SYLLABUS FOR LAB ASSISTANT EXAMINATION (PHYSICS)-2014

Scalar and vector fields:
Scalar and vectors, gradient, divergence and curl operations, laplacian operator, Physical interpretation of gradient, divergence related problems and curl related Problems, gauss's divergence theorem, stoke's theorem and its applications, related Problems in vector algebra.

Conservative forces: conservative force as negative gradient of potential, law of Conservation of mechanical energy.

Motion under central force:

Motion under a central force, conservation of angular momentum, kepler's laws, Gravitational field and potential due to spherical bodies, gauss and poisson

Equations, gravitational self-energy, two-body problem; reduced mass, scattering By hard spheres, centre of mass and laboratory reference frames, collisions in 2d & 3d, calculation of final velocities of colliding particles and scattering angle_

Mechanics of continuous media:

Elastic constants of an isotropic solid, poisson's ratio, relations connecting the elastic Constants, determination of young's modulus of a material, determination of Poisson's ratio (a) of rubber, dynamical method (maxwell's needle) of determination

Of the coefficient of rigidity (r1) of a wire. Bending of beam, bending moment, the

Cantilever, determination of 'y' of the material of a c.- iitilever — case study.

Ideal gas : review of the kinetic theory of an ideal gas model of an ideal gas;

Interpretation of temperature, equi-partition of energy; atomicity of gases and its

Relation with specific heats of gases

Real gas: van der waals model; equation of state, nature of van der waals forces,

Critical constants, mean free path, transport phenomena, transport of momentum

(viscosity) of energy (thermal conduction) and matter (diffusion), joule-thomson and adiabatic cooling; porous plug experiment, constancy of u + pv,

Liquefaction of gases: cascade process, principles of regenerative cooling, linde's Process

Different methods for production (and measurement) of low temperatures.

Otto engine; otto engine cycle, its efficiency, the second law, thermodynamic scale

Of temperature, concept of entropy, entropy change in reversible and irreversible Processes, principle of increase of entropy, entropy as a thermo-dynamical behavior,

Maxwell's thermo-dynamical equations, its application to clausius-clapeyron

Equation, cooling due to adiabatic demagnetization (derivation)

Simple applications : black-body radiation: thermal radiation, stefan-boltzmann

Law, spectral distribution, wien's displacement law, rayleigh-jeans law and the Ultraviolet catastrophe. .

1. Y. M. Of a wire
2. M. I. Of disc and rigidity of a wire
3. Bar pendulum
4. Newton's rings
5. Dispersive power of prism
6. N. L. Of cooling
7. If of liquid
8. Cvat
9. Melde's
10. experiment
11. Mr-wedge interference
12. Logic gates

Fermat's principle, laws of reflection and refraction from fermat's principle, principles - of reversibility, refraction at spherical surface, matrix method in paraxial optics, Coordinates of a ray, translation matrix, refraction matrix.

Aberration: aberration of a thin lens, longitudinal and lateral chromatic aberration, Achromatism of lenses: achromatism of two lenses in contact, achromatism of two Lenses separated by a distance, spherical aberration, spherical aberration due to Spherical surface, minimization of spherical aberration. .

Wave motion in a medium

Characteristic of progressive wave, mathematical representation of a plane progressive Wave, differential wave equation in one dimension, velocity of propagation of plane Longitudinal waves in an elastic fluid, velocity of sound in gases and liquids, velocity of Longitudinal waves in a solid bar, properties of the differential wave equation, solution Of the simple harmonic wave equation, energy density of plane progressive wave, phase Velocity and group velocity. .

Electricity and magnetism

Electrostatics (s. I. Units to be followed):

Concept of iirotational & rotational vector fields (gradient of scalar field and curl of a Vector field), field equation for *e* in vacuum. Gauss's law (div *e = qi eo),* energy Associated with *e* field, poisson's equation, laplace's equation and uniqueness

Theorems.

Conductor in electric field , electric dipole, dipole moment, polarization and charge

Density, e and d fields, polarizability and susceptibility, gauss's law in dielectrics,

Static boundary conditions in dielectric, energy of fields in the presence of dielectrics.

Magnetic field: magnetic field b (through lorentz force) on a moving charge, unit

For b, torque on a current loop in b field, magnetic dipoles in atoms and molecules,

Gyromagnetic ratio.

