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UNIVERSITY OF CALCUTTA · CCF (NEP 2020) UG SYLLABUS

Mathematics MDC (Pass) · Semester 6

Semester-wise syllabus · 3-Year Multidisciplinary Course · CC papers

What this file contains

- CC-7: Mathematical Methods
- CC-8: Discrete Mathematics
- Minor papers available in Semester 6
- Course structure page and question pattern

Source and note

The pages that follow are taken unchanged from the official University of Calcutta syllabus for Mathematics under the Curriculum and Credit Framework for Undergraduate Programmes (CCF, NEP 2020). PALMATHS has only selected the pages for this programme and semester and added this cover so students can find them quickly. Always check the University of Calcutta website (caluniv.ac.in) for later notifications, corrections or changes in paper options. PALMATHS is an independent coaching centre and is not part of, or endorsed by, the University of Calcutta.

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University of Calcutta



Syllabus for four-year (Eight Semester) B. Sc. Honours and Honours with Research Course with Mathematics Major

&

Mathematics as a Minor subject

and

Syllabus for three-year (Six Semester) Multidisciplinary Course with Mathematics

Under

Curriculum and Credit Framework (CCF)

Odd Semester : July to December

Even Semester : January to June

The syllabus for the 4 Year B.A./B.Sc. Honours and Honours with Research Course with Mathematics Major is effective from the academic year **2023-24**.

The syllabus for the 3 Year Multidisciplinary Course with Mathematics is effective from the academic year **2023-24**.

Course Structure for
3-year Multi-Disciplinary Course with Mathematics as a Core/Minor Subject

1. Mathematics opted as First Core Subject (i.e. Core Course 1)

Semester	Paper Code	Name of Paper	Credit	Page No.
I	MMTH-MDC-CC1	Calculus, Geometry & Vector Analysis	3TH+1TU = 4	10
II	MMTH-MDC-CC2	Basic Algebra	3TH+1TU = 4	12
III	MMTH-MDC-CC3	Ordinary Differential equations & Group Theory	3TH+1TU = 4	80
IV	MMTH-MDC-CC4	Mechanics	3TH+1TU = 4	82
	MMTH-MDC-CC5	Advanced Calculus	3TH+1TU = 4	84
V	MMTH-MDC-CC6	Statistics & Numerical Analysis	3TH+1TU = 4	86
	MMTH-MDC-CC7	Mathematical Methods	3TH+1TU = 4	88
VI	MMTH-MDC-CC8	Discrete Mathematics	3TH+1TU = 4	90

2. Mathematics opted as Second Core Subject (i.e. Core Course 2)

Semester	Paper Code	Name of Paper	Credit	Page No.
I	MMTH-MDC-CC1	Calculus, Geometry & Vector Analysis	3TH+1TU = 4	10
II	MMTH-MDC-CC2	Basic Algebra	3TH+1TU = 4	12
III	MMTH-MDC-CC3	Ordinary Differential equations & Group Theory	3TH+1TU = 4	80
IV	MMTH-MDC-CC4	Mechanics	3TH+1TU = 4	82
	MMTH-MDC-CC5	Advanced Calculus	3TH+1TU = 4	84
V	MMTH-MDC-CC6	Statistics & Numerical Analysis	3TH+1TU = 4	86
VI	MMTH-MDC-CC7	Mathematical Methods	3TH+1TU = 4	88
	MMTH-MDC-CC8	Discrete Mathematics	3TH+1TU = 4	90

3. Mathematics opted as a Minor Subject

Semester	Paper Code	Name of Paper	Credit	Page No.
III	MMTH-MDC-mn1	Calculus, Geometry & Vector Analysis	3TH+1TU = 4	10
IV	MMTH-MDC-mn2	Basic Algebra	3TH+1TU = 4	12
V	MMTH-MDC-mn3	Ordinary Differential equations & Group Theory	3TH+1TU = 4	80
	MMTH-MDC-mn4	Mechanics	3TH+1TU = 4	82
VI	MMTH-MDC-mn5	Advanced Calculus	3TH+1TU = 4	84
	MMTH-MDC-mn6	Statistics & Numerical Analysis	3TH+1TU = 4	86

Note : Skill Enhancement Course (SEC) on C Language with Mathematical Applications shall be studied either in Semester One or in Semester Two or in Semester Three.

