University of Kalyani

CBCS CURRICULUM FOR SEMESTERIZED UNDER-GRADUATE COURSE

IN

Mathematics (HONOURS)

WITH EFFECT FROM THE ACADEMIC SESSION

2018-19

CBCS CURRICULUM FOR SEMESTERIZED UNDER-GRADUATE COURSE IN Mathematics (HONOURS)

INTRODUCTION:

The University Grants Commission (UGC) has taken various measures by means of formulating regulations and guidelines and updating them, in order to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions in India. The various steps that the UGC has initiated are all targeted towards bringing equity, efficiency and excellence in the Higher Education System of country. These steps include introduction of innovation and improvements in curriculum structure and content, the teaching-learning process, the examination and evaluation systems, along with governance and other matters. The introduction of Choice Based Credit System is one such attempt towards improvement and bringing in uniformity of system with diversity of courses across all higher education institutes in the country. The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising of core, elective, skill enhancement or ability enhancement courses. The courses shall be evaluated following the grading system, is considered to be better than conventional marks system. This will make it possible for the students to move across institutions within India to begin with and across countries for studying courses of their choice. The uniform grading system shall also prove to be helpful in assessment of the performance of the candidates in the context of employment.

Outline of the Choice Based Credit System being introduced:

1. **Core Course (CC):** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. **Elective Course:** Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the student’s proficiency/skill is termed as an Elective Course.

   2.1 **Discipline Specific Elective Course (DSEC):** Elective courses that are offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

   2.2 **Generic Elective Course (GEC):** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

3. **Ability Enhancement Courses/ Skill Enhancement Courses:**

   3.1 **Ability Enhancement Compulsory Course (AECC):** Ability enhancement courses are the courses based upon the content that leads to Knowledge enhancement. They (i) Environmental Science, (ii) English Communication) are mandatory for all disciplines.

   3.2 **Skill Enhancement Course (SEC):** These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

CBCS CURRICULUM FOR SEMESTERIZED UNDER-GRADUATE COURSE IN Mathematics (HONOURS)

A. TOTAL Number of courses in UG-CBCS (B.A./B.Sc. Hons.):

Types of course	Core course (CC)	Elective course		Ability enhancement course		TOTAL
		Discipline specific elective course (DSE)	Generic elective course(GE)	Ability Enhancement compulsory course (AECC)	Skill Enhancement course (SEC)	
No. of course	14	4	4	2	2	26
Credit/course	6	6	6	2	2	140

TABLE-1: DETAILS OF COURSES & CREDIT OF B.A./ B.SC. (HONOURS) UNDER CBCS

S. No.	Particulars of Course	Credit Point	
1.	**Core Course: 14 Papers**	**Theory + Practical**	**Theory + Tutorial**
1.A.	Core Course: Theory (14 papers)	14x4 = 56	14x5 = 70
1.B.	Core Course (Practical/Tutorial)*(14 papers)	14x2 = 28	14x1 = 14
2.	**Elective Courses: (8 papers)**		
2.A.	A. Discipline specific Elective(DSE)(4 papers)	4x4 = 16	4x5 = 20
2.B.	DSE (Practical / Tutorial)* (4 papers)	4x2 =8	4x1 =4
2C.	General Elective(GE) (Interdisciplinary) (4 papers)	4x4 = 16	4x5 = 20
2.D.	GE (Practical / Tutorial)* (4 papers)	4x2 =8	4x1 =4
#Optional Dissertation/ Project Work in place of* one *DSE paper (6 credits) in 6th semester			
3. Ability Enhancement Courses			
A.	AECC(2 papers of 2 credits each) ENVS, English Communication/ MIL	2x2 = 4	2x2 = 4
B.	Skill Enhancement Course(SEC) (2 papers of 2 credits each)	2x2 = 4	2x2 = 4
	Total Credit:	**140**	**140**
## ***Wherever there is a practical, there will be no tutorial and vice- versa.***			

TABLE-2: SEMESTERWISE DISTRIBUTION OF COURSE & CREDITS IN B.A./B.SC. HONS

Courses/ (Credits)	Sem-I	Sem-II	Sem-III	Sem-IV	Sem-V	Sem-Vi	Total No. of Courses	Total credit
CC (6)	2	2	3	3	2	2	14	84
DSE (6)	--	--	--	--	2	2	04	24
GE (6)	1	1	1	1	--	--	04	24
AECC (2)	1	1			--	--	02	04
SEC (2)	--	--	1	1	--	--	02	04
Total No. of Course/ Sem.	4	4	5	5	4	4	26	--
Total Credit /Semester	**20**	**20**	**26**	**26**	**24**	**24**	**------**	**140**

TABLE-3: SEMESTER & COURSEWISE CREDIT DISTRIBUTION IN IN B.A./B.COM/B.SC. (Hons.)
(6 Credit: 75 Marks)

