National Educational Policy (NEP) 2020

MURSHIDABAD UNIVERSITY

DEPARTMENT OF MATHEMATICS

UNDERGRADUATE PROGRAMME
(MAJOR)

(Courses effective from Academic Year 2025-26)

SYLLABUS OF COURSES TO BE OFFERED

DEPARTMENT OF MATHEMATICS, MURSHIDABAD UNIVERSITY

DETAILS OF COURSE UNDER B. Sc. MAJOR in MATHEMATICS

Course Code	Course Title	Course wise Class (L+T+P)	Credit	Marks
SEMESTER-I				
UG-MAT-M-101	Classical Algebra and Ordinary Differential Equations-I	3:1:0	4	60+20=80
UG-MAT-SEC-101	Analytical Geometry	2:1:0	3	40+20=60
UG-MAT-Mi-101	Algebra & Analytical Geometry	3:1:0	4	60+20=80
UG-MAT-MDC-101	Basic Mathematics	2:1:0	3	45+15=60
SEMESTER-II				
UG-MAT-M-201	Modern Algebra, Matrix Theory& Real Analysis	3:1:0	4	60+20=80
UG-MAT-SEC-201	Application of Calculus	2:1:0	3	40+20=60
UG-MAT-Mi-201	Algebra & Analytical Geometry	3:1:0	4	60+20=80
UG-MAT-MDC-201	Basic Mathematics	2:1:0	3	45+15=60

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B.Sc. Mathematics (Major)
SEMESTER-I
Course Code: UG-MAT-M-101
Course title: Classical Algebra and Ordinary Differential Equations-I
Major Course; Credit-4; Full Marks-80
Course wise Class (L+T+P): 3:1:0

Classical Algebra

1. Complex numbers – definition and field structure, conjugate of a complex number, modulus of a complex number, triangle inequality, amplitude of a complex number, De Moivre's theorem, roots of a complex number, nth roots of unity, exponential and logarithm of a complex number, definition of a^z, a≠0.

2. Polynomials and polynomial equations, addition and multiplication of polynomials, statement of the division algorithm, remainder theorem, and factor theorem, fundamental theorem of classical algebra (statement only) and its consequences, polynomials with real co-efficient, Rolle's theorem (statement only) and its applications, multiple roots, Descartes rule of signs (statement only) and its consequences, Strum's function (emphasis on problems), relation between roots and coefficients, transformation of equation, reciprocal equation, binomial equation, special roots, Cardan's method for solving cubic equations, Ferrari's method for solving bi-quadratic equations.

3. Inequalities: A. M. $\geq$ G. M. $\geq$ H. M. and Cauchy's inequality – their simple and direct applications.

4. Integers, well ordering principle, principle of mathematical induction. Division algorithm ($a = bq + r$, $b \neq 0$, $0 \leq r < b$), greatest common divisor(g.c.d.) of two integers and its simple properties, co-prime integers, Euler's φ-function. Prime numbers, Euclid's theorem, fundamental theorem of arithmetic.

Ordinary Differential Equations-I

1. Significance of ordinary differential equations, geometrical and physical considerations, formation of differential equations by elimination of arbitrary constants, meaning of the solution of ordinary differential equations, concept of linear and non-linear differential equations.

2. Equations of first order and first degree: statement of existence and uniqueness theorem, separable, homogeneous, and exact equation, condition of exactness, integrating factor, rules of finding integrating factor, (statement of relevant results only).

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3. First-order linear equations: integrating factor (Statement of relevant results only), equations reducible to first-order linear equations (Bernoulli's Equation), method of variation of parameters.

4. Equations of first order but not of first degree. Clairaut's equation, singular solution.

5. Applications: geometric applications, ω-trajectories, orthogonal trajectories.

6. Higher order linear equations with constant coefficients: complementary function, particular integral, Wronskian – its properties and applications, method of undetermined coefficients, symbolic operator D, method of variation of parameters, exact equation, Euler's homogeneous equation, and reduction to an equation of constant coefficients.

