RAMAKRISHNA MISSION RESIDENTIAL COLLEGE

(Autonomous)

Narendrapur, Kolkata-700103

DEPARTMENT OF MATHEMATICS

B. SC. MATHEMATICS GENERAL SYLLABUS

(w.e.f. JULY, 2015)

SEMESTER SYSTEM

1st Semester

PAPER I	:	**Group A**	: Classical Algebra	(15 marks)
(75 marks)		**Group B**	: Analytical Geometry of two and three dimensions	(25 marks)
		Group C	: Modern Algebra	(15 marks)
		Group D	: Differential Calculus	(20 marks)

2nd Semester

PAPER II	:	**Group A**	: Applications of Differential Calculus	(15 marks)
(75 marks)		**Group B**	: Differential Equations	(10 marks)
		Group C	: Linear Algebra	(30 marks)
		Group D	: Integers	(20 marks)

3rd Semester

PAPER III	:	**Group A**	: Differential Calculus	(25 marks)
(75 marks)		**Group B**	: Numerical Methods	(20 marks)
		Group C	: Linear Programming	(30 marks)

4th Semester

PAPER IV	:	**Group A**	: Evaluation of Integrals and its application	(25 marks)
(75 marks)		**Group B**	: A Course of Calculus	(50 marks)

SEMESTER - I

PAPER I (75 marks)

Group A (15 marks)

Classical Algebra

1. **Complex Numbers :** De Moivre's Theorem and its applications. Exponential, Sine, Cosine and Logarithm of a complex number. Definition of a^z, $(a \neq 0)$. Inverse circular and Hyperbolic functions.
2. **Polynomials :** Fundamental Theorem of Classical Algebra (Statement only). Polynomials with real co-efficient : The n-th degree polynomial equation has exactly n roots. Nature of roots of an equation (Surd or Complex roots occur in pairs). Statement of Descartes' Rule of signs and its applications.

   Statements of :

   (i) If the polynomial $f(x)$ has opposite signs for two real values of x e.g. a and b, the equation $f(x) = 0$ has an odd number of real roots between a and b; if $f(a)$ and $f(b)$ are of same sign, either no real root or an even number of roots lies between a and b.

   (ii) Rolle's Theorem and its direct applications.

   Relation between roots and co-efficients. Symmetric functions of roots.

   Transformations of equations. Cardan's method of solution of a cubic.

Group B (25 marks)

Analytical Geometry of Two and Three Dimensions

1. **Transformations of Rectangular axes :** Translation. Rotation and their combinations. Invariants.
2. **General equation of second degree in x and y :** Reduction to canonical forms. Classification of conic.
3. **Pair of straight lines :** Condition that the general equation of 2^{nd} degree in x and y may represent two straight lines. Points of intersection of two intersecting straight lines. Angle between two straight lines given by $ax^2 + 2hxy + by^2 = 0$. Equation of bisectors. Equation of two straight lines joining the origin to the points in which a straight line meets a conic.
4. **Equations of pair of tangents from an external point, chord of contact, poles and polars in case of General conic :** Particular cases for Parabola, Ellipse, Circle, Hyperbola.
5. **Polar equation** of straight lines and circles. Polar equation of a conic referred to a focus as pole. Equation of chord joining two points. Equations of tangent and normal.
6. **Sphere and its tangent plane**
7. **Right circular Cone**

Group C (15 marks)

Modern Algebra

1. **Introduction of Group Theory :** Definition and examples taken from various branches (examples from number system, roots of unity, 2×2 real martices, non-singular real matrices of a fixed order, Symmetric group S_3. Group of residue Classes of integers). Elementary properties using definition of Group. Definition and examples of sub-group—Statement of necessary and sufficient condition—its applications. Order of an element in a finite group. Statement and application of Lagrange's theorem on Finite group.
2. **Definitions and examples** of (i) Ring, (ii) Field, (iii) Subring, (iv) Subfield.
3. **Rank of a matrix :** Elementary row and column operation, Inverse of a matrix by elementary row operation. Determination of rank of a matrix either by considering minors or by sweep-out process. Consistency of a system of linear of equations (with not more than 3 variables) by matrix method.
4. Real Quadratic Form involving not more than three variables, its rank, index and signature—Problems only.