SEMESTER-I			
Course Code	**Course Title**	**Course wise Class (L+T+P)**	**Credit**
MATH-H-CC-T-01	Calculus, Geometry & Differential Equations	5:1:0	6
MATH-H-CC-T-02	Algebra	5:1:0	6
MATH-H-GE-T-01	Differential Calculus	5:1:0	6
AECC-T-01	Environmental Studies	2:0:0	2
Total	**4 courses**	**Total**	**20**
SEMESTER-II			
Course Code	**Course Title**	**Course Nature**	**Credit**
MATH-H-CC-T-03	Real Analysis	5:1:0	6
MATH-H-CC-T-04	Differential Equations and Vector Calculus	5:1:0	6
MATH-H-GE-T-02	Differential Equations	5:1:0	6
AECC-T-02	English/Modern Indian Language	2:0:0	2
Total	**4 courses**	**Total**	**20**
SEMESTER-III			
Course Code	**Course Title**	**Course Nature**	**Credit**
MATH-H-CC-T-05	Theory of Real Functions & Introduction to Metric Spaces	5:1:0	6
MATH-H-CC-T-06	Group Theory I	5:1:0	6
MATH-H-CC-T-07	Numerical Methods & Numerical Methods Lab	5:1:0	6
MATH-H-GE-T-03	Real Analysis	5:1:0	6
MATH-H-SEC-T-01	A. Logic and Sets B. Computer Graphics (Choose any one)	2:0:0	2
Total	**5 courses**	**Total**	**26**
SEMESTER-IV			
Course Code	**Course Title**	**Course Nature**	**Credit**
MATH-H-CC-T-08	Riemann Integration and Series of Functions	5:1:0	6
MATH-H-CC-T-09	Multivariate Calculus	5:1:0	6
MATH-H-CC-T-10	Ring Theory and Linear Algebra I	5:1:0	6
MATH-H-GE-T-04	Algebra	5:1:0	6
MATH-H-SEC-T-02	A. Graph Theory B. Operating System (Linux) (Choose any one)	2:0:0	2
Total	**5 courses**	**Total**	**26**
SEMESTER-V			
Course Code	**Course Title**	**Course Nature**	**Credit**
MATH-H-CC-T-11	Partial Differential Equations and Applications	5:1:0	6
MATH-H-CC-T-12	Group Theory-II	5:1:0	6
MATH-H-DSE-T-01	A. Linear Programming B. Point Set Topology (Choose any one)	5:1:0	6x2=12
MATH-H-DSE-T-02	A. Probability & Statistics B. Differential Geometry (Choose any one)	5:1:0	
Total	**4 courses**	**Total**	**24**
SEMESTER-VI			
Course Code	**Course Title**	**Course Nature**	**Credit**
MATH-H-CC-T-13	Metric Spaces and Complex Analysis	5:1:0	6
MATH-H-CC-T-14	Ring Theory and Linear Algebra II	5:1:0	6
MATH-H-DSE-T-03	A. Fuzzy Set Theory B. Number Theory (Choose any one)	5:1:0	6x2=12
MATH-H-DSE-T-04	A. Mechanics B. Bio Mathematics (Choose any one)	5:1:0	
Total	**4 courses**	**Total**	**24**
Total (All semesters)	***26 courses***	***Total***	***140***

Detail Course & Contents of Mathematics (Honours) syllabus

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-I
Course: MATH-H-CC-T-01
Course title: Calculus, Geometry & Differential Equations
Core Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits(5+1) (Theory + Tutorial)

Unit 1. Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$, concavity and inflection points, envelopes, asymptotes, curve tracing in cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule, applications in business, economics and life sciences.

Unit 2. Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin nx\, dx$, $\int \cos nx\, dx$, $\int \tan nx\, dx$, $\int \sec nx\, dx$, $\int (\log x)^n\, dx$, $\int \sin^n x \sin^m x\, dx$, parametric equations, parameterizing a curve, arc length of a curve, arc length of parametric curves, area under a curve, area and volume of surface of revolution, techniques of sketching conics.

Unit 3. Reflection properties of conics, rotation of axes and second degree equations, classification of conics using the discriminant, polar equations of conics.

Spheres. Cylindrical surfaces. Central conicoids, paraboloids, plane sections of conicoids, generating lines, classification of quadrics, illustrations of graphing standard quadric surfaces like cone, ellipsoid.

Unit 4. Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.

Graphical Demonstration (Teaching Aid)

1. Plotting of graphs of function e^{ax+b}, log(ax + b), 1/(ax + b), sin(ax + b), cos(ax + b), |ax + b| and to illustrate the effect of a and b on the graph.
2. Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
3. Sketching parametric curves (Eg. trochoid, cycloid, epicycloids, hypocycloid).
4. Obtaining surface of revolution of curves.
5. Tracing of conics in Cartesian coordinates/ polar coordinates.
6. Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, and hyperbolic paraboloid using Cartesian coordinates.

SUGGESTED READINGS/REFERENCES:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.

4. S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
5. E. Rukmangadachari, Differential equations, Pearson
6. P.R. Vittal, Analytical Geometry 2D and 3D, Pearson
7. Murray, D., Introductory Course in Differential Equations, Longmans Green and Co.
8. G.F.Simmons, Differential Equations, Tata Mcgraw Hill.
9. T. Apostol, Calculus, Volumes I and II.
10. S. Goldberg, Calculus and mathematical analysis.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-I
Course: MATH-H-CC-T-02
Course title: Algebra
Core Course; Credit-6; Full Marks-75

COURSE CONTENT:

6 Credits(5+1) (Theory + Tutorial)

Unit 1. Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications.

Theory of equations: Relation between roots and coefficients, transformation ofequation, Descartes rule of signs, cubic and biquadratic equation.

Inequality: The inequality involving AM≥ GM≥ HM, Cauchy-Schwartz inequality.

Unit 2. Equivalence relations. Functions, composition of functions, Invertible functions, one to one correspondence and cardinality of a set. Well-ordering property of positive integers, division algorithm, divisibility and Euclidean algorithm. Congruence relation between integers. Principles of Mathematical induction, statement of Fundamental Theorem of Arithmetic.

Unit 3. Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence.

Unit 4. Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. Subspaces of R^n, dimension of subspaces of R^n, rank of a matrix, Eigen values, eigen vectors and characteristic equation of a matrix. Cayley-Hamilton theorem and its use in finding the inverse of a matrix.

SUGGESTED READINGS/REFERENCES:

1. TituAndreescu and DorinAndrica, Complex Numbers from A to Z, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
3. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
4. K.B. Dutta, Matrix and linear algebra.
5. M.K. Sen, S. Ghosh and P. Mukhopadhyay, Abstract Algebra, University Press
6. P.K. Saikai, Linear Algebra, Pearson
7. K. Hoffman, R. Kunze, Linear algebra.
8. W.S. Burnstine and A.W. Panton, Theory of equations.