Hysterisis loop: magnetizing current, vector, h and b fields, magnetic Permeability, susceptibility, retentivty, coercively and hysterisis loss, boundary Conditions for b and h. Measurement of susceptibility (gouy's method/quincke'sMethod).

Electric current and circuits: charge and current density and equation of continuity, conductivity, relaxation time, kirchoffs laws and their applications, non-ohmic circuit (thermistor case),rise and decay of currents in lr and rc circuits and lc circuits. Phaser algebra (addition, subtraction, multiplication and division), lcr series circuit (acceptor circuit) quality factor, parallel circuit (rejector circuit), sharpness of resonance circuit power in ac circuit, choke coil.

Laboratory experiments

1. P-n junction diode
2. Rectifier
3. Rc circuit -- time constant

4 emission spectrum analysis

5. Tcr

Wattage of a lamp
Deflection magnetometer
Vibration magnetometer

Bending of beam

Error analysis: measurement of radius of a rod using micrometer•screw gauge

Field along axis of coil Condition for sustained interference, classification of interference, division of wave Front: biprism, division of amplitude: newton's rings. Interference in thin films : interference due to reflected light and transmitted light, Variable thickness of film, michelson's interferometer, fabry-perot interferometer (etalon), applications of interferometers.

Diffraction : fresnel's assumption, rectilinear propagation of light, zone plate, fresriel and fraunhofer diffraction, diffraction due to a straight edge, fraunhofer diffraction due to a single slit, fraunhofer diffraction at n slits, diffraction grating: plane diffraction grating, dispersive power of a grating, prism and grating spectra.

Resolving power: rayleigh's criterion, resolving power of optical instrument :telescope and microscope, relation between resolving power and magnifying power, resolving power of a plane diffraction grating, huygen's and ramsden's eye-piece.

Polarization: polarization by scattering and by selective absorption double refraction, huygen's theory of double refraction, nicol's prism, production and detection of plane, elliptically and circularly polarized

lights, analysis of polarized lights (experimental aspects only), identification of polarizati quarter wave plate, babinet compensator.

Lasers : attenuation of light in an optical medium, thermal equilibrium, interaction Of light with matter, absorption, spontaneous emission, einstein's prediction, Stimulated emission, einstein relations, light amplification, condition for stimulated Emission to dominate spontaneous emission and absorption, population inversion, Active medium, pumping methods, meta-stable states, principle of pumping Schemes-three and four level scheme, optical resonant cavity, lasing action, he-ne Laser, p-n junction laser introduction to harmonic generation, non-linear optics, second harmonic generation, phase matching. (no derivation)

Electronics - i

Semiconductor diodes: review of p-n junction diode and characteristics, rectifiers equation, load line of a diode, diode as a half wave and full wave rectifier; efficiency of rectifier, ripple factor, filter circuit; l and 71 type filter with efficiency and ripple factors. Zener diode, use as a regulator.
Transistor biasing: base bias, voltage divider, transistor action; relation of a and 3,
Load lines, operating point stability (in common emitter only).

Transistor amplifier: transistor as a four terminal, hybrid parameter(model) in common emitterconfiguration (brief discussion only) with h-parameters equivalent circuit, common emitter amplifier with emitter resistance and voltage divider. Rc coupled amplifier frequency response in mid-, low- and high frequency ranges.

Feed back concept in amplification, closed and open loop gains, negative feed back amplifier, series and shunt feedback, advantages of negative feedback on band width, gain stability, frequency response, input and output impedance and distortion.

Oscillators: oscillatory circuit, undamped oscillations from tank circuit, positive feed-back, barkhausen criterion, rc oscillator tank circuit resonance; tuned collector oscillator, hartley oscillator, colpitt oscillator, phase shift oscillator (no derivation), limitations of rc & lc oscillator.
Semiconducting devices: zener diode, led, photo diode, tunnel diods, varactor
Laser diode, photo voltaic and voltage dependent resistor or varistors.
Physics laboratory experiments:

1. Diffraction grating
2. Cauchy's constants
3. Fresnel's bi-prism
4. Thermal conductivity of glass
5. Thermal conductivity by-lee's disc method
6. Stefan's constant using filament lamp
7. Magnetic field along solenoid axis
8. Magnetic hysteresis
9. Rigidity by maxwell's needle method
10. Rigidity by statical method

Modern physics

Millikan's oil drop experiment for electronic charge, determination of q/m of Positive rays, aston mass spectrograph. X rays production, origin and properties, diffraction of x rays, bragg's law, Moseley's law. Wave behaviour of particles; de broglie wave length wave packets and particles;

Heinsenberg's uncertainty relation; wave function; physical interpretation of Trapped particles and probability densities. *A* and f3 decay, radioactive dating, nuclear reactions, particle interaction (basic Forces) and families of elementary particles.

