SAMBALPUR UNIVERSITY
STRUCTURE OF THE BA/BSC MATHEMATICS (HONOURS) SYLLABUS BASED ON CHOICE BASED CREDIT SYSTEM
EFFECTIVE FROM 2018-19

Semester	Course Number	Title of the Course	Number of credits assigned to the course		Total Credits
			Theory	Practical(P)/ Tutorial((T)	
DISCIPLINE SPECIFIC CORE COURSES(14 PAPERS)(DSC)					
1st	**DSC- MATH-H -1**	Calculus(P)	4	2	6
	DSC—MATH-H-2	Algebra	5	1	6
2nd	**DSC- MATH-H -3**	Real Analysis	5	1	6
	DSC- MATH-H -4	Differential equations(P)	4	2	6
3rd	**DSC- MATH-H -5**	Theory of Real functions	5	1	6
	DSC- MATH-H -6	Group Theory-I	5	1	6
	DSC- MATH-H -7	Multivariable calculus	5	1	6
4th	**DSC- MATH-H -8**	Numerical Methods(P)	4	2	6
	DSC- MATH-H -9	Riemann integration and series of functions	5	1	6
	DSC-MATH-H -10	Ring Theory and Linear Algebra-I	5	1	6
5th	**DSC-MATH-H -11**	Partial differential equations and system of ODEs (P)	4	2	6
	DSC-MATH-H -12	Group Theory-II	5	1	6
6th	**DSC-MATH-H -13**	Metric Space and Complex analysis	5	1	6
	DSC-MATH-H -14	Ring Theory and Linear Algebra-II	5	1	6
DISCIPLINE SPECIFIC ELECTIVE COURSES(4 PAPERS)(DSE)					
5th	**DSE- MATH-H-1**	Discrete Mathematics Or Number Theory Or Object oriented programming in C++	5 5 5	1 1 1	6 6 6
5th	**DSE- MATH-H-2**	Probability and Statistics Or Industrial Mathematics	5 5	1 1	6 6

		Or Theory of Equations	5	1	6
6th	**DSE- MATH-H-3**	Mathematical Methods Or Bio Mathematics or Linear Programming	5 5 5	1 1 1	6 6 6
6th	**DSE- MATH-H-4**	Mathematical Modelling Or Mechanics Or Differential Geometry Or Project	5 5 5 6	1 1 1 1	6 6 6 6
GENERIC ELECTIVES(GE) 4 PAPERS					
1st	**GE-MATH-H-1A** **GE-MATH-H-1B**	Calculus Or Matrix Theory	5 5	1 1	6 6
Semester	**Course Number**	**Title of the Course**	**Number of credits assigned to the course**		**Total Credits**
			Theory	**Practical(P)/ Tutorial((T)**	
2nd	**GE-MATH-H-2A** **GE-MATH-H-2B**	Differential equations Or Numerical methods	5 5	1 1	6 6
3rd	**GE-MATH-H-3A** **GE-MATH-H-3B**	Linear Programming Or Discrete Mathematics	5 5	1 1	6 6
4th	**GE-MATH-H-4A** **GE-MATH-H-4B**	Algebra Or Mathematical methods	5 5	1 1	6 6
ABILITY ENHANCEMENT COURSES(AEC)TWO TYPES(AECC+SEC)					

ABILITY ENHANCEMENT COMPULSORY COURSES(AECC)					
1st	**AECC-MATH-1**	Environmental science	2		2
2nd	**AECC-MATH-2**	English/MIL/Hindi communication	2		2
SKILL ENHANCEMENT COURSES(SEC) 2 credits					
3rd	**SEC-MATH-H-1A** **SEC-MATH-H-1B**	Programming in C or Logic and Set theory	2 2		2 2
4th	**SEC-MATH-H-2A** **OR** **SEC-MATH-H-2B**	Graph theory or Operating System (LINUX)	2 2		2 2
		Total credits for honours Mathematics(DSC+DSE+GE+SEC)	**140 credits**		

DETAILED SYLLABUS FOR HONOURS MATHEMATICS COURSES

B.A./B.SC.(HONOURS)-MATHEMATICS

SEMESTER-I

(CORE COURSES)

DSC-MATH-H1

CALCULUS (WITH PRACTICAL) - 6 credits

Theory (Credits-4)

Objective: The main emphasis of this course is to equip the student with necessary analytic and technical skills to handle problems of mathematical nature as well as practical problems. More precisely, main target of this course is to explore the different tools for higher order derivatives, to plot the various curves and to solve the problems associated with differentiation and integration of vector functions.

Excepted Outcomes: After completing the course, students are expected to be able to use Leibnitz's rule to evaluate derivatives of higher order, able to study the geometry of various types of functions, evaluate the area, volume using the techniques of integrations, able to identify the difference between scalar and vector, acquired knowledge on some the basic properties of vector functions.

Unit-I

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of the type $e^{ax+b}sinx$, $e^{ax+b}cosx$, $(ax+b)^n \sin x$, $(ax+b)^n \cos x$, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L-Hospitals rule,

Unit-II

Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \tan^n x\, dx$, $\int \sec^n x dx$, $\int (\log x)^n dx$, $\int \sin^n x \cos^n x\, dx$, definite integral, integration by substitution.

Unit-III

Volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution, techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics.

Unit-IV

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration.

Practical (Credits-2)

LIST OF PRACTICALS

(Using any software/MATLAB to be performed on a Computer.)

- Plotting the graphs of the functions 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.
- Plotting the graphs of the polynomial of degree 4 and 5.
- Sketching parametric curves (Eg. Trochoid, cycloid, hypocycloid).
- Obtaining surface of revolution of curves.
- Tracing of conics in cartesian coordinates/polar coordinates.
- Sketching ellipsoid, hyperboloid of one and two sheets (using Cartesian co-ordinates

BOOKS FOR REFERENCE:

1. H. Anton, I. Bivens and S. Davis, *Calculus*, 10th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002. Chapters: 2(2.3), 3(3.1, 3.3), 5(5.2-5.5), 6(6.5, 6.8), 10(10.1, 10.4, 10.5), 11(11.1, 11.4), 12(12.1, 12.2, 12.6).
2. B. P. Acharya and D. C. Sahu, *Analytical Geometry of Quadratic Surfaces*, Kalyani Publishers, New Delhi, Ludhiana. Chapters: 2, 3.
3. Shanti Narayan, *Text Book of Calculus, Part-II*, S. Chand & Co., Chapters: 6, 7, 10(Art. 33-36).
4. Shanti Narayan, *Text Book of Calculus, Part-III*, S. Chand & Co., Chapters: 1(Art. 1, 2), 3(Art. 7, 8), 6 (15 restricted).
5. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
6. R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer-Verlag, New York, Inc., 1989.
7. Shanti Narayan and P.K. Mittal, *Analytical Solid Geometry*, S. Chand & Company Pvt. Ltd., New Delhi.
8. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.