B.A./B.Sc.. Other than Mathematics (Honours)
SEMESTER-I
Course: MATH-H-GE-T-01
Course title: Differential Calculus
General Elective Course; Credit-6; Full Marks-75

Limit and Continuity (ε and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem On homogeneous functions.

Tangents and normal Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of sin x, cos x, ex, log(l+x), (l+x)n, Maxima and Minima, Indeterminate forms.

SUGGESTED READINGS/REFERENCES:

1. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002.
2. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-II
Course: MATH-H-CC-T-03
Course title: Real Analysis
Core Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits(5+1) (Theory + Tutorial)

Unit 1. Review of algebraic and order properties of R, ε-neighborhood of a point in R. Idea of countable sets, uncountable sets and uncountability of R. Bounded above sets, bounded below sets, bounded sets, unbounded sets. Suprema and infima. Completeness property of R and its equivalent properties. The Archimedean property, density of rational (and Irrational) numbers in R, intervals. Limit points of a set, isolated points, open set, closed set, derived set,illustrations of Bolzano-Weierstrass theorem for sets, compact sets in R, Heine-Borel Theorem.

Unit 2. Sequences, bounded sequence, convergent sequence, limit of a sequence, liminf, lim sup. Limit theorems. Monotone sequences, monotone convergence theorem. Subsequences, divergence criteria. Monotone subsequence theorem (statement only), Bolzano Weierstrass theorem for sequences. Cauchy sequence, Cauchy's convergence criterion.

Unit 3. Infinite series, convergence and divergence of infinite series, Cauchy criterion, tests for convergence: comparison test, limit comparison test, ratio test, Cauchy's nth root test, integral test. Alternating series, Leibniz test. Absolute and conditional convergence.

Graphical Demonstration (Teaching aid)

1. Plotting of recursive sequences.
2. Study the convergence of sequences through plotting.
3. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent sub sequences from the plot.
4. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.

5. Cauchy's root test by plotting nth roots.
6. Ratio test by plotting the ratio of nth and (n+1)th term.

SUGGESTED READINGS/REFERENCES:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones& Bartlett, 2010.
3. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
4. S.K. Berberian, a First Course in Real Analysis, Springer Verlag, New York, 1994.
5. T. Apostol, Mathematical Analysis, Narosa Publishing House
6. Courant and John, Introduction to Calculus and Analysis, Vol I, Springer
7. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
8. V. Karunakaran, Real Analysis, Pearson
9. Terence, Tao, Analysis I, Hindustan Book Agency, 2006.
10. S. Goldberg, Calculus and mathematical analysis.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-II
Course: MATH-H-CC-T-04
Course title: Differential Equations & Vector Calculus
Core Course; Credit-6; Full Marks-75

COURSE CONTENT:

6 Credits (5+1) (Theory + Tutorial)

Unit 1. Lipschitz condition and Picard's Theorem (Statement only). General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.

Unit 2. Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients,

Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.

Unit 3. Equilibrium points, Interpretation of the phase plane

Power series solution of a differential equation about an ordinary point, solution bout a regular singular point.

Unit 4. Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions.

Graphical demonstration (Teaching aid)

1. Plotting of family of curves which are solutions of second order differential equation.
2. Plotting of family of curves which are solutions of third order differential equation.

SUGGESTED READINGS/REFERENCES:

1. Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab, 2nd Ed., Taylor and Francis group, London and New York, 2009.
2. C.H. Edwards and D.E. Penny, Differential Equations andBoundary Value problemsComputing and Modeling, Pearson Education India, 2005.
3. S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
4. Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.
5. P.K. Nayak, Vector Algebra and Analysis With Application, University Press.
6. E. Rukmangadachari, Differential equations, Pearson
7. Murray, D., Introductory Course in Differential Equations, Longmans Green and Co.
8. Boyce and Diprima, Elementary Differential Equations and Boundary Value Problems, Wiley.
9. G.F.Simmons, Differential Equations, Tata McGraw Hill
10. Marsden, J., and Tromba, Vector Calculus, McGraw Hill.
11. Maity,K.C. and Ghosh, R.K. Vector Analysis, New Central Book Agency (P) Ltd. Kolkata (India).
12. M.R. Speigel, Schaum's outline of Vector Analysis.

B.A./B.Sc.. Other than Mathematics (Honours)
SEMESTER-II
Course: MATH-H-GE-T-02
Course title: Differential Equations
General Elective Course; Credit-6; Full Marks-75

COURSE CONTENT:

6 Credits(5+1) (Theory + Tutorial)

First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x, y, p. Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties.

Solving a differential equation by reducing its order.

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations.

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method.

Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.

SUGGESTED READINGS/REFERENCES:

1. Shepley L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1967.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-III
Course: MATH-H-CC-T-05
Course title: Theory of Real Functions & Introduction to Metric Space
Core Course; Credit-6; Full Marks-75

COURSE CONTENT:

6 Credits(5+1) (Theory + Tutorial)

Unit 1. Limits of functions (ε - δ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

Unit 2. Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. Rolle's theorem. Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials.

Unit 3. Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, ln (1 + x), 1/(ax + b) and$(x+1)^n$. Application of Taylor's theorem to inequalities.

Unit 4. Metric spaces: Definition and examples. open and closed balls, neighbourhood,open set, interior of a set. Limit point of a set, closed set, diameter of a set, subspaces, dense sets, separable spaces.

