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(Accredited by NAAC with Grade A+)

GU/Acad –PG/BoS - GU-ART /2025-26/626 Date: 10.12.2025

CIRCULAR

The syllabus of the Goa University–Admission Ranking Test (GU-ART) for **Master of Science in Mathematics** and **B.Ed. in Mathematics** 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: 2025.12.10 17:29:30 +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 MATHEMATICS PROGRAMMES

Effective from AY: 2026-27

Modules	Content
Module 1:	**Foundational Mathematics:** Sets, Functions, Relations, Induction Principle, System of Linear Equations
Module 2:	**Elementary Mathematics:** Limits and Continuity, Types of discontinuities. Differentiability, Complex Numbers: Algebra of complex numbers; Vector Algebra: Addition of vectors; Gradient, divergence, and curl of a vector field.
Module 3:	**Analytical 2D Geometry**: Distance Formula; Section Ratio; Slope or Gradient; Locus; Area of Plane figures. Transformations and Invariants: Translation; Rotation; Invariants. Equations of lines, Perpendicular Distance of a Point from a Straight Line; Pair of Straight Lines. Conics and Circles.
Module 4:	**Enumerative Combinatorics:** Permutations and Combinations, Pigeon-hole principles, Mathematical induction, Binomial theorem, Multinomial theorem
Module 5:	**Graph Theory:** Graphs, Isomorphism, Decomposition, Paths, Cycles, and Trails: Bipartite Graphs, Eulerian Circuits , Vertex Degrees and Counting: Counting and Bijections, Extremal Problems, Graphic Sequences. Trees. Colouring of Graphs, Labelling, Planar and Euler's Formula
Module 6:	**Basic Number Theory:** The Division Algorithm, Greatest common divisor and Euclidean Algorithm, The Fundamental Theorem of Arithmetic, Congruences and Chinese Remainder Theorem, Fermat's Theorem and Wilson's Theorem. Euler's Phi Function, Diophantine Equations.
Module 7:	**Linear Algebra:** Vector space; Subspaces, Quotient space; Direct sums; Linear combinations; Span; Linear dependence and linear independence; Bases and Dimension; Linear transformation; Rank-Nullity theorem; Matrix representation of linear transformation; Eigen values and Eigen vectors; Characteristic polynomial; Eigen spaces and Diagonalizability; Inner product; Norm of a vector; Orthogonal and orthonormal vectors; Gram-Schmidt Orthogonalization Process.

Approved by: Academic Council on 7th November 2025

Module 8:	**Matrix Algebra :** Elementary operations on a matrix: Types of matrices, Rank of a Matrix and Echelon forms; Solutions of a system of linear equations using Rank method and their solution using Gauss Elimination, Gauss – Jacobi and Gauss – Siedel method; Characteristic Values of a Matrix; Caley – Hamilton Theorem; Diagonalisation of a matrix.
Module 9:	**Analysis:** Real Sequences; Convergence and Divergence; Cauchy sequences; Monotonic sequences; Sandwich Lemma; Series of Positive terms; Tests of Convergence of series; Alternating series, Absolute convergence; Conditional convergence;. Sequences of real valued functions, pointwise convergence ,Uniform convergence and consequences; Cauchy's criteria , Series of functions : Cauchy's condition for uniform Convergence of series; Comparison test; Weierstrass' M-test for Uniform convergence; Term by term integration and differentiation; Power series.
Module 10:	**Calculus of One Variable:** Real number system; Upper and Lower bounds of subsets of $\mathbb{R}$; Least Upper Bound Property and its Applications. Continuouity and uniform continuity of functions ; Intermediate value theorem; Extreme value theorem; Monotone functions, Differentiability and Mean value theorems. Rolle's theorem, Lagrange's Mean Value Theorem, Cauchy's Mean Value theorem, Darboux theorem.
Module 11:	**Ordinary Differential Equations:** Linear and Non-linear ODEs Classification and Solutions , Method of solving, The Existence and Uniqueness of solutions for initial value problem. Homogeneous Equations with Constant Coefficients. The Wronskian; Euler-Cauchy Equations; Solutions of homogeneous equations of second order; Nonhomogeneous Equations. General Theory of *n*th Order Linear Equations with Constant Coefficients**;** Homogeneous and Non-Homogeneous Equations**.** Inverse D – operators.
Module 12:	**Transformation Techniques:** Laplace and Z-Transforms, properties, Convolution theorems and applications to solve differential equations. Fourier Series; Bessel's inequality, Parseval's identity. Integration & differentiation of Fourier series at a point. Riemann – Lebesgue lemma. Infinite Fourier Transforms; Application of Fourier transforms to solve boundary value problems.
Module 13:	**Theory of Equations:** Polynomial equations, roots, Fundamental Theorem of Algebra, Relations between Roots and Coefficients, Symmetric functions of roots of polynomials. Quadratic , Cubic and Quartic Equations: Methods of solving. Graphs of polynomial equations and analysis.
Module 14:	**Elementary Statistics:** Measures of Central Tendencies: Mean, Median, Mode, Quartiles, Percentiles. Measures of Dispersion: Range, Quartile deviation, Standard deviation, Coefficient of variation. Correlation and Regression of bivariate data.

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Module 15:	**Probability Theory:** Random experiment; Sample space; Events; Probability of an event. Conditional probability and Baye's theorem. Random Variables and Distribution Functions, Probability mass function and probability density function; Conditional and marginal probability functions. Mathematical Expectation and Conditional expectations. Probability Distributions: Binomial distribution, Poisson distribution, Normal distribution.
References/ Readings:	1. E. Mendelson: Shaum's Outlines: Beginning Calculus, 3rd Edition, McGraw Hill Education, 2007. 2. S. C. Gupta: Fundamentals of Statistics, 7th Edition, Himalaya Publishing House, 2018. 3. A. Kumar, and S. Kumaresan: A Basic Course in Real Analysis, CRC Press, 2014. 4. Boyce, W. E. and DiPrima, R. C.: Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley Publications, 2009. 5. Iyengar, T. K. V., Krishna Gandhi, B., Ranganatham, S. and Prasad, M. V. S. S. N.: Mathematical Methods, S. Chand Publications, 2008. 6. S. Friedberg, A. Insel, L. Spence: Linear Algebra, 4th Edition 7. David M. Burton, Elementary Number Theory, Seventh Edition, Mc Graw Hill, 2017 8. Chatterjee, D. (2009). Analytical Geometry Two and Three Dimensions. Narosa Publishing House Pvt. Ltd., New Delhi. 9. H. Kishan: A Textbook of Matrices, Atlantic Publishers, 2008 10. Miklos Bona, A Walk Through Combinatorics – An Introduction to Enumeration and Graph Theory, World Scientific Publications, Fourth Edition 2017 11. M. D. Raisinghania: Advanced Differential Equations, 19th Edition, S. Chand Publications, 2018. 12. T. K. V. Iyengar, B. Krishna Gandhi, S. Ranganatham, and M. V. S. S. N. Prasad: Mathematical Methods, S. Chand & Company Ltd., 2008. 13. S. C. Gupta, and V. K. Kapoor: Fundamentals of Mathematical Statistics, 12th Edition, Sultan Chand & Sons, 2020. 14. Leonard Eugene Dickson, First Course in the Theory of Equations, John Wiley & Sons, Inc, 2009 15. Chartrand and Lesniak, Graphs and Digraphs, 6th edition, Chapman & Hall, 2015