4-yr Credit Distribution | MDC Credit Distribution | Course Overview
Major | Minor | MDC | Question Pattern

Mathematical Methods

Semester : V or VI	Paper Code : MMTH-MDC-CC7-TH
Credit : 4	Full Marks : 100 (Theory : 75 & Tutorial : 25)
Minimum number of classes required : 60	

4-yr Credit Distribution | MDC Credit Distribution | Course Overview

Major | Minor | MDC | Question Pattern

Course Outcome

CO1 : To learn sequence and series of functions in detail.

CO2 : To learn application of differential calculus and maxima and minima of functions.

CO3 : To learn Fourier series of periodic functions.

CO4 : To learn Laplace transform and its application to the solution of ordinary differential of second order with constant coefficients.

Group A [Marks : 25] [20 classes]

- **Sequence and Series of functions:** Concept of Point-wise and Uniform convergence of sequence of functions and series of functions defined on intervals with special reference of Power Series, Statement of Weierstrass' M-Test for Uniform convergence of sequence of functions and of series of functions, Simple applications. Statements of important properties like boundedness, continuity, differentiability of the limit function of uniformly convergent sequence of functions and of the sum function of uniformly convergent series of functions, Convergence of Power Series, Radius of convergence, Statement of Abel's Theorem on Power Series and region of convergence of Power Series, Simple problems.

Group B [Marks : 35] [28 classes]

- **Application of differential calculus:** Tangents and Normals, Pedal equations, Curvature, radius of curvature of plane curves, Rectilinear asymptotes (Cartesian only), Envelopes (Cartesian only), Concavity, Convexity, Point of inflection (Cartesian only), Definition and examples of singular points (viz. Node, Cusp, Isolated point) (Cartesian only).
- **Maxima and minima of functions:** Maxima and Minima of functions involving one and two variables, Lagrange's Method of undetermined multipliers of functions involving two variables (Problems only).

Group C [Marks : 15] [12 classes]

- **Fourier series on $[-\pi, \pi]$:** Periodic function, Determination of Fourier coefficients, Statement of Dirichlet's conditions (improperness excluded) for convergence and statement of the theorem on convergence and sum of Fourier series, Sine and Cosine series.
- **Laplace Transform and its application to ordinary differential equation:** Laplace Transform and Inverse Laplace Transform, Statement of Existence theorem, Statements of elementary properties of Laplace Transform and its Inverse, Application to the solution of ordinary differential equation of second order with constant coefficients.

References

[1] H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.

[2] T. Apostol, Calculus, Volumes I and II, Wiley Student Edition, 1967.

[3] R. Courant and F. John, Introduction to Calculus and Analysis (Vol. I &II), Springer- Verlag, New York, Inc., 1989.

[4] J. Edwards, An Elementary Treatise on Differential Calculus, Radha Publishers, 1992.

[5] J. M. H. Olmstead, Advanced Calculus, Prentice Hall, 1961.

[6] M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.

[7] A. E. Taylor and W. Robert Mann, Advanced Calculus (3rd Edition), John Wiley & Sons, Inc., 1983.

[8] G. B. Thomas and R. L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.

[9] D. Widder, Advanced Calculus, Prentice Hall, 1947.

[10] R. C. Wrede and M. Spiegel, Advanced Calculus, Schaum's Outline Series, McGraw-Hill, 2020.

