DHAKA UNIVERSITY
AFFILIATED COLLEGES

Third Year Syllabus
Department of Mathematics

Four Year B Sc Honours Course
Effective from the Session: 2019–2020

Affiliated Colleges

Subject: Mathematics

Syllabus for Four Year B Sc Honours Course

Effective from the Session: 2019-2020

Year wise Courses and marks distribution

THIRD YEAR

Subject Code	Title	Marks	Credits
MAT 301	Real Analysis	100	3
MAT 302	Complex Analysis	100	3
MAT 303	Ordinary Differential Equations II	100	3
MAT 304	Abstract Algebra	100	3
MAT 305	Mathematical Methods	100	3
MAT 306	Numerical Analysis II	100	3
MAT 307	Optimization	100	3
MAT 308	Mechanics	100	3
MAT 309	Differential Geometry	100	3
MAT 350	Math Lab III (Fortran)	100	3
MAT 399	Viva Voce	100	2

Detailed Syllabi

Subject Code	MAT 301	Marks: 100	Credits: 3	Hours: 45
Subject Title:	Real Analysis			

1. Bounded sets of real numbers. Supremum and infimum. The completeness axiom and its consequences. Dedekind's theorems. Archimedian property, Densencess of rational and irrational numbers. properties of Cluster (limit) points; Bolzano-Weierstrass theorem. Compact sets, Hiene-Borel theorem, connected sets.
2. Infinite sequences. Convergence. Theorems on limits. Monotone sequences, subsequences. Cauchy's general principle of convergence. Cauchy's first and second theorems on limits.
3. Infinite series of real numbers: convergence and absolute convergence. Tests for convergence; Gauss's tests (simplified form). Alternating series (Leibnitz's test). Product of infinite series.
4. Properties of continuous functions (with proofs). Intermediate value theorem.
5. The derivative : standard theorems (Rolle's theorem, Mean value theorem, Taylor's theorem Darboux's theorem.)
6. The Riemann integral; definitions via Riemann's sums and Darboux's sums. Darboux's theorem. (equivalence of the two definitions) Necessary and sufficient conditions for integrability. Classes of integrable functions. Fundamental theorem of calculus.
7. Euclidean n-spaces: Norm and distance in n-spaces. Converges and completeness, compactness. Continuous functions and their properties .

Evaluation: Incourse Assessment 30 Marks. Final examination (Theory, 3 hours). 70 Marks
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. K. A. Ross : Elementary Analysis : The Theory of Calculus.
2. R. G. Bartle, & D. R. Sherbert : Introduction to Real Analysis.
3. W. Rudin : Principles of Mathematical Analysis.
4. M. Ramzan Ali Sarder : Elements of Real Analysis.

Subject Code	MAT 302	Marks: 100	Credits: 3	Hours: 45
Subject Title:	Complex Analysis			

1. Complex plane: Metric properties and geometry of the complex plane. The point at infinity. Stereographic projection.
2. Functions of a complex variable: Limit, continuity and differentiability of a complex function. Analytic functions and their properties. Harmonic functions.
3. Complex integration: Line integration over rectifiable curves. Winding number. Cauchy's theorem. Cauchy's integral formula. Liouville's theorem. Fundamental theorem of Algebra. Rouche's theorem. The maximum and the minimum modulus principle.
4. Singularities: Power series of complex terms. Residues, Taylor's and Laurent's expansion. Cauchy's residue theorem. Evaluation of integrals by contour integration. Branch points and cuts.
5. Bilinear transformations and mappings: Basic mapping. Linear fractional transformations. Other mappings. Conformal mappings.

Evaluation: Incourse Assessment 30 Marks. Final examination (Theory, 4 hours). 70 Marks

Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. R.V. Churchill & J.W. Brown, Complex Variables and Applications.
2. L. Penniri, Elements of Complex Variables.
3. U. P. Palka, An Introduction to Complex Function Theory.
4. L.V. Ahlfors, Complex Analysis, McGraw-Hill
5. D G Zill, P.D. Shanahn, Complex Analysis: A first course with Applications.
6. M.R. Spiegel, Complex Variables Schaum's outline series
7. S Ponnusamy & Herb Silverman, Complex Variable with Applications.