Particle accelerators: linear accelerators, van-de- graph generator, cyclotron, Betatron (brief introduction).

Detectors: introduction to gas filled detectors, scimillation counter and Semiconductor detector.

Introduction to hydrogen atom spectrum, bohr magneton, larmor's precession, stem gerlach experiment, electron spin and gyro magnetic ratio, vector atom model, spin orbit interaction and fine structure, total angular momentum for many e ' atom; l-s & j-j coupling (inbrief)

Interaction with external fields: zeeman effect, anomalous zeeman Effect and its application to sodium lines, paschen-back effect, stark effect.

Relativity and statistical physics

Special theory of relativity inertial frames of reference, galilean transformation, invariance of newton's law. The michelson-morley experiment, expression for fringe shift, null ecperiment and its consequences, einstein's postulates, lorentz transformation, lorentz-fitzerald, contraction, length contractionand timedilation, relativistic velocity transformation equations, relativistic mass variation, einstein's mass-energy relation, momentum and energy relationship, particles with zero rest mass.

Basic concepts of statistical mechanics, density of states, maxwell — boltzmann (mb) Statistics, thermodynamic probability in mb statistics and distribution function, Applications of mb-statistics, equation of state, maxwell's energy and velocity Distribution law, limitations of mb-statistics.

Introduction to quantum statistics, bose-einstein (be) statistics, thermodynamic Probability, be distribution function, application of be-statistics, planck's radiation Law, bose condensate, fermi-dirac (fd) statistics, distribution function, Applications of statistics, electronic specific heat of metals, comparison of mb, Be and fd-statistics.

Physics laboratory experiments:

Filter circuit
Kater's pendulum
Fly wheel
Double refraction
Polarimeter
Small thickness by optical lever
Charging-discharging of a capacitor (rc circuit)
Transistor amplifier — current, voltage and power gains
Figure of merit of a ballistic galvanometer

High resistance by substitution method

Wave and quantum mechanics

Bohr's correspondence principle, wave properties of particles - de brogue's Hypothesis, davisson-germer's experiment, phase and group velocities, fourier series representation of wave packet, the uncertainty principle — position-momentum and time-energy uncertainty, applications of uncertainty relations, general information of quantum mechanics, linear vector space, linear operator eigen function and eiggen values of an operator, hermition operator.

Time-dependent schrodinger wave equation (one- and three-dimensional equations), Theorem. Simple problems related to wave equations, uncertainty principle and Calculation of expectation interpretation of the wave function, time-independent Schradinger equation. Schrodinger equation, completeness of eigen functions, Expectation values of an operator, ehrenfest's values.

Basic postulates of quantum mechanics of n-particle system, probability density and Continuity equation, admissibility condition on wave function, physical interpretation of wave function,

Free particle, particle in a box: energy quantization, wave functions and momentum Quantization, the particle in a non-rigid box.

Electrostatics and magnetostatics

b)

Energy in electrostatics: introduction to electrostatic potential, relation between the field and the potential) equiptgential surfaces, electrostatic energy. Electric dipole, dipole in uniform electric field, electric dipole in a non-unifntr: electric field, mutual potential energy of two dipoles, electric double layers, electric quadruple.

Electrostatics in dielectrics: revision of boundary conditions, gaseous non-polar dielectrics, gaseous polar dielectrics, non-polar liquids. Boundary value problems in electrostatics fields: poisson and laplace equations, earnshaw's theorem, boundary conditions and uniqueness theorem, solution of lap lace's equation in spherical polar coordinates, the multi-pole expansion, method of electrostatic images, images in dielectrics.