REFERENCES:

1. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser.
2. W. S. Burnstine and A.W. Panton, Theory of Equations, Nabu Press.
3. I. N. Herstein, Topics in Algebra, Wiley Eastern Limited, India.
4. K. B. Dutta, Matrix and Linear Algebra, Prentice-Hall of India Pvt. Ltd.
5. S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India.
6. E.L. Ince, Ordinary Differential Equations, Dover Publications.
7. E. Rukmangadachari, Differential Equations, Pearson.
8. D. Murray, Introductory Course in Differential Equations, Longmans Green and Co.
9. G.F. Simmons, Differential Equations with Applications and Historical Notes, Tata Mcgraw Hill.
10. Belinda Barnes, Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab, 2nd Ed., Taylor and Francis group, London and New York.
11. C.H. Edwards, D.E. Penny, Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India.
12. Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press.
13. Differential Equations: A visual introduction for beginners, Dan Umbarger

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B.Sc. Mathematics (Major)
SEMESTER-I
Course Code: UG-MAT-SEC-101
Course title: Analytical Geometry
Skill Enhancement Course; Credit-3; Full Marks-60
Course wise Class (L+T+P): 2:1:0

Analytic Geometry (2D)

1. Transformations of rectangular Axes: Translation, Rotation, and their combinations. Theory of Invariants.

2. General Equations of Second Degree in two variables: Reduction to canonical form.

3. Pairs of straight lines: The Condition that the general equation of the second degree in two variables may represent two straight lines. The point of intersection of two intersecting straight lines. The angle between two lines given by $ax^2 + 2hxy + by^2 = 0$. Angle bisectors. Equation of two lines joining the origin to the points where a line meets a conic.

4. Circle, parabola, ellipse, and hyperbola: Equations of a pair of tangents from an external point, chord of contact, Poles, and Polars. Conjugate point and conjugate line.

5. Polar Equations: Polar equations of straight lines and circles. Polar equation of a conic refers to a focus as a pole. Equations of tangent, normal, and chord of contact.

Analytical Geometry (3D)

1. Plane; Straight lines.

2. Sphere: General Equation, Circle, Sphere through circle, Tangent, Normal.
3. Cone: General homogeneous second-degree equation, Enveloping cone, Section of cone by a plane, Tangent and normal, Condition for three perpendicular generators, Reciprocal cone, Right circular cone, Cylinder, Enveloping cylinder, Right circular Cylinder.

4. Conicoid: Ellipsoid, Hyperboloid, Paraboloid: Canonical equations only. Plane sections of it.

5. Transformation of coordinates, Reduction of general second-degree equations.

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REFERENCES:

1. P. R. Vittal, Analytical Geometry 2D and 3D, Pearson.
2. S. L. Loney, Co-ordinate Geometry, Arihant Publications.
3. R.M. Khan, Analytical Geometry of Two and Three Dimensions and Vector Analysis, New Central Book Agency, 2010.
4. E.H. Askwith, The Analytical Geometry of the Conic Sections, Adam and Charles Black
5. London, 1908.
6. S. Karmakar & S. Karmakar, Analytic Geometry: Two Dimensions, CRC Press (Taylor & Francis Group)/Levant Books (India), London, 2022.
7. Robert J. T. Bell, An Elementary Treatise On Coordinate Geometry, Macmillan and Company Limited. 8. B.K. Kar, Advanced Analytical Geometry and Vector Analysis, Books & Allied Pvt. Ltd., Kolkata, 2000.

B.Sc. Mathematics (Major)
SEMESTER-I
Course Code: UG-MAT-Mi-101
Course title: Algebra & Analytical Geometry
Minor Course; Credit-4; Full Marks-80
Course wise Class (L+T+P): 3:1:0

Algebra

1. Integers, well ordering principle, principle of mathematical induction. Division algorithm ($a = bq + r$, $b \neq 0$, $0 \leq r < b$), greatest common divisor(g.c.d.) of two integers and its simple properties, co-prime integers, Euler's φ-function. Prime numbers, Euclid's theorem, fundamental theorem of arithmetic.