Group D (20 marks)

Differential Calculus

1. Rational Numbers, Geometrical representation. Irrational number. Real numbers represented as points on a linear—Line Continuum. Acquaintance with basic properties of real number (No deduction or proof is included).
2. **Real-valued functions defined on an interval :** Limit of a function (Cauchy's definition). Algebra of limits. Continuity of a function at a point and in an interval. Acquaintance (no proof) with the important properties of continuous functions on closed intervals. Statement of existence of inverse function of a strictly monotone function and its continuity
3. **Successive derivative**—Leibnitz's Theorem and its application.

   Application of the principle of Maxima and Minima for a function of single variable in geometrical, physical and other problems.
4. **Functions of two and three variables :** Their geometrical representations. Limit and Continuity (definitions only) for functions of two variables. Partial derivatives : Knowledge and use of Chain Rule. Exact differentials (emphasis on solving problems only). Function of two variables–Successive partial derivatives : Statement of Schwarz's Theorem on commutative property of mixed derivatives. Euler's theorem on homogeneous function of two and three variables. Maxima and minima of functions of not more than three variables—Problems only. Implicit function in case of function of two variables (existence assumed) and derivative.

QUESTION PATTERN

PAPER – I

Group A (15 marks)

3 questions, each carrying 5 marks are to be answered out of 6 questions covering all the topics. There will be at most 3 questions from each topic.

Group B (25 marks)

5 questions, each carrying 5 marks are to be answered out of 8 questions covering all the topics.

Group C (15 marks)

3 questions, each carrying 5 marks are to be answered out of 5 questions covering all the topics.

Group D (20 marks)

2 questions each carrying 2 marks are to be answered out of 4 alternatives.

2 questions, each of 8 marks, are to be answered out of 4 questions covering all the topics. Each question may have further parts.

SEMESTER - II

PAPER II (75 marks)

Group A (15 marks)

Applications of Differential Calculus

Tangents and Normals, Curvature (Cartesian and polar); Pedal equation and Pedal of a curve. Rectilinear Asymptotes (Cartesian only). Definition and examples of singular points (viz. Node, Cusp, Isolated point).

Group B (10 marks)

Differential Equations

1. (i) Exact equations and those reducible to such equation.
   (ii) Euler's and Bernoulli's equations (Linear).
   (iii) Clairaut's Equations : General and Singular solutions.
2. Simple applications : Orthogonal Trajectories.

Group C (30 marks)

Linear Algebra

1. Concept of Vector space over a Field : Examples, Concepts of Linear combinations, Linear dependence and independence of a finite set of vectors, Sup-space. Concepts of generators and basis of a finite-dimensional vector space. Problems on formation of basis of a vector space (No proof required).
2. Statement and application of Deletion theorem, Extension Theorem, Replacement Theorem on finite dimensional vector spaces.
3. Real Inner product space, norm, Statement of Cauchy-Schwarz inequality, Gram-Schmidt orthogonalization process, Orthonormal Basis. Stress should be on solving problems.
4. Characteristic equation of a square matrix of order not more than three, Determination of Eigen Values and Eigen Vectors of a square matrix—problems only. Statement and application of Cayley-Hamilton Theorem.
5. Diagonalization of a matrix—problems only (relevant theorems to be stated)

Group D (20 marks)

Integers

1. The division algorithm (statement only), GCD of two integers, Euclidean algorithm, Linear Diophantine equation, Congruence, Linear congruence in one variable. Statement and applications of Fermat's Little theorem and Euler's generalization of it. Euler's phi function and its simple application.

QUESTION PATTERN

PAPER – II

Group A (15 marks)

3 questions each carrying 5 marks are to be answered out of 6 alternatives. Each question may have further parts.

Group B (10 marks)

1 question of 2 marks is to be answered out of 2 questions.

2 questions, each carrying 4 marks are to be answered out of 4 questions.

Group C (30 marks)

2 questions, each carrying 3 marks are to be answered out of 5 questions. 4 questions, each carrying 6 marks are to be answered out of 6 questions. Each such question may have further parts.

