गोंय विद्यापीठ
ताळगांव पठार,
गोंय - ४०३ २०६
फोन : + ९१ - ८६६९६०९०४८

Goa University
Taleigao Plateau,Goa - 403 206
Tel : +91-8669609048
Email : registrar@unigoa.ac.in
Website : www.unigoa.ac.in

(Accredited by NAAC with Grade A+)

GU/Acad –PG/BoS - GU-ART /2025-26/612 Date: 05.12.2025

CIRCULAR

The syllabus for the Goa University–Admission Ranking Test (GU-ART) of **Master of Science in Physics** and **B.Ed. in Physics** Programmes, approved by the Academic Council in its meeting held on 7th November 2025 is attached.

The Dean/Vice-Dean (Academic) of the School of Physical and Applied Sciences and the Principals of all the affiliated Colleges are requested to take note of the above and bring the contents of this Circular to the notice of all concerned, including students aspiring to pursue the Master's and B.Ed. Programmes.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2025.12.05 11:08:37 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,
1. The Dean, School of Physical and Applied Sciences, Goa University.
2. The Vice-Dean (Academic), School of Physical and Applied Sciences, Goa University.
3. Principals of all the affiliated Colleges.

Copy to:
1. Controller of Examinations, Goa University.
2. Assistant Registrar (Admissions), Goa University.
3. Assistant Registrar Examinations (UG/PG), Goa University.
4. Director, Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

GOA UNIVERSITY

SYLLABUS FOR GOA UNIVERSITY-ADMISSIONS RANKING TEST (GU-ART) FOR MASTER'S & B.Ed. IN PHYSICS PROGRAMMES

Effective from AY: 2026-2027

Modules	Content
Module 1:	**FOUNDATIONS OF PHYSICS** **Mechanics:** Standards and units, vectors: vector addition, vector subtraction, components of vector. Force, discussion of Newton's First law of motion, Newton's second law, mass and weight, Motion with constant acceleration, freely falling body, Frictional force: frictional force acting on a block moving on the flat surface and inclined surface, Newton's third law of motion, Newton's law of Gravitation. Work and energy: work, work done by varying force, work and kinetic energy, gravitational potential energy, conservative and dissipative forces, impulse and momentum, Conservation of momentum. Collisions, moment or torque of force. Rotation: Angular velocity, angular acceleration, moment of inertia, angular momentum, conservation of angular momentum. **Properties of Matter:** Elasticity: stress, strain, elasticity and plasticity, elastic modulus, the force constant. Surface tension: Surface tension, surface energy, pressure difference across a surface film, contact angle and capillarity. Viscosity: Equation of Continuity, Bernoulli's equation, Viscosity, Poiseuille's law, Stokes law, Reynolds number. **Heat:** Concept of temperature, thermometers, defining of a temperature scale, The Celsius, Rankine and Fahrenheit scales, Thermal expansion, thermal stresses, heat transfer, Quantity of heat, heat capacity, experimental values of heat capacities, change of phase, conduction, convection, radiation, Stefan's Boltzmann law **Light:** The nature of light, Sources of light, speed of light, electromagnetic spectrum, waves, wavefronts and rays, reflection and refraction, total internal reflection, Huygens' principle, dispersion. Interference and coherent sources, interference fringe, Young's double slit experiment, interference in thin films Newton's rings, Diffraction: Fresnel diffraction, Fraunhofer diffraction by single slit, the plane diffraction grating. resolving

