National Curriculum and Credit Framework (NCCF)

Syllabus

for

3 YEARS DEGREE WITH MATHEMATICS/4 YEARS DEGREE WITH MATHEMATICS HONOURS/4 YEARS DEGREE WITH MATHEMATICS HONOURS WITH RESEARCH

w.e.f. Academic Session 2023-24

KaziNazrul University

Asansol, PaschimBardhaman

West Bengal-713340

SEMESTER-I

MAJOR COURSE-1

Course Name: Classical Algebra, Calculus and Analytical Geometry

Course Code: BSCMTMMJ101

Course Type: **MAJOR (Theoretical)**	Course Details: **MJC-1**			L-T-P: **4-1-0**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		……	**30**	……	**70**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

- Understand the importance of roots of real and complex polynomials and learn various methods of obtaining roots.
- Employ De Moivre's theorem in a number of applications to solve numerical problems.
- Understand various kinds of standard functions and graphs, techniques of integrations and limits.
- Understand theconcepts on two-dimensional and three-dimensional geometry.

Classical Algebra

Unit 1: Polar representation of complex numbers, n^{th} roots of unity, De Moivre's theorem for rational indices and its applications, complex functions and their applications.

Unit 2: Theory of equations: Relation between roots and coefficients, Transformation of equation, Descartes rule of signs, Cubic and biquadratic equations. Reciprocal equation, separation of the roots of equations, Strum's theorem.

Unit 3: Inequality: The inequality involving $AM \geq GM \geq HM$ and simple theorems, Cauchy-Schwartz inequality, Weierstrass inequality, Problems on maxima-minima.

(25 Classes)

Calculus

Unit 4: Hyperbolic functions, higher order derivatives, Successive differentiation, Leibnitz rule and its applications to problems of type $(ax+b)^n; e^{ax}\sin(bx+c); e^{ax}\cos(bx+c; \ loge(ax+b)$etc. L'Hospital's rule. concavity and inflection points, envelopes, asymptotes, Maxima and Minima, Curvature. (13 Classes)

Unit 5: Reduction formulae, derivations and illustrations of reduction formulae for the integration of $sin^n x, cos^n x, tan^n x, sec^n x, (logx)^n, sinnx.sinmx$, etc. parametric equations, parametrizing a curve, arc length, arc length of parametric curves, areas and volumes of surfaces of revolution. (12 Classes)

Analytical Geometry

Unit 6: Reflection properties of conics, translation, rotation and rigid motion of axes and second degree equations, classification of conics using the discriminant, Tangent, Normal, pole, polar, Diameter and conjugate diameters, Asymptotes. Polar equations of conics. (12 Classes)

Unit 7: Planes, Straight lines in 3D, Spheres. Cylindrical surfaces, Cone. Central conicoids, paraboloids, plane sections of conicoids, Generating lines, classification of quadrics, Tangent plane, Normal. (13 Classes)

References:

1. Titu Andreescu and DorinAndrica, Complex Numbers from A to Z, Birkhauser, 2006.
2. W. S. Burnstine and A.W. Panton, Theory of equations, 2007.
3. J. G. Chakravorty & P. R. Ghosh, Advanced Higher Algebra, U. N. Dhur& Sons Pvt. Ltd.
4. A. N. Das, Advanced Higher Algebra, Books & Allied (P) Ltd.
5. S. K. Mapa, Higher Algebra: Classical, Sarat Book House.
6. G. B. Thomas and R. L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
7. M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
8. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
9. T. Apostol, Calculus, Volumes I and II. Vol-I, 1966, Vol-II, 1968.
10. S. Goldberg, Calculus and Mathematical analysis, 1989.
11. R. K. Ghosh & K. C. Maity, An Introduction to Analysis: Differential Calculus: Part I, New Central Book Agency (P) Ltd. Kolkata (India).
12. D. Sengupta, Application of Calculus, Books and Allied (P) Ltd (1st edition, 2012).
13. S. Bandyopadhyay and S. K. Maity, Application of Calculus, Academic Publishers (2nd edition, 2011).
14. R. M. Khan, Analytical Geometry of Two and Three Dimensions and Vector Analysis, New Central Book Agency (2010).
15. A. Mukherjee and N. K. Bej, Analytical Geometry of Two and Three Dimensions, Books and Allied (P) Ltd. (2013).

SKILL ENHANCEMENT COURSE-1

Course Name: Graph Theory

Course Code: BSCMTMSE101

Course Type: **SEC (Theoretical)**	Course Details: **SEC-1**			L-T-P: **2-1-0**	
Credit: **3**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		……	**15**	**.....**	**35**

Course Learning Outcomes*:* This course will enable the students to

- Appreciate the definition and basics of graphs along with types and their examples.
- Understand the Eulerian circuits, Eulerian graphs, Hamiltonian cycles, representation of a graph by matrix.
- Relate the graph theory to the real-world problems.

