NATIONAL UNIVERSITY

Syllabus

Department of Mathematics

Four Year B.Sc Honours Course
Effective from the
Session : 2009–2010

National University

Subject: Mathematics

Syllabus for Four Year B.Sc. Honours Course

Effective from 2009-2010 Session

Course content and marks distribution

Third Year

SubjectCode	Subject Title	Marks	Credits
3772	Abstract Algebra	100	4
3773	Real Analysis	100	4
3774	Numerical Analysis	100	4
3775	Complex Analysis	100	4
3776	Differential Geometry	100	4
3777	Mechanics	100	4
3778	Linear Programming	100	4
3780	Math Lab (Practical)	100	4
		800	**32**

Course Code	3772	Marks: 100	Credits: 4	Class Hours: 60
Course Title:	Abstract Algebra			

Congruence: Equivalence relations and equivalence classes. Congruence modulo *n*. Addition and multiplication of residue classes.

Groups : Definition. Subgroups. Cyclic groups. Order of an element. Permutation groups. Symmetric groups. Homomorphisms and isomorphisms. Cosets. Lagrange's theorem. Normal subgroups. Factor groups. The isomorphism theorems.

Rings : Definition and simple properties. Commutative rings. Integral domains and fields. Ideals and factor rings. Ring homomorphisms. Ordered integral domains.

Polynomials : Polynomials in one and several indeterminates over a ring. Division algorithm. Uniqueness of factorization in Polynomial domain.

Fields : Definition and simple properties. The characteristic. Subfields. Algebraic extensions. Splitting fields. Finite fields.

Books Recommended :

1. W. K. Nicholoson: *Introduction to Abstract Algebra*
2. Neal H. Mecoy: *Introduction to Abstract Algebra.*
3. Hiram. Paley and P. M. Weichsel: *First Course in Abstract Algebra.*
4. P. B. Bhattacharya. S. K. Jain, S. R. Nagpaul: *Basic Abstract Algebra.*
5. F. Chowdhury, M. R. Chowdhury: *A Textbook of Abstract Algebra.*

Course Code	3773	Marks: 100	Credits: 4	Class Hours: 60
Course Title:	Real Analysis			

Real numbers as complete ordered fields: Supremum and infimum principles. Dedekind theorem and its equivalence. Archimedian property. Denseness of rational and irrational numbers.

Topology of real line : Neighborhoods. Open and closed sets. Limit points and Bolzano-Weierstrass theorem. Interior, boundary and closure. Compact sets. Hiene-Borel theorem. Connected sets.

Real sequences: Convergence. Theorems on limits. Subsequential limits. Limit superior & limit inferior, Monotone sequence. Cauchy sequence. Absolute convergence.

Infinite series of real numbers: Convergent and divergent series. Test for convergence (comparison tests, root test, ratio test, integral test, Raabe's test, Gauss's test). Rearrangements.

Real continuous functions: Local properties. Global properties (global continuity theorem, Preservation of compactness, maximum and minimum value theorem, intermediate value theorem, preservation of connectedness, uniform continuity).

Differentiability of real functions : Basic properties. Rolle's theorem. Mean value theorem. Taylor's Theorem.

Integration of real functions : Riemann sum and Riemann integral. Conditions for integrability. Properties of integrals. Darboux theorem. Fundamental theorem of calculus. Mean value theorem for integrals. Leibnitz theorem on differentiation under integral sign. Riemann-Stieltjes integration.

Sequences and Series of Real Numbers: Point-wise convergence and uniform convergence. Tests for uniform convergence. Cauchy criterion. Weierstrass *M* –test. Continuity, differentiability and integrability of limit functions of sequences and series of functions.

Euclidean *n*-spaces : Norms in R^n. Distance in R^n. Convergence and completeness. Compactness. Continuous functions and their properties.

Books Recommended :

1. Kenneth A. Ross : *Elementary Analysis: The theory of Calculus.*
2. Robert G. Bartle, Donald R. Sherbert : *Introduction to Real Analysis.*
3. Walter Rudin: *Principles of Mathematical Analysis.*

Course Code	3774	Marks: 100	Credits: 4	Class Hours: 60
Course Title:	Numerical Analysis			

Solution of equation in one variable: **Bisection algorithm. Method of false position. Fixed point iteration. Newton-Raphson method. Convergence analysis.**

Interpolation and polynomial approximation: Taylor polynomials. Interpolation and Lagrange polynomial. Iterated interpolation. Extrapolation.

Differentiation and Integration: Numerical differentiation. Richardson's extrapolation. Elements of Numerical Integration. Adaptive quadrature method. Romberg's integration. Gaussian quadrature.

Solutions of linear systems: Gaussian elimination and backward substitution. Pivoting strategies. LU decomposition method.

1. Iterative techniques in matrix algebra: **Linear systems of equations. Error estimations and iterative refinement. Eigenvalues and eigenvectors. The power method. Householder's method. Q-R method.**
2. Initial value problems for ODE : **Euler's and modified Euler's method. Higher order Taylor's method. Single-step method (Runge-Kutta, extrapolation), Multi-step method (Adams-Bashforth, Adams-Moulton, Predictor-Corrector).**
3. Boundary value problems for ODE: **Shooting method for linear and nonlinear problems. Finite difference method for linear and nonlinear problems.**

Books Recommended :

1. R. L. Burden & J. D. Faires, *Numerical Analysis.*
2. M. A. Celia & W. G. Gray, *Numerical Methods for Differential Equations.*
3. L. W. Johson & R. D. Riess, *Numerical Analysis.*

Course Code	3775	Marks: 100	Credits: 4	Class Hours: 60
Course Title:	Complex Analysis			

Metric Properties of complex plane.

