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(Accredited by NAAC with Grade A+)

GU/Acad –PG/BoS- CDT /2025-26/613 Date: 05.12.2025

CIRCULAR

The syllabus of the Change of Discipline Test (CDT) for **Master of Science in Physics** Programme, 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 Programmes.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2025.12.05 11:38:35 +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 CHANGE OF DISCIPLINE TEST (CDT) FOR MASTER OF SCIENCE IN PHYSICS PROGRAMME

Effective from AY: 2026-27

Modules	Content
Module 1:	**Mechanics**
	Newtonian Mechanics: Application of Newton's laws in one and two dimensions. The equation of motion and energy conservation theorems. Work and kinetic energy. Momentum, impulse, and collision. Motion under a conservative force. Motion under damping force. Body falling under gravity. Rotation of rigid bodies, Dynamics of rotational motion. Kepler's laws of planetary motion, Waves and oscillations.
Module 2:	**Properties of matter**
	Elasticity: Classification, stress and strain, Hooke's Law, elastic behavior of materials, factors affecting elasticity, classification of elastic moduli, Poisson's ratio, Bending of beam and cantilever. **Viscosity:** Coefficient of viscosity, streamline and turbulent motion, Raynold's number, Poiseuille's equation for the flow of a liquid through a tube, Bernoulli's equations **Surface Tension:** Brief review of molecular theory of surface tension. Relation between surface tension andsurface energy. Pressure difference across curved surfaces. Angle of contact. Capillarity, experimental determination of surface tension and angle of contact.
Module 3:	**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, 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 CO_2 and Amagat's experiment, critical constants, Van der Waal‟s equation of state, expression of Van der Waal's constants, Reduced equation of state, Law of corresponding state,

Approved by: Academic Council on 7th November 2025

	relation between Boyle temperature and critical temperature, critical coefficient. **Laws of Thermodynamics** **Basic concepts of thermodynamics:** Thermodynamic system, Thermodynamic variables, Thermodynamic equilibrium, and Thermodynamic processes, **Zeroth law of thermodynamics:** 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, 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.
Module 4:	**Optics** **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.
Module 5:	**Electromagnetism** **Electrostatics:** Coulomb's Law, Electric Field and electrostatic potential, Continuous Charge distribution, field lines, flux and Gauss‟ law with applications, the electric dipole- field and potential.

	Techniques to solve electrostatic problems: The electrostatic potential, Poisson's equation, Laplace's equation in one independent variable, solutions to Laplace's equation in spherical co-ordinates (zonal harmonics), conducting sphere in a uniform electric field, method of electrostatic images, point charge in front of grounded conducting plane. **Electric Fields in matter:** Polarization, Fields outside a dielectric medium, electric field inside a dielectric, Gauss's law in a dielectric, the electric displacement vector, electric susceptibility and dielectric constant. Boundary conditions on the field vectors, Dielectric sphere in a uniform electric field. **Steady currents and their magnetic fields:** Steady currents, current density, Biot-savart's law and its applications, Ampere's circuital law, magnetic vector potential, magnetic field of a distant circuit, magnetic dipoles, dipole moment and the field of a point magnetic dipole, magnetic scalar potential. **Magnetic Field in material media:** Magnetization, magnetic field produced by magnetized material, magnetic pole density, sources of the magnetic field, magnetic intensity H (Auxiliary magnetic field), The field equations, magnetic susceptibility and permeability, Hysteresis, Boundary conditions on B and H vectors, current circuits containing magnetic media, Magnetic circuits, Magnetic circuits containing permanent magnets **Maxwell's Equations**: Faraday's Law of electromagnetic induction, Generalization of Ampere's Law- Displacement current, Maxwell's equations and their empirical basis, Electromagnetic energy-Poyntings theorem.
Module 6:	**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. **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. Many electron atoms, Hund's rule, Spin orbit interaction, L-S and J-J coupling, Stern-Gerlach experiment, Larmour precession, Zeeman Effect **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.
Module 7:	**Basic 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 **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.
Module 8:	**Introduction to quantum mechanics** **Waves and particles:** De Broglie's hypothesis, Review of the Bohr's postulate about stationary states in the light of De Broglie's hypothesis, The concept of quantum (particle) nature of radiation. Demonstration of wave nature of particles-Davisson Germer experiment, electron diffraction experiment of G.P.Thomson, Dual nature of radiation/matter. Complimentary in Duality. **The Wave Function**: Representation of a De Broglie wave, Velocity of De Broglie wave, Construction of a wave group, Wave packet and its motion in one dimension., Group velocity and particle velocity, Max Born's interpretation of the wave function, probability concept, Acceptable wave function, Normalization of wave function. **Heisenberg's Uncertainty Principle:** Limitation of wave mechanics to predict the physical state of a particle/system accurately. Heisenberg Uncertainty principle. Illustration by thought experiments (γ - ray microscope, single slit diffraction and double slit experiment), Applications of Heisenberg Uncertainty principle. **Schroedinger's Wave Equation:** Wave equation for De Broglie waves and Schroedinger's time dependent wave equation, Concept of stationary states. Schroedinger's time independent equation. Postulates of Quantum mechanics, Definition of operators & their necessity, Expectation values, Extraction of information from solutions in terms of expectation values of