2. Complex Numbers: De Moivre's Theorem and its applications. Exponential, Sine, Cosine and Logarithm of a complex number. Definition of $a^z (a \neq 0)$.

3. Polynomials with real coefficients, Fundamental Theorem of Algebra (Statement only): The n-th degree polynomial equation has exactly n roots. Nature of roots of an equation (surd or complex roots occur in pairs). Existence of real roots, Descarte's rule of sign and application of intermediate value theorem. Relation between roots and coefficients, symmetric functions of roots. Cardan's method of solution of a cubic equation.

4. Matrices with real and complex entries. Inverse of a matrix. Elementary row operations and row reduced Echelon matrix. Rank of a matrix. System of linear equation, consistency and inconsistency of system of linear equation, solution of system of linear equations. Symmetric, skew symmetric, Hermitian, Skew-Hermitian, Unitary and orthogonal matrices.

5. Determinant and its basic properties. Laplace expansion of determinant. Singular and non singular matrix, rank of a matrix in terms of determinants.

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Analytical Geometry

1. Transformations of Rectangular axes: Translation, Rotation and their combinations. Invariants.

2. General equation of second degree in x and y: Reduction to canonical forms. Classification of conic.

3. Pair of straight lines: Condition that the general equation of second degree in x and y may represent two straight lines. Point of intersection of two intersecting straight lines. Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$. Equation of bisectors. Equation of two lines joining the origin to the points in which a line meets a conic.

4. Equations of pair of tangents from an external point, chord of contact, poles and polers in case of General conic: Particular cases for Parabola, Ellipse, Circle, Hyperbola.
5. Polar equation of straight lines and circles. Polar equation of a conic referred to a focus as pole. Equation of chord joining two points. Equations of tangent and normal.

6. Three dimensional coordinate system. Straight line, direction cosine, problems on straight lines. Equation of plane and elementary properties. Sphere and its tangent plane. Right circular cone.

REFERENCES:

1. S. L. Loney, The Elements of Coordinate Geometry, Macmillan and Co., 1895.

2. S. Bernard and J.M. Child, Higher Algebra, Macmillan and Co., 1952.

3. T. Andreescu and D. Andrica, Complex Numbers from A to...Z, Birkhauser, 2006.

4. D.C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

5. K.B. Dutta, Matrix and Linear algebra, Prentice-Hall of India Pvt.Ltd., 2004.

6. W.S. Burnside and A.W. Panton, The Theory of equations, Dublin University Press, 1954.

7. R.J.T. Bell, An elementary treatise on coordinate geometry of three dimensions, Macmillan and Co.

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Contd…. **Signature of the HOD**

B.Sc. Mathematics (Major)
SEMESTER-I
Course Code: UG-MAT-MDC-101
Course title: Basic Mathematics
Multidisciplinary Course; Credit-3; Full Marks-60
Course wise Class (L+T+P): 2:1:0

Set Theory

1. Introduction to sets and their representations. The empty set, finite and infinite sets, equal sets, subsets, power set, and Universal set.
2. Venn Diagrams, operations on sets, complement of a set, problems on union and intersection of sets.

Complex Numbers

1. Polar representation of complex numbers.
2. De Moivre's theorem (without proof) for rational indices and their applications.

Matrix & Determinant

1. Definition of a Matrix. Types of Matrices.
2. Determinant of a square matrix (up to third order). Properties of determinants. Cofactors and minor of a determinant.

REFERENCES:

1. A. Kumar, S. Kumaresan, B.K. Sarma, A Foundation Course in Mathematics, Narosa Publishing House.
2. Bernard and Child: Higher Algebra, Arihant Publications.
3. I. Stewart, D. Tall, The Foundations of Mathematics. Oxford University Press.
4. M.K. Sen, S. Ghosh and P. Mukhopadhyay, Topics in Abstract Algebra, University Press.
5. K.B. Dutta, Matrix and Linear Algebra, Prentice-Hall of India Pvt. Ltd.
6. Shanti Narayan: A Textbook of Matrices, S Chand.

