SYLLABUS FOR RECRUITMENT OF LECTURER IN SCIENCE IN THE DEPARTMENT OF TECHNICAL EDUCATION THROUGH KARNATAKA PUBLIC SERVICE COMMISSION

SCIENCE

MATHEMATICS

UNIT 1. ALGEBRA

MATRICES:- Elementary row and column transformations(operations) equivalent matrices, theorem on it . Row-reduced echelon form, Normal form of a matrix. Rank of a matrix, problems Homogeneous and Non-Homogenous systems of m linear equations in n unknowns consistency criterion-criterion for uniqueness of solutions. Solution of the same by elimination method. Eigen values and Eigen vectors of a square matrix of order 2 and 3 standard properties. Cayley-Hamilton theorem , finding A^{-1},A^{-2}, and A^2 A^3, A^4

SEQUENCE OF REAL NUMBERS:- Definition of sequence, bounded sequences, limit of sequences ,convergent, divergent and oscillatory sequences- Monotonic sequences and their properties Cauchy's criterion.

SERIES OF REAL NUMBERS:- Definitions of convergence, divergence and oscillation of series-properties of convergent series-properties of series of positive terms-Geometric series. Tests for convergence of series P-series-comparison of series Cauchy's root test. D'Alembert's test. Raabe's test-Absolute and conditional convergence D'Alembert test for absolute convergence Alternating series . Leibnitz test. Summation of Binomial, Exponential ,and Logathmic series.

LINEAR ALGEBRA:- Vector space-examples-properties-subspaces-criterion for a subset to be subspace-linear span of a set-linear combination linear independent and dependent subsets-Basis and dimensions-Standard properties- Examples illustrating concepts and results. Linear transformation s-properties –matrix of a linear transformation –change of basis range and kernel rank and nullity Rank Nullity theorem – Non-singular and singular linear transformations-standard properties, examples.

UNIT 2. ANALYTICAL GEOMETRY OF THREE DIMENSIONS

Direction cosines of aline (as components of unit vector)-Direction ratios-Angle between two lines, volume of a tetrahedron with given vertices. Equation of a line in different forms: one point form, Two point form , parallel and perpendicular Form a point onto a line, Reflection of appoint .Equation of plane in different forms-Perpendicular from a point onto a line Equation of a plane in different forms-perpendicular from a point onto a plane Reflection of a point in a plane.

Angle between two planes-Line of intersection of two planes-plane coaxal with given planes-planes bisecting the angle between two planes-Angle between a line and a plane-Coplanarity of two lines-Shortest distance between two lines. Equation of the sphere in general and standard forms-equation of a sphere, orthogonallity of spheres standard equations of right circular cone and right circular cylinder.

UNIT 3. DIFFERENTIAL CALCULUS

Successive Differentiation-nth derivatives of the functions: e^{ax} , $(ax-b)^n$, log(ax-b), sin(ax-b)Cos(ax+b), e^{ax} sin(bx+c) , e^{ax} cos(bx+c). problems. Leibnitz theorem and its applications. Partial differentiation - function of two and three variables-First and higher derivatives-Homogeneous functions-derivatives-Euler's theorem and its extension Total derivative and differential-Differentiation of implicit functions and composite functions-problems. Jacobians properties of jacobians problems.

Polar coordinates-Angle between the radius vector and the tangent- Angle of intersection of curves (polar forms) polar sub-tangent and polar subnormal-perpendicular from pole on the tangent-pedal equations. Derivatives of an arc in Cartesian,parametric and polar forms.

Curvature of plane curves-formula for radius of curvature in Cartesian, parametric,polar and pedal forms-centre of curvature-evolutes. Singular points. Asympototes- Envelopes.

Tracing of standard Cartesian ,parametric and polar curves (cissoids, strophic, Astroid, Folium of Descartes, Catenary, Cyloid, Cardiod, Lemniscate, Equiangular Spiral, Three leaved rose and four leaved rose)

Continuity and differentiability of functions of two and three variables-Taylor's theorem and expansions of functions of two variables-Maxima and minima of functions of two variables. Method of Langrange multipliers.

UNIT 4. INTEGERAL CALCULUS

Reduction formulae for $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \tan^n x dx$, $\int \cot^n x dx$, $\int \sec^n x dx$, $\int \cos ec^n x dx$

$\int \sin^m x cox^n x dx$ with definite limit, Differentiation under the integeral sign by Leibnitz rule.

Gamma and Beta functions-results following definitions-Relations connecting the two functions-duplication formula –Applications to evaluation of integrals.

UNIT 5. DIFFERENTIAL EQUATIONS

Solutions of ordinary differential equations of first order and first degree: (i) Homogenous and reducible to homogenous (ii) Linear equations, Bernoulli equation and those reducible to these (iii) Exact equations, equations reducible to exact form with grouping and standard integrating factors.

Equations of first order and higher degree-non linear first order, higher degree- solvable for p-solvable for y – solvable for x – Clairaut's equation-singular solution-Geometric meaning. Orthagonal trajectories in Cartesian and polar forms.

