NATIONAL UNIVERSITY

Degree (Pass) Course
1st, 2nd & 3rd year

Syllabus

Subject: Mathematics

Three Years B.Sc. Pass Course

Effective from the Session: 2013–2014

National University

Subject: Mathematics

Syllabus for Three Year B.Sc. Pass Course

Session: 2013-2014

Course content and marks distribution

Paper Code	Paper	Paper Title	Marks	Credits
		First Year		
113701	Paper-I	Fundamentals of Mathematics	100	4
113703	Paper-II	Coordinate Geometry and Vector Analysis	100	4
		Second Year		
123701	Paper-III	Calculus	100	4
123703	Paper-IV	Linear Algebra	100	4
		Third Year		
133701	Paper-V	Computer Programming and Numerical Analysis	100	4
133703	Paper-VI	Ordinary Differential Equations	100	4
133704	Paper-VII	Math Lab	100	4
		Total =	700	28

Detailed Syllabus

First Year

Paper Code	Paper	Paper Title	Marks	Credits
113701	Paper-I	Fundamentals of Mathematics	100	4

Elements of logic: Mathematical statements, Logical connectives, Conditional and bi-conditional statements. Truth tables and tautologies, Quantifiers, Logical implication and equivalence, Deductive reasoning. Methods of proof (direct, indirect and Method of Induction.)
Set Theory: Sets and subsets, Set operations, Cartesian product of two sets, De Morgan's laws.
Relations and functions: Relation and Functions, Order relation, Equivalence relations. Functions. Images and inverse images of sets Injective, surjective and bijective functions. Inverse functions.
The Real Number System: Field and order properties, Natural numbers, integers and rational numbers, Absolute value and their properties. Basic inequalities.(Including inequalities of means, powers; inequalities of Cauchy, Chebyshev, Weierstrass).
The Complex Number System: Field of Complex numbers, De Moivre's theorem and its applications.

Theory of equations: Number of roots of polynomial equation.Relations between roots and coefficients, Symmetric functions of roots, Sum of the powers of roots, Synthetic division, Des Cartes rule of signs, Multiplicity of roots, Transformation of equations.
Elementary number theory: Divisibility, Fundamental theorem of arithmetic, Congruences (basic properties only)
Summation of Series: Summation of algebrice and trigonometric series, Arithmetieo- geometric series.

Books Recommended:

1. Schaums Outline Series- *Theory and problems on set theory and related topics.*
2. S. Bernard & J M Child – *Higher algebra.*
3. Md. Abdur Rahman – *Basic Algebra*
4. Fazlur Rahman & Hafizur Rahman – F*undamentals of Mathmetics.*

Paper Code	Paper	Paper Title	Marks	Credits
113703	Paper-II	Coordinate Geometry and Vector Analysis	100	4

Two-dimensional Geometry: Transformation of coodinates, Pair of straight lines (homogeneous second degree equations, general second degree equations representing pair of straight lines, angle between pair of straight lines, bisectors of angle between pair of straight lines), General equations of second degree (reduction to standard forms, identifications, properties and tracing of conics).

Three-dimensional Geometry: Coordinates, Distance, Direction cosines and direction ratios, Planes (equation of plane, angle between two planes, distance of a point from a plane), Straight lines (equation of lines relationship between planes and lines, shortest distance) Spheres.

Vector Analysis: Vectors in plane and space. Algebra of vectors. Rectangular Components. Scatar and Vector products. Triple scalar product. Applications of vector to geometry (vector equations of straight lines and planes, areas and volunes). The gradient, divergence and curl of a vector function.

Book Recommended:

1. H. H. Askwith – *Analytic Geometry of Conic Section*
2. J. A. Hummel – *Vector Geometry*
3. Fazlur Rahman & Hafizur Rahman – *Analytic and Vector Geometry.*

Second Year

Paper Code	Paper	Paper Title	Marks	Credits
123701	Paper-III	Calculus	100	4

Functions & their graphs (Polynomial and rational functions, logarithmic and exponential functions, trigonometric functions and their inverses, hyperbolic functions and their inverses, combinations of such functions). Limit and continuity: Definitions and basic theorems on limit and continuity. limit at infinity and infinite limits Computation of limits.