4-yr Credit Distribution | MDC Credit Distribution | Course Overview

Major | Minor | MDC | Question Pattern

Discrete Mathematics

Semester : VI	Paper Code : MMTH-MDC-CC8-TH
Credit : 4	Full Marks : 100 (Theory : 75 & Tutorial : 25)
Minimum number of classes required : 60	

4-yr Credit Distribution | MDC Credit Distribution | Course Overview

Major | Minor | MDC | Question Pattern

Course Outcome

CO1 : To learn Graph theory in detail.

CO2 : To learn application of congruences.

CO3 : To learn combinatorics, recurrence relations, generating functions.

CO4 : To learn Boolean functions, Boolean polynomials, Minimal forms of Boolean polynomials, switching circuits, Logic gates.

Group A [Marks : 30] [24 classes]

- **Graph Theory :** Definition and examples of graphs, Walks, Trails, Paths, Circuits and cycles, Eulerian circuits and paths. Eulerian graphs, example of Eulerian graphs. Hamiltonian cycles and Hamiltonian graphs. Definition of Trees and their elementary properties. Definition of Planar graphs, Kuratowski's graphs.

Group B [Marks : 45] [36 classes]

- **Application of Congruences :** Congruence classes, addition and multiplication of congruence classes, Fermat's little theorem, Euler's Theorem, Wilson's theorem (statements only) and some applications. Divisibility tests by 2, 3, 4, 5, 7, 9, 11, 13 (Statements of relevant results, thrust will be on working out problems), Check Digits in ten digit International Standard Book Number (ISBN), Universal Product Code (UPC), VISA and MASTER card (Statements of relevant results and Problems only), Formation of Round Robin Tournament, Table using congruence of integers (Technique and Problems only).
- **Combinatorics, Recurrence Relations and Generating functions :** Statement of Fundamental counting principle, Recurrence Relations, Solution of recurrence relations by the method of Iteration (Consideration of problems of Rabbit on an island, The tower of Hanoi), Linear difference equations up to second order with constant coefficients.
- **Boolean Algebra :** Boolean Algebra (Definition, examples and basic properties), Boolean functions, Boolean polynomials, minimal forms of Boolean polynomials - CNF & DNF, Switching circuits and minimization of switching circuits using Boolean algebra, Logic Gates (Definition and examples).

References

[1] J. Clark and D. Holton, A first look at Graph Theory, World Scientific Publishing Co. Pvt. Ltd.(Allied Publishers Ltd.) 1991.

[2] N. Deo, Graph Theory with applications to Engineering and Computer Science, Prentice-Hall of India, 2000.

[3] E. G. Goodaire and M. M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Edition, Pearson India Education Services Pvt. Ltd., 2015.

[4] F. Harary, Graph Theory, Narosa Publishing House, New Delhi, 2001.

[5] K. H. Rosen, Discrete Mathematics and its applications with combinations and Graph Theory (7th Edition), Mc-Graw Hill Education (India) Pvt. Ltd., 2011.

[6] M. K. Sen and B. C. Chakraborty, Introduction to Discrete Mathematics, 4th Edition, Books & Allied Pvt. Ltd., 2019.

[7] R. J. Wilson, Introduction to Graph Theory, 4th edition, Pearson, 2007.

4-yr Credit Distribution | MDC Credit Distribution | Course Overview

Major | Minor | MDC | Question Pattern

Advanced Calculus

Semester : IV	Paper Code : MMTH-MDC-CC5-TH
Semester : VI	Paper Code : MMTH-MDC-mn5-TH
Credit : 4	Full Marks : 100 (Theory : 75 & Tutorial : 25)
Minimum number of classes required : 60	

4-yr Credit Distribution | MDC Credit Distribution | Course Overview

Major | Minor | MDC | Question Pattern

Course Outcome

CO1 : To learn sequence of real numbers and infinite series of constant terms.

CO2 : To understand limit, continuity of real valued functions and properties of continuous functions.

CO3 : To learn Rolle's theorem, mean value theorems, Taylor's and Maclaurin's infinite series.

CO4 : To learn limit, continuity, differentiability, partial derivatives of real valued functions of two or three variables, chain rule of partial derivatives, Euler's theorem on homogeneous functions.

