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UNIVERSITY OF CALCUTTA · CCF (NEP 2020) UG SYLLABUS

Mathematics MDC (Pass) · Semester 3

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

What this file contains

- CC-3: Ordinary Differential Equations and Group Theory
- Minor papers available in Semester 3
- MMTH-SEC: C Language with Mathematical Applications
- 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

Ordinary Differential Equations & Group Theory

Semester : III	Paper Code : MMTH-MDC-CC3-TH
Semester : V	Paper Code : MMTH-MDC-mn3-TH
Semester : V or VI	Paper Code : MMTH-MN3-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 understand the formation of differential equations and the methods for solving them.

CO2 : To learn techniques for solving first-order, first-degree, and higher-degree differential equations.

CO3 : To study methods for solving higher-order linear and nonlinear differential equations.

CO4 : To study the algebraic structure of groups, including elementary properties, subgroups, order of a group, cyclic groups, alternating groups, and related concepts.

Group A : Ordinary Differential Equations [Marks : 45] [36 classes]

- Formation of differential equations, order and degree of a differential equation. First order and first degree differential equations. Homogeneous and exact differential equations, conditions for an equation of the first order to be exact. Integrating factors. Rules for finding integrating factors. Linear equations and Bernoulli equations.
- First order higher degree differential equations solvable for x, y and p. Clairaut's forms. Singular solutions. Equations of tac-locus, nodal locus and cuspidal locus.
- Higher order linear and non-linear equations. Concept of Wronskian and its properties. Complementary functions, particular integrals. Linear homogeneous and non-homogeneous equations with constant coefficient. Method of undetermined coefficients. Method of variation of parameters. Simultaneous linear differential equations.
- Higher order linear equations with variable coefficients reducible to linear equations with constant coefficients (Euler's equation). Condition for exactness of higher order linear equations. Integrating factors. Equations of the form $\frac{d^n y}{dx^n} = f(y)$ $(n \geq 2)$.

Group B : Group Theory [Marks : 30] [24 classes]

- Definition of a group, examples of groups including permutation groups, dihedral groups and quaternion groups (through matrices), elementary properties of groups, examples of commutative and non-commutative groups. Subgroups and examples of subgroups, necessary and sufficient condition for a nonempty subset of a group to be a subgroup. Normalizer, centralizer, center of a group, product of subgroups.
- Order of an element of a group, order of a group. Cyclic groups. Properties of cyclic groups, classification of subgroups of cyclic groups. Permutation, cycle notation for permutations, properties of permutation, even and odd permutations. Alternating group. Properties of cosets. Lagrange's theorem and consequences including Fermat's Little theorem.

References

[1] S. Ahmed and A. Ambrosetti, A Textbook on Ordinary Differential Equations, Springer-Verlag, 2015.

[2] W. E. Boyce and R.C. DiPrima, Elementary Differential Equations and Boundary Value Problems, John Wiley & Sons, 2009.

[3] J. M. Cushing, Analysis of Ordinary Differential Equations, University of Arizona, 2018.

[4] E. A. Coddington, An Introduction to Ordinary Differential Equations, Dover Publications, 1989.

[5] D. A. Murray, Introductory course in Differential Equations, Orient and Longman, 1967.

[6] G. Nagy, Ordinary Differential Equations, Michigan State University, 2015.

[7] H. T. H. Piaggio, An Elementary Treatise on Differential Equations and Their Applications, C. B. S. Publishers & Distributors, Delhi, 1985.

[8] S. L. Ross, Differential Equations, 3rd Ed., John Wiley & Sons, India, 2004.

[9] G. F. Simmons, Differential Equations with Applications and Historical Notes, Tata McGraw Hill, 1972.

[10] W. F. Trench, Elementary Differential Equations, S. Chand & Co., Ltd., 1999

[11] M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.

[12] D. S. Dummit and R. M. Foote, Abstract Algebra, 3rd Ed., John Wiley & Sons, India, 2011.

[13] J. B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.

[14] J. A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.

[15] I. N. Herstein, Topics in Algebra, Wiley Eastern Ltd., India, 1975.

