Detailed Syllabus

B.SC. MATHEMATICS GENERAL

PART – I

PAPER – I

GROUP – A : 25 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-efficients: The nth degree polynomial equation has exactly n roots. Nature of roots of an equation (surd or complex roots occour in pairs). Statement of Descarte's rule of signs and its applications.

Statements of:

i) If the polynomial f(x) has opposite signs for two roal 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.

3. Determinants up to the third order: Properties, Cofactor and Minor, product of two determinants. Adjoint, Symmetric and Skew-symmetric

determinants. Solutions of linear equations with not more than three variables by Cramer's Rule.

4. Matrices of Real Numbers : Equality of matrices. Addition of Matrices. Multiplication of a matrix by scalar. Multiplication of matrices — Associative properties. Transpose of matrix – Its properties. Inverse of a non-singular square matrix. Symmetric and Skew - Symmetric matrices. Scalar matrix. Orthogonal matrix. Elementary operations on matrices.

   Rank of a matrix : Determination of rank either by considering minors or by sweep-out process. Consistency and solution of a system of linear equations with not more than 3 variables by matrix method.

GROUP – B : 15 MARKS
(ANALYTICAL GEOMETRY OF TWO 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 2nd degree in x and y may represent two straight lines. Point of intersection of two intersecting straight lines. Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$. Equation of bisectors. Equation of two lines joining the origin to the points in which a 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.

GROUP – C : 15 MARKS
(VECTOR ALGEBRA)

Addition of Vectors, Multiplication of a Vector by a Scalar. Collinear and Coplanar Vectors. Scalar and Vector products of two and three vectors. Simple applications to problems of Geometry. Vector equation of plane and straight line. Volume of Tetrahedron. Applications to problems of Mechanics (Work done and Moment).

GROUP-D : 25 MARKS
(DIFFERENTIAL CALCULUS)

1. Rational numbers, Geometrical representations, Irrational number, Real number represented as point on a line - Linear 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. Acquitance (on proof) with the important properties of continuous functions no closed intervals. Statement of existence of inverse function of a strictly monotone function and its continuity.

3. Derivative - its geometrical and physical interpretation. Sign of derivative-Monotonic increasing and decreasing functions. Relation between continuity and derivability. Differential - application in finding approximation.

4. Successive erivative - Leibnitz's theorem and its application.

5. Functions of two and three vaviables: their geometrical representations. Limit and Continuity (definitions only) for function of two variables. Partial derivatives. Knowledge and use of chain Rule. Exact differentials (emphasis on solving problems only). Functions 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.

6. Applications of Differential Calculus : Tangents and Normals, Pedal equation and Pedal of a curve. Curvature of plane curves.

GROUP – E : 10 MARKS
(INTEGRAL CALCULUS)

1. Integration of the form :-
$\int \frac{dx}{a+b\cos x}$ $\int \frac{l\sin x+m\cos x}{n\sin x+p\cos x}dx$ and
Integration of Rarional functions.

2. Evaluation of definite Integrals.

3. Integration as the limit of a sum (with equally spaced as well as unequal intervals.

4. 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)

GROUP-F : 10 MARKS

(ORDINARY DIFFERENTIAL EQUATIONS)

1. Order, degree and solution of an ordinary differential equation (ODE) in presence of arbitrary constants, Formation of ODE.

   First order equations :

   i) Variables separable.

   ii) Homogeneous equations and equations reducible to homogeneous forms.

   iii) Exact equations and those reducible to such equation.

   iv) Euler's and Bernoulli's equations (Linear).

   v) Clairaut's Equations : General and Singular solutions

PART-II

PAPER-II

GROUP – A : 25 MARKS
(MODERN ALGEBRA)

1. Basic concept : Sets, Sub-sets, Equality of sets, Operations on sets : Union, intersection and complement. Verification of the laws of Algebra of sets and De Morgan's Laws. Cartesian product of two sets.

   Mappings, One-one and Onto mapping, Composition of Mappings - concept only. Identity and Inverse mappings. Binary Operations in a set. Identity element. Inverse element.

2. Introduction of Group Theory : Definition and examples taken from various branches (example from number system, roots of Unity, 2x2 real matrices, non singular real matrices of a fixed order). Elementary properties using definition of Group. Definition and examples of sub-group - Statement of necessary and sufficient condition and its applications.

3. Definitions and examples of (i) Ring, (ii) Field, (iii) Sub-ring, (iv) Sub-field.

4. Concept of Vector space over a Field : Examples, Concepts of Linear combinations, Linear dependence and independence of a finite number of vectors, Sub- space, Concepts of generators and basis of a finite-dimensional vector space. Problems on formation of basis of a vector space (No proof required).