Approved by: Academic Council on 7th November 2025

	power of an optical instrument. Polarisation-Malus law, polarisers, Brewster's law, double refraction, optical activity **Sound and Acoustics**: Noises and Musical sounds, Loudness, how loudness is measured, Decibel, intensity of a sound. Acoustics- acoustic powers of different sources of sound, pitch, quality of sound, architectural acoustics, reverberation, acoustical demands on an auditorium, reverberation time and absorption coefficient. Sabine's law. **Electrostatics and Magnetism:** Electric charge, Coulomb's law, conductors and insulators, electric field, electric field lines, Gauss's law, Electric field potential, current, resistance, electromotive force. magnetic field, magnetic field lines, magnetic dipoles, Electromagnetic induction, Faradays' law, Lenz's' law. **Modern physics:** Dual nature of light, de Broglie waves, uncertainty principle. Bohr atom, Bohr's postulates. Semiconductors: Intrinsic semiconductors, doping a semiconductor, p- type and n- type semiconductor, unbiased diode, depletion layer, Forward bias, and reverse bias.
Module 2:	**PROPERTIES OF MATTER AND SOUND** **Elasticity** Hook's law, Stress Strain diagram, Elastic behaviours of solids in general (Elastic after effect, Elastic hysteresis, Elastic fatigue), working stress and factor of safety, factors affecting elasticity (effect of hammering, rolling and annealing, effect of impurities, effect of change of temperature) Moduli of Elasticity, Equivalence of shear to compression and extension at right angles, Deformation of cube (Bulk modulus, modulus of rigidity, Young's modulus) Relation connecting elastic constants, Poisson's ratio and its relation with bulk modulus and modulus of rigidity, limiting values of Poisson's ratio. Twisting couple on a cylinder, Beams, Bending of beams, flexural rigidity. Cantilever (rectangular bar), depression in a beam supported at ends and loaded in the middle. **Fluid Flow** Streamline flow, turbulent flow, Equation of continuity of flow, energy of a liquid in flow, Bernoulli's theorem, Bernoulli's equation, applications of Bernoulli's theorem: Torricelli's theorem and Venturimeter, Viscosity, coefficient of viscosity, Critical velocity, Reynold's number and its significance, Poiseuille's equation for flow of a liquid through a horizontal tube and its corrections, fluid flow, Stokes law, Ostwald viscometer, viscosity of gases: Mayer's formula. **Sound: Simple Harmonic Motion** Simple harmonic motion, differential equation for simple harmonic motion and its solution, relation of velocity and acceleration to displacement, superposition of SHM in a straight line: Two SH vibrations of equal periods but different amplitudes, any number of SH vibrations of same period but different amplitudes. Lissajous figures (concept only). Beats, applications of beats, distinction between stationary interference and beats. **Wave motion**