DSC-MATH-H2

ALGEBRA

Theory- 5 Credits, Tutorial-1 Credit

Objective: This is a preliminary course for the basic courses in mathematics like, abstract algebra and linear algebra. The objective is to acquaint students with the properties of natural numbers i.e. Euclidean algorithm, congruence relation, fundamental theorem of arithmetic, etc. An introduction to complex number especially, nth roots of unity, De Moivres theorem are there. Basics of linear algebra i.e. vector spaces, matrices are introduced here.

Expected outcomes: The acquired knowledge will help students to study further courses in mathematics like, group theory, ring theory and field theory and linear algebra. It has applications not only in higher mathematics but also in other science subjects like computer science, statistics, physics, chemistry etc. He learns the algebraic structure of real and compex number system.

Unit-I

Polar representation of complex numbers, n-th roots of unity, De Moivres theorem for rational indices and its applications,Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set,

Unit-II

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-III

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, Vector spaces and subspaces, examples, linear independence, linear dependence, basis, dimension, examples .

Unit-IV

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 and rank of a matrix, Eigen values, Eigen vectors and Characteristic equation of a matrix.

BOOKS FOR REFERENCE:

1. Andreescu and Dorin Andrica, 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. An Introduction to Linear Algebra by V Krishna Murthy, V P Mainra, J L Arora, Affiliated East-West Press Pvt. Ltd.
5. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed.,McGraw Hill International Edition, 2009.

SEMESTER-I

GENERIC COURSES

GE-MATH-H-1A

CALCULUS

Theory- 5 Credits, Tutorial-1 Credit

Objective: Calculus invented by Newton and Leibnitz is powerful analytical tool to solve mathematical problems which arise in all branches of science and engineering. The main emphasis of the GE-MATH-H-1A is to equip the student with necessary analytic and technical skills to handle problems of a mathematical nature as well as practical problems.

Excepted Outcomes: After completing the course, students are expected to be able to evaluate various limit problems both algebraically and graphically, evaluate limits with indeterminate forms using L'hospital's rule, check the continuity of various types of functions, differentiate various types of functions using the differentiation rules such as Powers, Sum, Difference, Product, Quotient Rules, Implicit and Logarithmic Differentiation, apply differentiation to find linear approximation, extrema, monotonicity, and concavity of functions, sketch the graph of some functions using differentiation, and are able to solve definite integrals and related problems.

Unit-I

Limit and Continuity, Continuity of Trigonometric, Exponential, and Inverse Functions, Discontinuity, Differentiation- derivative of functions, derivatives of parametrically defined functions, L'Hôpital's Rule; Indeterminate Forms, derivative of implicitly defined functions.

Unit-II

Successive differentiation: n^{th} derivative of rational functions, n^{th} derivative of power of sine and cosine function, Leibnitz's theorem Taylors series, Mean value theorems, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, ,

Unit-III

Partial differentiation: limit continuity of functions of two variables, partial derivative, maxima and minima: necessary and sufficient condition for extreme values, use of second order derivative.

Unit-IV

Definite integral: Reduction formulae, Fundamental theorem of integral calculus, summation of series, area between two curves, area of plane regions**,** rectification lengths of plane curves.

BOOKS FOR REFERENCE:

1. Shanti Narayan, P. K. Mittal, *Differential calculus*, S.Chand & Company P(Ltd.), 2012.
2. Shanti Narayan, P. K. Mittal, *Integral calculus*, S.Chand & Company P(Ltd.), 2011.
3. H. Anton, I. Bivens and S. Davis, *Calculus*, 10th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
4. G. B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
5. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag, New York, Inc., 1989.
6. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.

GE-MATH-H-1B

MATRIX THEORY

Theory- 5 Credits, Tutorial-1 Credit

Objective: The subject material is of vital importance in all fields of mathematics and in science in general. Matrix theory is a tool to study different aspects like linear transformations, system of linear equations those arise not only in mathematics but also in Physics, Chemistry, Statistics etc. This course will introduce some basic ideas on matrices which will be useful for future courses in pure mathematics.

Expected outcomes: On successful completion of this course students will be able to understand the basic ideas of linear dependence and independence and spanning of vectors. Students will know the use matrix theory in linear transformation and system of linear equations, etc.. The knowledge on this course is essential for further studies on linear algebra,optimsation problems,operator theory etc

UNIT- I

Vector spaces, Examples, subspaces, examples. Concept of Linear dependence and Independence, Basis and dimension , examples of different bases, Linear transformation, Representation of linear transformations by matrices.

UNIT-II

Kernel and images of a Linear transformation,Geometric ideas, Some special linear transformations and their matrices, Matrix operations, Types of matrices, Determinants, cofactors ,minors.

UNIT-III

Rank of a matrix. elementary row operations, matrix inverses, adjoints of matrix Eigen-values and Eigen vectors, characteristic equations.

UNIT-IV

Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3. Solutions of linear homogeneous and non-homogeneous equations with number of equations and unknowns upto four.

BOOKS FOR REFERENCE:

1. S Kumaresan, *Linear Algebra*, A geometric approach Prentice Hall of India Learning Pvt. Ltd., New Delhi, 2014.
2. An Introduction to Linear Algebra by V Krishna Murthy, V P Mainra, J L Arora, Affiliated East-West Press Pvt. Ltd.
3. Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill,
4. A.I. Kostrikin, *Introduction to Algebra*, Springer Verlag, 1984.

SEMESTER-II

CORE COURSES

DSC-MATH-H3

REAL ANALYSIS

Theory- 5 Credits, Tutorial-1 Credit

Objective: The objective of the course is to have the knowledge on basic properties of the field of real numbers, studying Bolzano-Weiersstrass Theorem , sequences and convergence of sequences, series of real numbers and its convergence etc. This is one of the core courses essential to start doing mathematics.

Expected Outcome: On successful completion of this course, students will be able to handle fundamental properties of the real numbers that lead to the formal development of real analysis and understand limits and their use in sequences, series, differentiation and integration. Students will appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.

UNIT-I

Review of Algebraic and Order Properties of *R*, d-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, The Completeness Property of *R*, The Archimedean Property, Density of Rational (and Irrational) numbers in *R*.

