and cylindrical charge distribution.

Electrical images, use of electrical image to the field problems in the case of point charges near conducting plate and conducting sphere.

Capacitance of spherical capacitors and cylindrical capacitors, attracted disc electrometer and quadrant electrometer (only basic principle).

Dipole-dipole interaction, Dielectric medium, polarization and susceptibility, boundary conditions of D and E. dielectric spheres in uniform field.

Intensity of magnetization, permeability, susceptibility and their relations,Boundary conditions for B and H. Hysteresis and hysteresis loss, its importance, magnetic circuit: its theory and applications.

UNIT-II: Optics (24 + 6 internal)

Refraction at spherical surface, thin lenses and their combination, cardinal points, equivalent lens, chromatic and spherical aberration, qualitative and quantitative study of their remedies with reference to the construction of Ramsden and Huygen's eyepiece.

Interference of light: Young's experiment, Fresnel's biprism, Interference by Lloyd mirror, interference by thin films including wedge shaped film, Newton's ring; theory and experiment.

Diffraction (Fresnel class): half period zone, explanation of rectilinear propagation of light, principle of zone plate and its behavior as convergent lens.

Diffraction (Fraunhofer class): diffraction pattern of single slit, double slit and plane transmission grating (rigorous treatment), Rayleigh criterion of resolution: resolving power of grating. Prism, telescope and microscope.

Polarization: Nicol prism, polaroids and their uses, production and analysis of plane, circularly and elliptically polarized light by retardation plates and Babinet's compensator, optical activity, Fresnel's explanation of optical activity , Biquartz and half shade polarimeter.

Practical Paper = H2-B: (Total marks: 40)

12 marks = 30 minutes written examination of 12 short questions to be suppliedby the Head Examiner, 08 marks = Internal Assessment including Laboratory Note Book

1. Determination of thermal conductivity of material of disc by Lees and Chorlton's method (applying Bedford's correction)

2. Determination of dispersive power of material of a prism.

3. To draw $(\delta - \lambda)$ curve and to determine unknown wavelength by prism.

4. To determine unknown concentration of an optically active substance by a polarimeter and to find the specific rotation of the substance.

5. To find the slit width and the separation between slits of a double slit for Fraunhoffer diffraction.

6. To determine the coefficient of viscosity of a liquid by Poiseuillie's method.

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Semester – III

2014

Theory paper H3-A (60 marks)

Total Theory Marks 60

(48+12 internal)

Two units: each unit has (24+06 marks internal)

Third Semester: Theory Paper = H3-A

UNIT – I

Current Electricity (24+6 internal)

D.C. circuits: Kirchoff's laws, Thevenin's theorem ,Norton's theorem' Superposition theorem' maximum power transfer theorem, problems on current in complicated circuits' inadequacy of Wheatstone's bridge. Platinum resistance thermometer, Callender& Griffith bridge and measurement of high temperature by Platinum resistance thermometer .Working principle of potentiometer and its applications.

Thermoelectricity: Thermo emf, laws of thermoelectricity, Peltier and Thomson's coefficient, total emf developed in a thermocouple, thermoelectric curve and the concept of neutral temperature and temperature of inversion of a thermocouple ,thermoelectric power, thermoelectric diagram and it's applications, calculation of Peltier and Thomson's coefficients from thermodynamic considerations, uses of thermocouple.

Theory of moving coil dead-beat and ballistic galvanometer, corrections due to damping in ballistic galvanometer ,applications of ballistic galvanometer ,measurement of capacitance of a capacitor (principle only).

Electromagnetic induction: Self and mutual inductance and relation between them, coefficient of coupling, combination of inductances, self-inductance of a circular coil and solenoid, mutual inductance between two circular coils and between two coaxial solenoids. Eddy current and its explanation.

Charging and discharging of condenser in L-C-R circuit considering various conditions. Current in L-R'C-R and L-C-R circuits using operator and imaginary quantity method' resonance in series and parallel L-C-R circuits, power in a.c circuits, power factor, wattles current, choke coil and bypass capacitor, principle of ideal transformer losses.

