GOA UNIVERSITY
Taleigao Plateau

SYLLABUS FOR GOA UNIVERSITY ADMISSIONS RANKING TEST (GU-ART) IN PHYSICS

1. MATHEMATICAL METHODS

Matrices and determinants: Linear equations, System of linear equations, matrices and determinants.

Elementary Vector Algebra: Scalars and vectors, addition and subtraction of vectors, multiplication by a scalar, basis vectors and components, magnitude of a vector, unit vector, dot and cross product of vectors and their physical interpretation.

Complex numbers: Complex numbers, notation of complex number, complex planes, physical meaning of complex quantities, exponential, logarithmic and trigonometric functions, hyperbolic functions. De'Moivre's Theorem, Roots of unity.

Limits and Continuity: Definition, intervals and neighborhoods, algebra of limits, limits of trigonometric functions, exponential limits. Concept of continuity, left and right hand limits, graphical representation of continuity.

Differentiation: Differentiation from first principles, derivative of polynomials, trigonometric, exponential, logarithmic functions and implicit functions. Rules of differentiation, Leibnitz theorem, higher order derivatives.

Integration: Integration from first principles, integration as inverse of derivative, integration by inspection. Standard Integrals: (Algebraic, trignometric, exponential logarithmic), integration by parts, substitution methods, reduction formulae).

2. MECHANICS

Motion of a particle in one dimension: Discussion of the general problem of one dimensional motion. Dependence of force in general on position, velocity and time. Motion under a constant force with illustrations - Atwood's machine, free fall near the surface of the earth. Motion along a rough inclined plane. The equation of motion, momentum and energy conservation theorems. Motion under a force which depends on time-general approach to the solution. Illustration using force of the type $F = F_o \sin(\omega t + \varphi)$. Motion under a conservative force dependent on position, potential energy. Motion under damping force depending on velocity - general dependence of resistive force on velocity. Motion in a medium with resistive force proportional to first power of velocity. Body falling under gravity in a resistive medium near the surface of the earth.

Motion in two dimensions : Equations of motion in plane polar coordinates. Momentum and energy theorems. Plane and vector angular momentum theorems. Projectile motion in a non-resistive and resistive medium, (resistive force proportional to the first power of velocity).

3. ELECTRICAL CIRCUIT THEORY

Circuit Analysis: Concept of constant current and constant voltage source, Maxwell's cyclic current method for circuit analysis, Superposition theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorem (with proof) and their application to simple networks.

Inductance: Self Inductance, self inductance of two parallel wires carrying equal current in opposite directions, Principle of non-inductive resistance coils, self inductance of co-axial cables, mutual inductance, coefficient of coupling, inductance in series and parallel.

Response of circuits containing L, C and R to DC: Growth and decay of current in L-R circuit, Charging and discharging of capacitor in C-R circuit and in a series L-C-R circuit.

AC Circuits: AC applied to L-R and C-R circuits, Inductive and Capacitive reactance, impedance and admittance, The j operator and vector or phasor method applied to LR, CR and LCR circuits. Series and parallel resonance. Q factor and Bandwidth. Graphic representation of resonance (Variation of resistance, inductive reactance, capacitive reactance with frequency)

Mutually Coupled L-R circuits: AC applied to mutually coupled L-R circuits. Reflected impedance. Transformers, Effect of loading the secondary of a transformer.

AC Bridges: General AC bridges, Maxwell's bridge, Maxwell's L/C bridge,De-Sauty's bridge. Wein's frequency bridge.

4. HEAT AND THERMODYNAMICS I

Kinetic theory of gases

Three states of matter, concept of ideal gas, postulates of Kinetic Theory of gases, expression of pressure of a gas, relation between rms velocity and temperature, Average kinetic energy of a gas molecule, heat and temperature, kinetic interpretation of temperature, Degrees of freedom, Law of equipartition of energy and its application to specific heats of gases. Brownian motion and its features, Einstein's equation, Determination of Avogadro's number. Mean free path and derivation to calculate MFP, Transport phenomena, transport of momentum (viscosity).