	physical variables/observable. Eigen value equation, Commutation relations. **Applications of Schrödinger's Time Independent Wave Equation:** Free particle, Infinite square well potential: Energy eigen functions and eigen values, One dimensional finite square step potential of height Vo: Comparison of classical and quantum mechanical results for particle energy E>Vo and E and, and. Particle in a three-dimensional box, Concept of degeneracy.
Module 9:	**Basic Mathematics** **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).
References/ Readings:	**1. Mechanics** 1. R. G. Takawale and P. S. Puranik, Introduction to Classical Mechanics, Tata McGraw-Hill (1997). 2. Hugh D. Young, R. A. Freedman, University Physics, Pearson, 14th edition. **2. Properties of matter** 1. Elements of Properties of Matter, by D. S. Mathur, S. Chand and Sons, (2013). 2. Hugh D. Young, R. A. Freedman, University Physics, Pearson, 14th edition. **3. Heat and thermodynamics** 1. Heat, Thermodynamics and Statistical Physics, BrijLal, N. Subrahmanyam and P. S. Hemne, S. Chand. PYC 2. Treatise on heat, M. N. Saha and B. N. Shrivastava, The Indian Press (1965) 3. Hugh D. Young, R. A. Freedman, University Physics, Pearson, 14th edition. **4. Optics** 1. N Subrahmayam and N.Brijlal, Text Book of Optics, S. Chand & Company Ltd,(1991).

	2. Ajoy Ghatak, Optics, Tata McGraw-Hill Publicashing Company Limited. (1977). 3. A. Ghatak and S. Tyagrajan, Contemporary Optics, Mc Millan (2003) **5. Electromagnetism** 1. Reitz and Milford, Foundations of Electromagnetic Theory, Addision- Wesley Publishing Company (2008). 2. David Griffiths, Introduction to Electrodynamics, Prentice Hall of India Ltd, New Delhi (1995) **6. Modern Physics** 1. Arthur Beiser, Concepts of Modern Physics, 5th Edition, McGraw Hill (1985). 2. H. E. White, Introduction to Atomic Spectra, McGraw Hill (Latest edition) **7. Basic Electronics** 1. A.P.Malvino, Electronic Principles –TMH 5th edition (1996). 2. Ramakant Gayakwad, Op-amp and Linear Intergrated Circuits, PHI (2002). **8. Introduction to quantum mechanics** 1. Ghatak and Lokanathan, Quantum Mechanics, Theory and Applications, Mc Millan (2004). 2. P.S. Bangui & others, New Course in Physics, Sheth Publishers 3. Arthur Beiser, Concepts of Modern Physics, 5th Edition, McGraw Hill (1995). **9. Basic Mathematics** 1. K. F. Riley, M. P. Hobson and S. J. Bence, Mathematical methods for Physics and Engineering, Cambridge University Press (2006). 2. Schaum Differential and Integral Calculus (3E) by Frank Ayres, Elliott Mendelson