UNIT-II

Thermal Physics (Thermodynamics,Radiation,Kinetic Theory of Gases,Transport Phenomena and

Refrigeration

(24+6 internal)

Limitation of first law of thermodynamics. Necessity of Second law of thermodynamics, Carnot's cycle and its efficiency. Carnot's theorem, thermodynamic scale of temperature. Clausius inequality. Entropy:its properties and physical significance, change of entropy in reversible and irreversible changes, entropy of a perfect gas, entropy of a mixture of N- number of gases, principle of degradation of entropy. Temperature-entropy (T-S) diagram and representation of Carnot's cycle with the help of T-S diagram.

State functions: exact and inexact differential. Thermodynamic functions. Maxwell's thermodynamic relations, their simple deductions and their applications. Clausius-Clapeyron equation. Thermodynamic potentials, enthalpy.

Porus-plug experiment Joule-Thomson effect and inversion temperature.

Radiation: emissive power and absorptive power of a body, black body, black body radiation spectrum, Kirchoff's law and its rigorous derivation, pressure and energy density of diffused radiation ,Stefan-Boltzmann law. Solar constant and solar temperature. Wien's law, Rayleigh-Jeans law, basic assumptions and statement of Plank's law.

Kinetic theory of Gases :Basic assumptions of kinetic theory ,Ideal gas approximation, Maxwell's distribution law (both in terms of velocity and energy).root mean square and most probable speeds. Collision probability, distribution of free paths and mean free path fromMaxwell's distribution .Expression for pressure according to kinetic theory. Degrees of freedom, equipartition of energy(detailed derivation not required), relation between Υ and degree of freedom.

Transport phenomena: Viscosity and thermal conductivity and their relation in the case of gas, diffusion in gases .Brownian motion: Einstein's theory and Perrin's work for determination of Avogadro number.

Refrigeration: Basic principle,

Third Semester:Practical paper=H3-B

(Total marks 40)

Marks division :

12 marks=30 minutes written examination of 12 short questions to be supplied by the Head Examiner

08 marks=Internal assessment including Laboratory Note Book

20 marks=performance of the experiment.

Electrical Experiments:

Experiment No	Name of Experiment
1	To construct an 1-ohm coil and its comparison with standard 1-ohm .
2	To draw thermoelectric curve and to find thermoelectric power at $60^0 C\ using\ t\ \ ermocouple$.
3	To determine the boiling point of a liquid by platinum resistance thermometer.
4	Determination of high resistance by the method of leakage.
5	Determination of mutual inductance between two coils.
6	Construction of a rectifier circuit and study of output using a CRO with filter and without filter

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Semester – IV

2014

Fourth Semester
Total Marks – 100
Paper Name – H-4
(Theory paper H4-A = 60 marks, Practical paper H4-B = 40 marks)

Theory paper H4-A (60 marks)
Total Theory Marks 60
(48 + 12 Internal)
Two units: each unit has (24+6 marks internal)

Fourth Semester: Theory Paper =H4-A
UNIT-I
Mechanics – II and Relativity: (24 + 6 internal)

Mechanics –II

Rigid body , angular momentum of a rigid body , moment and product of inertia, kinetic energy of rotation of a rigid body , ellipsoid of inertia , inertia tensor , principle axis in simple symmetric cases , Euler's angles.

Generalised coordinate, constraints, forces of constraints, degrees of freedom , application of generalised coordinate and concept of constraints in different cases , generalized velocity ,generalized potential, generalized force.

Lagrangian formulation and its superiority over Newtonian approach, Principle of virtual work, D'Alemberts principle, Lagrange's equation for a conservative system from D'Alemberts principle and its application to different cases (see appendix) , cyclic coordinates and its applications.

Hamiltonian formulation and its superiority, Calculation of Hamiltonian in simple cases (see appendix).

Relativistic mechanics: Galilean transformation and invariance, Michelson Morley experiment: its outcomes and difficulties. Postulates of the Special theory of relativity, simple derivation of Lorentz transformation formula, relativity of simultaneity, length contraction, time dilation, addition of velocities (velocities along same line) , variation of mass with velocity (head-on and oblique collision), Equivalence of mass and energy.