Magnetostatics: the laws of magnetostatics, the magnetic potentials, current loops in external fields - magnetic dipole, magnetic dipole in a non-uniform magnetic field, magnetic vector potential due to a small current loop, an alternative method for finding the vector potential a and, hence, the field b due to a current loop, magnetic media, magnetization, magnetic field vector, magnetic susceptibility and permeability.

Boundary conditions (magnetic field), uniformly magnetized sphere in external magnetic field, a comparison of static electric and magnetic fields. Electromagnetic induction: electromotive force, faraday's law of electromagnetic induction, induction law for moving circuits, integral and differential form of faraday's law, self-inductance and mutual inductance, energy in magnetic fields, hysteresis, maxwell's equations.

Electromagnetic waves: plane waves in non-conducting media, polarization, energy flux in a plane wave, plane waves in a conducting medium, the skin effect.

Nuclear physics

Radioactivity: review of disintegration and displacement law, growth and decay of radioactivity. Deterrninalion of the velocity of alpha particles, alpha disintegration energy, range of alpha particles, range energy relationship for alpha particles, geiger-nuttal law, alpha particle spectra. Long range alpha particles and fine structure. Nuclear energy levels, theory of alpha decay_beta decay, condition for spontaneous erlissoan, energy measurement of beta panicles, origin of continuous beta spectrum, neutrino hypothesis, fermi theory of beta decay (qualitative), life time of beta decay and strength of the interaction matrix element. Energy levels and decay schemes, selection rules in beta decay, symmetry law, parity non-conservation in beta decay, the neutrino and helicity of the neutrino.

Introduction to gamma emission: selection rules, internal conversion, nuclear isomerism,

Interaction of gamma rays with matter, e – e pair production by gamma rays.

'Structure of atomic nuclei, non existence of electrons in nucleus, qualitative discussion on:

Angular momentum, magnetic dipole moment, eleric quadrupole moment, parity, statistics of nuclei,

lsospin qualitative discussion on two body nuclear forces. Binding energy, feature of binding energy versus mass number curve, liquid drop model, semi empirical mass formula, shell model.

Types of the nuclear reactions, reaction cross-section, conservation laws, kinematics of nuclear reaction, q-value and its physical significance. Bohr hypothesis of compound nucleus.

Distribution of fission products, energy release in fission process, neutron emission in fission process, theory of nuclear fission, chain reaction, nuclear reactor, fusion, thermonuclear

Reaction, classification of particles, elementary particles and fundamental interactions.

Classical mechanics

Motion in a central field, general features of motion, the central force (inverse square law) equation and eccentricity, circular and elliptical orbits, the kepler's problem, the two body-problem, reduced mass, inelastic collision of equal masses, chemical reactions 1

Example: vibration of a diatomic molecule, problems.

Inertial and accelerated frames of reference, the earth as a reference frame, fixed stars and inertial refereke frame, forces in inertial reference system, absolute and relative acceleration, fictitious forces, accelerometer, centrifugal (also pseudo force : coriolis force) and centripetal forces, cyclone formation and freely falling particle under gravitation, acceleration in uniformly rotating frame, foucault pendulum, mechanics of

N-particle system, type of constraints, classification and examples.

Fluid motion and lagrange's equations: kinematics of moving fluid; equation of continuity and irrotational flow, equations of motion of an ideal fluid, euler's equation of motion, generalized coordinates, principle of virtual work, d'alembert principle

Lagrange's equation, examples, systems subject to constraints, generalized kinetic energy with example, constants of motion and ignorable coordinates, examples, electromagnetic forces and velocity dependent potentials, system of n particles, problems

Mathematical methods

Orthogonal curvilinear coordinates, gradient, divergence and curl, laplacian (v^2) in

Spherical and cylindrical coordinates, resolution of cartesian unit vectors into their

Spherical polar coordinates, conversion of *a* —and — into their spherical polar

Coordinates, expression for angular momentum l and l^2 in spherical polar coordinates. .

Numerical methods:

Experimental errors and their analysis, roots of polynomial equation using newton –
Raphson's and laggurre's methods. Least square approximation: (a) linear regression (b) polynomial regression (c) fitting of exponential and trigonometric functions (d) curve fitting by interpolation and extrapolation.