UNIT-II

Intervals, Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrass theorem for sets, Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems

UNIT-III

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-IV

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.

BOOKS FOR REFERENCE:

1. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis* (3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. G. Das and S. Pattanayak, Fundamentals of Mathematical Analysis, TMH Publishing Co.
3. S.C. Mallik and S. Arora-Mathematical Analysis, New Age InternationalPublications.
4. A.Kumar, S. Kumaresan, *A basic course in Real Analysis*, CRC Press, 2014.
5. Brian S. *Thomson*, Andrew. M. *Bruckner*, and Judith B. *Bruckner*, *Elementary Real Analysis*, Prentice Hall, 2001.
6. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, *An Introduction to Analysis*,Jones & Bartlett, Second Edition, 2010.

DSC-MATH-H-4

DIFFERENTIAL EQUATIONS (With Practicals)

Theory- 4 Credits, Practical-2 Credits

Objective: Differential Equations introduced by Leibnitz in 1676 models almost all Physical, Biological, Chemical systems in nature. The objective of this course is to familiarize the students with various methods of solving differential equations and to have a qualitative applications through models. The students have to solve problems to understand the methods.

Expected Outcomes: A student completing the course is able to solve differential equations and is able to model problems in nature using Ordinary Differential Equations. This is also prerequisite for studying the course in Partial Differential Equations and models dealing with Partial Differential Equations.

UNIT-I

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 equations and Bernoulli's equation, special integrating factors and transformations.

UNIT-II

Introduction to compartmental models, Exponential decay radioactivity (case study of detecting art forgeries), lake pollution model (with case study of Lake Burley Griffin), drug assimilation into the blood (case study of dull, dizzy and dead), exponential growth of population, Density dependent growth, Limited growth with harvesting.

UNIT-III

General solution of homogeneous equation of second order, principle of superposition, Wronskian, its properties and applications, method of undetermined coefficients, Method of variation of parameters, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation.

UNIT-IV

Equilibrium points, Interpretation of the phase plane, predatory-pray model and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.

Practical / Lab work to be performed on a computer: 2 credits

Modeling of the following problems using *Matlab / Mathematica / Maple* etc.

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. (a) Lake pollution model (with constant/seasonal flow and pollution concentration)/
   (b) Case of single cold pill and a course of cold pills.
   (c) Limited growth of population (with and without harvesting).
6. (a) Predatory-prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).
   (b) Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).
   (c) Battle model (basic battle model, jungle warfare, long range weapons).
7. Plotting of recursive sequences.
8. Study the convergence of sequences through plotting.

9. Verify Bolzano Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.
10. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.
11. Cauchy's root test by plotting nth roots.
12. Ratio test by plotting the ratio of nth and n+1th term

BOOKS FOR REFERENCE:

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. S.L. Ross, *Differential Equations,* 3rd Ed., John Wiley and Sons, India, 2004.
3. Martha L Abell, James P Braselton, *Differential Equations with MATHEMATICA,* 3rd Ed., Elsevier Academic Press, 2004.
4. Simmons G F Diffrential equation Tata Mc GrawHill, 1991.
5. Martin Braun, Differential Equations and their Applications, Springer International, Student Ed.
6. Zafer Ahsan, Differential Equations and their Applications, PHI, 2016.

SEMESTER-II
GENERIC COURSES

GE-MATH-H-2A

DIFFERENTIAL EUATIONS (6 credits)

Theory- 5 Credits, Tutorial-1 Credit

Objective: Differential Equations introduced by Leibnitz in 1676 models almost all Physical, Biological, Chemical systems in nature. The objective of this course is to familiarize the students with various methods of solving differential equations and partial differential equations. The students have to solve problems to understand the methods.

Expected Outcomes: A student completing the course is able to solve differential equations and is able to model problems in nature using Ordinary Differential Equations. This is also prerequisite for studying the higher course in Partial Differential Equations and models dealing with Partial Differential Equations.

UNIT-I

First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x, y, p.

UNIT-II

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.

UNIT-III

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.

UNIT -IV

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.

BOOKS FOR REFERENCE:

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.
3. Simmons G F Diffrential equation Tata Mc GrawHill, 1991

GE-MATH-H-2B

NUMERICAL METHODS (6 Credits)

Theory- 5 Credits, Tutorial-1 Credit

Objective: Calculation of error and approximation is a necessity in all real life, industrial and scientific computing. The objective of this course is to acquaint students with various numerical methods of finding solution of different type of problems, which arises in different branches of science such as locating roots of equations, finding solution of nonlinear equations, systems of linear equations, differential equations, Interpolation, differentiation, evaluating integration.

Expected Outcome: Students can handle physical problems to find an approximated solution. After getting trained a student can opt for advance courses in Numerical analysis in higher mathematics. Use of good mathematical software will help in getting the accuracy one need from the computer and can assess the reliability of the numerical results, and determine the effect of round off error or loss of significance.

UNIT-I

Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method.

Gauss Elimination and Gauss Jordan methods, LU decomposition, Gauss-Jacobi, Gauss-Siedel.

UNIT-II

Lagrange and Newton interpolation: linear and higher order, finite difference operators.

UNIT-III

Numerical differentiation: forward difference, backward difference and central Difference.

UNIT-IV

Integration: trapezoidal rule, Simpson's rule, Euler's method, Runge-Kutta methods of orders two and four.

BOOKS FOR REFERENCE:

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 5th Ed., New age International Publisher, India, 2007.
2. S. S. Sastry, Introductory method for Numerical Analysis, PHI New Delhi,2012.
3. S. D. Conte and Carl De Boor, Elementary Numerical Analysis, Mc Graw Hill, 1980.

SEMESTER-III
CORE COURSES

DSC-MATH-H5

THEORY OF REAL FUNCTIONS

Theory-5 Credits, Tutorial-1 Credits

Objective: The objective of the course is to have knowledge on limit theorems on functions, limits of functions, continuity of functions and its properties, uniform continuity, differentiability of functions, algebra of functions and Taylor's theorem and, its applications. The student how to deal with real functions and understands uniform continuity, mean value theorems also.

Expected Outcome: On the completion of the course, students will have working knowledge on the concepts and theorems of the elementary calculus of functions of one real variable. They will work out problems involving derivatives of function and their applications. They can use derivatives to analyze and sketch the graph of a function of one variable, can also obtain absolute value and relative extrema of functions. This knowledge is basic and students can take all other analysis courses after learning this course.

Unit-I

Limits of functions (epsilon-delta approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits, Infinite limits & limits at infinity, Continuous functions, sequential criterion for continuity & discontinuity. Algebra of continuous functions, Continuous functions on an interval, Intermediate value theorem, location of roots theorem, preservation of intervals theorem.

