NATIONAL UNIVERSITY

Fourth Year Syllabus
Department of Mathematics

Four Year B.Sc Honours Course
Effective from the Session : 2013–2014

National University

Subject: Mathematics

Syllabus for Four Year B.Sc Honours Course

Effective from the Session: 2013-2014

Year wise Papers and marks distribution

FOURTH YEAR

Paper Code	Paper Title	Marks	Credits
243701	Theory of Numbers	100	4
243703	Topology &Functional Analysis	100	4
243705	Methods of Applied Mathematics	100	4
243707	Tensor Analysis	100	4
243709	Partial Differential equations	100	4
243711	Hydrodynamics	100	4
	Any Two of **the following**		
243713	Discrete Mathematics	100	4
243715	Astronomy	100	4
243717	Mathematical Modeling in Biology	100	4
243718	Math Lab (Practical)	100	4
243720	Viva-Voce (Comprehensive)	100	4
	Total =	1000	40

Detailed Syllabus

Paper Code	243701	**Marks: 100**	**Credits: 4**	**Class Hours: 60**
Paper Title:	Theory of Numbers			

Arithmetic in Z. Euclidean algorithm. Continued fractions.
The ring *Z,* and its group of units. Chinese remainder theorem. Linear Diophantine equations.
Arithmetical functions. Dirichlet convolution. Multiplicative function.
Representation by sum of two and four squares.
Arithmetic of quadratic fields. Euclidean quadratic fields.

Books Recommended :

1. Niven, H. S. Zuckerman : *An Introduction to the Theory of Numbers.*
2. G. H. Hardy & E. M. Wright, *An introduction to Theory of Numbers.*
3. I. S. Niven and H. S. Zuckermann, *An introduction to Theory of Numbers.*
4. W. J. LeVeque, *Fundamentals of Number Theory.*
5. Fazlur Rahman – *Theory of Numbers*

Paper Code	243703	**Marks: 100**	**Credits: 4**	**Class Hours: 60**
Paper Title:	Topology and Functional Analysis			

Metric Spaces: Definition with examples. Open sets. Closed sets. Convergence. Completeness. Baire's theorem. Continuous mappings. Spaces of continuous functions. Euclidean and unitary spaces.
Topological Spaces: Definition with examples. Elementary concepts. Open bases and open subbases. Weak topologies. Function algebras.
Compactness: Compact spaces. Product spaces. Tychonoff 's theorem. Locally compact spaces. Compactness for metric spaces.
Separation: T_I-spaces and Hausdorff spaces. Completely regular spaces and normal spaces.
Connectedness: Connected spaces. Locally connected spaces. Pathwise connectedness.
Banach Spaces: Definition with examples. Continuous linear transformations. Hahn-Banach theorem. Natural embedding. Open mapping theorem. Conjugate of an operator.
Hilbert Spaces: Definition and simple properties. Orthogonal complements. Orthogonal sets. Conjugate spaces. Adjoint and self-adjoint operators.
Fixed point theory : Banach contraction principle (with proof). Schauder Principle. (without proof). Applications.

Books Recommended :

1. G. Simons – *Introduction to Topology and Modern Analysis.*
2. S. Willard- *General Topology.*

3. Fatema Chowdhury and Munibur Raman Chowdhury – Essentials of Topology and Functional Anlysis

4. Fazlur Rahman – *Topology*

5. Fazlur Rahman - *Functional Analysis*

Paper Code	243705	**Marks: 100**	**Credits: 4**	**Class Hours: 60**
Paper Title:	Methods of Applied Mathematics			

Fourier Series: Fourier series and its convergence. Fourier sine and cosine series. Properties of Fourier series. Operations on Fourier series. Complex form. Applications of Fourier series.

Laplace transforms: Basic definitions and properties, Existence theorem. Transforms of derivatives. Relations involving integrals. Laplace transforms and application to initial value problems and ordinary differential equations. Transforms of periodic functions. Transforms of convolutions . Inverse transform. Calculation of inverse transforms. Applications.

Fourier transforms: Fourier transforms. Inversion theorem. sine and cosine transforms. Transforms of derivatives. Transforms of rational functions. Convolution theorem. Parseval's theorem. Applications to boundary value problems and integral equation.

Special functions: Gamma and Beta functions. Error function. Legendre functions (Generating function, recurrence relations and other properties of Legendre polynomials, Legendre differential equation, Legendre function of the first kind, Legendre function of the second kind, associated Legendre functions). Bessel functions (Generating function, recurrence relations, Bessel differential equation, Integral representations, Orthogonality relations, Modified Bessel functions). Laguerrre polynomials (Generating function, Rodrigue formula, Orthogonality relations, Recurrence relations). Hermite polynomials (Generating function, Rodrigue formula, orthogonal properties, Hermite differential equation, recurrence relations). Hypergeometric and confluent hypergeometric functions. Expansion theorem.