Numerical methods:
Lagrange's interpolation formula, forward and backward differences, derivatives of function, detection of error in data table, maxima and minima of a tabulated function, gaussian integration, double integration.
list of practicals

1. Quarter wave plate
2. Fabry perot etalon
3. Lloyd's mirror
4. hartman's formula
5. Goniometer
6. Application of c. R. 0.
7. Bridge rectifier (for mutual inductance)
8. Thermistor
9. Photocell
10. Anchor ring
11. Mutaual inductance
12. Susceptibility of a solution
13. Pentode and tetrode
14. R. P. Of a prism
15. Double slit source method
16. R. C. Coupled amplifier(transistorised)
17. Series and parallel resonance
18. Stafan's constant
19. Filter circuits : ripple factor and voltage regulation

Quantum mechanics and spectroscopy
The harmonic oscillator, energy levels, wave functions, rigid rotator, solution of schrodinger equation for finite potential well and potential barrier, 3-d schrodinger equation, schrodinger equation for the hydrogen atom, separation of variables

Total quantum number, orbital quantum number, torque on a magnetic dipole in a magnetic field, angular momenta and magnetic moment, gyro-magnetic ratio, larmor frequency and larmor precession, magnetic quantum number, electron probability density, system of two identical particles.
Orbital magnetic dipole moment, larmor precession, space-quantization, stern- gerlach experiment and its significance, electron spin, quantum numbers — general account, total angular momentum, spin-orbit coupung, ls and j-j coupungs, interaction energy in spin-orbit coupling, characteristics of vector atom model, spectroscopic terms and their notations, pauu's exclusion principle, hund's rule, aufbau principle, electron Configurations, the periodic table.

One electron spectra, two electron spectra, molecular formation, ionic bonding, covalent bonding, electron sharing, theories of bonding- the valence-bond approach, molecular orbital, the $h2^+$ molecular ion, the h2 molecule, electro negativity, molecular spectra : rotational energy levels of diatomic molecules, rotational spectra, vibrational energy levels of diatomic molecules, vibration-rotation spectra, electronic spectra

Transistor stabilization: selection of operating point bias stabilization, stabilization factor, Transistor biasing circuits:- fixed bias, potential divider bias circuits,
Transistor amplifier circuit design in ce with self bias, its load line analysis, voltage and Current gains, analysis of a common emitter transistor amplifier using & parameter in low,mid and high frequency range. Variation of gain with frequency & bode plotfeed back in amplifier: principles of feed back negative. Feed back- stabilization of, reduction in nonlinear distortion, reduction in noise, effect of feedback in input and output impedance on band width: current series feedback amplifier; circuit analysis, its feed back ratio, voltage gain, feedback factor.emitter follower: its operation and circuit analysis.

Transistor oscillators: principle of feedback in oscillators, tuned collector oscillator and its operation and circuit analysis, tuned emitter oscillator and its operation and circuit analysis and blocking oscillator. Multivibrators: switching characteristics and switching times of a transistor, astable multivibrator: circuit conditions and frequency of oscillator schmitt trigger, clamping circuits:- positive & negative peak clamping, zero level clamping, clamping at a reference dc voltage clipping circuits:- diode clipper (negative, positive peak), double ended zener diode and p-n junction diode clipping and voltage multiplier circuit.
Operational amplifier characteristics:- common mode rejection ration; differential mode, Input off set voltage common mode input voltage, bias current, input off set current, slow rate, input-output impedance, negative feedback in op-amp inverting, non-inverting, summing, voltage follower, zero level detector & comparator circuit analysis. Digital electronics:- binary number system its conversion to decimal hexdecimal and octal system and vice versa, two's complement representation and subtract ion, bcd code, excess-3code, gray code. Digital gates, buffers formation of other gates by universal gates, boolean algebraic laws and de morganization, simplification of boolean algebraic expressions, parity generator and parity checker.
Solid state physics

The crystalline state: basics of crystal structures, unit cell- primitive cell structures, Symmetry operations, crystal types, indices′ of a lattice direction and a lattice plane, Crystal point groups and space groups, common crystal structures, introduction of Amorphous, glass and liquid crystal materials, quasi-crystals.