Unit-II

Uniform continuity, non-uniform continuity criteria, uniform continuity theorem, Differentiability of a function at a point & in an interval, Caratheodory's theorem, algebra of differentiable functions, Relative extrema, interior extremum theorem.

Unit-III

Rolle's theorem, Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities & approximation of polynomials, Taylor's theorem to inequalities.

Unit-IV

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 & Maclaurin's series expansions of exponential & trigonometric functions.

REFERENCES:

1. R. G.,Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons (2003).

2. K. A. Ross, Elementary Analysis: The Theory of Calculus, Springer (2004).
3. G. Das and S. Pattanayak, Fundamentals of Mathematical Analysis, TMH Publishing Co.
4. A. Mattuck, Introduction to Analysis, Prentice Hall (1999).
5. S. R. Ghorpade & B. V. Limaye, A Course in Calculus and Real Analysis - Springer (2006).

DSC-MATH-H6

GROUP THEORY-I

Theory-5 Credits, Tutorial-l Credit

Objective: Group theory is one of the building blocks of modern algebra. Objective of this course is to introduce students to basic concepts of group theory and examples of groups and their properties. This course will lead to future basic courses in advanced mathematics, such as Group theory-II and ring theory.

Expected outcomes: A student learning this course gets idea on concept and examples of groups and their properties . He understands cyclic groups, permutation groups, normal subgroups and related results. After this course he can opt for courses in ring theory, field theory, commutative algebras, linear classical groups etc. and can be apply this knowledge to problems in physics, computer science, economics and engineering.

UNIT-I

Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups, Subgroups and examples of subgroups, centralizer, normalizer, center of a group,

UNIT-II

Product of two subgroups, Properties of cyclic groups, classification of subgroups of cyclic groups,Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group,

UNIT-III

Properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem, external direct product of a finite number of groups, normal subgroups, factor groups.

UNIT-IV

Cauchy's theorem for finite abelian groups, group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, first, second and third isomorphism theorems.

BOOK FOR REFERENCES

1. Joseph A. Gallian, *Contemporary Abstract Algebra* (4th Edition), Narosa Publishing House, New Delhi, 1999.(IX Edition 2010).
2. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
3. M. *Artin, Abstract Algebra*, 2nd Ed., Pearson, 2011.
4. Joseph 1. Rotman, *An Introduction to the Theory of Groups*, 4th Ed., Springer Verlag, 1995.
5. I. N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, India, 1975.

DSC-MATH-H7

MULTIVARIATE CALCULUS

Theory-5 Credits, Tutorial-l Credit

Objective: The objective of this course to introduce functions of several variable to a student after he has taken a course in one variable calculus. The course will introduce partial derivatives and several of its consequences and will introduce double and triple integrals along with line integrals which are fundamental to all streams where calculus can be used.

Expected outcomes: After reading this course a student will be able to calculate partial derivatives,directional derivatives,extremum values and can calculate double, triple and line integrals. He will have idea of basic vector calculus including green's theorem, divergence theorem.and stokes theorem. He can take courses in calculus on manifolds, Differential geometry and can help in numerical computations involving several variables.

UNIT-I

Functions of several variables, limit and continuity of functions of two 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.

UNIT-II

Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems.

Definition of vector field, divergence and curl, Double integration over rectangular region, double integration over nonrectangular region. Double integrals in polar co-ordinates,

UNIT-III

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-IV

Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path. Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stokes' theorem, The Divergence theorem.

BOOK FOR REFERENCES:

1. M. J,.Strauss, G. L. Bradley and K. J. Smith, Calculus (3rd Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
2. G.B. Thomas and R.L. Finney, *Calculus,* 9th Ed., Pearson Education, Delhi, 2005.
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. S Ghorpade, B V Limaye, Multivariable calculus, Springer international edition

GENERIC COURSES

GE-MATH-H-3A

LINEAR PROGRAMMING

Theory- 5 Credits, Tutorial- l Credit

Objective: The objective of this course is to familiarize industrial problems to students with various methods of solving Linear Programming Problems, Transportation Problems, Assignment Problems and their applications. Also, students will know the application of linear Programming method in Game Theory.

Expected Outcomes: More knowledge on this topic in higher studies will help students to deal industrial models. This is also prerequisite for studying advanced courses in Nonlinear Programming Problems, Inventory Control Problem and Queuing Theory etc.

UNIT-I

Introduction to linear Programming problem, Theory of simplex method, optimality and unboundedness, the simplex alorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison.

UNIT-II

Duality, formulation of the dual problem, primal-dual relationships, Fundamental Theorem of Duality, economic interpretation of the dual.

UNIT-III

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-IV

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

BOOK FOR REFERENCES:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows* (2nd edition), John Wiley and Sons, India, 2004.
2. F:S. Hillier and G.J. Lieberman, *Introduction to Operations Research- Concepts and Cases* (9th Edition), TataMcGraw Hill, 2010.
3. Hamdy A. Taha, *Operations Research, An Introduction* (9th edition), Prentice-Hall, 2010. Chapter:5 (5.1,5.3-5.4).
4. G. Hadley, *Linear Programming,* Narosa Publishing House, New Delhi, 2002.
5. Kanti Swarup, Operations Research, Sultan Chand & Sons, New Delhi.

GE-MATH-H-3B

DISCRETE MATHEMATICS

Theory- 5 Credits, Tutorial – 1 Credit

Objective: The main objectives of this course is to introduce topics and techniques of counting principles,combinatorics, and graph theory to understand problems in almost all areas of knowledge.

Expected Outcomes: Upon successful completion of this course ,students will be able to learn core ideas in logic, permutations and combinations counting principles such as pigeonhole principle. They learn to use generating functions to solve a variety of combinatorial problems, apply mathematical ideas to practical problems and get a good knowledge of basics of graph heory and Boolean algebra.

Unit-I

Propositional logic, proportional equivalences, predicates and quantifiers, nested quantifiers, rules of inference, methods of proof, relations and their properties, n- ary relations and their applications.

Unit-II

The basic counting principle, the Pigeon-hole principle, generalized permutations and combinations, recurrence relations, counting using recurrence relations, solving linear homogeneous recurrence relations with constant coefficients, generating functions, solving recurrence relations using generating functions,

Unit-III

Partially ordered sets, Hasse diagram of partially ordered sets, maps between ordered sets, duality principle, Lattices (definition and example only), Boolean algebra (definition and example only), graphs: basic concepts and graph terminology.