	Transverse and longitudinal waves, mechanical analogy of longitudinal waves, progressive wave and its general equation, particle velocity and acceleration, relation between wave velocity and particle velocity, differential equation of wave motion, energy of a plane progressive wave. **Velocity of sound waves** Velocity of longitudinal waves in fluids, Newton's formula for velocity of sound in air, Laplace's correction, effect of pressure, density and temperature, Velocity of longitudinal wave in a rod. Kundt's tube experiment to find velocity of sound in a gas or a solid rod. Doppler's effect: Source in motion and listener and medium at rest, Listener in motion and source and medium at rest, Source and listener both in motion and medium at rest. Effect of wind on the pitch of sound Indirect approach of source and listener.
Module 3:	**ELECTRICITY AND MAGNETISM** **Circuit Analysis** Steady current, concept of constant current source and constant voltage source, Maxwell's cyclic current method for circuit analysis, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem. **Inductance** Self-inductance, Self-inductance of two parallel wires carrying equal current in opposite directions, Self-inductance of co-axial cables, Mutual inductance, Coefficient of coupling. **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 LCR circuit. **A.C. circuits** A.C. applied to L-R and C-R circuits, Inductive and Capacitive reactance, Impedance and Admittance, the j operator, AC applied to L-C-R circuits, Series and Parallel resonance. AC applied to mutually coupled L-R circuits, Transformers. **Force on a Moving Charge** Magnetic induction B and magnetic intensity H, Lorentz force law, Work done by a magnetic field on a moving charge, Force on a moving charge, Magnetic flux. **Force on conductor carrying current** Force on a conductor carrying current in uniform magnetic field, rectangular current loop in external magnetic field, Dead beat galvanometer, Theory of Ballistic galvanometer. **Torque on current loop** Torque on a current loop, Magnetic moment of a current loop, Equivalence of current coil to a bar magnet, Magnetic moment of atomic dipole, Angular momentum and gyromagnetic ratio.
Module 4:	**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. **Transistor Biasing and 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. Bias stability, Stability factor, Different methods of biasing, biasing compensation. **Oscillators** 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.
Module 5:	**OPTICS and MODERN PHYSICS** **Interference** Introduction: Interference by division of wavefront & division of amplitude, Fresnel's biprism and Lloyd's mirror, formation of colours in thin films – reflected system, transmitted system, wedge shaped film, Newton's rings. **Diffraction** Concept of diffraction, Fresnel & Fraunhoffer diffraction, division of cylindrical wavefront 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- Raleigh'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. **Properties of electromagnetic radiation** Black body radiation, Kirchoff's radiation law, Stefan's law, Wein's 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. **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. **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.
Module 6:	**CLASSICAL MECHANICS** **Motion of a Particle in One and in Two dimensions** Dependence of force in general on position, velocity and time. The equation of motion of particle along straight line. Motion under a constant force with illustrations - Atwood's machine, free fall near the surface of the earth, Motion along a rough inclined plane, motion under a force which depends on time. Motion under a force which depends on time-general approach to the solution. Illustration using force of the type $F = F\sin(\omega t + \varphi)$. Motion of a particle subjected to a resistive force: Resistive force proportional to first power of velocity, Motion of a particle falling under gravity near the surface of the earth. **Projectile Motion** Momentum and energy theorem, projectile motion in non-resistive and resistive medium (force proportional to first power of velocity, no derivation). **Motion under a central force** Central Force, motion in terms of eccentricity (nature of orbits), equivalent one body problem, General features of motion in an arbitrary potential field. Motion in an inverse –square law force field. Equation of the orbit. Kepler's Laws of planetary motion, elliptical orbits. **Moving coordinate system** Inertial and non- inertial coordinate frames, rotating coordinate systems, laws of motion on the rotating earth, Coriolis force, Foucault's pendulum (no derivation), and Larmor's theorem.