Unit -1: Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bipartite graphs isomorphism of graphs. (10 Classes)

Unit -2: Paths and circuits ,Eulerian circuits, Eulerian graph, semi-Eulerian graph and theorems, Hamiltonian cycles and theorems. Representation of a graph by a matrix, the adjacency matrix, incidence matrix, weighted graph, Königsberg bridge problem; Subgraphs. (20 Classes)

Unit -3: Travelling salesman's problem, shortest path, Tree and their properties, spanning tree, Shortest path and Dijkstra's algorithm, Warshall algorithm. (15 Classes)

References:

1. J. Clark and D. A. Holton: A First Look at Graph Theory, Allied Publishers Ltd., 1995.
2. D. S. Malik, M. K. Sen and S. Ghosh: Introduction to Graph Theory, Cengage Learning Asia, 2014.
3. Nar Sing Deo:*Graph Theory*, Prentice-Hall, 1974.
4. J. A. Bondy and U.S.R. Murty: Graph Theory with Applications, Macmillan, 1976.
5. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
6. D.N.Ghosh, Discrete Mathematics, Academic Publishers.
7. D.K.Ghosh, Introduction to Graph Theory, New Central Book Agency(P) Ltd.

SEMESTER-II

MAJOR COURSE-2

Course Name: Linear Algebra I, Ordinary Differential Equations and Vector Calculus

Course Code: BSCMTMMJ201

Course Type: **MAJOR (Theoretical)**	Course Details: **MJC-2**			L-T-P: **4-1-0**	
Credit: **5**	Full Marks:**100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		……	**30**	……	**70**

Course Learning Outcomes: This course will enable the students to

- Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
- Find eigenvalues and corresponding eigenvectors for a square matrix.
- Understand the genesis of ordinary differential equations.
- Understand the various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.
- Know how to solve linear homogeneous and non-homogeneous equations of higher order with constant coefficients.
- Understand the system of linear differential equations and the solution techniques.
- Understand the theory and applications of vector analysis.

Linear Algebra I

Unit 1: Systems of linear equations, vector equations, the matrix equation $Ax=b$, vectors in R^2 and R^3row reduction (column reduction) and echelon forms, congruent operations and congruence of matrices, matrices and matrix operations, inverse of a matrix, rank of a matrix, determinants and their properties, Cramer's rule, solution sets of linear systems and their geometrical interpretation, applications of linear systems, linear independence, characteristic equations, eigenvalues and eigenvectors of a matrix, geometrical interpretations and related theorems, algebraic and geometric multiplicity, Cayley Hamilton's theorem. (15 Classes)

Ordinary Differential Equations

Unit 2: Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Lipschitz condition and Picard's Theorem (Statement only). Existence and uniqueness of the solution of first order ODE (IVP). Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations, oblique and orthogonal trajectories, equations of first order but not first degree, Clairaut's form, Extraneous loci. (15 Classes)

Unit 3: General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters. Reduction of order of ODE and solution. (15 Classes)

Unit 4: Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Matrix Method. Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions. Stability analysis: Equilibrium points, Interpretation of the phase plane and phase portrait. Solution ofsimultaneous equations of the form dx/P = dy/Q = dz/R. Pfaffian Differential Equation Pdx+Qdy+Rdz = 0, Necessary and sufficient condition for existence ofintegrals of the above (proof not required), Total differential equation. (15 Classes)

Vector Calculus

Unit 5: Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, vector equations and its simple applications, differentiation and integration of vector functions. Differential operators: gradient, divergence, curl. (15 Classes)

References:

1. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
2. K. B. Dutta, Matrix and linear algebra, 2004.
3. P. K. Nayak, Linear Algebra, Books & Allied (P) Ltd.
4. S. K. Mapa, Higher Algebra: Abstract and Linear, Sarat Book House.
5. K. Hoffman, R. Kunze, Linear algebra, 1971.
6. H. Anton & C. Rorres, Elementary Linear Algebra, Wiley, 2017.
7. S. L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
8. D. Murray, Introductory Course in Differential Equations, Longmans Green and Co.
9. G. F. Simmons, Differential Equations, Tata Mcgraw Hill, 1991.
10. P. R. Ghosh & J. G. Chakraborty, Differential Equations, U. N. Dhur and Sons.
11. R. K. Ghosh and K. C. Maity, Introduction to Differential Equations, New Central
12. M. D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand.
13. N. Mandal & B. Pal, Differential Equations, Books and Allied (P) Ltd., 2022.
14. D. Sengupta, Introduction to Differential Equations, Books and Allied (P) Ltd., 2019.
15. J. Marsden & Tromba, Vector Calculus, McGraw Hill, 1987
16. K. C. Maity& R. K. Ghosh, Vector Analysis, New Central Book Agency (P) Ltd.
17. J. G. Chakravorty & P. R. Ghosh, Vector Analysis, U. N. Dhur& Sons Private Ltd.
18. Shanti Narayan & P. K. Mittal, A Textbook of Vector Calculus, S. Chand & Company.
19. M. R. Speigel, Schaum's outline of Vector Analysis, McGraw Hill, 1980.