Eigenvalue problems and Strum-Liouville boundary value problems: Regular Strum-Liouville boundary value problems. Nonhomogeneous boundary value problems. Solution by eigenfunction expansion. Green's functions. Singular Strum-Liouville boundary value problems.

Book Recommended :

1. R. V. Churchill & J. W. Brown- *Fourier series & boundary value problmes.*
2. M. R. S. Piekel- (*i*) *Fourier analysis with application to boundary value problems*
   (ii) Laplace Transforms.
3. L. A. Pipes & L. R. Harvill- *Applied mathematics for engineering and physics.*
4. W. N. Lebedev & R.A. Silverman, *Special Functions and their Applications.*
5. M. R. Spiegel, Schaum's Outline Series: *Laplace Transforms.*

Paper Code	243707	**Marks: 100**	**Credits: 4**	**Class Hours: 60**
Paper Title:	Tensor Analysis			

Coordinates, vectors and tensors: Curvilinear coordinates. Kronecker delta. Summation convention. Space of *n*-dimensions. Euclidean and Riemannian spaces. Coordinate transformation. Contravariant and covariant vectors. The tensor concept. Symmetric and skew-symmetric tensors.

Riemannian metric and metric tensors: Basis and reciprocal basis vectors. Euclidean metric in three dimensions, Reciprocal or conjugate tensors. Conjugate metric tensor. Associated vectors and tensor's length. Angle between two vector's. The Christoffel symbols.

Covariant Differentiation of Tensors : Covariant derivatives of tensors. Covariant curvature tensor. The Ricci identity. The Ricci tensor. Scalar Curvature. Bianchi's identity.

Application of Tensors: Applications of tensor analysis to elasticity theory and electromagnetic theory.

Book Recommended :

1. Schaum's Outline Series : *Vector and Tensor Analysis.*
2. B. Spain : *Tensor Calculus.*
3. C. E. Weatherburn : *An Introduction to Riemannian Geometry and the Tensor Calculus.*
4. A.J. McConnell, *Applications of Tensor Analysis.*

Paper Code	243709	**Marks: 100**	**Credits: 4**	**Class Hours: 60**
Paper Title:	Partial Differential Equations			

First order equations: Complete integral. General solution. Cauchy problems. Method of characteristics for linear and quasilinear equations. Charpit's method for finding complete integrals. Methods for finding general solutions.

Second order equations: Classifications. Reduction to canonical forms. Characteristic curves.

Boundary value problems: Boundary value problems related to linear equations. Applictions of Fourier methods (Coordinate systems and separability, Homogeneous equations, Nonhomogeneous boundary conditions, Inhomogeneous equations.)

Problems involving symmetry: Problems involving cylindrical and spherical symmetry, Boundary value problems involving special functions.

Transform methods for boundary value problems: (Applications of the Laplace transforms; applications of Fourier sine and cosine transforms). Inhomogeneous equations.

Books Recommended :

1. J. N. Sneddon- *Elements of Partial Differential Equations.*
2. J. M. Kar – *Partial Differential Equations.*
3. B. Epsteim - *Partial Differential Equations.*
4. Schaum's outline Series - B. Epsteim - *Partial Differential Equations.*

Paper Code	243711	**Marks: 100**	**Credits: 4**	**Class Hours: 60**
Paper Title:	Hydrodynamics			

Velocity and acceleration of fluid particles. Relation between local and individual rates. Steady and unsteady flows. Uniform and nonuniform flows. Stream lines. Path lines. Bernoulli's equations and its application.

Rotational and irrotational flows, velocity potential vorticity and, vortex lines. Equation of continuity in spherical and cylindrical polar coordinates. Boundary surfaces.

Euler's equation of motion. Conservative field of force. Lamb's hydrodynamical equations of Motion. Motion under conservative body force. Vorticity equation(Helmholtz's vorticity equation)

Motion in two-dimensions. Stream function. Physical meaning of stream function. Velocity in polar-Coordinates. Relation between stream function and velocity potential.

Circulation and vorticity. Relation between circulation and vorticity. Kelvin's circulation theorem, Kelvin's minimum energy theorem. Generalized Joukowki's transformation. Elliptic coordinates and its application.

The circle theorem. Motion of a circular cylinder. Pressure at any point on a circular cylinder. Application of circle theorem. Blasius theorem.