Subject Code	**MAT 303**	**Marks: 100**	**Credits: 3**	**Hours: 45**
Subject Title:	**Ordinary Differential Equations II**			

1. Existence and uniqueness theory: Fundamental existence and uniqueness theorem. Dependence of solutions on initial conditions and equation parameters. Existence and uniqueness theorems for systems of equations and higher-order equations.
2. Series solutions of second order linear equations: Taylor series solutions about an ordinary point. Frobenius series solutions about regular singular points.
3. Legendre functions (Generating function, recurrence relations and other properties of Legendre polynomials, Expansion theorem, Legendre differential equation, Legendre function of first kind, Legendre function of second kind, associated Legendre functions).
4. Bessel functions (Generating function, recurrence relations, Bessel differential equation, Integral representations Orthogonality relations, Modified Bessel functions).
5. Hermite polynomials, Laguerre polynomials (Generating function, Rodrigue's formula, orthogonal properties, Hermite and Laguerre differential equation, recurrence relations, expansion theorems).
6. Special functions: Gamma function. Error function. Hyper geometric function (Hyper geometric equation, special hyper geometric function, Generalized hyper geometric function, special confluent hyperbolic functions).
7. Systems of linear first order differential equations: Elimination method. Matrix method for homogeneous linear systems with constant coefficients. Variation of parameters. Matrix exponential.

Evaluation: Incourse Assessment 30 Marks. Final examination (Theory, 3 hours). 70 Marks

Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. S. L. Ross, Differential Equations
2. D. G. Zill, A First Course in Differential Equations with Applcations.
3. F. Brauer & J. A. Nohel, Differential Equations.
4. H.J.H. Piaggio, An Elementary Treatise on Differential Equations
5. W.N. Lebedev & R.A. Silverman, Special Functions and their Applications.

Subject Code	MAT 304	Marks: 100	Credits: 3	Hours: 45
Subject Title:	Abstract Algebra			

Group

1. Groupoids. Semigroups. Monoids. Order of an element of a group. Cyclic group.
2. Subgroups. Algebra of complexes. Subgroup generated by a complex. Cosets. Coset decompositions. Lagrange's theorem. Normal subgroups. Quotient (factor) groups. Product of cosets.
3. Permutation groups. Symmetric groups of permutations. Cyclic permutations. Transpositions. Even and odd permutations. Altering groups.
4. Homomorphisms and isomorphisms of groups. Cayley's theorem. Automorphism. Inner automorphism. Outer automorphism. The isomorphism theorems.

Ring

5. Rings. Various types of rings. Properties of rings. Characteristic of a ring.
6. Subring. Ideal. Principle ideal. Maximal ideal. Prime ideal. Quotient ring.
7. Homomorphism of rings. Isomorphism theorems. Embedding of an integral domain in a field
8. Divisibility. Units. Associates. Highest common factor (HCF). Least common multiple (LCM). Coprimes. Prime elements. Irreducible elements. Principal ideal domains. Euclidean domains. Unique factorization domains.

Evaluation: Incourse Assessment 30 Marks. Final examination (Theory, 3 hours): 70 Marks

Eight questions of equal value will be set, of which any **five** are to be answered taking at least **two** from each part.