Unit-IV

Representing graphs and graph isomorphism, distance in a graph, cut vertices and cut edges, connectivity, Euler and Hamiltonian path, Shortest-Path problems planar graphs, graph coloring.

REFERENCES:

1. Kenneth H. Rosen, Discrete Mathematics and Applications (Sixth Edition), Tata McGraw Hill Publications, 2007.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory (2nd Edition), Pearson Education (Singapore) Pte. Ltd., Indian Reprint 2003.
3. B A. Davey and H. A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
4. Rudolf Lidl and Gnter Pilz, Applied Abstract Algebra (2nd Edition), Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
5. Kevin Ferland-Discrete Mathematical Structures, Cengage Learning India Pvt. Ltd.,2009.

SKILL ENHANCEMENT COURSES

SEC- MATH-H-1A

PROGRAMMING IN C

Theory- 2 Credits

Objective: The course fully covers the basics of programming in the "C" programming language and demonstrates fundamental programming techniques, customs and vocabulary including the most common library functions and the usage of the pre-processor. The objective of the course is to familiarize the students with basic concepts of computer programming, develop tools and present the syntax and semantics of the "C" language.

Expected Outcome: On successful completion of the course students get idea on compiling and software development, Basic scalar data types and their operators, Flow control, Complex data types: arrays, structures and pointers, Structuring the code: functions and modules, Preprocessing source code. Finally, students should write their own programs using standard language infrastructure regardless of the hardware or software platform

UNIT-I

Fundamentals, Introduction to C, Data types: Computer fundamentals, Evolution of programming Languages, structure of C- program, writing a simple C program, identifiers, basic data types, storage classes, constants, variables, different types of operators, precedence of operators.

UNIT-II

Input- output statements, statements and blocks, if and switch statements, loops-while, do-while and for statements, break, continue, Arrays, Structure, Pointers: Arrays concepts, declaration, definition, accessing elements, strong elements,Multi-dimensional arrays, strings.

UNIT-III

Structure: declaration, definition and initialization of structures, accessing structures, nested structures, arrays of structures, self referential structures, Unions, Pointers: concepts, initialization of pointer variables, concept of arrays and pointer, character pointers, pointers to structures.

UNIT-IV

Functions, C-preprocessors structures: basics, different types parameter passing, User defined functions, standard library functions, recursive functions, structure and functions, C-preprocessors and header files.

BOOK FOR REFERENCES

1. E. Balaguruswami, The C Programming Language, TMH.
2. Kernighan & Ritchie The C-Prograamming Language Prentice Hall of India, 1990

SEC- MATH-H-1B

LOGIC AND SET THEORY

Theory- 2 Credits

Objective: The objective of the course is to acquaint a student to basic operations of set theory such as relations, partitions, partial order etc. Since every other course of mathematics depend on the language of this course, this is taken as a basic requirement.

Expected outcome: After learning the details of propositional and predicate logic and set theory, a student will be able to read any other course on algebraic structures and analysis. He can use the idea of equivalence classes and partial order relations to do many constructions necessary in mathematics, statistics and computer science.

UNIT-I

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators.

UNIT-II

Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

UNIT-III

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-IV

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.

BOOK FOR REFERENCES:

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005. Chapters: 1, 2.
2. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.
3. P.R. Halmos, *Naive Set Theory*, Springer, 1974.
4. E. Kamke, *Theory of Sets*, Dover Publishers, 1950.

SEMESTER-IV
CORE COURSES

DSC-MATH-H8

NUMERICAL METHODS

Theory-4 Credits, Practical-2 Credits

Use of Scientific Calculator is allowed.

Objective: Calculation of error and approximation is a necessity in all real life, industrial and scientific computing. The objective of this course is to acquaint students with various numerical methods of finding solution of different type of problems, which arises in different branches of science such as locating roots of equations, finding solution of systems of linear equations and differential equations, interpolation, differentiation, evaluating integration.

Expected Outcome: Students can handle physical problems to find an approximated solution. After getting trained a student can opt for advance courses in Numerical analysis in higher mathematics. Use of good mathematical software will help in getting the accuracy one need from the computer and can assess the reliability of the numerical results, and determine the effect of round off error or loss of significance.

UNIT-I

Rate of convergence, Algorithms, Errors: Relative, Absolute, Round off, Truncation. Numerical solution of non-linear equations: Bisection method, Regula-Falsi method, Secant method, Newton-Raphson method, Fixed-point Iteration method, Rate of convergence of these methods.

UNIT-II

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. Polynomial interpolation: Existence uniqueness of interpolating polynomials.

UNIT-III

Lagrange and Newtons divided difference interpolation, Error in interpolation, Central difference & averaging operators, Gauss-forward and backward difference interpolation.

Numerical Integration: Some simple quadrature rules, Newton-Cotes rules, Trapezoidal rule, Simpsons rule, Simpsons *3/8th* rule.

UNIT-IV

Compound quadrature rules, compound mid-point rule, compound trapezoidal rule, compound Simpsons rule, Gauss-Legendre 2-point and 3-point rules.

Numerical solutions of Differential Equations: Euler's Method, Runge-Kutta methods of orders two and four.

PRACTICAL/.LAB WORK TO BE PERFORMED ON A COMPUTER:

Use of computer aided software (CAS), for example *Matlab / Mathematica / Maple / Maxima* etc., for developing the following Numerical programs:

(i) Calculate the sum *1/1 + 1/2 + 1/3 + 1/4* + ----------+ 1/*N*.
(ii) To find the absolute value of an integer.
(iii) Enter- 100 integers into an array and sort them in an ascending' order.

(iv) Any two of the following
   (a) Bisection Method
   (b) Newton Raphson Method
   (c) Secant Method
   (d) Regular Falsi Method
   (v) Gauss-Jacobi Method
   (vi) SOR Method or Gauss-Siedel Method
   (vii) Lagrange Interpolation or Newton Interpolation
   (viii) Simpson's rule.

Note: For any of the CAS *Matlab / Mathematica / Maple / Maxima* etc., Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expression, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

BOOK FOR REFERENCES:

1. B. 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 Computation,* New age International Publisher, India, 5th edition, 2007.
3. C. F. Gerald and P. O. Wheatley, *App.ied Numerical Analysis*, Pearson Education, India, 7th Edition, 2008

DSC-MATH-H9

RIEMANN INTEGRATION AND SERIES OF FUNCTIONS

Theory - 5 Credits, Tutorial – l Credit

Objective: Aim of this course is to explore the ideas on definite and indefinite integrals and to study the convergence of series functions in detail.