SUGGESTED READINGS/REFERENCES:

1. R. Bartle and D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, 2003.
2. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004.
3. A. Mattuck, Introduction to Analysis, Prentice Hall, 1999.
4. S.R. Ghorpade and B.V. Limaye, a Course in Calculus and Real Analysis, Springer, 2006.
5. T. Apostol, Mathematical Analysis, Narosa Publishing House
6. V. Karunakaran, Real Analysis, Pearson
7. Courant and John, Introduction to Calculus and Analysis, Vol II, Springer
8. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
9. Terence Tao, Analysis II, Hindustan Book Agency, 2006
10. SatishShirali and Harikishan L. Vasudeva, Metric Spaces, Springer Verlag, London, 2006
11. S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House,2011.
12. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill,2004.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-III
Course: MATH-H-CC-T-06
Course title: Group Theory 1
Core Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits(5+1) (Theory + Tutorial)

Unit 1. Symmetries of a square, dihedral groups, definition andexamples of groups including permutation groups and quaternion groups (through matrices), elementary properties of groups.

Unit 2. Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

Unit 3. Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

Unit 4. External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

Unit 5. Group homomorphisms, properties of homomorphisms, Cayley'stheorem, properties of isomorphisms. First, Second and Third isomorphism theorems.

SUGGESTED READINGS/REFERENCES:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
4. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
5. R.K. Sharma, S.K. Shah and A.G. Shankar, Algebra-I, Pearson
6. U.M. Swamy, A.R.S.N. Murthy, Algebra, Pearson
7. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.
8. D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-III
Course: MATH-H-CC-T-07
Course title: Numerical Methods & Numerical Methods Lab
Core Course; Credit-6; Full Marks-75

Numerical Methods

COURSE CONTENT: 6 Credits (4+2) (Theory + Practical)

Unit 1. Algorithms. Convergence. Errors: relative, absolute. Round off. Truncation.

Unit 2. Transcendental and polynomial equations: Bisection method, Newton's method, secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods.

Unit 3. System of linear algebraic equations: Gaussian elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. LU decomposition

Unit 4. Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation.

Numerical differentiation: Methods based on interpolations, methods based on finite differences.

Unit 5. Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpsons 3/8th rule, Weddle's rule, Boole's Rule. Midpoint rule, Composite trapezoidal rule, composite Simpson's 1/3rd rule, Gauss quadrature formula.

The algebraic eigen value problem: Power method.

Approximation: Least square polynomial approximation.

Unit 6. Ordinary differential equations: The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four.

SUGGESTED READINGS/REFERENCES:

1. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering
3. Computation, 6th Ed., New age International Publisher, India, 2007.
4. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.
5. Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.
6. P.S. Das, C. Vijayakumari, Numerical analysis, Pearson
7. John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.
8. Scarborough, James B., Numerical Mathematical Analysis, Oxford and IBH publishing co.
9. YashavantKanetkar, Let Us C , BPB Publications.

Numerical Methods Lab

List of practical (using any software)

1. Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.
2. Enter 100 integers into an array and sort them in an ascending order.
3. Solution of transcendental and algebraic equations by
    - i) Bisection method
    - ii) Newton Raphson method.
    - iii) Secant method.
    - iv) RegulaFalsi method.
4. Solution of system of linear equations
    - i) LU decomposition method
    - ii) Gaussian elimination method
    - iii) Gauss-Jacobi method
    - iv) Gauss-Seidel method
5. Interpolation
    - i) Lagrange Interpolation

ii) Newton Interpolation

6. Numerical Integration
   i) Trapezoidal Rule
   ii) Simpson's one third rule
   iii) Weddle's Rule
   iv) Gauss Quadrature
7. Method of finding Eigenvalue by Power method
8. Fitting a Polynomial Function
9. Solution of ordinary differential equations
   i) Euler method
   ii) Modified Euler method
   iii) RungeKutta method

Note: For any of the CAS (Computer aided software) Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

B.A./B.Sc.. Other than Mathematics (Honours)
SEMESTER-III
Course: MATH-H-GE-T-03
Course title: Real Analysis
General Elective Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R, intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.

Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).

Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test(Tests of Convergence without proof). Definition and examples of absolute and conditional convergence.

Sequences and series of functions, Pointwise and uniform convergence. Mn-test, M-test, Statements of the results about uniform convergence and integrability and differentiability of functions, Power series and radius of convergence.

SUGGESTED READINGS/REFERENCES:

1. T. M. Apostol, Calculus (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
2. R.G. Bartle and D. R Sherbert, Introduction to Real Analysis, John Wiley and Sons (Asia) P.Ltd., 2000.
3. E. Fischer, Intermediate Real Analysis, Springer Verlag, 1983.

4. K.A. Ross, Elementary Analysis- The Theory of Calculus Series- Undergraduate Texts in Mathematics, Springer Verlag, 2003.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-III
Course: MATH-H-SEC-T-1A
Course title: Logic and Sets
Skill Enhancement Course; Credit-2; Full Marks-25

COURSE CONTENT: 2 Credits (Theory)

Unit 1. Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, quantifiers, binding variables and negations.

Unit 2. Sets, subsets, set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

Unit 3. Difference and Symmetric difference of two sets. Set identities, generalized union and intersections. Relation: Product set. Composition of relations, types of relations, partitions, equivalence Relations with example of congruence modulo relation. Partial ordering relations, n- ary relations.

SUGGESTED READINGS/REFERENCES:

1. R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
2. P.R. Halmos, Naive Set Theory, Springer, 1974.
3. E. Kamke, Theory of Sets, Dover Publishers, 1950.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-III
Course: MATH-H-SEC-T-1B
Course title: Computer Graphics
Skill Enhancement Course; Credit-2; Full Marks-25

COURSE CONTENT: 2 Credits (2+0) (Theory + Tutorial)

Unit 1. Development of computer Graphics: Raster Scan and Random Scan graphics storages, displays processors and character generators, colour display techniques, interactive input/output devices.

Unit 2. Points, lines and curves: Scan conversion, line-drawing algorithms, circle and ellipse generation, conic-section generation, polygon filling anti-aliasing.

