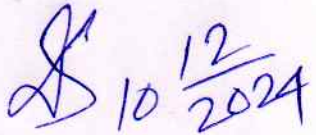# UNIVERSITY OF CALCUTTA

Notification No. CSR/138/2024

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in the exercise of her powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 05.012.2024, approved revised course Structure for all the six semesters and detail syllabus for semester 4,5 & 6 of 3-year MDC Mathematics under CCF, under this University, as laid down in the accompanying pamphlet.

The above shall take immediate effect from the Odd Semester Examinations, 2024 and onwards.

SENATE HOUSE

Kolkata-700073

10.12.2024

Prof.(Dr.) Debasis Das

Registrar

SYLLABUS
FOR
THREE -YEAR (SIX-SEMESTER)
MULTIDISCIPLINARY COURSE WITH MATHEMATICS

1. **FOLLOWING TABLE IS TO BE FOLLOWED WHEN MATHEMATICS IS THE FIRST CORE SUBJECT IN THREE-YEAR-MDC:**

CORE COURSES OFFERED (each carries 4 credits or 100 marks)		
SEMESTER	COURSE CODE	COURSE NAME
I	MATH-MD-CC-1-1-TH	Calculus Geometry and Vector Analysis
II	MATH-MD-CC-2-2-TH	Basic Algebra
III	MATH-MD-CC-3-3-TH	Ordinary Differential Equations and Group Theory
IV	MATH-MD-CC-4-4-TH	Mechanics
	MATH-MD-CC-5-4-TH	Advanced Calculus
V	MATH-MD-CC-6-5-TH	Statistics and Numerical Analysis
	MATH-MD-CC-7-5-TH	Mathematical Methods
VI	MATH-MD-CC-8-6-TH	Discrete Mathematics

2. **FOLLOWING TABLE IS TO BE FOLLOWED WHEN MATHEMATICS IS THE SECOND CORE SUBJECT IN THREE-YEAR-MDC:**

CORE COURSES OFFERED (each carries 4 credits or 100 marks)		
SEMESTER	COURSE CODE	COURSE NAME
I	MATH-MD-CC-1-1-TH	Calculus Geometry and Vector Analysis
II	MATH-MD-CC-2-2-TH	Basic Algebra
III	MATH-MD-CC-3-3-TH	Ordinary Differential Equations and Group Theory
IV	MATH-MD-CC-4-4-TH	Mechanics
	MATH-MD-CC-5-4-TH	Advanced Calculus
V	MATH-MD-CC-6-5-TH	Statistics and Numerical Analysis
VI	MATH-MD-CC-7-6-TH	Mathematical Methods
	MATH-MD-CC-8-6-TH	Discrete Mathematics

3. **FOLLOWING TABLE IS TO BE FOLLOWED WHEN MATHEMATICS IS ONE MINOR SUBJECT IN THREE-YEAR-MDC:**

MINOR COURSES OFFERED (each carries 4 credits or 100 marks)		
SEMESTER	COURSE CODE(For MC)	COURSE NAME
III	MATH-MD-MC 1-3-TH (same as MATH-MD-CC 1-1-TH)	Calculus Geometry and Vector Analysis
IV	MATH-MD-MC 2-4-TH (same as MATH-MD-CC 2-2-TH)	Basic Algebra
V	MATH-MD-MC 3-5-TH (same as MATH-MD-CC 3-3-TH)	Ordinary Differential Equations and Group Theory
	MATH-MD-MC 4-5-TH (same as MATH-MD-CC 4-4-TH)	Mechanics
VI	MATH-MD-MC 5-6-TH (same as MATH-MD-CC 5-4-TH)	Advanced Calculus
	MATH-MD-MC 6-6-TH (same as MATH-MD-CC 6-5-TH)	Statistics and Numerical Analysis

4. **SEC paper(4 credits or 100 marks): "C Language with Mathematical Applications" which is to be taught in Semester I or Semester II or Semester III.**
5. **IDC paper(3 credits or 75 marks): "Mathematics in Daily Life" which is to be taught in Semester I or Semester II or Semester III.**

MATH-MD-CC 5-4-TH

Advanced Calculus

Full Marks: 100 (Theory: 75 and Tutorial: 25)

(60 classes)

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 (application 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 ($\varepsilon - \delta$ 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 $R_n \rightarrow 0$]

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

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

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

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

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

MATH-MD-CC 6-4-TH

Statistics and Numerical Analysis

Full Marks: 100 (Theory: 75 and Tutorial: 25)

(60 classes)

Group A: Statistics

[50 Marks] [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, 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
[25 Marks] [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-spaced arguments, Lagrange's Interpolation Formula (Statement only), Related problems.

Numerical Integration: Trapezoidal rule and Simpson's 1/3-rd 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, Volume 1, 3e, Wiley, 1968.

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

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

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

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

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

[7] M. K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific

and Engineering Computation, New Age International Publishers, 4e, 2005.

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

[9] J. B. Scarborough, Numerical Mathematical Analysis, Oxford and IBH Publishing Co., 6e, 2017.

MATH-MD-CC 7-5-TH

Mathematical Methods

Full Marks: 100 (Theory: 75 and Tutorial: 25)

(60 classes)

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 [-π, π]: 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] D. Widder; Advanced Calculus; Prentice Hall, 1947.

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

[3] R. C. Wrede and M. Spiegel; Advanced Calculus, (Schaum's outline series); McGraw – Hill, 2020.

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

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

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

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

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

[9] J. Edwards, An Elementary treatise on Differential Calculus, Radha Publishers, 1992.

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

MATH-MD-CC 7-6-TH

Syllabus is same as **MATH-MD-CC 7-5-TH**

MATH-MD-CC 8-6-TH

Discrete Mathematics

Full Marks: 100 (Theory: 75 and Tutorial: 25)

(60 classes)

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] R. J. Wilson: Introduction to Graph Theory; 4th edition, Pearson, 2007.

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

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

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

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

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