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Signature of the HOD

B.Sc. Mathematics (Major)
SEMESTER-II
Course Code: UG-MAT-M-201
Course title: Modern Algebra, Matrix Theory & Real Analysis
Major Course; Credit-4; Full Marks-80
Course wise Class (L+T+P): 3:1:0

Modern Algebra

1. Recapitulation**:**Sets, subsets, equality of sets, operations on sets – Union, Intersection, Complements, and Symmetric difference. Properties including De Morgan's laws.

2. Cartesian products, Binary relation from a set to a set (domain, range, Examples from R × R). Equivalence relation. Fundamental theorem on Equivalence relation. Partition, Relation of partial order. The congruence relation modulo n is an equivalence relation—congruence classes.

3. Mapping**:** different types of mappings, the composition of mapping, restriction, and extension of mapping.

Matrix Theory

1. Matrices of Real and Complex Numbers: Definition, examples, equality, addition, multiplication of matrices, Transpose of a matrix, Symmetric and Skew-symmetric matrices.

2. Determinants:Definition of a determinant of a square matrix, Basic properties, Minors and Cofactors, equations by Cramer's rule. Problems of determinants up to order 3.

3. Rank of a Matrix:Adjoint of a square matrix. Singular, non-singular, and invertible matrices. Elementary operations. Rank of a matrix and its determination. Normal forms: Elementary matrices; The normal form equivalence of matrices. Congruence of Matrices. Diagonalisation of matrices. Real quadratic form involving three variables. Reduction to Normal form.

Real Analysis

1. Finite and infinite sets, countable and uncountable sets, cardinality of R, Q, and intervals.

2. Natural numbers, well ordering principle for N, mathematical induction – simple applications, rational numbers – examples, algebraic property, order property and density property of rational numbers, real Numbers – algebraic property and order property, point
3. set in one-dimension, bounded set, least upper bound axiom or completeness axiom, Archimedean property and density property of real numbers.

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4. Point set theory in one dimension**:** neighbourhood of a point, interior, accumulation points, and isolated points. Bolzano – Weierstrass theorem for accumulation point. Union, intersection, complement of open and closed sets in R, derived set, closure of a set, deduction of basic properties of the interior of a set, and closure of a set.

5. Sequence of real numbers**:** bounds, limits, convergence and non-convergence of a sequence, operations on limits. Sandwich rule. monotone sequences and their convergence, the theorem on nested intervals. Cauchy's general principle of convergence, Cauchy sequence. Cauchy's first and second limit theorems, subsequence, Bolzano–Weierstrass theorem for sequences, subsequential limits. upper limit and lower limit of a sequence, results on upper and lower limits.

6. Infinite Series of Real Numbers**:**Convergence, Cauchy's criterion of convergence.

   Series of non-negative real numbers**:** tests of convergence – comparison test, Cauchy's condensation test, ratio test.

   Statements and applications of: Cauchy root test, Abel–Pringsheim's test, Kummer's test, Raabe's test, Bertrand's test, logarithmic test, and Gauss's test.

   Series of arbitrary terms**:** absolute and conditional convergence.

   Alternating series**:** Leibniz test.

   Non-absolute convergence**:** Abel's and Dirichlet's test (statements and applications).

   Riemann's rearrangement theorem and rearrangement of absolutely convergent series.

