SYLLABUS FOR THREE YEAR MULTIDISCIPLINARY UG PROGRAMME IN MATHEMATICS

Under National Education Policy (NEP)

Effective from 2023-2024

West Bengal State University
Barasat
Kolkata-700 126
West Bengal

Semester wise Course Structures

Semester	Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Marks	Credit
I	MINOR	MA-1	Algebra	4:1:0	100	5
II	MINOR	MA-2	Calculus	4:1:0	100	5

Detailed Syllabus

SEM-I

Course: MA-1

Algebra (Marks: 100, Credits: 5)

Unit -1 : Classical Algebra

De-Moivre's theorem for integer and rational indices and their applications, The n-th roots of unity. Definitions of exponential and trigonometrical functions of a complex variable, Logarithm of a complex number and its properties, Definitions of a^z, Inverse circular functions, hyperbolic functions.

Relation between roots and coefficients, Transformation of equation, Equation of squared differences of a cubic, reciprocal equations, Binomial equations and their properties, Descartes' rule of signs, Upper bounds for the real roots; Cardan's solution of the cubic and the nature of the roots of the cubic, Ferrari's methods of solution of biquadratic equations.

The inequality involving AM $\geq$ GM $\geq$ HM, Extreme values of sum and product, theorem of weighted means, Cauchy's inequalities, m-th power theorem.

Unit – 2 : Abstract Algebra

Equivalence relations and partitions, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set. Permutations, inversions, cycles and transpositions.

Definition and examples of groups, examples of abelian and nonabelian groups, the group Zn of integers under addition modulo n and the group U(n) of units under multiplication modulo n, groups of symmetries of an equilateral triangle, the permutation group S3, the general linear group GL(n, R), $n \leq 3$.

Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset, Cosets, Index of subgroup, Lagrange's theorem and its converse, order of an element, Normal subgroups: their definition, examples, and characterizations.

Definition and examples of rings, examples of commutative and non-commutative rings, Zn, the ring of integers modulo n, polynomial rings, Definitions of Subrings, Integral domains, skew-fields, fields and subfields, their examples and elementary properties.

Unit – 3 : Linear Algebra

Matrix of real and complex numbers, Algebra of matrices(structure only); symmetric and skew symmetric matrices, Hermitian and skew Hermitian matrices; Orthogonal and Unitary matrices. Determinants, Laplace expansions, cofactors, adjoint, inverse of a matrix, Cramer`s Rule.

Vector space, Linearly dependent and independent set, Basis, Dimension, Linear Transformation and their elementary properties and examples, Matrix representation of Linear Transformation. Rank of a matrix; Determination of rank (relevant results are to be stated only); System of linear equations in matrix form AX = B; Consistency and inconsistency (by rank method); Types and determination of solution (by using notion of rank), Solving linear systems using Gaussian elimination.

Eigenvalues, Eigenvectors, Eigenspace, Diagonalization of matrices, Characteristic polynomial of a matrix, Cayley-Hamilton theorem and its application for determining inverse of square matrix . Bilinear forms, real quadratic forms Sylvester`s law of inertia, positive definiteness.

Books Recommended :

- Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
- Dickson, Leonard Eugene (2009), First Course in the Theory of Equations, John Wiley & Sons, Inc. The Project Gutenberg eBook: http://www.gutenberg.org/ebooks/29785 3
- W.S. Burnstine and A.W. Panton, Theory of equations, Vol. 1. Fourteenth Edition, S. Chand and Co Ltd, New Delhi.
- S. Barnard and J.M. Child, Higher Algebra, Surjeet Pbl., New Delhi, 1990.
- Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
- Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., 1999.
- John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
- David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
- K.B. Dutta, Matrix and linear algebra.
- K. Hoffman, R. Kunze, Linear algebra.

SEM-II

Course: MA-2

Calculus (Marks: 100, Credits: 5)

Unit – 1 : Limits, Continuity and Differentiability

Limit of a function, ε - δ definition of a limit, Infinite limits, Continuity and types of discontinuities; Differentiability of a function, Relation between differentiability and continuity, Successive differentiation, Leibnitz theorem and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n \sin x, (ax+b)^n \cos x$; Partial differentiation, Euler's theorem on homogeneous functions and its converse.

Unit – 2 : Mean Value Theorems and its Applications

Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Geometrical interpretation of mean value theorems and applications to monotonic functions and inequalities; Taylor's theorem, Taylor's series, Maclaurin's series expansions of $e^x, \sin x, \cos x, \log(1+x), (1+x)^m$; Indeterminate forms.

Unit -3 : Integral Calculus

Integration of rational and irrational functions, Evaluation of definite integrals, Special integrals, Reduction formulae, derivations and illustrations of reduction formulae for the integration of $\sin^n x, \cos^n x, \tan^n x, \sec^n x, (\log x)^n, \sin^n x \cos^m x$ and their applications; Improper integrals, Beta and Gamma functions.

Unit – 4 : Applications

Tangent and Normal; Curvature; Asymptotes of general algebraic curves, Parallel asymptotes, Asymptotes parallel to axes; Envelopes; Maxima and Minima; Concavity and convexity, Points of inflexion; Tracing of Cartesian and polar curves; Length of plane curve and area bounded by plane curves, Volume and Surface area of solids of revolution.

Graphical Demonstration (Teaching Aid)

1. Plotting of graphs of function e^{ax+b}, log(ax + b), 1/(ax + b), sin(ax + b), cos (ax + b), |ax + b| and to illustrate the effect of a and b on the graph.
2. Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second

derivative graph and comparing them.

3. Sketching parametric curves.
4. Obtaining surface of revolution of curves.
5. Tracing of conics in Cartesian coordinates/polar coordinates.

Books Recommended :

- G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
- M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
- Gorakh Prasad, Differential Calculus (19th edition), Pothishala Pvt. Ltd., 2016.
- R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer- Verlag, New York, Inc., 1989.
- Gorakh Prasad, Integral Calculus, Pothishala Pvt. Ltd., Allahabad, 2015.
- Gabriel Klambauer, Aspects of Calculusm, Springer-Verlag, 1986.
- Howard Anton, I. Bivens & Stephan Davis, Calculus (10th edition), Wiley India, 2016.
- T. Apostol, Calculus, Volumes I and II.
- S. Goldberg, Calculus and Mathematical analysis.