Expected Outcomes: On successful completion of this course, students can calculate definite integrals. They understand Fundamental Theorem of Calculus and are able to explain the difference between and definite and indefinite integral. They are able to use the Fundamental Theorem to calculate a definite integral when the integrand is given algebraically, or graphically and are able to convert an improper integral to a definite integral involving a limit.They learn on convergence/divergence of an improper integrals, power series etc. This course will help study future courses in Riemann-Stieltjes integration and Lebesgue integration theory.

UNIT-I

Riemann integration; inequalities of upper and lower sums; 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 theorems of Calculus.

UNIT-II

Improper integrals: Convergence of Beta and Gamma functions. Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions.

UNIT-III

Series of functions; Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and WeierstrassM-Test Limit superior and Limit inferior.

Unit-IV

Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.

BOOK FOR 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 Edition), John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
3. Charles G. Denlinger, *Elements of real analysis*, Jones and Bartlett (Student Edition), 2011.
4. G. Das and S. Pattanayak, *Fundamentals of mathematics analysis*, TMH Publishing Co.
5. S.C. Mallik and S. Arora, *Mathematical analysis*, New Age International Ltd., New Delhi,

DSC-MATH-H10

RING THEORY AND LINEAR ALGEBRA-I

Theory - 5 Credits, Tutorial – l Credit

Objective: This is a second course in modern algebra which deals with ring theory and linear algebra. Some basics of ring theory like rings, subrings, ideals, ring homomorphisms and their properties and basics of linear algebra like vector space, subspace, quotient space, basis , dimension, linear transformations, rank, and theory of matrices are introduced here. This course is an integral part of any course on Modern algebra the ohers being Group heory and Field Theory.

Expected outcomes: After completing this course, this will help students to continue more courses in advanced Ring theory modules, Galois groups,and Linear algebra.

UNIT-I

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring, Ideals, ideal generated by a subset of a ring, factor rings, operations on ideals.

UNIT-II

Prime and maximal ideals. Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients.

UNIT-III

Vector spaces, subspaces, algebra of subs paces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces. Linear transformations, null space, range, rank and nullity of a linear transformation.

UNIT-IV

Matrix representation of a linear transformation, Algebra of linear transformations, Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

BOOK FOR REFERENCES

1. Joseph A. Gallian, *Contemporary Abstract Algebra* (4th Edition), Narosa Publishing House, New Delhi, 1999.
2. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra* (4th Edition), Prentice-Hall ofIndia Pvt. Ltd., New Delhi, 2004.
3. LN. Herstein, *Topics in Algebra,* Wiley Eastern Limited, India, 1975.
4. John B. Fraleigh, *A First Course in Abstract Algebra,* 7th Ed., Pearson, 2002.
5. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007
6. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.

GENERIC COURSES

DSC-MATH-H4A

ALGEBRA

Theory - 5 Credits, Tutorial – l Credit

Objective: This is a preliminary course for the basic courses in mathematics i.e. abstract algebra and linear algebra which has applications not only in higher mathematics but also in science subjects like computer science, statistics, physics, chemistry etc..

Expected outcomes: Students will acquire knowledge on complex number system, Principle of Mathematical induction , basic linear algebra and matrix theory which will help to study further courses in mathematics in modern algebra and linear algebra..

UNIT-I

Polar representation of complex numbers, n-th roots of unity, De Moivres theorem for rational indices and its applications. Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set,

UNIT-II

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-III

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,Vector spaces and subspaces, examples, linear independence, linear dependence, basis, dimension, examples

UNIT-IV

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 and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

BOOK FOR REFERENCES

1. Andreescu and Dorin Andrica, 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. An Introduction to Linear Algebra by V Krishna Murthy, V P Mainra, J L Arora, Affiliated East-West Press Pvt. Ltd.
5. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw Hill International Edition, 2009.

DSC-MATH-H4B

MATHEMATICAL METHODS

Theory - 5 Credits, Tutorial – l Credit

Objective: The objective of this course is to prepare a student in basics of Integral transforms and Integral equations. These tools have engineering applications. Fourier transform and Laplace transform help in studying differential equations and other engineering problems.

Expected outcomes: A student trained in this course can opt for higher studies in digital signal processing and population dynamics modeling. This exposes the application of mathematics to various real life problems.

UNIT-I

Laplace transforms: Definitions, Existence of Laplace transform, Properties, Laplace transforms of some elementary functions, Convolution Theorem, Inverse Laplace transformation, Applications of Laplace transform.

UNIT-II

Fourier integral theorem, Fourier transforms: Definitions, Properties, Fourier transforms of some elementary functions, Convolution,

UNIT-III

Volterra Integral Equations: Basic concepts, Relationship between Linear differential equations and Volterra integral equations, Resolvent Kernel and Solution of Integral equations by Resolvent Kernel, The Method of successive approximations.

UNIT-IV

Fredholm Integral equations: Fredholm equations of the second kind, Iterated Kernel, Constructing the resolvent Kernel with the aid of iterated Kernels, Integral equations with degenerate Kernels.

BOOK FOR REFERENCES

1. Sneddon L, The use of Integral Transformations ,Tata McGraw Hill, 1974.
2. Schaum's Series, Laplace Transforms, McGraw-Hill, 1965.
3. Ram P Kanwa, Linear Integral Equations, Academic Press, 1971.

SKILL ENHANCEMENT COURSE

SEC-MATH-H2A

GRAPH THEORY

Theory - 2 Credits

Objective: The main objectives of this course are to introduce the basics of graphs, their properties and applications, to apply graph theory based tools in solving practical problems.

Expected Outcomes: Upon successful completion of this course students will be able to apply principles and concepts of graph theory in practical situations, to formulate problems in terms of graphs and solve graph theoretic problems using algorithms.

Unit-I

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs.

Unit-II

Isomorphism of graphs, paths and circuits, Eulerian circuits.

Unit-III

Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem.

Unit-IV

Shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

REFERENCES:

1. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*, 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
2. B.A. Davey and H.A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

SEC- MATH-H-2B

OPERATING SYSTEM (LINUX)

Theory- 2 Credits

Objectives: This course is designed with the objectives that a student will be able to understand the usages of UNIX inter process communications (IPC), control the resources with various commands, understand File systems and File structures, provide support for distributed and networked applications in UNIX environment, understand the concepts of multithreaded programming and socket programming, study the detail concepts of low level file access, understand the client, server programming, know the basic concept of Linux scripting

Expected Outcomes: Upon completion of this course, students will be able to mastery of the basic UNIX process structure and the UNIX file system, understand all the UNIX utilities, and implement shell scripting, mastery of simple UNIX filters , familiarity of UNIX pipes and redirection, UNIX environment, traps,

signals, filter parameters, filter options, UNIX contentions, and Regular Expressions, mastery of at least one Shell scripting language, understand the concepts of process, threads, and file structure.