Group A : [Marks : 20] [16 classes]

- **Sequence of real numbers :** Definition of bounds of a sequence and monotone sequence. Limit and convergence of a sequence. Statements of limit theorems. Convergence and divergence of monotone sequences and applications. Convergence of r^n, $r^{\frac{1}{n}}$ and $n^{\frac{1}{n}}$ in particular. Statement of Cauchy's general principle of convergence and its applications.
- **Infinite series of constant terms :** Convergence and Divergence (definitions and examples). Cauchy's principle as applied to infinite series (applications only). Series of positive terms: Statements of Comparison test, Limit form of Comparison Test, D. Alembert's Ratio test. Cauchy's root test and Rabbe's test : Applications. Alternating series: Statement of Leibnitz's test and its applications.

Group B : [Marks : 25] [20 classes]

- **Real-valued functions defined on an interval :** Limits of functions (ϵ-δ approach), Cauchy's criterion of existence of limit (statement only). Algebra of limits (statements only), Continuity of a function at a point and on an interval, Properties of continuous functions on closed and bounded intervals without proof (Boundedness and Intermediate value property) Statement of existence of inverse function of a strictly monotone function and its continuity.
- **Derivative :** Statement of Rolle's theorem and its geometrical interpretation. Mean Value Theorems of Lagrange and Cauchy as a consequence of Rolle's theorem. Geometrical interpretation of Lagrange's Mean value Theorem, Statements of Taylor's and Maclaurin's Theorems with Lagrange's and Cauchy's form of remainders, Taylor's and Maclaurin's Infinite series, Expansion of the functions e^x, $\sin x$, $\cos x$, $(1+x)^n$ and $\log(1+x)$ [with restrictions wherever necessary and assuming $R_n \to 0$].

Group C : [Marks : 30] [24 classes]

- **Multivariate Calculus :** Real-valued Functions of two and three real variables: Their geometrical representations. Limit and Continuity (definitions only) for functions of two variables, Partial derivatives,

Differentiability, sufficient condition for differentiability (statement only), Chain rule for two independent variables, Higher order partial derivatives up to second order, Statement of Schwarz's Theorem for equality of mixed partial derivatives, Euler's theorem on homogeneous functions of two variables. Derivative of Implicit functions of two variables (existence assumed).

References

[1] T. Apostol, Calculus, Volumes I and II, John Wileyand Sons, 1969.

[2] R. Courant and F. John, Introduction to Calculus and Analysis (Vol. I & II), Springer-Verlag, New York, Inc., 1998.

[3] S. Lang, A First course in Calculus, Springer, 1986.

[4] S. C. Malik and S. Arora, Mathematical Analysis, New Age International Publishers, 4e, 2014.

[5] G. B. Thomas and R. L. Finney, Calculus, 14th Ed., Pearson Education, Delhi, 2018.

4-yr Credit Distribution | MDC Credit Distribution | Course Overview

Major | Minor | MDC | Question Pattern

Statistics & Numerical Analysis

Semester : V	Paper Code : MMTH-MDC-CC6-TH
Semester : VI	Paper Code : MMTH-MDC-mn6-TH
Credit : 4	Full Marks : 100 (Theory : 75 & Tutorial : 25)
Minimum number of classes required : 60	

4-yr Credit Distribution | MDC Credit Distribution | Course Overview

Major | Minor | MDC | Question Pattern

Course Outcome

CO1 : To learn probability theory, discrete and continuous distribution, mathematical expectations.

CO2 : To learn measures of central tendency, measures of dispersion, correlation and regression.

CO3 : To learn sampling theory, basic idea of some distributions used in sampling theory.

CO4 : To learn estimation of parameters, point estimation, interval estimation, testing of hypothesis, type I and type II error.

CO5 : To learn interpolation and numerical integration.

CO6 : To learn methods for solving transcendental equations and Gauss elimination method for solving system of linear equations.