SKILL ENHANCEMENT COURSE-2

Course Name: Mathematical Tools and Latex

Course Code: BSCMTMSE201

Course Type: **SEC(Theoretical)**	Course Details: **SEC-2**			L-T-P: **2-1-0**	
Credit: **3**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		……	**15**	**.....**	**35**

Course Learning Outcomes: This course will enable the students to

- Familiar with open-source mathematical tools.
- Utilize Scilab for displaying graphs, plots, etc.
- Get acquainted with LaTex software
- Prepareresume, question paper, project report, etc. using LaTeX

Unit 1: Open-Source Mathematical tool. Introduction to Scilab and its benefits, the general environment, editor, command window,graphics window, Variablesassignments, functions, conditional statements, loops, display of array in terms of matrices and vectors, displaying graphs, plots, output data, datafile. The following programs need to be completed in Scilab:

(i) Computation of addition and multiplication of matrices.
(ii) Computation of Trace and Transpose of Matrix
(iii) Computation of Rank of matrix and Row reduced Echelon form.
(iv) Computation of Inverse of a Matrix.
(v) Solving the system of homogeneous and non-homogeneous linear equations.
(vi) Finding the nth Derivative of algebraic and logarithmic functions.
(vii) Computation of maxima and minima of functions.
(viii) Definite and indefinite integration.
(ix) Solution of algebraic and transcendental equations.
(x) Solution of ODEs.

(15 Classes)

Unit 2:Graphical demonstration

(Conceptual Discussion and Practical using Scilab)

Plotting of graphs of function exp(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. Plotting the graphs of polynomials, the derivative graph, the second derivative graph and comparing them. Sketching parametric curves (eg. Trochoid, cycloid). Obtaining surface of revolution of curves. Tracing of conics in Cartesian coordinates/polar coordinates. Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic paraboloid, and hyperbolic paraboloid using Cartesian coordinates. (15 Classes)

Unit 3: LaTeX. Installation of MikTeX, Basic Syntex, Understanding Latex compilation. Use of templates, using various Classes and Packages, Latex Preamble, Latex commands and debugging errors, formatting text, symbols, indenting, paragraphs, line-spacing, titles and subtitles. Mathematical environment: mathematical symbols, functions and equations, theorem declarations, drawing matrices. Inserting figures, tables with captions, in-text references to figures and tables. Creating contents, citation and bibliography. Preparing resume, question paper, project report, etc. in LaTeX. (15 Classes)

References:

1. Sandeep Nagar, Introduction to Scilab: For Engineers and Scientists. Apress publisher, New York, USA, 2017.
2. A.S.Nair, SCILAB (A free software to MATLAB), S. Chand Publishing, New Delhi, India, 2012.
3. Stefan Kottwitz, LaTeX Beginner's Guide, Packt Publishing; 2nd ed. edition (October 6, 2021).
4. Ms FiruzaKarmaliAibara, A short introduction to LaTeX: A book for beginners, CreateSpace Independent Publishing Platform (January 3, 2019)
5. WEB REFERENCES: https://www.scilab.org/; https://onlinecourses.swayam2.ac.in/aic20_sp38/preview

Pool of Minor Courses offered by Mathematics Discipline

SEMESTER-I

MINOR COURSE-1

Course Name: Classical Algebra, Calculus and Analytical Geometry

Course Code: BSCMTMMN101

Course Type: **MINOR (Theoretical)**	Course Details: **MNC-1**			L-T-P: **4-1-0**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		……	**30**	……	**70**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

- Understand the importance of roots of real and complex polynomials and learn various methods of obtaining roots.
- Employ De Moivre's theorem in a number of applications to solve numerical problems.
- Understand various kinds of standard functions and graphs, techniques of integrations and limits.
- Understand the concepts on two-dimensional and three-dimensional geometry.

Classical Algebra

Unit 1: Polar representation of complex numbers, n^{th} roots of unity, De Moivre's theorem for rational indices and its applications, complex functions and their applications.

Unit 2: Theory of equations: Relation between roots and coefficients, Transformation of equation, Descartes rule of signs, Cubic and biquadratic equations. Reciprocal equation, separation of the roots of equations, Strum's theorem.

Unit 3: Inequality: The inequality involving $AM \geq GM \geq HM$ and simple theorems, Cauchy-Schwartz inequality, Weierstrass inequality, Problems on maxima-minima.