Group D (20 marks)

2 questions, each carrying 2 marks are to be answered out of 4 questions. 4 questions, each carrying 4 marks are to be answered out of 6 questions. Each such question may have further parts.

SEMESTER - III

PAPER III (75 marks)

Group A (25 marks)

Differential Calculus

1. Statement of Rolle's Theorem and its geometrical interpretation. Mean Value Theorems of Lagrange and Cauchy. 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 for functions like e^x, $\sin x$, $\cos x$, $(1 + x)^n$, $\log(1 + x)$ [with restrictions wherever necessary]

   Indeterminate Forms : L' Hospital's Rule : Statement and problems only.

2. **Sequence :** Definition of bounds of a sequence and monotone sequence. Limit of a sequence. Statements of limit theorems. Concept of convergence and divergence of monotone sequences—applications of the theorems, in particular, definition of e. Statement of Cauchy's general principle of convergence and its application.

3. **Infinite series of constant terms :** Convergence and Divergence (definitions). Cauchy's principle as applied to infinite series (application only). Series of positive terms : Statements of Comparison test, D' Alembert's Ratio test. Cauchy's nth root test and Raabe's test—Applications. Alternating series: Statement of Leibnitz test and its applications.

Group B (20 marks)

Numerical Methods

1. Approximate numbers, Significant figures, Rounding off numbers. Error—Absolute, Relative and Percentage.

2. **Operators :** Δ, ∇ and E (Definitions and some relations among them).

3. **Interpolation :** The problem of Interpolation, Equispaced arguments—Difference Tables, 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). Numerical problems on Interpolation with both equi-and unequally-spaced arguments.

4. **Number Integration :** Trapezoidal and Simpson's $\frac{1}{3}$ rd formula (statement only). Problems on Numerical Integration.

5. **Solution of Numerical Equation :** To find a real root of an algebraic or transcendental equation. Location of root (Tabular method), Bisection method. Newton-Raphson method with geometrical significance. Numerical problems.

[***Note*** **:** emphasis should be given on problems]

Group C (30 marks)

Linear Programming

1. Slack and Surplus Variables, L.P.P. in matrix form. Convex set. Hyperplane, Extreme points, Convex Polyhedron, Basic solutions and Basic Feasible Solutions (B.F.S.), Degenerate and Non-degenerate B.F.S.

   The set of all feasible solutions of a L.P.P. is a convex set. The objective function of a L.P.P. assumes its optimal value at an extreme point of the convex set of feasible solutions. A B.F.S. to a L.P.P corresponds to an extreme point of the convex set of feasible solutions.

   Fundamental Theorem of L.P.P. (Statement only). Reduction of a feasible solution to a B.F.S. Standard form of a L.P.P. Solution by simplex method and method of penalty. Concept of duality. The dual of the dual is the primal. Relation between the objective values of a dual and the primal problems. Dual problems with at most one unrestricted variable, one constraint of equality.

   Transportation and Assignment problem and their optimal solutions.

QUESTION PATTERN

PAPER – III

Group A (25 marks)

1 compulsory question of 5 marks and 2 other questions of 10 marks each are to be answered following the norms mentioned below :

(i) The compulsory question will contain conceptual/objective type questions (viz. 'correct or justify', 'prove or disprove', 'true or false' etc.) of marks 2 and 3 respectively, having alternatives/options in both the cases.

(ii) 2 questions each of 10 marks are to be answered out of 4 questions. Each such question may contain further parts.

Group B (20 marks)

4 marks is reserved for short answer type/objective type questions.

2 questions, each of 2 marks are to be answered out of 4 questions.

2 questions, each of 8 marks are to be answered out of 4 questions and each such question may have further parts.

Group C (30 marks)

6 marks are reserved for short answer type/objective type questions.

3 questions, each of 2 marks are to be answered out of 5 questions.

2 questions, each of 12 marks are to be answered out of 4 questions and each such question may have further parts.