Group A : Statistics [Marks : 50] [40 classes]

- **Probability Theory:** Theorems on Total Probability, Conditional probability and Multiplication theorem, Bayes' Theorem (application only). Independence of events, Related Problems.
  Compound experiment, Independent trials, Bernoulli's trials, Binomial law.
- **Probability Distribution:** Random Variables, Probability Distribution function, Properties of probability distribution function, Discrete and continuous distribution, Probability mass and probability density function, Some important probability distributions and their properties – Binomial, Poisson, Uniform and Normal distributions, Related problems.
  Two-dimensional random variables and bivariate distribution (discrete and continuous), Marginal distribution, Bivariate Uniform and Normal distributions. Related problems.
- **Mathematical Expectation:** Definition of mathematical expectation, Mean, Variance, Standard Deviation, Moments, Theorems on mathematical expectation (statement only), Standardized random variate, Mean, Variance and standard deviation of Binomial, Poisson and Normal distributions.
  Mathematical Expectation in bivariate distribution, Moments, Covariance, Correlation coefficient, $E(X+Y) = E(X) + E(Y)$, $E(XY) = E(X).E(Y)$ for independent variates.
- **Elements of Statistical Methods:** Measure of Central tendency: Arithmetic Mean, Geometric Mean, Harmonic Mean, Median and Mode (their advantages and disadvantages), Relation between Mean, Median and Mode, Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Variance / Standard Deviation, Moments, Raw moments and Central moments and relation between them, Effect of change of origin and change of scale on moments.
  Correlation and Regression: Bivariate data, Scatter Diagram, Correlation coefficient-its determination and properties. Regression lines of y on x and x on y – their deductions and properties.

- **Sampling Theory:** Meaning and objects of sampling, Parameter and Statistic, Sampling distribution of a statistic, Methods of drawing random sample, Mean and Variance of sample mean, Basic idea of some distributions used in Sampling Theory - (i) Standard Normal distribution, (ii) Chi-square distribution (iii) Student's t-distribution (iv) Snedecor's F-distribution, Related problems.
- **Statistical Inference:** Estimation of Parameters, Unbiased estimator, Consistent estimator, Sample mean is an unbiased estimate of population mean, Sample variance is a biased estimator of population variance, Point estimation, Interval estimation, Method for finding Confidence Intervals, Confidence intervals for m of Normal (m, σ) population when σ is known and when σ is unknown.
  Statistical Hypothesis – Null Hypothesis and Alternative Hypothesis, Critical Region, Type I and II error, Level of significance, Related simple problems.
  (Note: Emphasis should be given on definitions and problem solving)

Group B : Numerical Analysis [Marks : 25] [20 classes]

- **Approximate numbers:** Significant figures, Rounding off of numbers. Errors – Absolute, Relative and Percentage.
- **Operators** - Δ, ∇ and E (Definitions and some relations among them).
- **Interpolation:** Problem of interpolation, Equi-spaced arguments, Difference Table, Deduction of Newton's Forward Interpolation Formula, remainder term (expression only). Newton's Backward interpolation Formula (Statement only) with remainder term. Unequally-space arguments, Lagrange's Interpolation Formula (Statement only), Related problems.
- **Numerical Integration:** Trapezoidal rule and Simpson's $\frac{1}{3}$ rule with geometrical interpretation, Related problems.
- **Numerical solution of nonlinear equations:** To find a real root of an algebraic or transcendental equation. Location of root (tabular method), Bisection method, Newton-Raphson method with geometrical interpretation, Related problems.
- **Numerical solution of system of linear equations:** Gauss elimination method using partial pivoting for solution of system of three linear equations in three unknowns.
  (Note : Emphasis should be given on problems)

References

[1] W. Feller, An introduction to Probability Theory and its Applications, Vol. 1, 3e, Wiley, 1968.

[2] A. Gupta, Groundwork of Mathematical Probability and Statistics, Academic Publishers, 1983.