(25 Classes)

Calculus

Unit 4: Hyperbolic functions, higher order derivatives, Successive differentiation, Leibnitz rule and its applications to problems of type $(ax+b)^n$; $e^{ax}\sin(bx+c)$; $e^{ax}\cos(bx+$

$c)$; $log_e(ax+b)$ etc. L'Hospital's rule. concavity and inflection points, envelopes, asymptotes, Maxima and Minima, Curvature. (13 Classes)

Unit 5: Reduction formulae, derivations and illustrations of reduction formulae for the integration of $sin^n x, cos^n x, tan^n x, sec^n x, (logx)^n, sinnx.sinmx$, etc. parametric equations, parametrizing a curve, arc length, arc length of parametric curves, areas and volumes of surfaces of revolution. (12 Classes)

Analytical Geometry

Unit 6: Reflection properties of conics, translation, rotation and rigid motion of axes and second degree equations, classification of conics using the discriminant, Tangent, Normal, pole, polar, Diameter and conjugate diameters, Asymptotes. Polar equations of conics. (12 Classes)

Unit 7: Planes, Straight lines in 3D, Spheres. Cylindrical surfaces, Cone. Central conicoids, paraboloids, plane sections of conicoids, Generating lines, classification of quadrics, Tangent plane, Normal. (13 Classes)

References:

1. Titu Andreescu and DorinAndrica, Complex Numbers from A to Z, Birkhauser, 2006.
2. W. S. Burnstine and A.W. Panton, Theory of equations, 2007.
3. J. G. Chakravorty & P. R. Ghosh, Advanced Higher Algebra, U. N. Dhur& Sons Pvt. Ltd.
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9. T. Apostol, Calculus, Volumes I and II. Vol-I, 1966, Vol-II, 1968.
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14. R. M. Khan, Analytical Geometry of Two and Three Dimensions and Vector Analysis, New Central Book Agency (2010).
15. A. Mukherjee and N. K. Bej, Analytical Geometry of Two and Three Dimensions, Books and Allied (P) Ltd. (2013).

SEMESTER-II

MINOR COURSE-2

Course Name: Linear Algebra I, Ordinary Differential Equations and Vector Calculus

Course Code: BSCMTMMN201

Course Type: **MINOR (Theoretical)**	Course Details: **MNC-2**			L-T-P: **4-1-0**	
Credit: **5**	Full Marks:**100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		……	**30**	……	**70**

Course Learning Outcomes: This course will enable the students to

- Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
- Find eigenvalues and corresponding eigenvectors for a square matrix.
- Understand the genesis of ordinary differential equations.
- Understand the various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.
- Know how to solve linear homogeneous and non-homogeneous equations of higher order with constant coefficients.
- Understand the system of linear differential equations and the solution techniques.
- Understand the theory and applications of vector analysis.

Linear Algebra I

Unit 1: Systems of linear equations, vector equations, the matrix equation $Ax=b$, vectors in R^2 and R^3row reduction (column reduction) and echelon forms, congruent operations and congruence of matrices, matrices and matrix operations, inverse of a matrix, rank of a matrix, determinants and their properties, Cramer's rule, solution sets of linear systems and their geometrical interpretation, applications of linear systems, linear independence, characteristic equations, eigenvalues and eigenvectors of a matrix, geometrical interpretations and related theorems, algebraic and geometric multiplicity, Cayley Hamilton's theorem. (15 Classes)

Ordinary Differential Equations

Unit 2: Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Lipschitz condition and Picard's Theorem (Statement only). Existence and uniqueness of the solution of first order ODE (IVP). Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations, oblique and orthogonal trajectories, equations of first order but not first degree, Clairaut's form, Extraneous loci. (15 Classes)

Unit 3: General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters. Reduction of order of ODE and solution. (15 Classes)

Unit 4: Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Matrix Method. Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions. Stability analysis: Equilibrium points, Interpretation of the phase plane and phase portrait. Solution ofsimultaneous equations of the form dx/P = dy/Q = dz/R. Pfaffian Differential Equation Pdx+Qdy+Rdz = 0, Necessary and sufficient condition for existence ofintegrals of the above (proof not required), Total differential equation. (15 Classes)

Vector Calculus

Unit 5: Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, vector equations and its simple applications, differentiation and integration of vector functions. Differential operators: gradient, divergence, curl. (15 Classes)

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1. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
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17. J. G. Chakravorty & P. R. Ghosh, Vector Analysis, U. N. Dhur& Sons Private Ltd.
18. Shanti Narayan & P. K. Mittal, A Textbook of Vector Calculus, S. Chand & Company.
19. M. R. Speigel, Schaum's outline of Vector Analysis, McGraw Hill, 1980.