Differentiation: Tangent lines and rates of change. Definition of derivative. One-sided derivatives. Rules of differentiation (proofs and applications). Successive differentiation. Leibnitz theorem (proofs and application). Related rates. Linear approximations and differentials.

Applications of Differentiation: Rolle's theorm, mean value theorem. Maximum and minimum values of functions. Concavity and points of inflection. Oplimization problems, Curvature.

Function of several variables: Limit and continuty. Partial derivatives Defferentiability. linerarization and differentials. The chain rule. Partial derivatives with constrained variables Derictional variables. Lagrange multipliers, Taylor's formula.

Integration: Antiderivatives and indefinite integrals. Techniques of integration. Definite integration using antiderivatives. Definite integration using Riemann sums. Fundamental theorems of calculus (proofs and applications). Basic properties of integration. Integration reduction.

Applications of Integration: Arc length. Plane areas. Surfaces of revolution. Volumes of solids of revolution.
Graphing in polar coordinates. Tangents to polar curves. Areas in polar coordinates. Arc length in polar coordinates.

Multiple Integration: Double integrals and iterated integrals. Double integrals over nonrectangular regions. Double integrals in polar coordinates. Area by double integral. Triple integrals and iterated integrals. Volume as a triple integrals.

Improper integrals. Tests of convergence and their applications. Gamma and Beta functions.

Indeterminate forms, L' Hospital's rule.

Approximation and Series: Taylor polynomials and series. Convergence of series. Taylor's sesies. Taylor's theorem and remainders. Differentiation and integration of series. Validity of Tailor expansions and computations with series.

Book Recommended:

1. Howard Anton : *Calculus*
2. Mohammad and Bhattacharjee : *Text Book on Differential Calculus*
3. : *Text Book on Integral Calculus*
4. Matin and Chakrabarty : *Differential Calculus*
5. Abu Yusuf : *Differential Calculus*
   : *Integral Calculus*

6. Fazlur Rahman & Hafizur Rahman : *Calculus-I & Calculus-II*

Paper Code	Paper	Paper Title	Marks	Credits
123703	Paper-IV	Linear Algebra	100	4

Matrices and Determinants:
Notion of matrix. Type of matrices. Algebra of matrics. Determinant function. Properties of determinants. Minors, Cofactors, epansion and evaluation of determinants. Elementary row and colum operations and row reduced cehelon matrices. Invertible matriees Different types of matrices, Rank of matrices.
Vectors in R^n and C^n: Review of geometric vectors in R^2 and R^3 spaces. Vectors in R^n and C^n. Inner product. Norm and distance in R^n and C^n.
System of Linear Equations: System of linear equations (homogeneous and non-homogeneous) and their solutions. Application of matrices and determinants for solving system of linear equations. Applications of system of equations in real life problems.
Vector Space: Nation of groups and fields. Vector spaces. Subspaces. Linear combination of vectors. Linear dependence of vectors. Basis and dimension of vector spaces. Row and column space of matrix. Rank of matrices. Solution spaces of systems of linear equations.
Linear Transformation: Linear transformations. Kernel and image of linear transformation and their properties. Matrix representation of linear transformations. Change of bases.
Eigenvalues and Eigenvectors: Eigenvalues and Eigenvectors. Diagonalization. Cayley-Hamilton theorem and its application.

Book Recommended:
1. Howard Anton & Chris Rorres – *Elementary Linear Algebra with Application*
2. Seymour Lipschutz (Schaum's Outline Series) – *Linear Algebra*
3. Md. Abdur Rahman - *Linear Algebra*
4. Fazlur Rahman & Hafizur Rahman - *Linear Algebra*

Third Year

Paper Code	Paper	Paper Title	Marks	Credits
133701	Paper-V	Computer Programming and Numerical Analysis	100	4

Part-I: Computer Programming

Algorithm and programs: Problem analysis and development of algorithms. Program coding, execution, design, validation and refinement.
Basic FORTRAN: Data type, operations functions, assignment statement, input-output, stop and end statement.
Control structure: Logical data type, logical if and block if, do and continue, Go to statement, While statement.
Input-output: formatted input and output, File processing.
Dimensional arrays: Arrays and subscripted variables, dimension statement, parameter and data statement, examples average group data, sorting and searching.
Multidimensional arrays: Matrix operations, Solving linear system, Functions and subroutines: Library functions and statement functions, function subprogram, subroutine, subprogram, Common statement.