Unit 3. Two-dimensional viewing: Coordinate systems, linear transformations, line and polygon clipping algorithms.

SUGGESTED READINGS/REFERENCES:

1. D. Hearn and M.P. Baker, Computer Graphics, 2nd Ed., Prentice–Hall of India, 2004.
2. J.D. Foley, A van Dam, S.K. Feiner and J.F. Hughes, Computer Graphics: Principals andPractices, 2nd Ed., Addison-Wesley, MA, 1990.
3. D.F. Rogers, Procedural Elements in Computer Graphics, 2nd Ed., McGraw Hill BookCompany, 2001.
4. D.F. Rogers and A.J. Admas, Mathematical Elements in Computer Graphics, 2ndEd.,McGraw Hill Book Company, 1990.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-IV
Course: MATH-H-CC-T-08
Course title: Riemann Integration and Series of Functions
Core Course; Credit-6; Full Marks-75

COURSE CONTENT:

6 Credits (5+1) (Theory + Tutorial)

Unit 1. Riemann integration: inequalities of upper and lower sums, Darbaux integration, Darbaux theorem, Riemann conditions of integrability, Riemann sum and definition of Riemann integral through Riemann sums, equivalence of two definitions. Riemann integrability of monotone and continuous functions, properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions.

Intermediate Value theorem for Integrals; Fundamental theorem of Integral Calculus.

Unit 2. Improper integrals. Convergence of Beta and Gamma functions.

Unit 3. Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions;

Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.

Unit 4. Fourier series: Definition of Fourier coefficients and series, ReimannLebesgue lemma, Bessel's inequality, Parseval's identity, Dirichlet's condition. Examples of Fourier expansions and summation results for series.

Unit 5. Power series, radius of convergence, Cauchy Hadamard theorem. Differentiation and integration of power series; Abel's theorem; Weierstrass approximation theorem.

SUGGESTED READINGS/REFERENCES:

1. K.A. Ross, Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
2. R.G. Bartle D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
3. V. Karunakaran, Real Analysis, Pearson
4. Charles G. Denlinger, Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.
5. S. Goldberg, Calculus and mathematical analysis.
6. Santi Narayan, Integral calculus.
7. T. Apostol, Calculus I, II.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-IV
Course: MATH-H-CC-T-09
Course title: Multivariate Calculus
Core Course; Credit-6; Full Marks-75

COURSE CONTENT:

6 Credits (5+1) (Theory + Tutorial)

Unit 1. Functions of several variables, limit and continuity of functions of two or more variables

Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems

Unit 2. Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, Triple integrals, triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates.Change of variables in double integrals and triple integrals.

Unit 3. Definition of vector field, divergence and curl.

Line integrals, applications of line integrals: mass and work. Fundamental theorem for line integrals, conservative vector fields, independence of path.

Unit 4. Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem.

SUGGESTED READINGS/REFERENCES:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
3. E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.
4. James Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001
5. L . J. Goldstein, D.C. Lay and N. H. Asmar and D. I . Schneider, Calculus and its applications, Pearson
6. T. Apostol, Mathematical Analysis, Narosa Publishing House
7. Courant and John, Introduction to Calculus and Analysis, Vol II, Springer
8. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
9. Marsden, J., and Tromba, Vector Calculus, McGraw Hill.
10. Maity, K.C. and Ghosh, R.K. Vector Analysis, New Central Book Agency (P) Ltd. Kolkata (India).
11. Terence Tao, Analysis II, Hindustan Book Agency, 2006
12. M.R. Speigel, Schaum's outline of Vector Analysis.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-IV
Course: MATH-H-CC-T-10
Course title: Ring Theory and Linear Algebra I
Core Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn of integers under addition modulo n and the group U(n) of units under multiplication modulo n. Cyclic groups from number systems, complex roots of unity, circle group, the general linear group GLn(n,R), groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle,(iii) a rectangle, and (iv) a square, the permutation group Sym (n), Group of quaternions.

Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Zn the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Zp, Q, R, and C. Field of rational functions.

SUGGESTED READINGS/REFERENCES:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa, 1999.
4. George E Andrews, Number Theory, Hindustan Publishing Corporation, 1984.

B.A./B.Sc.. Other than Mathematics (Honours)
SEMESTER-IV
Course: MATH-H-GE-T-04
Course title: Algebra
General Elective Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn of integers under addition modulo n and the group U(n) of units under multiplication modulo n. Cyclic groups from number systems, complex roots of unity, circle group, the general linear group GLn(n,R), groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle,(iii) a rectangle, and (iv) a square, the permutation group Sym (n), Group of quaternions.

Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Zn the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Zp, Q, R, and C. Field of rational functions.

SUGGESTED READINGS/REFERENCES:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. M.K. Sen, S. Ghosh and P. Mukhopadhyay, Abstract Algebra, University Press
4. Joseph A Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa, 1999.
5. George E Andrews, Number Theory, Hindustan Publishing Corporation, 1984.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-IV
Course: MATH-H-SEC-T-2A
Course title: Graph Theory
Skill Enhancement Course; Credit-2; Full Marks-25

COURSE CONTENT: 2 Credits (2+0) (Theory + Tutorial)

Unit 1. Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bipartite graphs isomorphism of graphs.

Unit 2. Eulerian circuits, Eulerian graph, semi-Eulerian graph, theorems, Hamiltonian cycles,theorems

Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph,

Unit 3. Travelling salesman's problem, shortest path, Tree and their properties, spanning tree, Dijkstra's algorithm, Warshall algorithm.