Behavior of real gases

Deviation from perfect gas behavior, Discussion of results of Andrew's experiments on CO2 and Amagat's experiment, critical constants, Van der Wall's equation of state, expression of Wan der Wall's constants, Reduced equation of state, Law of corresponding state, relation between Boyle temperature and critical temperature, critical coefficient.

Zeroth and First Law of Thermodynamics

Basic concepts of thermodynamics: Thermodynamic system, Thermodynamic variables, Thermodynamic equilibrium, and Thermodynamic processes, Zeroth law of thermodynamics and concept of temperature, Internal energy and First law of thermodynamics, Relation between pressure, volume and temperature in adiabatic process, Work done in isothermal and adiabatic processes, Path dependence of heat and work.

Second Law of Thermodynamics

Process-reversible and irreversible, condition of reversibility, Second law of thermodynamics, Carnot's cycle, efficiency of Carnot's cycle, reversibility of Carnot's cycle, Carnot's theorem, coefficient of performance of a refrigerator, Thermodynamic scale of temperature, its identity with perfect gas scale, Clapeyron latent heat equation and its applications.

Entropy

Entropy as a Thermodynamic variable, Entropy change in reversible and irreversible processes, Temperature–Entropy diagram of Carnot's Cycle, Entropy of a perfect gas, Physical significance of Entropy: Entropy and Unavailable Energy, Entropy and molecular disorder, Entropy and Second Law of Thermodynamics. Impossibility of attaining Absolute Zero (Third law of Thermodynamics).

5. PROPERTIES OF MATTER AND ACOUSTICS

Elasticity:

Brief review of moment of Inertia. Modulii of elasticity, Strain energy, equivalence of shear to compression and extension at right angles to each other, Poisson's ratio and its limiting values, Relationship between the elastic constants. Torsion in a string-couple per unit twist, Torsional Pendulum. Bending of beams-bending moment, flexural rigidity. Cantilever (rectangular bar). Depression of a beam supported at the ends and loaded at the center. Theory of Loaded pillars, Critical load for pillars.

Surface Tension:

Brief review of molecular theory of surface tension. Relation between surface tension and surface energy. Pressure difference across curved surfaces. Angle of contact. Capillarity, experimental determination of surface tension and angle of contact.

Flow of liquids and Viscosity:

Streamline flow, Turbulent flow, Critical velocity. Coefficient of viscosity, Poiseuille's formula for flow of liquid through a capillary tube. Viscosity of gases – Mayer's formula.

Acoustics:

Differential equation for harmonic oscillator, Velocity of longitudinal waves in fluids. Newton's formula for velocity of sound, vibrations in stretched strings. (transverse and longitudinal modes). Vibration in rods. Superposition of two simple harmonic motions, standing waves and beats, Helmholtz resonator.

Doppler effect. Intensity level - Bel and Decibel.

Production and detection of Ultrasonic waves and its applications.

Reverberation of sound

Reverberation of Sound, Reverberation time, Absorption coefficient, Sabine's formula for reverberation time, Acoustic requirements of an auditorium.

6. WAVES AND OSCILLATIONS

Waves and Oscillations:
Periodic oscillations and potential well, differential equation for harmonic oscillator and its solutions (case of harmonic oscillations), kinetic and potential energy. Examples of simple harmonic oscillations: spring and mass system, simple and compound pendulum, Helmholtz resonator, bifilar oscillations.

Superposition of Waves:
[8Wave equation and solutions, Superposition of two simple harmonic motions of the same frequency along the same line, interference, superposition of two mutually perpendicular simple harmonic vibrations of the same frequency, Lissajous figures, case of different frequencies.

Oscillatory Motion in a Resistive Medium:
Damped harmonic oscillator, Damped forced harmonic oscillator. Displacement and velocity Resonance, Sharpness of resonance, Phase relationships, Energy

consideration in a forced harmonic oscillator. Harmonic oscillator with an arbitrary applied force.

7. ELECTRONICS

Rectifiers and Regulators

Volt-ampere characteristics of Junction diode, Half wave, Full wave and Bridge rectifiers using Junction diodes without and with capacitive filters. Percentage regulation, Ripple factor and Rectification efficiency. Zener diode characteristics and its use as a simple voltage regulator. Thermistor characteristics and its use in A.C. voltage regulation.