Functions of a complex variable. Differentiability of a complex function. Analytic functions and their properties. Harmonic functions.

Complex integration: Line integration over rectifiable curves. Cauchy-Goursat theorem. Cauchy's integral formulae. Fundamental theorem of algebra. Liouville's theorem. Morera's theorem .

Different types of singularities. Residues. Taylor's and Laurent's expansion. Entire functions. Meromorphic function. Cauchy's residue theorem. Evaluation of integrals by contour integration. Branch points and cuts. Rouche's theorem. The maximum modulus principle.

Conformal mapping. Bilinear transformations.

Books Recommended :

1. Ruel V. Churchill- *Complex Variables and Applications.*
2. Schaum's Outline Series- *Complex Variables.*

Course Code	3776	Marks: 100	Credits: 4	Class Hours: 60
Course Title:	Differential Geometry			

Curves in space: Vector functions of one variable. Space curves. Unit tangent to a space curve. Equation of a tangent line to a curve. Osculating plane.

Vector function of two variables. Tangent and normal plane for the surface $f(x,y,z)=0$. Principal normal. Binormal. Curvature and torsion. Serret- Frenet formulae. Theorems on curvature and torsion.

Helices and their properties. Circular helix. Spherical indicatrix, Curvature and torsion for spherical indicatrices. Involute and Evolute of a given curve. Bertrand curves.

Surface: Curvilinear coordinates, parametric curves, Analytical representation, Monge's form of the surface, first fundamental form, relation between coefficients E, F, G; properties of metric, angle between any two directions and parametric curves, condition of orthogonality of parametric curves, elements of area, unit surface normal, tangent plane, Weingarten equations (or derivatives of surface normal).

Second fundamental form, Normal curvature. Meusrier's theorem. Curvature directions. Condition of orthogonality of curvature directions. Principal curvatures. Lines of curvature. First curvature mean curvature, Gaussian curvature, centre of curvature, Rodrigues' formula.

Euler's Theorem. Elliptic, hyperbolic and parabolic points. Dupin Indicatrix. asymptotic lines. Third Fundamental form.

Books Recommended :

1. L. P. Eisenhart : *An Introduction to Differential Geometry.*
2. Schaum's Outline Series : *Differential Geometry.*
3. C. E. Weatherburn : *Differential Geometry of three dimensions.*
4. D. J. Struik: *Lectures on Classical Differential Geometry.*
5. T. T. Willmore : *An Introduction to Differential Geometry.*

Course Code	3777	Marks: 100	Credits: 4	Class Hours: 60
Course Title:	Mechanics			

Motion of a particle in one dimension: Momentum and energy equations. One-dimensional motion under variable forces. Falling bodies. Simple harmonic oscillator. Damped harmonic oscillator. Forced harmonic oscillator.

Motion of a particle in two or three dimensions: Kinetics in a plane. Kinematics in three dimensions. Momentum and energy theorems. Plane and vector angular momentum theorems. Projectiles. Harmonic oscillator in two and three dimensions. Motion under a central force. Elliptic orbits. Hyperbolic orbits.

Gravitation : Centers of gravity of solid bodies. Gravitational field and gravitational potential.

Lagrange's equations: Generalized coordinates. Lagrange's equations. Systems subject to constraints.

Motion of rigid bodies: Moment of inertia. D'Alembert's principle. Motion about fixed axes.

Books Recommended :

1. S. L. Loney- *An Elementary treatise on Statics.*

2. S. L. Loney- *An Elementary treatise on the Dynamic of a Particle & of Rigid Bodies.*

3. L. A. Pars : *Introduction to Dynamics.*

Course Code	3778	Marks: 100	Credits: 4	Class Hours: 60
Course Title:	Linear Programming			

1. Convex sets and related theorems.
2. Introduction to linear programming. Feasibility and optimality.
3. Formulation of linear programming problems.
4. Graphical solutions.
5. Simplex method. Two phase and Big-M simplex methods.
6. Duality of linear programming and related theorems. Dual simplex method.
7. Sensitivity analysis in linear programming.
8. Transportation and assignment problems.

Book Recommended:

1. F. S. Hiller and G. T. Lieberman : *Linear Programming.*

2. P. R. Thie : *Introduction to Linear Programming and Game theory.*

3. N. S. Kambu : *Mathematical Programming Techniques.*

4. Hamdy A. Taha : *Operations Research.*

Course Code	3780	Marks: 100	Credits: 4	Class Hours: 60
Course Title:	Math Lab (Practical)			

Problem solving in concurrent courses (e.g., Calculus, Complex Analysis, Numerical Analysis, Linear Programming, and Mechanics) using FORTRAN.

Lab Assignments: There shall be at least 15 lab assignments. Evaluation: Internal Assessment (Laboratory works): 30 marks. Final Exam (Lab : 3 hours) : 70 marks