SUGGESTED READINGS/REFERENCES:

1. B.A. Davey and H.A. Priestley, Introduction to Lattices and Order, Cambridge UniversityPress, Cambridge, 1990.
2. R.J. Wilson, Introduction to graph theory, Pearson
3. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 2ndEdition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
4. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts inMathematics, Springer (SIE), Indian reprint, 2004.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-IV
Course: MATH-H-SEC-T-2B
Course title: Operating System (Linux)
Skill Enhancement Course; Credit-2; Full Marks-25

COURSE CONTENT: 2 Credits (2+0) (Theory + Tutorial)

Unit 1. Linux – The operating system: Linux history, Linux features, Linux distributions, Linux's relationship to Unix, overview of Linux architecture, installation, start up scripts, system processes (an overview), Linux security.

Unit 2. The Ext2 and Ext3 file systems: General characteristics of the Ext3 file system, file permissions. User management: types of users, the powers of root, managing users (adding and deleting): using the command line and GUI tools.

Unit 3. Resource management in Linux: file and directory management, system calls for files process
Management, signals, IPC: Pipes, FIFOs, System V IPC, message queues, system calls for processes, memory management, library and system calls for memory.

SUGGESTED READINGS/REFERENCES:

1. Arnold Robbins, Linux Programming by Examples The Fundamentals, 2nd Ed., PearsonEducation, 2008.
2. Cox K, Red Hat Linux Administrator's Guide, PHI, 2009.
3. R. Stevens, UNIX Network Programming, 3rd Ed., PHI, 2008.
4. Sumitabha Das, UNIX Concepts and Applications, 4th Ed., TMH, 2009.
5. Ellen Siever, Stephen Figgins, Robert Love, Arnold Robbins, Linux in a Nutshell, 6thEd.,O'Reilly Media, 2009.
6. Neil Matthew, Richard Stones, Alan Cox, Beginning Linux Programming, 3rd Ed., 2004.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-V
Course: MATH-H-CC-T-11
Course title: Partial Differential Equations & Applications
Core Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. Partial differential equations – Basic concepts and definitions. Mathematical problems. First- order equations: classification, construction and geometrical interpretation. Method of characteristics for obtaining general solution of quasi linear equations. Canonical forms of first-order linear equations. Method of separation of variables for solving first order partial differential equations.

Unit 2. Derivation of heat equation, wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order linear equations to canonical forms.

Unit 3. The Cauchy problem, Cauchy-Kowalewskaya theorem, Cauchy problem of an infinite string. Initial boundary value problems. Semi-infinite string with a fixed end, semi-infinite string with a free end. Equations with non-homogeneous boundary conditions. Non- homogeneous wave equation. Method of separation of variables, solving the vibrating string problem. Solving the heat conduction problem

Graphical Demonstration (Teaching aid)

1. Solution of Cauchy problem for first order PDE.
2. Finding the characteristics for the first order PDE.
3. Plot the integral surfaces of a given first order PDE with initial data.
4. Solution of wave equation $\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions:

   (a) $u(x,0) = \phi(x),\ u_t(x,0) = \psi(x),\ x \in R,\ t > 0.$

   (b) $u(x,0) = \phi(x),\ u_t(x,0) = \psi(x), u(0,t) = 0\ \ x \in (0,\infty),\ t > 0$

5. Solution of wave equation $\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions:

   (a) $u(x,0) = \phi(x),\ u\ \ (o,t) = a, u\ \ (l,t) = b,\ \ 0 < x < l, t > 0.$

$u(x,0) = \phi(x),\ x \in R,\ \ 0 < t < T.$

SUGGESTED READINGS/REFERENCES:

1. TynMyint-U and LokenathDebnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.
7. S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
8. Martha L Abell, James P Braselton, Differential equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.
9. Sneddon, I. N., Elements of Partial Differential Equations, McGraw Hill.
10. Miller, F. H., Partial Differential Equations, John Wiley and Sons.
11. Loney, S. L., An Elementary Treatise on the Dynamics of particle and of Rigid Bodies,LoneyPress .

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-V
Course: MATH-H-CC-T-12
Course title: Group Theory II
Core Course; Credit-6; Full Marks-75

COURSE CONTENT:

6 Credits (5+1) (Theory + Tutorial)

Unit 1. Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups, Characteristic subgroups, Commutator subgroup and its properties.

Unit 2. Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental theorem of finite abelian groups.

Unit 3. Groups acting on themselves by conjugation, class equation and consequences, conjugacy in Sn, p-groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of An for n ≥ 5, non-simplicity tests.

SUGGESTED READINGS/REFERENCES:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7^{th} Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2^{nd} Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4^{th} Ed., Narosa Publishing House, 1999.
4. David S. Dummit and Richard M. Foote, Abstract Algebra, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.
5. R.K. Sharma, S.K. Shah and A.G. Shankar, Algebra-I, Pearson
6. M.K. Sen, S. Ghosh and P. Mukhopadhyay, Abstract Algebra, University Press
7. U.M. Swamy, A.R.S.N. Murthy, Algebra, Pearson
8. J.R. Durbin, Modern Algebra, John Wiley & Sons, New York Inc., 2000.
9. D. A. R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998
10. D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra.
11. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-V
Course: MATH-H-DSE-T-1A
Course title: Linear Programming
Department Specific Elective Course; Credit-6; Full Marks-75

COURSE CONTENT:

6 Credits (5+1) (Theory + Tutorial)

Unit 1. Introduction to linear programming problem. Theory of simplex method, graphical solution, convex sets, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method. Big-M method and their comparison.

Unit 2. Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

Unit 3. Game theory: formulation of two persons zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.

SUGGESTED READINGS/REFERENCES:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2^{nd} Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. by T. Veerarajan, Operation Research, University Press
4. Hamdy A. Taha, Operations Research, An Introduction, 8^{th} Ed., Prentice-Hall India, 2006.
5. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-V
Course: MATH-H-DSE-T-1B
Course title: Point Set Topology
Department Specific Elective Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. Countable and Uncountable Sets, Schroeder-Bernstein Theorem, Cantor's Theorem. Cardinal numbers and cardinal arithmetic. Continuum Hypothesis, Zorns Lemma, Axiom of Choice. Well-ordered sets, Hausdorff's maximal principle. Ordinal numbers.