References

1. P.B. Bhattarcharya, S.K. Jain & S.R. Nagpaul, Basic Abstract Algebra.
2. W.K. Nicholson, Introduction to Abstract Algebra.
3. J.B. Fraleigh, Introduction to Abstract Algebra.
4. M.Artin, Algebra.
5. R S Aggarwal, A Text Book on Modern Algebra

Subject Code	MAT 305	Marks: 100	Credits: 3	Hours: 45
Subject Title:	Mathematical Methods			

1. Fourier Series: Fourier series and its convergence. Fourier sine and cosine series. Properties of Fourier series. Operations on Fourier series. Complex from. Applications of Fourier series.
2. Laplace transforms: Basic definitions and properties, Existence theorem. Transforms of derivatives. Relations involving integrals. Laplace transforms of periodic functions. Transforms of convolutions. Inverse transform. Calculation of inverse transforms. Use of contour integration. Applications to boundary differential equations.
3. Fourier transforms: Fourier transforms. Inversion theorem. Sine and cosine transforms. Transform of derivatives. Transforms of rational function. Convolution theorem. Parseval's theorem. Applications to boundary value problems and integral equation.
4. Eigenvalue problems and Strum-Liouvile boundary value problems: Regular Strum-Liouville boundary value problems. Non-homogeneous boundary value problems and the Fredholm

alternative. Solution by eigenfunction expansion. Green's functions. Singular Strum Liouville boundary value problems/Oscillation and comparison theory.

Evaluation: Incourse Assessment 30 Marks. Final examination (Theory, 4 hours): 70 Marks

Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. R.V. Churchill & J. W. Brown, Fourier Series and Boundary value problems.
2. W.N. Lebedev & R.A. Silverman, Special Functions and their Applications.
3. E. Kreuszig, Advanced Engineering Mathematics.
4. M. R. Spiegel, Laplace Transforms, Schaum's Outline Series.
5. S. L. Ross, Differential Equations

Subject Code	MAT 306	Marks: 100	Credits: 3	Hours: 45
Subject Title:	Numerical Analysis II			

1. Iterative techniques in matrix algebra: Eigenvalues and eigenvectors, the power method, Householder's method, Q-R method.
2. Nonlinear system of equations: Fixed point for functions of several variables, Newton's method, Quasi-Newton's method, Steepest Descent techniques.
3. Initial value problems for ODE : Euler's and modified Euler's method, Higher order Taylor's method, Single-step methods (Runge-Kutta methods, extrapolation methods-higher order differential equations and systems of differential equations), Multi-step methods (Adams-Bashforth, Adams-Moulton, Predictor-Corrector), error and stability analysis. Numerical solutions of Systems of Differential Equations (IVP)
4. Boundary value problem for ODE: Shooting method for linear and nonlinear problems, Finite difference methods for linear and nonlinear problems, the Rayleigh-Ritz Method (Piecewise Linear, and cubic splines).
5. Finite difference method for PDEs: Numerical Solution of initial boundary value problems (heat equation, one and two way wave equations in one space dimension only), 2D Elliptic BVPs using finite difference method.

Evaluation: Incourse Assessment 30 Marks. Final examination (Theory, 3 hours). 70 Marks

Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. R.L. Burden & J.D. Faires, Numerical Analysis.
2. Eddre Suli and Devid F Mayers, Introduction to Numerical Analysis., second edition
3. K. Atkinson & W. Han Kendall Atkinson, Weimin Han, Theoretical Numerical Analysis: A Functional Analysis Framework
4. M.A. Celia & W.G. Gray, Numerical Methods for Differential Equations.
5. L.W. Johson & R.D. Riess, Numerical Analysis.

Subject Code	**MAT 307**	**Marks: 100**	**Credits: 3**	**Hours: 45**
Subject Title:	**Optimization**			

1. Introduction: Convex sets and related theorems, introduction to linear programming (LP)
2. Formulation: Formulation of LP problems.
3. Solution Techniques: Graphical solutions, Simplex method, Two -phase and Big-M simplex methods.
4. Duality and Sensitivity: Duality and related theorems, Dual simplex method, shadow prices and Sensitivity analysis of LP.
5. Introductory concepts of Nonlinear programming (NLP): Classification of NLP problems, Convexity of Nonlinear functions, Gradient and Hessian matrix and related theorems.
5. Solution Techniques of constrained NLPs: Lagrange's Multiplier method, Kuhn-Tucker method.
7. Solution of Quadratic programming (QP): Complementary pivot method, Wolfe's method etc.