[16] D. S. Malik, J. M. Mordeson and M. K. Sen, Fundamentals of abstract algebra, McGraw Hill, 1997.

[17] J. J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.

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

Major | Minor | MDC | Question Pattern

C Language with Mathematical Applications

Semester : I	Paper Code : MTHM-SEC 1-TH MMTH-SEC-TH
Semester : II or III	Paper Code : MMTH-SEC-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 C language in detail.

CO2 : To learn how to use different types of control statements and arrays.

CO3 : To learn how to write different types of computer programs using C language.

- **Overview** of architecture of a computer, compiler, interpreter, assembler, machine language, high level language, procedural vs object oriented language.
- **Constants, Variables and Data types :** Character set, constants and variables, data types, C statements, declaration.
- **Operations and Expressions:** Arithmetic operators, relational operators, logical operators, assignment operator, expressions.
- **Decision Making and Branching:** decision making with if, if-else, Nested if, switch-case, break and continue statements.
- **Control Statements:** while, do-while and for statements.
- **Arrays and Strings:** One-dimensional, two-dimensional and multidimensional arrays, declaration of arrays, initialization of arrays, strings.
- **User-defined Functions:** Definition of functions, Scope of variables, return values and their types, function declaration, function call by value, Nesting of functions, passing of arrays to functions, Recursive function.
- **Introduction to Library functions:** stdio.h, math.h, string.h, stdlib.h, time.h etc.

Sample problems:

1. Display first 15 natural numbers.
2. Compute the sum of first 10 natural numbers.
3. Read 10 numbers from keyboard and find their average.
4. Find the sum of first 15 even natural numbers.
5. Write a program to find factorial of a number using recursion.
6. Write a program to make a pyramid pattern with numbers increased by 1.

7. From the terminal read three values, namely, length, width, height. Print a message whether the box is a cube or rectangle or semi-rectangle.
8. Find the AM, GM, HM of a given set of numbers.
9. Write a program to print multiplication table.
10. Find the maximum and minimum element of a given array.
11. Sort the elements of an array in ascending order.
12. Write a program to read in an array of names and to sort them in alphabetical order.
13. Write a program for addition of two matrices.
14. Find the transpose of a given matrix.
15. Find the product of two matrices.
16. Write a program to check whether two given strings are an anagram.
17. Write a program to check Armstrong and Perfect numbers.
18. Write a program to check whether a number is a prime number or not.
19. Prepare a code for summing a Series.
20. Compute approximate value of pi .
21. Compute the area under a given curve.
22. Solve a quadratic equation.
23. Write a program to solve a system of two linear equations in two unknowns.
24. Write a program to find the shortest distance between two straight lines (parallel or intersecting or skew) in space.
25. Prepare an investment report by calculating compound interest.

Note: A practical notebook must be maintained for internal assignments and submitted for the partial fulfillment of the course.

References

[1] E. Balagurnsamy, Programming in ANSI C, Tata McGraw Hill, 2004.

[2] Y. Kanetkar, Let Us C, BPB Publication, 1999.

[3] B. W. Kernighan and D. M. Ritchi, The C-Programming Language, 2nd Edi. (ANSI Refresher), Prentice Hall, 1977.

[4] V. Rajaraman, Computer Oriented Numerical Methods, Prentice Hall of India, 1980.

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

Major | Minor | MDC | Question Pattern

Calculus, Geometry & Vector Analysis

Semester : I	Paper Code : MTHM-DSCC 1-TH MMTH-MN1-TH MMTH-MDC-CC1-TH
Semester : III	Paper Code : MMTH-MN1-TH MMTH-MDC-mn1-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 understand and compute higher-order derivatives, apply Leibniz's rule and its applications, and use L'Hospital's rule to evaluate limits.

CO2 : To develop proficiency in solving problems involving higher-order derivatives, Leibniz's rule, and L'Hospital's rule.

CO3 : To learn reduction formulae and apply them to determine the arc length of a curve, the area under a curve, and the area and volume of surfaces of revolution.