Unit 2. Topological spaces, basis and Subbasis for a topology, subspace topology, interior points, limit points, derived set, boundary of a set, closed sets, closure and interior of a set. Continuous functions, open maps, closed maps and homeomorphisms. Product topology, quotient topology, metric topology, Baire category theorem.

Unit 3. Connected and path connected spaces, connected sets in R, components and path components, local connectedness. Compact spaces, compact sets in R. Compactness in metric spaces. Totally bounded spaces, Ascoli-Arzela theorem, the Lebesgue number lemma. Local compactness.

SUGGESTED READINGS/REFERENCES:

1. Munkres, J.R., Topology, A First Course, Prentice Hall of India Pvt.Ltd., New Delhi, 2000.
2. Dugundji, J., Topology, Allyn and Bacon, 1966.
3. Simmons, G.F., Introduction to Topology and Modern Analysis, McGraw Hill, 1963.
4. Kelley, J.L., General Topology, Van Nostrand Reinhold Co., New York,1995.
5. Hocking, J., Young, G., Topology, Addison-Wesley Reading, 1961.
6. Steen, L., Seebach, J., Counter Examples in Topology, Holt, Reinhart andWinston, New York, 1970.
7. AbhijitDasgupta, Set Theory, Birkhäuser.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-V
Course: MATH-H-DSE-T-2A
Course title: Probability and Statistics
Department Specific Elective Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

Unit 2. Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient.

Unit 3. Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers. Central limit theorem for independent and identically distributed random variables with finite variance.

Unit 4. Random Samples, Sampling Distributions, Estimation of parameters, Testing of hypothesis.

SUGGESTED READINGS/REFERENCES:

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, John E. Freund, Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.
4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw- Hill, Reprint 2007
5. E. Rukmangadachari, Probability and Statistics, Pearson
6. G.S. Rao, Probability and Statistics, University Press
7. A. Gupta, Ground work of Mathematical Probability and Statistics, Academic publishers.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-V
Course: MATH-H-DSE-T-2B
Course title: Differential Geometry
Department Specific Elective Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. Theory of space curves: Space curves. Planer curves, curvature, torsion and Serret-Frenet formula. Osculating circles, osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves.

Unit 2. Theory of surfaces: Parametric curves on surfaces. Direction coefficients. First and second Fundamental forms. Principal and Gaussian curvatures. Lines of curvature, Euler's theorem. Rodrigue's formula. Conjugate and asymptotic lines.

Unit 3. Developables: Developable associated with space curves and curves on surfaces. Minimal surfaces. Geodesics: Canonical geodesic equations. Nature of geodesics on a surface of revolution. Clairaut's theorem. Normal property of geodesics. Torsion of a geodesic. Geodesic curvature. Gauss-Bonnet theorem.

SUGGESTED READINGS/REFERENCES:

1. T.J. Willmore, An Introduction to Differential Geometry, Dover Publications, 2012.
2. B. O'Neill, Elementary Differential Geometry, 2nd Ed., Academic Press, 2006.
3. C.E. Weatherburn, Differential Geometry of Three Dimensions, Cambridge University Press2003.
4. D.J. Struik, Lectures on Classical Differential Geometry, Dover Publications, 1988.
5. S. Lang, Fundamentals of Differential Geometry, Springer, 1999.
6. B. Spain, Tensor Calculus: A Concise Course, Dover Publications, 2003

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-VI
Course: MATH-H-CC-T-13
Course title: Metric Spaces and Complex Analysis
Core Course; Credit-6; Full Marks-75

COURSE CONTENT:

6 Credits (5+1) (Theory + Tutorial)

Unit 1. Metric spaces: sequences in metric spaces, Cauchy sequences. Complete metric spaces, Cantor's theorem.

Unit 2. Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Compactness and connectedness in metric spaceses.

Compactness: Sequential compactness, Heine-Borel property, totally bounded spaces, finite intersection property, and continuous functions on compact sets.

Homeomorphism..

Unit 3. Limits, limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings.

Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

Unit 4. Analytic functions, examples of analytic functions, exponential function, logarithmic function, trigonometric function, derivatives of functions, and definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy- Goursat theorem, Cauchy integral formula.

SUGGESTED READINGS/REFERENCES:

1. SatishShirali and Harikishan L. Vasudeva, Metric Spaces, Springer Verlag, London, 2006.
2. S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011.
3. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.
4. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw – Hill International Edition, 2009.
5. R. Roopkumar, Complex Analysis, Pearson
6. Joseph Bak and Donald J. Newman, Complex Analysis, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., NewYork, 1997.
7. S. Ponnusamy, Foundations of complex analysis.
8. E.M.Stein and R. Shakrachi, Complex Analysis, Princeton University Press.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-VI
Course: MATH-H-CC-T-14
Course title: Ring Theory and Linear Algebra II
Core Course; Credit-6; Full Marks-75

COURSE CONTENT:

6 Credits (5+1) (Theory + Tutorial)

Unit 1. Ring homomorphisms, properties of ring homomorphisms. Isomorphism theorems I, II and III, field of quotients. Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, and unique factorization in Z [x].

Unit 2. Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators. Eigen spaces of a linear operator.

Unit 3. Diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator, canonical forms, Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal complements.

