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UNIVERSITY OF CALCUTTA · CCF (NEP 2020) UG SYLLABUS

Mathematics MDC (Pass) · Semester 4

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

What this file contains

- CC-4: Mechanics
- CC-5: Advanced Calculus
- Minor paper available in Semester 4
- 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

Mechanics

Semester : IV	Paper Code : MMTH-MDC-CC4-TH
Semester : V	Paper Code : MMTH-MDC-mn4-TH
Semester : V or VI	Paper Code : MMTH-MN4-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 principles of forces, including resultant forces, resultant couples, and coplanar force systems.

CO2 : To study rectilinear motion and simple harmonic motion.

CO3 : To develop the ability to solve problems related to work, power, and energy.

CO4 : To study impulsive forces and the collision of elastic bodies.

CO5 : To develop the ability to solve problems involving the motion of a particle in two dimensions.

Statics - I

- Idea about Physical Independence Principle of Forces, Principle of transmissibility of a force, Principle of action and reaction and Principle of parallelogram law of forces, Composition and resolution of forces, Concurrent Forces in a plane, Composition and resolution of forces, Equilibrium of three forces acting at a point, Lami's theorem, Moment of a force about a point and an axis, Varignon's theorem, Resultant forces and resultant couple, Coplanar forces: Its reduction and conditions of equilibrium. [8 classes]

Particle Dynamics - I

- Law of gravitation, Concept of inertial frame, Newton's laws of motion, Concept of equation of motion of a particle, Rectilinear motion in a given force field, Simple harmonic motion, damped and forced oscillations, Concept of resonance, motion of elastic strings, Rectilinear motion under uniform gravity, Rectilinear motion in a resisting medium where resistance is proportional to velocity. [18 classes]
- Work, power, energy, Conservative forces, Potential energy, Existence of potential energy function, Conservative field and Principle of conservation of energy.
. [6 classes]
- Impulse of a force, Impulsive force, Principle of conservation of linear momentum, Collision of elastic bodies: Coefficient of restitution, Newton's law of collision, Direct and oblique impact of a smooth sphere with a fixed plane, Direct and oblique impact of two smooth spheres. [8 classes]
- Motion of a particle in a plane (2D Cartesian): Angular velocity and angular acceleration, Expressions for components of velocity and acceleration, Tangential and normal components of velocity and acceleration, Motion of a projectile in a resisting medium under gravity. Motion of a particle in a plane (2D Polar): Expressions for components of velocity and acceleration, Central forces and central orbits, Motion under inverse square law, Times of describing the arcs of central orbits for a particle moving under inverse square

law, Kepler's laws on planetary motion, Motion of artificial satellites, Tangential and normal components of velocity and acceleration, Constrained motion of a particle on smooth curve. [20 classes]

References

[1] D. Chernilevski, E. Lavrova and V. Romanov, Mechanics for Engineers, MIR Publishers, 1984.

[2] F. Chorlton, Textbook of Dynamics, CBS Publishers, 2nd Ed., 2002.

[3] R. Douglas Gregory, Classical mechanics, Cambridge University Press, 2006.

[4] D. T. Greenwood, Principle of Dynamics, Prentice-Hall, 2nd Ed, 1988.

[5] D. Kleppner and R. Kolenkow, An Introduction to Mechanics, Cambridge University Press, 2010.

[6] S. L. Loney, An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Cambridge University Press, 1913.

[7] S. L. Loney, An Elementary Treatise on Statics, Cambridge University Press, 2nd Ed., 1917.

[8] A. S. Ramsey, Dynamics(Part I & Part II), CBS Publishers, 2nd Edition, 2002.

[9] J. L. Synge and B.A. Griffith, Principles of Mechanics, McGraw-Hill, 3rd Ed., 1959.

[10] S. Timoshenko and D. H. Young, Engineering Mechanics, McGraw-Hill, 5th Ed., 2017.

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

Basic Algebra

Semester : II	Paper Code : MTHM-DSCC 2-TH MMTH-MN2-TH MMTH-MDC-CC2-TH
Semester : IV	Paper Code : MMTH-MN2-TH MMTH-MDC-mn2-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 study exponential, logarithmic, trigonometric, and hyperbolic functions of a complex variable.

CO2 : To develop the ability to solve cubic and biquadratic equations.

CO3 : To acquire knowledge of equivalence relations, partial order relations, linear order relations, and composition of mappings.

CO4 : To understand the well-ordering property of positive integers, the division algorithm, and congruence relations among integers.

CO5 : To learn about the existence and uniqueness of solutions to systems of linear equations, including row reduction and echelon forms.

CO6 : To study the algebraic and geometric properties of vectors in n-dimensional space, including linear independence and its algebraic and geometric characterizations.

Group A [Marks : 25] [20 classes]

- Polar representation of complex numbers, n-th roots of unity, De Moivre's theorem for rational indices and its applications. Exponential, logarithmic, trigonometric and hyperbolic functions of complex variable.
- Theory of equations : Relation between roots and coefficients, transformation of equation, Descartes rule of signs, application of Sturm's theorem, cubic equation (solution by Cardan's method) and biquadratic equation (solution by Ferrari's method).
- Inequalities : The inequality involving $AM \geq GM \geq HM$, Cauchy-Schwartz inequality.

Group B [Marks : 25] [20 classes]

- Relation : equivalence relation, equivalence classes & partition, partial order relation, poset, linear order relation.
- Mapping : composition of mappings, relation between composition of mappings and various set theoretic operations. Meaning and properties of $f^{-1}(B)$, for any mapping $f : X \to Y$ and $B \subseteq Y$.
- Well-ordering property of positive integers, Principles of Mathematical induction, equivalence of Well-ordering property and Principles of Mathematical induction (statement only), division algorithm, divisibility and Euclidean algorithm. Prime numbers and their properties, Euclid's theorem. Congruence relation between integers. Fundamental Theorem of Arithmetic. Chinese remainder theorem. Arithmetic functions, some arithmetic functions such as φ, τ, σ and their properties.

Group C [Marks : 25] [20 classes]

- Systems of linear equations, homogeneous and non-homogeneous systems. Existence and uniqueness of solution. The matrix equation $Ax = b$, row reduction and echelon forms, uniqueness of reduced echelon form. Rank of a matrix and characterization of invertible matrices, Pivot positions, basic and free variables, parametric description of the solution set. Existence and uniqueness theorem.
- Vectors in $\mathbb{R}^n$, algebraic and geometric properties of the vectors. Vector form of a linear system and the column picture. Existence of solutions and linear combination of vectors. Geometry of linear combination and subsets spanned by some vectors. Uniqueness of solution and Linear independence of vectors. Algebraic and geometric characterizations of linearly independent subsets.

References

[1] Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, 2nd Ed., Springer Nature, 2014.

[2] W. S. Burnside and A.W. Panton, Theory of equations, Dublin University Press Series, S. Chand & Co., Pvt. Ltd., 1986.

[3] Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.

[4] Anton Howard and Chris Rorres, Elementary Linear Algebra with Supplemental Applications, 11th Ed., Wiley, 2014.

[5] K. Hoffman, R. Kunze, Linear algebra, Prentice Hall India Learning Pvt. Ltd., 2015.

[6] David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

[7] Gilbert Strang, Introduction to Linear Algebra, 5th Ed., Wellesley-Cambridge Press, 2019.

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.