UNIT-I

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).

UNIT-II

Linux Security, The Ext2 and Ext3 File systems: General Characteristics of, The Ext3 File system, file permissions.

UNIT-III

User Management: Types of users, the powers of Root, managing users (adding and deleting): using the command line and GUI tools.

UNIT-IV

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.

BOOK FOR REFERENCES:

1. Arnold Robbins, *Linux Programming by Examples the Fundamentals*, 2nd Ed., Pearson Education, 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*, 6th Ed., O'Reilly Media, 2009.
6. Neil Matthew, Richard Stones, Alan Cox, *Beginning Linux Programming*, 3rd Ed., 2004.

SEMESTER-V
CORE COURSES

DSC-MATH-H11

PARTIAL DIFFERENTIAL EQUATIONS AND SYSTEM OF ODEs(P)

Theory- 4 Credits, Practical – 2 Credits

Objective: The objective of this course is to understand basic methods for solving Partial Differential Equations of first order and second order. In the process, students will be exposed to Charpit's Method, Jacobi Method and solve wave equation, heat equation, Laplace Equation etc. They will also learn classification of Partial Differential Equations and system of ordinary differential equations.

Expected Outcomes: After completing this course, a student will be able to take more courses on wave equation, heat equation, diffusion equation, gas dynamics, non linear evolution equations etc. All these courses are important in engineering and industrial applications for solving boundary value problem.

UNIT-I

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-II

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-III

The Cauchy problem, 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

UNIT-IV

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, The method of successive approximations.

LIST OF PRACTICALS (USING ANY SOFTWARE)

(i) Solution of Cauchy problem for first order PDE.

(ii) Finding the characteristics for the first order PDE.

(iii) Plot the integral surfaces of a given first order PDE with initial data.

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

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

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

(c) $u(x, 0)=¢(x), u_t\{ (x, 0) = \psi(x)$, $u_x (0,t) = 0, x \in (O,\infty), t > 0$

(d) $u(x, 0) = ¢(x), ut (x, 0) = \psi(x), u(0,t) = 0, u(l,t) = 0, 0 < x < l, t > 0$

(v) Solution of wave equation $\frac{\partial u}{\partial t} - \kappa \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions

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

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

(c) $u(x,0) = \phi(x), u(0,t) = a, x \in (0,\infty), t \geq 0$

BOOK FOR REFERENCES:

1. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers,* 4th edition, Springer, Indian reprint, 2006.
2. S.L. Ross, *Differential equations,* 3rd Ed., John Wiley and Sons, India, 2004.
3. Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA,* 3rd Ed., Elsevier Academic Press, 2004.

DSC-MATH-H11

GROUP-THEORY-II

Theory- 5 Credits, Tutorial – 1 Credits

Objective: The objective of this course **i**s to be exposed to more advanced results in group theory after completing a basic course., The course introduces results on automorphism, commutator subgroup,group action Sylow theorems etc.

Expected outcomes: The knowledge of automorphism helps to study more on field theory. Students learn on direct products ,group actions , class equations and their applications with proof of all results . This course helps to opt for more advanced courses in algebra and linear classical groups.

UNIT-I

Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups. Characteristic subgroups.

UNIT-II

Commutator subgroup and its properties, 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-III

Group actions, stabilizers and kernels, permutation representation associated with a given group action, Application of group actions: Generalized Cayley's theorem, Index theorem.

UNIT-IV

Groups acting on themselves by conjugation, class equation and consequences, conjugacy in S_n , p - groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of A_n for $n \geq 5$, non-simplicity tests.

BOOK FOR 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. David S. Dummit and Richard M. Foote, *Abstract Algebra,* 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.
5. J.R. Durbin, *Modern Algebra,* John Wiley & Sons, New York Inc., 2000.
6. D. A. R. Wallace, *Groups, Rings and Fields,* Springer Verlag London Ltd., 1998.

DISCIPLINE SPECIFIC ELECTIVE COURSES

DSC-MATH-H1(i)

DISCRETE MATHEMATICS

Theory- 5 Credits, Tutorial – 1 Credits

Objective: The main objectives of this course is to introduce topics and techniques of counting principles,combinatorics, and graph theory to understand problems in almost all areas of knowledge.

Expected Outcomes: Upon successful completion of this course ,students will be able to learn core ideas in logic, permutations and combinations counting principles such as pigeonhole principle. They learn to use generating functions to solve a variety of combinatorial problems, apply mathematical ideas to practical problems and get a good knowledge of basics of graph heory and Boolean algebra.

Unit-I

Propositional logic, proportional equivalences, predicates and quantifiers, nested quantifiers, rules of inference, methods of proof, relations and their properties, n- ary relations and their applications.

Unit-II

The basic counting principle, the Pigeon-hole principle, generalized permutations and combinations, recurrence relations, counting using recurrence relations, solving linear homogeneous recurrence relations with constant coefficients, generating functions, solving recurrence relations using generating functions,

Unit-III

Partially ordered sets, Hasse diagram of partially ordered sets, maps between ordered sets, duality principle, Lattices (definition and example only), Boolean algebra (definition and example only), graphs: basic concepts and graph terminology.

Unit-IV

Representing graphs and graph isomorphism, distance in a graph, cut vertices and cut edges, connectivity, Euler and Hamiltonian path, Shortest-Path problems planar graphs, graph coloring.

REFERENCES:

1. Kenneth H. Rosen, Discrete Mathematics and Applications (Sixth Edition), Tata McGraw Hill Publications, 2007.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory (2nd Edition), Pearson Education (Singapore) Pte. Ltd., Indian Reprint 2003.
3. B A. Davey and H. A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
4. Rudolf Lidl and Gnter Pilz, Applied Abstract Algebra (2nd Edition), Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
5. Kevin Ferland-Discrete Mathematical Structures, Cengage Learning India Pvt. Ltd.

DSC-MATH-H1(ii)

NUMBER THEORY

Theory- 5 Credits, Tutorial – 1 Credits

Objective: The main objective of this course is to build up the basic theory of the integers, prime numbers and their primitive roots, the theory of congruence, quadratic reciprocity law and number theoretic functions, Fermat's last theorem, to acquire knowledge in cryptography specially in RSA encryption and decryption.