Fourth Semester: Theory Paper =H4-A
UNIT-II
Electromagnetism and Electromagnetic Theory : (24+6 internal)

Application of Biot-savart law and Ampere's circuital law (see appendix), Lorentz force and concept of magnetic induction , non-existence of magnetic monopole, $\nabla . B = 0$; magnetic vector potential , calculation of vector potential and magnetic induction in simple cases.

Displacement current , Maxwell's electromagnetic inductions (using Divergence and stocks theorem) , propagation of plan electromagnetic waves in free space, transvers character and polarized electromagnetic wave, pointing vector and pointing theorem, energy density in electromagnetic field, Hertz's experiment.
Reflection and refraction of plane wave at the boundary of two dielectrics (law in generalized case and calculation of intensity only for normal incidence), waves in conducting media –skin effect and skin depth.
Normal and anomalous dispersion, Cauchy and Sellemier equation and Lorentz modification.

Fourth Semester: Practical Paper = H4-B
(Total marks: 40)

Marks division:
10 marks = One flow chart (question to be supplied by the Head examiner)
10 marks = First program (question to be supplied by the Head examiner)
10 marks = Second program (question to be supplied by the Head examiner)
05 marks = Viva Voce
05 marks = Laboratory Note Book
Computer Programming in Basic/Fortran.

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Semester – V

2014

Fifth Semester Major
Paper H5
Full Marks-100 (Internal Assessment: 20, Semester Exam: 80)

UNIT-I: MATHEMATICAL METHODS IN PHYSICS-II

Partial Differential equation: Laplace equation and wave equation and their solution in Cartesian, spherical polar and cylindrical polar coordinates by the method of separation of variables.

Series solution: Series solution of Legendre, Hermite and Laguerre's differential equation, orthogonality of the solution and recurrence relation

Complex variables: Complex variables and function of complex variables, continuity, differentiability, singular points, removable singularities, essential singularities, isolated singularities, poles, singularity at infinity. Branch points, branch cuts, Riemann sheet and Riemann Surface, single and multi-valued function, idea about complex plane, analytic function and necessary and sufficient condition for a function to be analytic:- Cauchy Riemann Equation, harmonic functions, Cauchy Riemann Equation in polar coordinate.

Laplace's Transformation: Properties of Laplace's Transform, important formula related to Laplace's Transform, Laplace's Transform of the derivatives of $f(t)$, Laplace's Transform of the derivatives of$tf(t)$Laplace's Transform of the derivatives of$\frac{f(t)}{t}$, evaluation of integrals using Laplace's transform

UNIT-II: ATOMIC AND MOLECULAR PHYSICS, LASER AND FIBRE OPTICS:

Spectrum of hydrogen atom with reduced mass correction, vector atom model, qualitative idea of Bohr-Somerfield model, space quantization, Stern-Gerlach experiment and intrinsic spin of electron, magnetic moment of electron, Bohr Magneton

Spectroscopic notation, L-S and j-j coupling, Lande-g-factor, spectra of alkali atoms, doublet structure of spectral lines, normal and anomalous Zeeman effect

Basic idea about molecular spectra, rotational and vibrational spectra of diatomic molecules, Compton effect and calculation of Compton shift.

Laser: Population inversion, Einstein's A & B co-efficients, feedback of energy in a resonator, 3-level and 4-level system, Ruby, Helium-Neon and Semiconductor Lasers, Laser applications, Holography (Basic principle)

Optical fibre: Core and cladding, total internal reflection, optical fibre as waveguide, Step index and graded index fiber, communication through optical fiber, energy loss, band width and channel capacity, -a typical system, attenuation and dispersion, splicing and couplers, fiber sensors

UNIT-III: ELECTRONICS

Applications of PN Junction diode, bridge rectifier, clipper and clamper

Transistors, working of PNP and NPN transistor, current component in a junction transistor, CB, CE and CC configurations and their comparison

Transistor characteristics in CB, CE and CC configurations, definition of alpha and beta and their interrelations, working of a CE transistor amplifier, hybrid parameters, analysis of small single low frequency CE transistor amplifier with hybrid parameters, calculation of current gain, input impedance, voltage gain and output conductance

Transistor biasing, fixed bias and its disadvantage, self-bias or emitter bias, and its advantage with respect to stability, voltage divider method.