[3] A. M. Goon, M. K. Gupta and B. Dasgupta, Fundamental of Statistics, World Press, Vol 1, 2013 & Vol 2, 2016.

[4] R. V. Hogg, J. W. McKean and A. T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.

[5] S. Ross, Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.

[6] B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.

[7] C. F. Gerald and P. O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.

[8] M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, 4e, 2005.

4-yr Credit Distribution | MDC Credit Distribution | Course Overview

Major | Minor | MDC | Question Pattern

MMTH-MN3-TH **MMTH-MDC-mn3-TH** **MMTH-MDC-CC3-TH**	**Ordinary Differential Equations & Group Theory**
Group A: Ordinary Differential Equations (Marks : 45)	9 questions are to be attempted out of 16 questions each carrying 5 marks.
Group B : Group Theory (Marks : 30)	6 questions are to be attempted out of 10 questions each carrying 5 marks.
MMTH-MN4-TH **MMTH-MDC-mn4-TH** **MMTH-MDC-CC4-TH**	**Mechanics**
(Marks : 75)	(a) Short answer type questions: 6 questions are to be attempted out of 10 questions each carrying 2 marks. (b) Long answer type questions: (i) 7 questions are to be attempted out of 11 questions each carrying 6 marks. (2 questions from Statics, 4 questions from Law of gravitation portion, 3 questions from Work, Power, Energy portion and 2 questions from Impulse of a force portion are to be set.) (ii) 3 questions are to be attempted out of 6 questions each carrying 7 marks. (questions are to be set from Motion of a particle in a plane)
MMTH-MDC-CC5-TH **MMTH-MDC-mn5-TH**	**Advanced Calculus**
Group A: (Marks : 20)	4 questions are to be attempted out of 7 questions each carrying 5 marks.
Group B : (Marks : 25)	5 questions are to be attempted out of 9 questions each carrying 5 marks.
Group C : (Marks : 30)	6 questions are to be attempted out of 10 questions each carrying 5 marks.
MMTH-MDC-CC6-TH **MMTH-MDC-mn6-TH**	**Statistics & Numerical Analysis**
Group A: Statistics (Marks : 50)	(i) 5 questions are to be attempted out of 9 questions each carrying 5 marks. Each question may have further parts. These 9 questions must be set from Probability Theory, Probability Distribution and Mathematical Expectation. (ii) 5 questions are to be attempted out of 9 questions each carrying 5 marks. Each question may have further parts. These 9 questions must be set from Elements of Statistical Methods, Statistical Inference, Sampling Theory
Group B : Numerical Analysis (Marks : 25)	5 questions are to be attempted out of 9 questions each carrying 5 marks. Each question may have further parts.

MMTH-MDC-CC7-TH	Mathematical Methods
Group A: **Sequencs and series of functions** (Marks : 25)	5 questions are to be attempted out of 9 questions each carrying 5 marks. Each question may have further parts.
Group B : **Application of differential calculus** (Marks : 35)	7 questions are to be attempted out of 11 questions each carrying 5 marks. Each question may have further parts.
Group C : **Fourier series and Laplace Transform** (Marks : 15)	3 questions are to be attempted out of 7 questions each carrying 5 marks. Each question may have further parts.
MMTH-MDC-CC8-TH	**Discrete Mathematics**
Group A: Graph Theory (Marks : 30)	6 questions are to be attempted out of 10 questions each carrying 5 marks. Each question may have further parts.
Group B : (Marks : 35)	(i) 6 questions are to be attempted out of 10 questions each carrying 5 marks. These 11 questions will be set from Combinatorics, Recurrence Relations and Generating functions. Each question may have further parts. (ii) 3 questions are to be attempted out of 5 questions each carrying 5 marks. These 5 questions will be set from Boolean Algebra. Each question may have further parts.

4-yr Credit Distribution | MDC Credit Distribution | Course Overview
Major | Minor | MDC | Question Pattern