CO4 : To study the classification of conic sections, reduce them to canonical form, and determine equations of tangents, normals, and polars.

CO5 : To acquire detail knowledge of spheres, cylindrical surfaces, central conicoids, different quadric surfaces.

CO6 : To apply vector equations to problems in geometry and mechanics, and to perform differentiation and integration of vector functions.

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

- Differentiability of a function at a point and in an interval. Meaning of sign of derivative. Differentiating Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to functions of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$. Indeterminate forms. L'Hospital's rule (statement and example).
- Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \tan^n x dx$, $\int \sec^n x dx$, $\int (\log x)^n dx$, $\int \sin^n x \sin mx\, dx$, $\int \sin^n x \cos^m x\, dx$. Parametric equations, parametrizing a curve, arc length of a curve, arc length of parametric curves, area under a curve, area and volume of surface of revolution.

Group B : Geometry [Marks : 35] [28 classes]

- Rotation of axes and second degree equations, classification of conics using the discriminant, reduction to canonical form, tangent and normal, polar equations of conics.
- Spheres, Cylindrical surfaces. Central conicoids, paraboloids, plane sections of conicoids, generating lines, identification of quadric surfaces like cone, cylinder, ellipsoid, hyperboloid, classification of quadrics.

Group C : Vector Analysis [Marks : 20] [16 classes]

- Triple product, vector equations, applications to geometry and mechanics — concurrent forces in a plane, theory of couples, system of parallel forces. Introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions of one variable.

References

[1] H. Anton, I. Bivens and S. Davis, Calculus, 10th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2015.

[2] T. Apostol, Calculus, Volumes I and II, Wiley and Sons, 1969.

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

[4] R. R. Goldberg, Methods of Real analysis, Oxford and IBH Publishing, 2020.

[5] M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2022.

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

[7] Robert J. T. Bell, Co-ordinate Geometry of Three Dimensions, Macmillan and Co. Ltd., London, 2018.

[8] S. L. Loney, Co-ordinate Geometry, 6th Ed., Arihant Publications, 2016.

[9] J. Marsden and Tromba, Vector Calculus, W. H. Freeman and Co., 6th Ed., 2011.

[10] M. R. Speigel, Schaum's outline of Vector Analysis, Tata McGraw Hill, 2011.

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

Major | Minor | MDC | Question Pattern

Question Pattern for

3-year Multidisciplinary Course with Mathematics and Mathematics as a Minor subject

MMTH-MN1-TH **MMTH-MDC-mn1-TH** **MMTH-MDC-CC1-TH**	**Calculus, Geometry & Vector Analysis**
Group A : Calculus (Marks : 20)	(a) Short answer type questions: 4 questions are to be attempted out of 7 questions each carrying 2 marks. (b) Long answer type questions: 3 questions are to be attempted out of 6 questions each carrying 4 marks.
Group B : Geometry (Marks : 35)	(a) Short answer type questions: 2 questions are to be attempted out of 4 questions each carrying 2.5 marks (b) Long answer type questions: 5 questions are to be attempted out of 9 questions each carrying 6 marks
Group C : **Vector Analysis** (Marks : 20)	(a) Short answer type questions: 4 questions are to be attempted out of 7 questions each carrying 2 marks. (b) Long answer type questions: 3 questions are to be attempted out of 6 questions each carrying 4 marks.
MMTH-MN2-TH **MMTH-MDC-mn2-TH** **MMTH-MDC-CC2-TH**	**Basic Algebra**
Group A, B, C : (Each group carries 25 marks)	(a) Short answer type questions: 2 questions are to be attempted out of 4 questions each carrying 2.5 marks. (b) Long answer type questions: 4 questions are to be attempted out of 7 questions each carrying 5 marks.
MMTH-SEC-TH	**C Language with Mathematical Applications**
(Marks : 75)	(a) Short answer type questions: 5 questions are to be attempted out of 8 questions each carrying 3 marks. (b) Long answer type questions: 5 questions are to be attempted out of 8 questions each carrying 8 marks. (a) Longer answer type questions: 2 questions are to be attempted out of 4 questions each carrying 10 marks.

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.