	Rigid bodies Translation and Rotational motion of a rigid body, Compound pendulum, Location of center of mass relative to the two different origins, theorems to locate the center of mass, Parallel axis and Perpendicular axis theorems. Rotation of a rigid body about an axis, Expression for angular momentum of a rigid body, moment of inertia tensor, Euler's equations of motion of a rigid body, Euler's equation for torque free motion.
Module 7:	**MATHEMATICAL METHODS** **Matrices & Determinants** Definition and Notations, Addition and Multiplication of Matrices, Properties of Matrix addition and Matrix multiplication, Partition of a Matrix, Rank of a Matrix. Properties of Determinants and Applications. **Limits, Continuity, and differentiation** Algebra of limits, Limits of the trigonometric and exponential function, concept of continuity, left and right-hand limits. Differentiation of first principle, Derivative of polynomials, trigonometric, exponential & logarithmic functions, Rules of differentiation. **Integration** Integration as inverse process of differentiation, Integration of a variety of functions by substitution, by partial function & by parts. Standard integrals: - Algebraic, trigonometric, exponential and logarithmic. **Vector Analysis** Addition and Subtraction of Vectors, Multiplication by scalar, Resolution of Vectors, Magnitude of vector, dot & cross product of vectors and their physical interpretation. Directional derivatives, gradient, del operator, Divergence and Curl, Laplacian operator, Integration of a vector function: - line, surface, & volume integral. Gauss divergence theorem (no proof), Stokes theorem (no proof), Differential vector identity. Expression for Laplacian operator in Cartesian, spherical and cylindrical coordinate. **Differential Equations** Definition of Partial derivative, Total differential chain rule, first order & second order partial differential equations.
Module 8:	**HEAT AND THERMODYNAMICS** **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 (qualitative), Determination of Avogadro's number. Mean free path and derivation to calculate MFP, Transport phenomena, transport of momentum (viscosity). **Behaviour of real gases** Deviation from perfect gas behaviour, 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 and Third 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. 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 **Power cycles** Internal Combustion Engines – The Otto cycle and its efficiency, Diesel cycle and its efficiency. **Production of low temperature.** Cooling by evaporation. Vapour compression machines. Refrigerators based on Vapour absorption. Cooling by sudden adiabatic expansion of compressed gases. Efficiency and performance of refrigerating machines. Enthalpy and heat flow. Joule Kelvin effect. Expression for Joule Kelvin coefficient and inversion temperature. Application to Van der Waals' gas. Principles of regenerative and cascade cooling. Liquifaction of hydrogen and helium. Production of temperatures below 4o K. Properties of He I and He II.
Module 9:	**ENERGY PHYSICS** **Energy** Energy, efficiency and entropy, entropy and environment, mechanical work- force and energy, energy power and units, kinetic and potential energy, electrical energy, electrical power and transmission, power station capacity, electric motors and generators. **Conventional and non-conventional -energy sources** Conventional energy sources fossil fuel, hydro -electric, thermal, Nuclear, advantages, disadvantages. Non-conventional Bio-mass, geo-thermal, solar, wind energy, ocean energy, wave energy, advantages and disadvantages. **Solar Energy**

	Sun as source of energy, Solar spectrum, sun earth radiation, extraterrestrial and terrestrial radiation spectral energy distribution of radiation, depletion of solar radiation, pyranometer, sunshine recorder, solar radiation data, solar time. **Wind Energy** Origin of wind, nature of winds, variation of wind speed with time, wind turbine siting, Types of turbines and their aerodynamics, wind energy conversion system., wind energy storage. **Biomass Energy** Bio-gas as a source of energy. Benefits of bio-gas. Technology of biogas. Biogas production from waste biomass, Classification of biogas plant, operational parameters of biogas plant. **Geothermal Energy** Geothermal energy, origin and distribution of geothermal energy, types of geothermal resources. analysis of geothermal resources. **Ocean energy** Tidal energy, limitations of tidal energy wave energy, ocean thermal energy. **Energy storage** Flywheel storage, compressed air storage, Battery storage, electrostatic energy storage, thermal energy storage.
Module 10:	**COMMUNICATION PHYSICS** **Electronic communication:** Introduction to communication systems. Need for modulation and frequency allocation for radio communication system. Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio. **Analog Modulation:** Amplitude Modulation, modulation index and frequency spectrum, Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector), Super heterodyne receiver. **Analog Pulse Modulation** Channel capacity, Sampling theorem, Basic Principles of PAM, PWM, PPM modulation and detection technique for PAM only, Multiplexing. **Transmission Lines and Antenna system** Introduction, Transmission line, Constants, Characteristic impedance, Propagation constant, Standing waves & SWR. Principles of radiation, Isotropic radiator, Hertzian dipole, Antenna gain, Directivity, Radiation resistance, Wave guides, RADAR. **Fibre Optics** Optical fibres and their properties, Principal of light propagation through a fibre, refractive index profile, The numerical aperture, Attenuation in