Reciprocal lattice and determination of crystal structure: reciprocal lattice, Bragg law, laue's interpretation of x-ray diffraction by crystals, construction of Reciprocal lattice, relationships between a, b, c and a*,b*,c*, application to some Crystals lattices, analysis of x-ray powder diffraction pattern from crystals, Measurements of diffraction pattern of crystals, determination of lattice constants, Selection of incident beam.

Lattice vibrations: the 'balls and springs' model of a harmonic crystal, normal Modes of a one-dimensional monatomic chain, normal modes of one -dimensional Diatomic chain, the reststrahien band, general theory of harmonic approximation, Normal modes of real crystals, quantization of lattice vibrations, measurement of Phonon dispersion by inelastic neutron scattering.

Free electron theory of metals: the drude model, lorentz modification of the drude Model, the fermi-dirac distribution function, the sommerfeld model, free electron Model, density of states, the electron heat capacity, the sommerfeld theory of Electric conduction in metals, matthiessen's rule, thermoelectric effects.
Superconductivity: phenomena without observable quantization, energy gap, Properties dependent on energy gap, isotope effect, meissner effect, type-i and Type-ii superconductor, bcs theory: a qualitative approach.

Special theory of relativity
Rotation of a rigid body about a fixed axis, time dependence of motion, behaviour of angular momentum vector, moments and products of inertia (euler's equation), torque —free motion, euler's angles, spinning of a top(symmetrical top/ heavy symmetrical top), precession of equinox.
Doppler effect, space-time diagram, world-line, the twin paradox, relativity in Electromagnetism, variation of mass with velocity. Relativistic formula for kinetic energy, Experimental verification of time dilation, lorentz transformation, minkowski space, Time like and space like intervals

Four vectors, four velocity, four momentum, four force, general introduction to tensor, invariant, covariant and contravariant tensors and their products, einstein's summation convention, problems invariance of electric charge, addition of velocities, problems in relativistic dynamics, acceleration of ,a charged particle by constant longitudinal and transverse electric fields
Charged particle in a magnetic field, covariant formulation of motion of a charge particle in the electromagnetic field (lagrangian method) relativistic elastic scattering, centre of mass system and threshold energy, examples from photo production of pion and antiproton, general theory of relativity (elementary)
Numerical solution of differential equations:

Solution of 1*' order differential equations:[i.v.p.] euler's method, runge-kutta method (2^{nd} and 4^{th} order), simultaneous I' order d.e., predictor-corrector method. [b.v.p.] finite difference approximation.
Solution of rd order linear partial differential equations: applying different methods. (i) laplace equation [gauss elimination method], (ii) poisson's equation [iterative method: successive over relaxation scheme], (iii) one dimensional heat flow equation [crank- nicholson method], (iv) wave equation [central difference method].
Computer programming: fortran 90 & 95 (introduction to computer characteristic, algorithm and flow chart.) Characters, constants, variables, data types, operators: arithmetic, relational etc. Arithmetic statements. I/o & 0/p statements. Control statements: if, 1f-else, go to, do loop. Arrays, statement function, programs: bisection method, newton-raphson method, matrix multiplication.
Programs: applications of numerical methods to problems in physics

1. *Decay* of radio active disintegration.
2. Growth of charge/potential on a capacitor [1' order ode].
3. Flow of current in closed lcr circuit with source [runge-kutta method].
4. Find area under curve to caiculate velocity of electron in e/m Experiment [discrete data set].
5. Motion of a particle in a viscous field [numerical integration].
6. Bending of beam supported at the two ends.

Programs: applications of numerical methods to problems in physics
1. Motion of a simple pendulum under gravitational field (frictionless) [$2'^{d}$ order ode].

2. Current passing through r-c series combination [predictor-corrector method].
3. Application of kirchhoffs law fof eleciri-cal circuit !iterative method].
4. Eigen value of 2 x 2 matrix [power method)
5. Evaluate the spring constant from a given data set [least square approximation].
6. Calculate one dimensional heat flow [crank nicholson method]

List of practicals

babinet compenstor
temperature of a flame
r. P. Of grating
g. M. Counter
capicity of a condenser
self inductance (rayleigh's method)
'h' by photocell
high resistance by leakage
positive feed back
multivibrator
owen's bridge
edser butler fringes
aberation meter
r. P. Of a telescope
'elm' by hellical method
regulated power supply
band gap of semiconductor
push-pull amplifier study
study of different diffraction patterns using lasers