Part-II: Numerical Analysis

Solutions of equations of one variable: Bisection method, Fixed point iteration, Newton-Raphson method, Error analysis for iterative method.
Interpolation and polynomial approximation: Taylor polynomials, Interpolation and Lagrange polynomial, Iterated interpolation.
Numerical differentiation & integration: Numerical differentiation with backward – difference formula, forward difference formula, Adaptive quadrature method, Trapezium method, Simpson method, Matrix algebra and system of equations. Matrix operations, Gauss-Jordan elimination method. SOR Method. (Successive over-Relaxation method).

Books Recommended:

1. Schaum's Outline Series : Fortram 77
2. V. Rajaraman : Fortram 90/95
3. S. S. Kuo : *Numerical methods & Computers*
4. Burdin & J. D. Faires : *Numerical Analysis*
5. S. S. Shastry : *Introductory Methods of Numerical Analysis*
6. হোসাইন, ভট্টাচার্য, ইলিয়াস : *সাংখ্যিক বিশেণ্ঢষণ*

Paper Code	Paper	Paper Title	Marks	Credits
133703	Paper-VI	Ordinary Differential Equations	100	4

1. **Ordinary differential equations and their solutions:** Definition and formation of differential equations. Classification of differential equations. Solutions. Implicit solutions. Singular solutions. Initial value problems. Boundary value problems. Basic existence and uniqueness theorems (statement and illustration only). Direction fields. Phase line.
2. **Solution of first order Differential equations :** Separable equations. Linear equations. Exact equations. Special integrating factors. Substitutions and transformations. Homogeneous equations. Bernoulli equation. Riccati equation. First order higher degree equation-solvable for x, y and p. Clairaut's equation.
3. **Modelling with first order differential equations:** Construction of differential equations as mathematical models (exponential growth and decay, heating and cooling, mixture of solution. Series circuit, logistic growth, chemical reaction, falling bodies). Model solutions . and interpretation of results. Orthogonal trajectories.
4. **Solution of higher order linear equations:** Linear differential operators. Basic theory of linear differential equations. Solution space of homogeneous linear equations. Fundamental solutions of homogeneous solutions. Reduction of orders, Homogeneous linear equations with constant coefficients. Non-homogeneous equation. Method of undetermined coefficients. Variation of

parameters. Euler-Cauchy differential equation.

5. **Series solutions of second order linear equations :** Taylor series solutions. Frobenious series solutions. Series solutions of Legendre, Bessel, Laguerre and Hermite equations and their solutions.

Books Recommended:

1. S.L. Ross- *Diferential Equations.*
2. Denis *Gill-Introduction to Diferential Equations.*
3. Frank Ayres, J R. *Theory and Problems of Difrential Equations.*
4. Martin Braun. *An introduction to Diferential Equations and their Applications.*
5. কুদ্দুস, আওয়াল, হাফিজ - *Ordinary differential Equation*

Paper Code	Paper	Paper Title	Marks	Credits
133704	Paper-VII	Math Lab	100	4

Problem-solving using Mathematica: Running the package. Numerical computation. Algebraic computation. Mathematical functions. Derivatives and integrals. Limits and series. Determinents and matrices. Graphics. Standard packages. Solving problems in Algebra, Geometry, Calculus, differential equations and Computing. Problems will be selected from courses studied in the first and second years.

Students are required to work on their assignments in the sessions.

Evaluation: Internal Assessment (Laboratory works): 30 marks. Final Exam (Lab) (4 hours): 70 marks.

Books Recommended:

1. Schaum's Outline Series – *Mathematica*
2. Worlfarm's Research (Student edition) – *Mathematica*