5. Real Quadratic Form involving not more than three variables (problems only).

6. Characteristic equation of square matrix of order not more than three determination of Eigen Values and Eigen Vectors (problems only). Statement and Illustration of Cayley-Hamilton Theorem.

GROUP- B : 20 MARKS

(ANALYTICAL GEOMETRY OF THREE DIMENSIONS)

1. Rectangular Cartesian co-ordinates : Distance between two points. Division of a line segment in a given ratio. Direction cosines and direction ratios of a straight line. Projection of a line segment on another line. Angle between two straignt lines.

2. Equation of Plane : General form, Intercept and normal form. Angle between two planes. Signed distance of a point from a plane. Bisectors of angles between two intersecting planes.

3. Equations of Straight line : General and symmetric form. Distance of a point from a line. Coplanarity of two straight lines. Shortest distance between two skew lines.
4. Sphere and its tangent plane.

5. Right circular cone.

GROUP – C : 25 MARKS

(DIFFERENTIAL CALCULUS)

1. Sequence of real numbers : 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.

2. 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 comparision 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.

3. Real-Valued functions defined on an interval: 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 from of remainders. Taylor's and Maclaurin's Infinite series of functions like e^x, sinx, cosx, $(1+x)^n$, log(1+x) with restrictions wherever necessary.

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

5. Application of the principle of Maxima and Minima for a function of single variable in geometrical, physical and to other problems.
6. Maxima and minima of functions of not more than three variables Lagrange's Method of underiermined multiplier - Problems only.

7. Applications of Differential calculus : Rectilinear Asymptotes (Cartesian only). Envelope of family of straight lines and of curves (problems only). Definitions and examples of singular points (Viz. Node. Cusp, Isolated point).

GROUP-D : 20 MARKS
(INTEGRAL CALCULUS)

1. Definition of Improper Integrals : Statements of i) u-test (ii) Comparison test (Limit from excluded) - Simple problems only. Use of Beta-and Gamma functions (convergence and important relations being assumed).

2. Working knowledge of Double integral.

3. Applications : Rectification, Quardrature, volume and surface areas of solids formed by revolution of plane curve and areas problems only.

GROUP-E : 10 MARKS
(ORDINARY DIFFERENTIAL EQUATIONS)

1. Second order linear equations : Second order linear differential equation with constant co-efficients. Euler's Homogeneous equations.

1.2. Simple applications : Orthogonal Trajectories.

M.T.M.G. PAPER -3 and PAPER - 4 as in the present syllabus will remain unchanged.

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PART-II

PAPER-III

(Groups A and B are compulsory and any one of Groups C, D & E)

GROUP – A : 20 MARKS
(NUMERICAL METHODS)

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

2. Operators D, N 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 Largrange's Interpolation Formula (Statement only). Numerical problems on Interpolation with both equi-and unequally spaced arguments.

4. Numerical Integration : Trapazicial and Simpson's 1/3rd 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-B : 40 MARKS
(LINEAR PROGRAMMING)

Motivation of Linear Programming problem. Statement of L.P.P. Formulation of L.P.P. Slack and Surplus variables. L.P.P. is matrex 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 an L.P.P. is a convex set. The objective function of an L.P.P. assumes its optimal value at an extreme print of the convex set of feasible solutions, A.B.F.S. to an 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 an L.P.P. Solution by graphical method (for two variables), by simplex method and method of penalty. Concept of Duality. Duality Theory. The dual of the dual is the primal. Relation between the objective values of 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.

GROUP – C : 40 MARKS
(ANALYTICAL DYNAMICS)

1. Velocity and Acceleration of a particle. Expressions for velocity and acceleration in rectangular cartexian and polar co-ordinates for a particle moving in a plane. Tangential and normal components of velocity and acceleration of a particle moving along a plane curve.

2. Concept of Force : Statement and explanation of Newton's laws of motion.. Work, power and energy. Principles of conservation of energy

and momentum. Motion under impulsive forces. Equations of motion of a particle (i) moving in a straight line, (ii) moving in a plane.

3. Study of motion of a particles in a straight line under (i) constant forces, (ii) Variable forces (S.H. M. Inverse square law, Dampped oscillation, Forced and Damped oscillation, Motion in an elastic string). Equation of Energy Conservative forces.

4. Motion in two dimensions : Projectiles in vacuo and a medium with resistance varying linearly as velocity. Motion under forces varying as distance from a fixed point.