SEMESTER - IV

PAPER IV (75 marks)

Group A (25 marks)

Evaluation of integrals and its application

1. Reduction formulae of $\int \sin^m x \cos^n x\, dx$, $\int \frac{\sin^m x}{\cos^n x}\, dx$, $\int \tan^n x\, dx$ and associated problems (m and n are non-negative integers).
2. **Definition of improper Integrals :** Statements of (i) μ-test, (ii) Comparison test (Limit form excluded)—Simple problems only. Use of Beta and Gamma functions (convergence and important relations being assumed).
3. Working knowledge of Double integral.
4. **Applications :** Rectification, Quadrature, Volume and Surface areas of solids formed by revolution of plane curve and areas—Problems only.

Group B (50 marks)

A Course of Calculus

1. Concept of Point-wise and Uniform convergence of sequence of functions and series of functions with special reference of Power Series. Statement of Weierastrass M-Test for Uniform convergence of sequence of functions of functions and of series of functions. Simple applications. Statement of important properties like boundedness, continuity, differentiability and integrability of the limit function of uniformly convergent sequence of functions and of the sum function of uniformly convergent series of functions. Determination of Radius of convergence of Power Series. Statement of properties of continuity of sum function power series. Term by term integration and Term by term differentiation of Power Series. Statements of Abel's Theorems on Power Series. Convergence of Power Series. Expansions of elementary functions such as e^x, $\sin x$, $\log(1 + x)$, $(1 + x)^n$. Simple problems.
2. Fourier series on $(-\delta, \delta)$: Periodic function. Determination of Fourier co-efficients. Statement of Dirichlet's conditions of convergence and statement of the theorem on convergence of Fourier sine and Cosine series.
3. Higher order ordinary differential equation with constant co-efficients. Euler's Homogeneous Equation.
4. Second order differential equation : (a) Method of variation of parameters. (b) Method of undetermined co-efficients. (c) Simple eigen value problem.
5. Simultaneous linear differential equation with constant co-efficients.
6. Laplace Transform and its application to ordinary differential equation. Laplace Transform and Inverse Laplace Transform. Statement of Existence theorem. Elementary properties of Laplace Transform and its Inverse. Application to the solution of ordinary differential equation of second order with constant co-efficients. Simple problems only.

QUESTION PATTERN

PAPER – IV

Group A (25 marks)

(i) Answer any 2 questions from section 1 & 2 out of 4 given questions each of 5 marks.

(ii) Answer any 3 questions from Section 3 & 4 out of 5 given questions each of 5 marks.

Group A (50 marks)

Answer any 5 questions each of 10 marks (5 + 5) out of 8 given questions.

2 questions from each of section 1 & 6 and 1 question from each of Section 2, 3, 4 & 5.

REFERENCE BOOKS FOR GENERAL COURSE

A. CLASSICAL ALGEBRA

1. Basic Algebra—S. Ganguli, M.N. Mukherjee
2. Higher Algebra—Chakraborty & Ghosh
3. Higher Algebra (Classical)—S.K. Mapa
4. Algebra—R.M. Khan

B. ANALYTICAL GEOMETRY

1. Analytical Geometry—Chakraborty & Ghosh.
2. Analytical Geometry—R.M. Khan

C. LINEAR PROGRAMMING

1. Linear Programming—Chakraborty & Ghosh
2. Linear Programming—P.M. Karak
3. Linear Programming—Sanyal and Das

D. DIFFERENTIAL EQUATIONS

1. Differential Equations—Chakraborty & Ghosh
2. Differential Equations—Maity & Ghosh
3. Differential Equations—D. Murray

E. CALCULUS

1. Differential Calculus (with applications)—Das & Mukherjee
2. Integral Calculus (with applications)—Das & Mukherjee
3. A course of advanced Calculus—A Sarkar & N. Mandal
4. Application of Calculus—D. Sengupta
5. Application of Calculus : Problems and Solutions—Sitansu Bandyopadhyay and Sunil Kumar Maity

F. NUMERICAL METHODS

1. Numerical Analysis—N. Islam
2. Numerical Analysis—Sanyal & Das
3. Numerical Analysis and Statics—N. Islam & J. Banerjee

G. INTEGERS AND MODERN ALGEBRA

1. Topics in Abstract Algebra (2nd Edition)—Sen, Ghosh, Mukhopadhyay
2. Elementary Number Theory—Jones and Jones
3. Higher Algebra (Abstract and Linear)—S.K. Mapa
4. Fundamentals of Llinear Algebra—Friedberg, Insel, Spance