	optical fibre and attenuation limit, Single mode and multimode fibres. Fibre Optic communication- basic principle, Transmission characteristics of optical fibre, attenuation, absorption and scattering losses, nonlinear losses, wavelengths for communication, bend losses, dispersion effects in optical fibres. **Digital Communication:** Need for digital transmission, Pulse Code Modulation, Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), and Binary Phase Shift Keying (BPSK). **Satellite Communication** Introduction, Geosynchronous satellite orbits, geostationary satellite, advantages of geostationary satellites. Satellite visibility, ground station, Overview of Indian satellite missions. **Cellular Communication** Concept of cellular mobile communication – cell and cell splitting, frequency bands used in cellular communication, authentication of the SIM card of the subscribers, IMEI number, GSM and CDMA technology- an overview, simplified block diagram of cellular phone handset, 2G, 3G,4G and 5G concepts.
Module 11:	**ENVIRONMENTAL PHYSICS** **Fundamentals of environmental physics** Basic concept of light and matter, spectroscopic concepts, introduction to the concept of absorption and emission spectrum and transmission of light, Beer-Lambert law; Scattering of light, basic concepts of force (action and reaction, friction and air resistance), Gravity: Newtonian gravity and universal gravity, terminal and settling velocity, central forces, Coriolis force, Electric and magnetic field and their forces, earth's magnetic field, electromagnetism in animals and plants. **Heat Transfer and Energy** Concept of heat, Basic laws of thermodynamics; concept of enthalpy, entropy. Heat transfer- conduction, convection and radiation, Steady state of heat balance of water surfaces, soil and vegetation, steady state heat balance of animals. heat transmission, heat balance in animals and plants, transmission, absorption and reflection of radiation, biological effects of non-ionising radiation, Energy efficiency, Electrical energy, renewable energy, renewable resources – hydro-electric power, wind power, tidal power, wind power, solar power. Energy storage, energy use in transport, energy use in biosphere, biological energy sources. **Basic atmospheric physics** Atmosphere, General circulation of the atmosphere, Weather disturbances (clouds, tropical cyclones, ocean currents, ozone layer) radiative balance, concept of albedo, solar constant and greenhouse effect, greenhouse gases & greenhouse warming potentials and its impact on climate. **Radiation environment:** Solar radiation, spectrum of solar radiation, attenuation of solar radiation in the atmosphere, radiative properties of natural materials (water, soil,

	metals and animals), radiation interception by solid structures, plant canopies and animal coats.
References/ Readings:	1. K. F. Riley, M. P. Hobson and S. J. Bence, Mathematical methods for Physics and Engineering, Cambridge University Press (2006). 2. K. R. Symon, Mechanics, Addison Wesley (1962). 3. R. G. Takawale and P. S. Puranik, Introduction to Classical Mechanics, Tata McGraw-Hill (1997). 4. D. N. Vasudeva, Fundamentals of Electricity and Magnetism, S. Chand and Company Ltd. New Delhi (2012). 5. Brijlal and Subramaniam, Electicity and Magnetism, Ratan Prakashan, New Delhi (1966). 6. M.W. Zemansky and R.H. Ditman Heat and Thermodynamics, McGraw Hill (1997). 7. BrijLal, N. Subrahmanyam and P. S. Hemne Heat, Thermodynamics and Statistical Physics, S. Chand and Company (2008). 8. D. S. Mathur, Elements of Properties of Matter, S. Chand and Sons, (2013). 9. A.P.Malvino, Electronic Principles –TMH 5th edition (1996). 10. Allen Mottershed, Electronics Devices and Circuits an Introduction-3rd edition PHI (1997). 11. N Subrahmayam and N.Brijlal, Text Book of Optics, S. Chand & Company Ltd,(1991). 12. Ajoy Ghatak, Optics, Tata McGraw-Hill Publicashing Company Limited. (1977). 13. Arthur Beiser, Concepts of Modern Physics, 5th Edition, McGraw Hill (1985). 14. J. R. Reitz, F. J.Milford and R. W. Christy, Foundations of Electromagnetic Theory, 4th Edition, Pearson/Addision- Wesley Publishing Company. (2009). 15. A. Ghatak and S. Lokanathan, Quantum Mechanics, Theory and Applications, Mc Millan (2004). 16. Kerson Huang, Statistical Mechanics, 2/e, Wiley India 2008.