SUGGESTED READINGS/REFERENCES:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, 1999.
4. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.
5. R.K. Sharma, S.K. Shah and A.G. Shankar, Algebra-I, Pearson
6. U.M. Swamy, A.R.S.N. Murthy, Algebra, Pearson
7. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
8. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
9. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
10. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
11. S.H. Friedberg, A.L. Insel and L.E. Spence, Linear Algebra, Prentice Hall of India Pvt. Ltd., 2004

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-VI
Course: MATH-H-DSE-T-3A
Course title: Fuzzy Set Theory
Department Specific Elective Course; Credit-6; Full Marks-75

COURSE CONTENT:

6 Credits (5+1) (Theory + Tutorial)

Unit 1. Interval numbers, arithmetic operations on interval numbers, distance between intervals, two level interval numbers.

Unit 2. Fuzzy versus crisp sets, Different types of fuzzy sets, α-cuts and its properties, representations of fuzzy sets, decomposition theorems, support, convexity, normality, cardinality, standard set-theoretic operations on fuzzy sets, Zadeh's extension principle.

Unit 3. Crisp versus fuzzy relations, fuzzy matrices and fuzzy graphs, composition of fuzzy relations, relational join, binary fuzzy relations.

Unit 4. Fuzzy numbers, arithmetic operations on fuzzy numbers (multiplication and division on $\mathbb{R}^+$ only), fuzzy equations.

SUGGESTED READINGS/REFERENCES:

1. Fuzzy Set Theory and Its Applications – H.-J. Zimmermann.
2. Introduction to Fuzzy Arithmetic Theory and Applications – A. Kaufmann and M.M. Gupta.
3. Fuzzy Set Theory – R. Lowen.
4. Fuzzy Set, Fuzzy Logic, Applications – G. Bojadziev and M. Bojadziev.

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-VI
Course: MATH-H-DSE-T-3B
Course title: Number Theory
Department Specific Elective Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. Linear diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues. Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

Unit 2. Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.

Unit 3. Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli. Public key encryption, RSA encryption and decryption, the equation x2 + y2= z2, Fermat's Last theorem. (statement)

SUGGESTED READINGS/REFERENCES:

1. David M. Burton, Elementary Number Theory, 6th Ed., Tata McGraw-Hill, Indian reprint, 2007.
2. Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-VI
Course: MATH-H-DSE-T-4A
Course title: Mechanics
Department Specific Elective Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. Co-planar forces. Astatic equilibrium. Friction. Equilibrium of a particle on a rough curve. Virtual work.. Forces in three dimensions. General conditions of equilibrium. Centre of gravity for different bodies. Stable and unstable equilibrium.

Unit 2. Central force. Constrained motion, varying mass, tangent and normal components of acceleration, modelling ballistics and planetary motion, Kepler's second law.

Unit 3. Equations of motion referred to a set of rotating axes. Motion of a projectile in a resisting medium. Stability of nearly circular orbits. Motion under the inverse square law.Slightly disturbed orbits. Motion of artificial satellites. Motion of a particle in three dimensions. Motion on a smooth sphere, cone, and on any surface of revolution.

Unit 4. Degrees of freedom. Moments and products of inertia. Momental Ellipsoid. Principal axes. D'Alembert's Principle. Motion about a fixed axis. Compound pendulum. Motion of a rigid body in two dimensions under finite and impulsive forces. Conservation of momentum and energy.

SUGGESTED READINGS/REFERENCES:

1. I.H. Shames and G. Krishna Mohan Rao, Engineering Mechanics: Statics and Dynamics, (4th Ed.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
2. R.C. Hibbeler and Ashok Gupta, Engineering Mechanics: Statics and Dynamics, 11th Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.
3. Chorlton, F., Textbook of Dynamics.
4. Loney, S. L., An Elementary Treatise on the Dynamics of particle and of Rigid Bodies,Loney Press .
5. Loney, S. L., Elements of Staticsand Dynamics I and II.
6. Ghosh, M. C, Analytical Statics.
7. Verma, R. S., A Textbook on Statics,Pothishala, 1962.
8. MatiurRahman, Md., Statics.
9. Ramsey, A. S., Dynamics (Part I).

B.A./B.Sc.. Mathematics (Honours)
SEMESTER-VI
Course: MATH-H-DSE-T-4B
Course title: Bio Mathematics
Department Specific Elective Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. Mathematical biology and the 27arbour27r process: an overview. Continuous models: Malthus model, logistic growth, Allee effect, Gompertz growth, Michaelis-Menten Kinetics, Holling type growth, bacterial growth in a chemostat, harvesting a single natural population, Prey predator systems and LotkaVolterra equations, populations in competitions, epidemic models (SI, SIR, SIRS, SIC)

Unit 2. Activator-inhibitor system, insect outbreak model: Spruce Budworm. Numerical solution of the models and its graphical representation. Qualitative analysis of continuous models: Steady state solutions, stability and linearization, multiple species communities and Routh-Hurwitz Criteria. Phase plane methods and qualitative solutions, bifurcations and limit cycles with examples in the context of biological scenario.

Spatial models: One species model with diffusion. Two species model with diffusion, conditions for diffusive instability, spreading colonies of microorganisms, Blood flow in circulatory system, travelling wave solutions, spread of genes in a population.

Unit 3. Discrete models: Overview of difference equations, steady state solution and linear stability analysis. Introduction to discrete models, linear models, growth models, decay models, drug delivery problem, discrete prey-predator models, density dependent growth models with harvesting, host-parasitoid systems (Nicholson-Bailey model), numerical solution of the models and its graphical representation. Case studies. Optimal exploitation models, models in genetics, stage structure models, age structure models.

SUGGESTED READINGS/REFERENCES:

1. L.E. Keshet, Mathematical Models in Biology, SIAM, 1988.
2. J. D. Murray, Mathematical Biology, Springer, 1993.
3. Y.C. Fung, Biomechanics, Springer-Verlag, 1990.
4. F. Brauer, P.V.D. Driessche and J. Wu, Mathematical Epidemiology, Springer, 2008.
5. M. Kot, Elements of Mathematical Ecology, Cambridge University Press, 2001.