Transistors

Basic configurations of transistors, Transistor characteristic in CE and CB mode, Current gains α and β and their interrelation, Leakage current in transistors.

Basic Amplifier Characteristics

Current gain, Voltage gain, Power gain, Input resistance, Output resistance, Conversion efficiency, Classes of amplifier operations, Decibel, Frequency response, Amplifier bandwidth.

C-E amplifier: Class A

Graphical analysis, Effect of adding A.C. load, Input and Output resistance, Conversion efficiency, Phase relationship between input and output.

Transistor Biasing

Bias stability, Stability factor, Different methods of biasing, biasing compensation.

Feedback

Positive and negative feedback, Voltage and current feedback, series and shunt feedback.

Effect on negative feedback on gain, frequency response, input and output resistance and distortion. **Positive feedback,** Barkhausen criterion for oscillations, Phase shift oscillator, Wein bridge oscillator, LC tank circuit, Hartley oscillator and Colpitts oscillator.

Linear IC's and Operation Amplifiers

The Differential Amplifier, OP-Amp characteristics, Input and Output impedance, Input bias and offset currents, Input and output offset voltages. Differential and Common mode gains, CMRR, Slew rate, OP-Amp as inverting , Non Inverting amplifier and Difference amplifier.

8. OPTICS And MODERN PHYSICS

Interference

Introduction: Interference by division of wave front & division of amplitude. Fresnel's biprism and Lloyd's mirror.

Formation of colors in thin film- reflected system, Transmitted system, wedge shaped film, Newton's Rings and its application to determine refractive index of liquids (Normal Incidence only).

Interferometry:- Michelson interferometer-its principle, working and its application to determine wavelength and difference between two wavelengths. Fabri Perot Interferometer.

Diffraction

Concept of Diffraction, Fresnel and Fraunhoffer Diffraction. Division of cylindrical wave-front into half period strips, Fresnel's diffraction at straight edge and cylindrical wire. Fraunhoffer diffraction at single, double and N slits. Diffraction grating, width of principal maxima of plane diffraction grating. Resolving power of optical instruments- Rayleigh's criterion, Resolving power of telescope, Prism and grating.

Polarization

Concept of polarization, Plane of polarization, Polarization by reflection, Brewster's law, Polarization by refraction, Double refraction, uniaxial and biaxial crystals, positive and negative crystals, Nichol's Prism, Circularly and Elliptically polarized light - Theory and analysis, Polaroid, Retardation plates - Quarter wave plate and Half wave plate, Optical activity, specific rotation, simple polarimeter, Laurent's half shade polarimeter.

9. MODERN PHYSICS

Motion of charged particles in electric and magnetic fields

Lorentz force , Motion in a uniform electric field, magnetic field, parallel and crossed fields.

Electric discharge through gases, Determination of e/m for cathode rays, Charge and mass of an electron, Atomic masses, Energy and mass units.

Particle Accelerators

Linear accelerator and Cyclotron.

Atomic Physics

Measurement of Mass: Thomson's positive ray analysis, Dempster's Mass spectrometer, Bainbridge Mass spectrograph. Review of Bohr's Hydrogen atom, Correction due to finite nuclear mass. Frank-Hertz experiment and atomic energy levels.

Properties of electromagnetic radiation

Black Body Radiation, Kirchoff's radiation law, Stefan's law, Wien' law, Raleigh - Jean's law, Planck's law. Photoelectric effect and Compton Effect – observation, description, derivations of relevant equations and failure of classical physics to explain the same. Experimental verification of the Photoelectric and Compton effects.

Crystal Structure

Crystal lattice,crystal planes and Miller indices, unit cells, typical crystal structures.

X-rays

Coolidge tube generator, Continuous X-ray spectra and its dependence on voltage, Duane and Hunt's law, Wave nature of X-rays – Laue's pattern, Diffraction of X-rays by crystal, Bragg's law, Bragg single crystal spectrometer, Analysis of crystal structure - simple cubic crystal.