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REFERENCES:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett, 2010.
3. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis,Prentice Hall, 2001.
4. S.K. Berberian, a First Course in Real Analysis, Springer Verlag, New York, 1994.
5. T. Apostol, Mathematical Analysis, Narosa Publishing House
6. Courant and John, Introduction to Calculus and Analysis, Vol I, Springer
7. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
8. C. C. Pugh, Real Mathematical Analysis, Springer, 2002.
9. Terence Tao, Analysis I, Hindustan Book Agency, 2006.
10. S. Goldberg, Calculus and mathematical analysis.
11. Horst R. Beyer, Calculus and Analysis, Wiley, 2010.
12. K.B. Dutta, Matrix and Linear Algebra, Prentice-Hall of India Pvt. Ltd.
13. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint.
14. K. Hoffman, R. Kunze, Linear Algebra, Pearson.
15. Modern Algebra, Arnab Chakraborty, Levant
16. Real Analysis, Arnab Chakraborty, Levant

B.Sc. Mathematics (Major)
SEMESTER-II
Course Code: UG-MAT-SEC-201
Course title: Application of Calculus
Skill Enhancement Course; Credit-3; Full Marks-60
Course wise Class (L+T+P):2:1:0

Application of Calculus

1. Differential Calculus: Higher order derivatives, Leibnitz rule of successive differentiation and its applications; Indeterminate forms, L'Hospital's rule; Basic ideas of Partial derivatives, Chain Rules, Jacobian, Euler's theorem and its converse; Tangents and Normals, Sub-tangent and sub-normals, Derivatives of arc lengths, Pedal equation of a curve; Curvature and radius of curvature; Asymptotes; Envelopes; Concavity, convexity and point of inflexion.

2. Integral Calculus: Reduction formulae; Rectification & quadrature of plane curves, length of a curve; Arc length as a parameter; Volume and surface area of revolution.

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3. Familiarity with common figures, including cycloid, catenary, lemniscate of Bernoulli, astroid, cardioid, folium of Descartes, equiangular spiral.

REFERENCES:

1. G. B. Thomas and R.L.Finney, Calculus, 9 thEd.,Pearson Education, Delhi, 2005.
2. M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus, 3 rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis, Calculus, 7thEd., John Wiley and Sons(Asia) P.Ltd.,Singapore,2002.
4. R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), SpringerVerlag, NewYork, Inc., 1989.
5. T. Apostol, Calculus, Volumes I and II.
6. S. Goldberg, Calculus and Mathematical Analysis.

B.Sc. Mathematics (Major)
SEMESTER-II
Course Code: UG-MAT-Mi-201
Course title: Algebra & Analytical Geometry
Minor Course; Credit-4; Full Marks-80
Course wise Class (L+T+P): 3:1:0

Algebra

1. Integers, well ordering principle, principle of mathematical induction. Division algorithm ($a = bq + r$, $b \neq 0$, $0 \leq r < b$), greatest common divisor(g.c.d.) of two integers and its simple properties, co-prime integers, Euler's φ-function. Prime numbers, Euclid's theorem, fundamental theorem of arithmetic.

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4. Matrices with real and complex entries. Inverse of a matrix. Elementary row operations and row reduced Echelon matrix. Rank of a matrix. System of linear equation, consistency and inconsistency of system of linear equation, solution of system of linear equations. Symmetric, skew symmetric, Hermitian, Skew-Hermitian, Unitary and orthogonal

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matrices.

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5. Determinant and its basic properties. Laplace expansion of determinant. Singular and non singular matrix, rank of a matrix in terms of determinants.

Analytical Geometry

1. Transformations of Rectangular axes: Translation, Rotation and their combinations. Invariants.

2. General equation of second degree in x and y: Reduction to canonical forms. Classification of conic.

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B.Sc. Mathematics (Major)
SEMESTER-II
Course Code: UG-MAT-MDC-201
Course title: Basic Mathematics
Multidisciplinary Course; Credit-3; Full Marks-60
Course wise Class (L+T+P): 2:1:0

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1. Introduction to sets and their representations. The empty set, finite and infinite sets, equal sets, subsets, power set, and Universal set.
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3. I. Stewart, D. Tall, The Foundations of Mathematics. Oxford University Press.
4. M.K. Sen, S. Ghosh and P. Mukhopadhyay, Topics in Abstract Algebra, University Press.
5. K.B. Dutta, Matrix and Linear Algebra, Prentice-Hall of India Pvt. Ltd.
6. Shanti Narayan: A Textbook of Matrices, S Chand.

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