5. Central orbit. Kepler's laws of motion. Motion under inverse square law.

GROUP-D : 40 MARKS
(PROBABILITY & STATITICS)
(EMPHASIS ON APPLICATIONS ONLY)

A. Elements of probability Theory : Random experiment, Outcome, Event, Mutually Exclusive Events, Equally likely and Exhaustive. Classical definition of probability, Theorems of Total Probability, Conditional probability and Statistical Independence. Baye's Theorem. Problems, Shortcoming of the classical definition. Axiomatic approach problems, Random Variable and its Expectation, Theorems on mathematical expectation. Joint distribution of two random variables.

Theoretical Probability Distribution
Discrete and Continuous (p.m.f., p.d.f.) Binomial, Poisson and Normal distributions and their properties.

B. Elements of Statistical Methods. Variables, Attributes. Primary data and secondary data, Population and sample. Census and Sample Survey. Tabulation Chart and Diagram, Graph, Bar diagram, Pie diagram etc.

Frequency Distribution Un-grouped and grouped cumulative frequency distribution. Histogram, Frequency curve, Measures of Central tendencies. Averages : AM,; GM, HM, Mean, Median and Mode (their advfantages and disadvantages). Measures of Dispersions - Range, Quartile Deviation, Mean Deviation, Variance / S.D., Moments, Skewness and Kurtosis.

C. Sampling Theory : Meaning and objects of sampling. Some ideas about the methods of selecting samples, Statistic and parameter, Sampling Proportion. Four fundamental distributions, derived from the normal: (i) standard Normal Distribution, (ii) Chi-square distribution (iii) Student's distribution (iv) Snedecor's F-distribution. Estimation and Test of Significance. Statistical Inference. Theory of estimation Point estimation and Interval estimation. Confidence Interval / Confidence Limit. Statistical Hypothesis - Null Hypothesis and Alternative Hypothesis. Level of significance. Critical Region. Type I and II error. Problems.

D. Bivariate Frequency Distribution. Scatter Diagram, Co-relation co-efficient Definition and properties. Regression lines.

E. Time Series : Definition, Why to analyse Time series data? Components. Measurement of Trend (i) Moving Average method, (i) Curve Fittings (linear and quadratic curve). (Ideas of other curves, e.g. exponential curve etc.). Ideas about the measurement of other components.

F. Index number: Meaning of Index number. Construction of Price Index Number. Consumer Price Index Number. Calculation of Purchasing Power of Rupee.

GROUP – E : 40 MARKS
(ELEMENTS OF DIFFERENCE EQUATION AND CALCULUS OF VARIATION)

1. Difference equations-- Difference operator Δ. Algebra of Difference Operator. Shift Operator. Anti-difference of $\gamma(t)$. Algebra of anti-difference. Linear difference, equation with constant co-efficients. Solution of homogeneous and non-homogeneous equations.

2. Concept of functional. Difference between functional and function. Continuity of functional. Aim of calculus of variation. The variation of a functional. Statement of the necessary condition for an extremum. Euler's Equation (no proof). Extreme value of the functional

$$V[y(x)] = \int_{x_1}^{x_0} F(x)y(x),\ y'(x))dx$$

The problem of Brachistochrone. The problem of Geodesics. The Isoerimetric problem. Extremals of functional

$$L[y(x)] = \int_{x_0}^{x_1} \sqrt{1+y^{12}}\,dx,\ t[y(x)] = \int_{x_0}^{x_1} \frac{\sqrt{1+y^{12}}}{2}dx$$

Simple problems on application of Euler's equation can be decuced to 2nd order ODE with constant coefficients.

PART-III

PAPER – IV

(Any two groups from Group-A, B and C)

GROUP- A : 50 MARKS

(Elements of Computer Science and Programming)

A. Boolean algebra

Basic Postulates and Definition. Two-element Boolean algebra. Boolean Function. Truth table. Standard forms of Boolean function DNF and CNF.Minterms and maxterms. Principle of Duality.

Some laws and theorem of Boolean algebra. Simplification of Boolean expressions Algebraic method and Karnaugh Map method. Application of Boolean algebra Switching Circuits, circuit having some specified properties. Logical Gates - AND, NOT, OR, NAND, NOR etc.

B. Computer Science and Programming : Historical Development, Computer Generation, Computer Anatomy Different Components of a computer system. Operating System, hardware and Software.