Second and higher order ordinary linear differential equations with constant coefficients-complementary function-particular integerals (standard type)-Cauchy-Euler differential equation. Simultaneous linear differential equations (two variables) with constant coefficients. Solutions of

second order ordinary linear differential equations with variable coefficients by the following methods: (i) when a part of complementary function is given (ii) changing the independent variable (iii) changing the dependent variable (iv) variation of parameters (iv) variation of parameters (v) conditions for exactness and the solution when the equation is exact.

Total differential equations-Necessary condition for the equation Pdx-Qdy-Rdz=0 be integerable-simultaneous equations of the form $\frac{dx}{P}=\frac{dy}{Q}=\frac{dz}{R}$

Formation of partial differential equation .Equations of First order Langrange's linear equation. Charpits method standard types of first order non-linear partial differential equation (by known substitution)

Solution of second order linear partial differential equations in two variables with constant coefficients by finding complementary function and particular integral

Solution of one-dimensional heat equations, solution of one-dimensional wave equations using Fourier series.

PHYSICS

Unit -1

Motion & Friction.

Newton's laws of motion with illustrations (review); Enumeration of II law – Motion in a resistive medium – Form of Newton's law for non conservative velocity dependent forces; Examples of drag force – Drag force with v dependence (both horizontal and vertical) and v^2 dependence (both horizontal and vertical), Concept of terminal velocity – Definition, Expressions for terminal velocity; Role of static and dynamic friction – Friction is a self adjusting force, Coefficient of static and dynamic friction; Motion along inclined plane with and without frictional force – Expression for acceleration with and without friction on the inclined plane, derivation of $\mu_s = \tan\theta$ for inclined plane with friction;

Planetary & Satellite motion.

Newton's law of gravitation – Statement; Kepler's laws (Statement only); Escape velocity- Derivation of expression for Escape velocity of a particle from the surface of a planet; Orbital velocity –Expression for orbital velocity of a particle around the surface of a planet; Launching of Artificial satellite, Geostationary and Geosynchronous satellites - (qualitative discussion

System of particles

Definition of rigid body; Centre of mass of rigid bodies – Definition - general expression; Newton's law for a system of particles – To derive $\sum \vec{F}_{ext} = M\,\vec{a}_{cm}$; Linear momentum for a particle and a system of particles - Definitions; Conservation of linear momentum – Statement; System with varying mass - With Rocket motion as an example(non-relativistic); Rocket motion - Derivation of expression for instantaneous acceleration & velocity and final velocity neglecting and considering the effect of gravitation; Elastic and inelastic collisions (oblique) – All cases

including stationary target (2D collision).

Moment of inertia.

Review of rotational motion of rigid bodies – review of rotational variables; Kinetic energy of rotation – Derivation of $K = \frac{1}{2} I\omega^2$; Moment of Inertia of a body - Definition; Theorem of Moment of inertia- Parallel and perpendicular axes theorem with proofs (2-D case)- Statement and explanation only; Calculation of Moment of inertia of a disk, annular ring, solid sphere and solid cylinder and rectangular bar rectangular plate and as a special case – Relevant derivations; Conservation of angular momentum with illustrations - Statement and any three examples.

Unit –2

Elasticity

Modulus of elasticity for isotropic materials, relation between elastic constants. Bending expression for bending moment, uniform bending, theory of light cantilever and section girder torsion, expression for couple per unit twist, torsion pendulum.

Surface tension

Forces on a surface, angle of contact and surface energy; effect of temperature and impurity, pressure within a curved surface with example.

Viscosity

Streamline and turbulent motion. Derivation of poiseulle's equation. stoke's law. Effect of temperature on viscosity.

Kinetic theory

Maxwell's law for distribution of molecular velocity mean free path, rms velocity. Degrees of freedom, principle of equipartition of energy ,application to the specific heat of gases.

Thermodynamics

First law of thermodynamics, isothermal and adiabatic changes, work done in isothermal and adiabatic changes, phase diagrams. Heat engine, expression for efficiency f carnot's cycle, reversibility of carnot's cycle, principle of refrigeration. Second law of thermodynamics. Entropy, macroscopic and microscopic definitions, principle of increase of entropy in irreversible process. Clausius and clayperon equation for variations of melting and boiling points.

Radiation

Black body radiation, Stefan's law, distribution of energy in the black body spectrum, statement of wien's law and Rayleigh-jeans law. Plank's quantum theory of radiation, radiation momentum and pressure, crooke's radiometer.

UNIT-3

Theories of Light

Wave theory; Huygen's principle, explanation of laws of reflection and refraction. Group and wave velocity and relation between them. Corpuscular theory; Quantum nature, concept of photon, photoelectric effect

Interference

Coherent sources, interference by division of wave front, young's double slit-theory and experiment, Fresnel's Biprism. Theory and experiment (determination of λ) ,Lloyd's mirror interference by division of amplitude thin film of uniform thickness(both reflected and transmitted) and wedge shaped film. Newton's rings theory and experiment. Michelson interferometer.

Diffraction

Concepts of Fresenel and Frauhoffer diffractions. Rectilinear propagation of light. Theory of zone plate, comparison between zone plate and convergine lens. Fresnel's diffraction at straight edge and wire . Fraunhoffer diffraction at a single slit ,double slit with theory, transmission grating-theory and experiment ,dispersion and resolution of a grating.