Field effect transistor (FET) and its difference from bipolar transistor, n- and p-channel FET, FET operations, FET characteristics, static and dynamic characteristics, FET parameters and their relations, use of FET as a Voltage amplifier and calculation of voltage gain,

Operational Amplifier (OP-AMP), concept of virtual ground, uses of OP_AMP as an inverter, phase shifter, adder, differentiator, integrator, solution of simultaneous equations, real OP-AMP, input Offset voltage, input offset current, common mode rejection ratio (CMRR) and slew rate, Square wave and triangular wave generator

Feedback amplifiers, positive and negative feedback, voltage gain with feedback, Barkhausen criterion for oscillation, Hartley, Colpitt and Wien-Bridge Oscillators with transistor and FET, Qualitative description and advantages of crystal oscillator

Principles of radio transmission and reception using block diagram

Ionosphere: Different layers, their role in radio wave propagations.

UNIT- IV: STATISTICAL MECHANICS

System and ensembles, microstates and macro-states, calculation of microstates and macro-states in different cases, postulate of equal a prior probability, concept of chemical potential, micro-canonical, canonical and grand canonical ensembles, few examples of different ensembles from the physical world, phase space and its feature, dimension of elementary phase cell, thermodynamic probability and its calculation in various cases, partition function and its significance, calculation of partition function in different cases, Plank-Boltzmann definition of entropy, entropy and probability, third law of thermodynamics and its consequences, most probable distribution, derivation of distribution function for Maxwell-Boltzmann for a system of non-interacting particles, equipartition of energy and Richardson-Dushman equation from classical statistical mechanics.

Spin angular momentum of identical and indistinguishable particles and their symmetry requirements, calculation of macro-states, microstates and wave function in case of assemblies of identical and indistinguishable particles, Bose-Einstein and Fermi-Dirac statistics for a system of non-interacting particle.

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Semester – VI

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UNIT-I: NUCLEAR PHYSICS

Characteristic of nucleus: mass, charge, size, binding energy, spin, magnetic moment,, packing fraction, atomic mass unit, isobars, isotopes, isotones.

Nuclear structure: nature of nuclear force, nuclear stability and nuclear binding, binding energy curve and its significance, description of liquid drop model and Bethe-Weizsacker mass formula

Radioactivity: Successive disintegration, secular and transient equilibrium.

α decay: Rutherford α-scattering experiment and formula (deduction not necessary) and its significance, range of α particles, Geiger-Nuttal law, α-ray scattering, fine structure in α-ray spectrum, theory of α-disintegration.

β-decay: Different types of β-ray spectrum and their nature, neutrino hypothesis, β-disintegration energy, internal conversion, Curie plot, β-ray absorption (qualitative discussion).

γ-decay: γ-ray spectra and nuclear energy levels, qualitative discussion on γ-ray absorption in matter, -photoelectric process, Crompton scattering and pair production, electron-positron annihilation (qualitative).

Nuclear reaction: conservation principles in nuclear reaction, Q-value and thresholds, exoergic and endoergic reaction, artificial radioactivity, nuclear reaction induced by α-particle, proton, deuteron, γ –rays, neutron, Bohr's postulates of compound nuclear reaction.

Spontaneous and induced fission, nuclear chain reaction and basic principle of nuclear reactors. Four basic interactions in nature and their relative strengths, example of different types of interactions.

Acceleration and detectors: Betatron, Synchrotron (principle only), Ionization chamber, Proportional counter, G.M. counter

UNIT-II: QUANTUM MECHANICS

UNIT-III: CONDENSED MATTER PHYSICS

UNIT IV: DIGITAL ELECTRONICS, COMPUTER FUNDAMENTALS