Sources, sinks and doublets. Complex potential and complex velocity. Stagnation points. Complex potential due to sources and doublets, Image in two and three dimensions. Stoke's stream function.

Vortex motion. Complex potential due to vortex motion.

Wave motion. Mathematical representation of wave. Surface wave, Canal wave, Long wave.

Books Recommended :

1. L. M. Milne, Thomson - *Theoretical Hydrodynamics.*
2. F. Chorlton - *A Text Book of Fluid dynamics.*
3. P. P. Gupta - *Hydrodynamics.*

Paper Code	243713	**Marks: 100**	**Credits: 4**	**Class Hours: 60**
Paper Title:	Discrete Mathematics			

Mathematical reasoning: Inference and fallacies. Methods of proof. Recursive definitions. Program verification.

Combinatorics: Counting- principles. Inclusion-exclusion principle. Pigeonhole principle. Generating functions. Recurrence relations. Applications to computer operations.

Algorithms and their efficiency : Searching algorithms. Sorting algorithms. Bin packing algorithms. Algorithms on integer operations. Recursive algorithms.

Graphs: **Structure and symmetry of graphs, adjasency matrix, Trees and connectivity. Eulerian and Hamiltonian graphs Diagraphs. Directed graphs. Planar graphs.**

Algorithms on graphs : Introduction to graphs, paths and trees. Shortest path problems (Dijkstra's algorithm, Floyd-Warshall algorithm and their comparisons). Spanning tree problems. (Kruskal's greedy algorithm, Prim's greedy algorithm and their comparisons).

Network flows: Flows and cuts. Flow augmentation algorithms. Application of max-flow min-cut theorem.

Books Recommended :

1. Schaum's Outline Series – *Discrete Mathematics.*
2. Kenth H.Rosen – *Discrete Mathematics and it's Application.*
3. Fazlur Rahman - *Discrete Mathematics.*
4. C.I. Liu - *Discrete Mathmatics.*

Paper Code	243715	Marks: 100	Credits: 4	Class Hours: 60
Paper Title:	Astronomy			

Sphere and spherical triangles. (Celestial sphere) Astronomical Co-ordinate systems. Conversion of Coordinates system . planetary motion, Keplar's laws. Equation of time. Unit of time. Astronomical refraction, Aberation, Parallax (Geocentric annual) Precession and nutation, Eclipses. Solar System. Stellar astronomy.

Books Recommended :

1. S.K. Bhattacharjee, *A Text Book of Astronomy*
2. K.K. Dey –Astronomy
3. Tod Hunter – *Spherical Trigonometry*
4. J.M. Kar – *Astronomy*
5. A.F.M. Abdur Rahman – *A Text Book of Modern Astronomy*..
6. Kvjx c` `vm –Astronomy
7. M. L Khanna – *Spheriacal Astronomy.*

Paper Code	243717	Marks: 100	Credits: 4	Class Hours: 60
Paper Title:	**Mathematical Modeling in Biology**			

Continuous population models for single species: Continuous growth models. Mathusiam model, Logistic model, Delay models. Periodic fluctuations. Harvesting models.

Discrete population models for single species: Simple models. Discrete logistic models. Discrete delay models. Fishery management models

Continuous models for interacting populations: Predator-prey models. Lotka-Volterra systems. Complexity and stability. Periodic behavior. Competition Models. Mutualism, war models.

Discrete growth models for interacting populations: Predator-prey models. Competition models.

Epidemic models and dynamics of infectious diseases: Simple epidemic models (SI model, SIS model, SIR model) and practical applications. (HIV/AIDS model), control of epidemic model.

Books Recommended :

1. J. C. Frauenthal : *Introduction to Population Modeling.*
2. 'D.N. Burghes and M.S. Bowie: *Modeling with Differential Equations.*
3. J.D. Murray : *Mathematical Biology.*
4. Fazlur Rahman – *Mathemalical Modeling in Biology.*

Paper Code	243718	**Marks: 100**	**Credits: 4**	**Class Hours: 60**
Paper Title:	Math Lab (Practical)			

Using Mathematica:

Geometry , Linear Algebra, Calculas, Vector calculas, Complex Analysis, Numerical Analysis, Ordinay differential Equation, Mehtods of Applied Mathematics.

Using Fortran:

Numerical Analysis, Complex Analysis, Linear Programming.

Evaluation: Internal Assessment (Laboratory works): 30 marks

Final Exam (Lab 3 hours): 70 marks.

Paper Code	243720	**Marks: 100**	**Credits: 4**	**Class Hours: 60**
Paper Title:	Viva- Voce			