Polarization

Double refraction in uniaxial crystal, Huygens theory, positive and negative crystals, principal refractive indices. Huygen's construction of O and E waves in uniaxial crystal for plane wave front. Quarter wave and half wave plate.

Lasers :

Introduction characteristics - spontaneous and stimulated emission Laser –Einsteins coefficients and optical amplification, population inversion, main components of a laser, construction and working - energy level diagram. He Ne Laser - construction and working - energy level diagram, Fiber Laser setup, - Master Oscillator power amplifier schematic, working. Solid State Laser - construction and working. Applications of Lasers - Holography, bloodless surgery (principles only).

Optical Fibers :

Emission-Einstein's coefficients and optical amplification $A_{21}/B_{21}=\hbar\omega^3 n_0^3/\pi^2 c^3$ (derivation)- population inversion derive W_{12} and W_{21} - main components of a laser - lasing action. Rub

Optical Fiber – Principle (Total internal reflection ray diagram, critical angle), Description and classification (single mode and multimode – Step Index and Graded Index), Why glass fibers? - coherent bundle (explanation). Numerical aperture of fiber (derive expression for numerical aperture) - attenuation in optical fibers (define expression for attenuation- limit (for attenuation). Multimode optical fibers - ray dispersion in multi-mode Step index fibers. Dispersion due to material; dispersion and maximum bit rates define, expression and explain. Fiber optic sensors (as an application).

Modes in fibers : Introduction - modes in fibers. Symmetric step index planar waveguide TE modes - propogation constants - field distribution. Physical

understanding of modes. TM modes of a symmetric step index planar wave guide.

UNIT-4

Magnetic fields and forces:

Motion of charged particles in a magnetic field (Unit of B, Mention of three special cases : =0^o,$90^o$and between 0^o & 90^o), Magnetic force on a current carrying conductor (explanation and derivation), Force and torque on a current loop Principle and theory of a moving coil BG

Source of magnetic field:

Magnetic field due to moving charge (explanation), Biot and Savart's law (statement and explanation), Magnetic field due to a straight current carrying conductor , Force between parallel conductors, Definition of ampere, Magnetic field of a circular loop (Mention), (Construction and) Theory of HTG (double coil), Field on the axis of a solenoid ,Ampere's law (Circuital law: statement), Application of Ampere's law to straight wire, solenoid and toroid.

Electromagnetic induction:

Faraday's laws (statement, experiment, explanation and summary of results), Lenz's law (statement and explanation), Expression for induced emf motional emf, eddy currents (brief explanation) and applications.

Band Theory of solids:

Elementary ideas regarding formation of energy bands- Bloch Theorem- One dimensional Kronig-Penney

Semiconductor Physics

Distinction between metals, semiconductors and insulators based on band theory – (magnitudes of energy gaps and significance of Fermi level). Intrinsic semiconductors - concept of holes – effective mass - expression for carrier concentration (for both holes and electrons) and electrical conductivity (derivation) – extrinsic semiconductors (mention of expressions for carrier concentrations and conductivity)– impurity states in energy band diagram and the Fermi level. Formation of P-N junction, depletion region – (mention of width, resistance, capacitance) - Biased P-N junction - (V-I characteristics), variation of width of the depletion region, drift and diffusion current (in both Forward-bias and reverse bias)–expression for diode current

UNIT-5

Atomic physics

Properties of atom; Cathode rays, determination of charge of electron by Millikan's

oil drop method, e/m by j-j Thomson and Dunnington method. Atomic mass by Dempster's method, atomic mass unit.

Models of atom: Review of Rrutherford's model ,Rutherford's alpha scattering experiment ,Bohr's theory of hydrogen atom and its inadequacies, effect of nuclear mass, Summerfeld model ,excitation and ionization energies and potentials, Frank-Hertz experiment.

Molecular physics

Molecular spectra: Intrtoduction, classification of molecular spectra; electronic, pure rotation and vibrational spectra of diatomic molecules and band structure. Fluorescence and phosphorescenc Scattering of Light: Brief discussion of Tyndall, Rayleigh, Brillouin and Raman scattering. Intensity and polarization of Raman lines use of Raman effect in determining molecular structure.

Nuclear physics

Properties of nucleus: Constitutions; proton-electron and proton-neutron hypothesis of nucleus.

Qualitative description of properties; Distribution of mass, charge, size, density, spin and magnetic moment. Binding energy of nucleus. Nuclear force: characteristics of nuclear forces, Yukawa theory, Nuclear models; liquid drop model; shell model nuclear energy levels and magic numbers.

Radioactivity: Radioactive decay law, half life and mean life, successive disintegration, radioactive equilibria. Alpha decay; Alpha rays range and energy ,Geiger-Nuttal law ,Beta decay ,Beta rays, spectrum, neutrino hypotheses, attenuation of beta rays, Gamma decay ,Gamma rays attenuation of gamma rays.

Elementary particles; Classification ,particles and antiparticles, four basic interactions in nature.

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