Positional Number System. Binary to Decimal and Decimal to Binary. Other systems. Binary Arithmetic. Octal, Hexadecimal, etc. Storing of data in *a* Computer - BIT, BYTE, WORD etc. Coding of a data- ASCII, etc.

Programming Language : Machine language, Assembly language and High level language, Compiler and interpreter. Object Programme and source Pragramme. Ideas about some HLL-- e.g. BASIC, FORTRAN, C, C++, COBOL, PASCAL, etc.

Algorithms and Flow Charts-- their utilities and important features, Ideas about the complexities of an algorithm. Application in simple problems. FORTRAN 77/90: Introduction, Data Type-- Keywords, Constants and Variables – Integer, Real, Complex, Logical, character, subscripted variables, Fortran Expressions.

I/O statements - formatted and unformatted. Programme execution control— Logical if, if-then-else etc.. Arrays, dimension statement. Repetitive Compuation - D0. Nested Do etc.

Sub programms. --- i) Function Sub Programme
ii) Subroutine Sub programme

Elements of BASIC Programming Language : Reading Printing, Branch & Loop, Array, Functions.

Application to Simple problems. An exposure to M.S. Office, E-mail, Internet (Through Demonstration 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 to power Series. Statement of Weierstrass M-Tests for Uniform convergence of sequence of functions and of series of functions. Simple applications. Statement of important properties like boundedness, continuity, differentiability and intergrability 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 of 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 elementry functions such as e^x, sinx, log(1+x), $(1+x)^n$. Simple problems.

2. Fourier Series on ($-\pi, \pi$): 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. Third and Fourth order ordinary differential equalition 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 eigenvalue 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.

7. Partial Differential Equation (PDE): Introduction, of PDE, Formation of Solution of PDE, Lagrange's method of solution.

GROUP – C (50 MARKS)

(DISCRETE MATHEMATICS)

1. Integers : Principle of Mathematical Induction. Division algorithm. Representation of integer in an arbitary base. Prime Intergers. Some properties of prime integers. Fundamental theorem of Arithmetic. Euclid's Theorem. Linear Diophantine equations. (Statement of Principle of Mathematical Induction, Strong form of Mathematical induction. Applications in different problems. Proofs of division algorithm. Representation of an integer uniquely in an arbitrary base, change of an integer from one base to another base. Computer operations with integers - divisior of an integer, g.c.d. of two positive integers, prime integer, proof of fundamental theorem. Proof of Euclid's Theorem. To show how to find all prime numbers less then or equal to a given positive integer. Problems related to prime number, Linear Diophantine equation - when such an equation has solution, some aplications).

2. Congruences : Congruence relation on integers, Basic properties of this relation. Linear congruences, Chinese Remainder Theorem. System of Linear congruences. (Definition of Congruence - to show it is an equivalence relation, to prove the following : $a \equiv b \pmod m$ implies (i) $(a+b) = (b+c) \pmod m$ (ii) $ac=bc \pmod m$ (iii) $a^n=b^n \pmod m$. for any polynomial f (x) with integral coefficients $f(a) \equiv f(b) \pmod m$ etc. Linear Congruence, to show how to solve these congruences, Chinese remainder theorem-- Statement and proof and some applications. System of linear congruences, when solution exists - some applications).

3. Application of Congruences : Divisibility tests. Computer file Storage and Hashing functions. Round-Robin tournaments. Check-digit and an ISBN, in Universal product Code, in major credit cards. Error detecting capability, (using congruence, develop divisibility tests for integers based on their expansions with respect to different bases. If d divides (b -1) then n= (a_k a_{k-1} a_1b) is divisible by d if and only if the sum of the digits is divisible by d etc. Show that congruence can be used to schedule Round -Robin tournaments. A university wishes to store a file for each of its students in its computer. Systematic methods of arranging files have been developed based on Hashing functions h(k) ≡ k (mod m). Discuss different properties of this congruence and also problems based on this congruence. Check digits for different identification numbers - International standard book number, universal product code etc. .Theorem regarding error detecting capability).

4. Congruence Classes : Congruence classes, addition and multipication of congruence classes. Fermat's little theorem. Euler's theorem. Wilson's theorem. Some simple applications (definition of congruence Classes, Properties of congruence Classes, addition and multiplication, existence of inverse. Fermat's little theorem. Euler's theorem. Wilson's theorem - Statement, proof and some applications)

5. Recurrence Relations and Generating functions : Recurrence Relations. The method of Iteration. Linear difference equations with constant coefficients. Counting with generating functions.

6. Boolean algebra : Boolean Algebra, Boolean functions, Logic gates, Minimization of circuits.