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(Accredited by NAAC with Grade A+)

GU/Acad –PG/BoS- CDT /2025-26/625 Date: 10.12.2025

CIRCULAR

The syllabus of the Change of Discipline Test (CDT) for **Master of Science in Mathematics** 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: 2025.12.10 17:26:37 +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 CHANGE OF DISCIPLINE TEST (CDT) FOR MASTER OF SCIENCE IN MATHEMATICS PROGRAMME

Effective from AY: 2026-2027

Modules	Content
Module 1:	**Foundations of Mathematics** **(i) Sets and Logic:** Statements, Compound statements; Implications; Proofs in Mathematics. Sets; subsets, Operations on sets, Power sets; Cartesian product of sets. Countability of sets, cardinality, Finite sets; Countable sets; infinite sets **(ii) Relations and Functions:** Relations on sets; Types of relations; Equivelence relations; Equivelence classes and partitions of sets. Functions, one-one, onto functions and bijections; Composition of functions; Inverse of a function **(iii) Induction Principles:** The induction Principle; The Strong Induction Principle; The Well-Ordering Principle; Equivalence of the three principles. **(iv) Order Relation:** Partial and total orders; Chains, bounds and maximal elements; Axiom of choice.
Module 2:	**Algebra** **(i) Group Theory:** Finite groups, subgroups; Cyclic groups, Permutation groups; Normal subgroups and factor groups; direct products of groups, group homomorphisms; First Isomorphism Theorem, Cayley's Theorem, Fundamental Theorem of Finite Abelian Groups. **(ii) Ring Theory:** Rings; Subrings; Integral domains, Fields; Charecteristic of a ring, Ideals and Factor rings; Prime ideals; maximal ideals; Ring homomorphisms; Field of quotients.

Approved by: Academic Council on 7th November 2025

	(iii)<u>Polynomial rings:</u> The Division Algorithm and consequences.
Module 3:	**Analysis** **(i) <u>Improper Integrals:</u>** Improper Integrals of type I, II and III; and their convergences, Comparison test; p – test, Beta and Gamma Functions **(ii) <u>Power series in $\mathbb{R}$:</u>** Radius and interval of convergence, Uniform convergence and absolute convergence, Term by term differentiation and integration of power series in $\mathbb{R}$, Power series definitions of Exponential, Logarithmic and trigonometric functions, Weierstrass' polynomial approximation theorem. **(iii)<u>Fourier series:</u>** Fourier series of real functions on $(-\pi, \pi)$ and $(0, \pi)$. Fourier coefficients; propertie Fourier series of a function relative to an orthonormal system. Bessel's inequality. Trigonometric series, Fourier series of odd and even functios. Integration and differentiation of Fourier series at a point. Fourier theorem. Riemann-Lebesgue Lemma. Parsevel's identity.
Module 4:	**Differential Equations** **(i) <u>First and Second order ordinary differential equations:</u>** with constant coefficients.Homogeneous and non homogeneous equations. Exact and non exact differential equations. Integrating factors. Second order differential equations with constant coefficients. Complementary function and particular solution. Linearly independent second solution. Method of variation of parameters. Equations with variable coefficients. Method of undetermined coefficients. **(ii) <u>Laplace Transforms:</u>** Laplace transforms, Inverse Laplace transforms, Convolution theorem, Application of Laplace transforms to solve differential equations. **(iii)<u>Numerical Methods of Solving Differential Equations:</u>** Picard's method, Euler's method, Modified Euler's method, Runge-Kutta method, Milne's method, Adams-Bashforth-Moulton method.
Module 5:	**Complex Analysis** **(i) <u>Complex Numbers:</u>** Algebraic properties, Complex conjugates, Polar form, Arguments, Roots of complex numbers, Regions in the complex plane.

	(ii) Analytic Functions: Functions of complex variable, Limits, Theorems on limits, Continuity, Derivatives, Differentiation formulas, Cauchy-Riemann equations, Sufficient condition for Differentiability, Polar coordinates, Analytic functions, Harmonic functions. **(iii) Elementary Functions:** Exponential function, Logarithmic function, Complex exponents, Trigonometric functions, Hyperbolic functions, Inverse trigonometric and hyperbolic functions. **(iv) Complex Integrals:** Definite integrals of functions, Contours, Contour integrals, Upper bounds for moduli of contour integrals, Antiderivatives, Cauchy-Goursat theorem, Simply and Multiply connected domains, Cauchy integral formulas, Liouville's theorem, Fundamental theorem of algebra, Maximum modulus principle. **(v) Series:** Convergence of sequences and series, Taylor series, Taylor's theorem, Laurent series, Laurent's theorem. **(vi) Residues and Poles:** Isolated singular points, Residues, Cauchy Residue theorem, Residue at infinity, The three types of Isolated singular points, Residues at poles, Zeros of analytic functions, Zeros and Poles.
Module 6:	**Metric spaces** **(i) Basics:** Open Balls and Closed Balls, Hausdorff Property, Interior Point and Interior and limit points, isolated points of a Set, Open Sets, Closed Sets, Derived Set , Closure of a Set and its ,Boundary Points, Distance between Sets, Diameter of a Set, Subspace of Metric Space, Boundedness in a Metric Space. **(ii) Sequences in metric Spaces:** Convergence, Cauchy Sequence, Complete Metric Spaces, Cantor's Intersection Theorem. **(iii) Continuity in metric spaces:** Equivalent definitions of continuity- $\varepsilon - \delta$ definition, sequential form, open sets form Contraction map and Fixed Points, Picard's Fixed-Point Theorem, Picard's Existence and Uniqueness Theorem for First Order Initial Value Problem. **(iv) Compactness in metric spaces:** Compact Metric Spaces and Compact Sets, Sequential Compactness, Bolzano – Weierstrass Property, Heine – Borel Theorem, Totally Boundedness, Equivalence of Compactness and Sequential

	Compactness, Lebesgue Covering Lemma, Compactness and Finite Intersection. Property, Continuous Functions and Compactness. **(v) <u>Connectedness in metric spaces:</u>** Separated Sets, Connected Metric Spaces and Connected Sets, Properties of Connected Metric Spaces and Connected Sets, Connected Subsets of IR, Connectedness and Continuous Functions, Intermediate value Theorem.
References/ Readings:	1. Gallian, J. A. (2012). Contemporary abstract algebra (8th ed.). Brooks/Cole, Cengage Learning. 2. Coddington, E. A. (1995). An introduction to ordinary differential equations. Prentice-Hall of India. 3. Deo, S. G., Raghavendra, V., & Lakshmikantham, V. (2015). A textbook of differential equations (TMH ed.). Tata McGraw-Hill. 4. Jain, M. K., Iyengar, S. R. K., & Jain, R. K. (2007). Numerical methods for scientific and engineering computation (5th ed.). New Age International Publishers. 5. Sharma, J. N. (2020). Mathematical Analysis-I.(Metric spaces). Krishna Prakashan Mandir. 6. Malik, S. C. (2012). Principles of mathematical analysis (4th ed). New Age International Publishers. 7. Bhatt, R. D. (2009). Mathematical analysis II. Narosa Publishing House. 8. Grewal, B. S. (2014). Higher engineering mathematics. Khanna Publishers. 9. Brown, J. W., & Churchill, R. V. (2014). Complex variables and applications , McGraw-Hill Higher Education. 10. Boyce, W. E. and DiPrima, R. C.: Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley Publications, 2009.