Evaluation : Incourse Assessment 30 Marks. Final examination (Theory, 3 hours) 70 Marks.
Eight questions will be set, of which any five are to be answered. AMPL, LINDO, LINGO, Mathematica, or MAT-LAB can be used for analyzing the solutions.

References

1. W.L. Winston: Operations Research: Applications and algorithms, 4th edition, CENGAGE Learning publisher, USA.
2. Hiller and Lieberman: Introduction to operations research.
3. C. Van De Panne: MethodS for LPs and QPsS.I. Gass, Linear Programming.
4. G. Hadley, Linear Programming.
5. N.S. Kambo, Mathematical Programming Techniques.
6. Ravindran, Phillips & Solberg, Operations Research.

Subject Code	**MAT 308**	**Marks: 100**	**Credits: 3**	**Hours: 45**
Subject Title:	**Mechanics**			

1. General conditions of equilibrium. Principle of virtual work. Stable and unstable equilibrium. Centre of gravity.
2. Rectilinear motion.
3. Motion in a plane. Motion of a particle under a central force.
4. Motion of a particle in space.
5. Motion of rigid bodies. Moment of inertia. D'alembert's principle.
6. Motion about fixed axes.
7. Motion in two dimensions.

References :

1. S.L. Loney : Statics.
2. L.A. Pars : Introduction to Dynamics.
3. S.L. Loney : Analytical Dynamics of a Particle.

Evaluation : Incourse Assessment 30 Marks. Final examination (Theory, 4 hours). 70 Marks
Eight questions of equal value will be set, of which any **five** are to be answered.

Subject Code	**MAT 309**	**Marks: 100**	**Credits: 3**	**Hours: 45**
Subject Title:	**Differential Geometry**			

1. 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 (or Plane of curvature).
2. Vector functions of two variables. Tangent and normal plane to the surface $f\ (x\ ,y\ ,z\ )=0$. Principal normal, binormal and Funamental planes, equation of principal normal and biromal line, curature and torsion, Serret-Frent's formulae, theorems on curature and torsion.
3. Helices and their properties, Circular helix. Spherical indicatrix of tagent, normal and binormal, curature and torsion of spherical indicatrieces, Involutes and evolutes, Bertand curves.
4. Surface: Curvilinear coordinates, parametric curves, Analytical representation, Monge's form of the surface, first fundamental form or metric geometrical represenation of metric, 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).
5. Second fundamental form, Normal curvature, Meusrier's theorem, curvature directions, condition of orthogonality of curvature direction, Principal curvatiures, lines of curvature, first curvature, mean curvature, Gaussian curvature, centre of curvature, Rodrigues's formula.
6. Euler Euler's Theorem, Elliptic, hyperbolic and parabolic points, Dupin Indicatrix, asymptotic lines, Third Fundamental form, Theorem of BeltramiEnnerper.

Evaluation: Incourse Assessment 30 Marks. Final examination (Theory, 3 hours): 70 Marks
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. M.L. Khanna, Differential Geometry.
2. M.M. Lispchutz, Theory and Problems of Differential Geometry.
3. D.J. Struik, Lecturer on Classical Differential Geometry.
4. C.E. Weatherburn, Differential Geometry of Three Dimensions.

Subject Code	**MAT 250**	**Marks: 100**	**Credits: 3**	**Hours: 45**
Subject Title:	**Math Lab II (Fortran)**			

Problem Solving in concurrent courses (Complex Analysis, Numerical Analysis and Applied Mathematics, Linear Programming) using FORTRAN.

Lab Assignments: There shall be at least 5 lab assignments

Evaluation: Internal Assessment (Laboratory works). 40 Marks
Final Examination (Lab, 3 hours). 60 Marks

Subject Code	**MAT 399**	**Marks: 100**	**Credits: 2**	
Subject Title:	**Viva Voce**			

Viva Voce on courses taught in the Third Year.