Expected Outcomes: Upon successful completion of this course students will able to know the basic definitions and theorems in number theory, to identify order of an integer, primitive roots, Euler's criterion, the Legendre symbol, Jacobi symbol and their properties, to understand modular arithmetic number-theoretic functions and apply them to cryptography.

Unit-I

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-II

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-III

Order of an integer modulo *n*, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol, Jacobi symbol and their properties, quadratic reciprocity, quadratic congruences with composite moduli.

Unit-IV

Affine ciphers, Hill ciphers, public key cryptography, RSA encryption and decryption, the equation $x^2 + y^2 = z^2$, Fermat's Last Theorem.

REFERENCES:

1. David M. Burton, *Elementary Number Theory* (6th Edition), Tata McGraw-Hill Edition, Indian reprint, 2007.
2. Thomas Koshy, *Elementary Number Theory with Applications* (2nd Edition), Academic Press, 2007.
3. Neville Robinns, *Beginning Number Theory* (2nd Edition), Narosa Publishing House Pvt. Limited, Delhi, 2007.

DSC-MATH-H1(iii)

OBJECT ORIENTED PROGRAMMING IN C++

Theory- 5 Credits, Tutorial – 1 Credits

Objective: The objective of the course is to learn the basics about C++ programming language such as variables, data types, arrays, pointers, functions and classes etc.

Expected Outcome: On successful completion of the course, students should have a good understanding about the concept of object-oriented programming using C++ and be able to write and read basic C++ code

UNIT-I

Introduction to structured programming: data types- simple data types, floating data types, character data types, string data types, arithmetic operators and operators precedence.

UNIT-II

Variables and constant declarations, expressions, input using the extraction operator >> and cin, output using the insertion operator << and cout, Preprocessor directives, increment(++) and decrement(--) operations.

UNIT-III

Creating a C++ program, input output, relational operators, logical operators and logical expressions, if and if-else statement, switch and break statements. for, while and do-while loops, Continue statement, nested control statement.

UNIT-IV

Functions, Value returning functions, value versus reference parameters, local and global variables, One dimensional array, two dimensional array, pointer data and pointer variables.

BOOKS FOR REFERENCES:

1. D. S. Malik: C++ Programming Language, Course Technology, Cengage Learning, India Edition, 2009.
2. E. Balaguruswami: Object oriented programming with C++, fifth edition, Tata McGraw Hill Education Pvt. Ltd.,2008.
3. R. Johnsonbaugh and M. Kalin-Applications Programming in ANSI C, Pearson Education.
4. S. B. Lippman and J. Lajoie, C++ Primer, 3rd Ed., Addison Wesley, 2000.
5. Bjarne Stroustrup , The C++ Programming Language, 3rd Ed., Addison Welsley, 2010.

DSC-MATH-H2(i)

PROABILITY AND STATISTICS

Theory- 5 Credits, Tutorial – 1 Credits

Objective: The objective of the course is to expertise the student to the extensive role of statistics in everyday life and computation, which has made this course a core course in all branches of mathematical and engineering sciences.

Expected outcome: The students shall learn probability and statistics for various random variables, multivariate distributions, correlations and relations. He shall learn law of large numbers and shall be able to do basic numerical calculations.

UNIT-I

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-II

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, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.

UNIT-III

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, Markov Chains, Chapman-Kolmogorov equations, classification of states.

BOOK FOR REFERENCES:

l. 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's Mathematical Statistics with Applications* (7th Edition), Pearson Education, Asia, 2006.
3. Sheldon Ross, *Introduction to Probability Models* (9th Edition), Academic Press, Indian Reprint, 2007.
4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, *Introduction to the Theory of Statistics,* (3rd Edition), Tata McGraw- Hill, Reprint 2007
4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, *Introduction to the Theory of Statistics,* (3rd Edition), Tata McGraw- Hill, Reprint 2007

DSC-MATH-H2(ii)

INDUSTRIAL MATHEMATICS

Theory- 5 Credits, Tutorial – 1 Credits

Objective: The objective of the course is to educate the students in applications of calculus, differential equations and matrices to inverse problems. The applications in medical imaging, tomography, X-ray, CT scan etc are also taught.

Expected Outcome: After taking the course students can mathematical model real life situations and can take advanced course in medical imaging and inverse problems.

UNIT-I

Medical Imaging and Inverse Problems. (The content is based on Mathematics of X-ray and CT scan based on the knowledge of calculus, elementary differential equations, complex numbers and matrices.) Introduction to Inverse problems: Why should we teach Inverse Problems? Illustration of Inverse problems through problems taught in Pre-Calculus, Calculus, Matrices and differential equations. Geological anomalies in Earth's interior from measurements at its surface (Inverse problems for Natural disaster) and Tomography.

UNIT-II

X-ray: Introduction, X-ray behavior and Beers Law (The fundament question of image construction) Lines in the place. Radon Transform: Definition and Examples, Linearity, Phantom (Shepp - Logan Phantom - Mathematical phantoms). Back Projection: Definition, properties and examples.

UNIT-III

CT Scan: Revision of properties of Fourier and inverse Fourier transforms and applications of their properties in image reconstruction. Algorithms of CT scan machine. Algebraic reconstruction techniques abbreviated as ART with application to CTscan.

BOOK FOR REFERENCES:

1. Timothy G. Feeman, *The Mathematics of Medical Imaging, A Beginners Guide,* Springer Under graduate Text in Mathematics and Technology, Springer, 2010.
2. C.W. Groetsch, *Inverse Problems,* Activities for Undergraduates, The Mathematical Association of America, 1999.
3. Andreas Kirsch, *An Introduction to the Mathematical Theory of Inverse Problems,* 2nd Ed., Springer, 2011.

DSC-MATH-H2(iii)

THEORY OF EQUATIONS

Theory- 5 Credits, Tutorial – 1 Credits

Objective: The main objectives of this course is to give knowledge about the polynomials and their graphical representations, to solve algebraic cubic and bi- quadratic equations, to understand the separation of the roots of equations, Strums theorem etc.

Expected Outcomes: Upon successful completion of this course students will able to demonstrate a variety of problem-solving techniques, to create, interpret and analyze graphical representations of equations, to perform and model calculations in different numeration systems, to solve various numerical equations.

Unit-I

General properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of a polynomials, General properties of equations, Descarte's rule of signs positive and negative rule.

Unit-II

Relation between the roots and the coefficients of equations, Symmetric functions, Applications of symmetric function of the roots, Transformation of equations. Solutions of reciprocal and binomial equations.

Unit-IlI

Algebraic solutions of the cubic and bi quadratic. Properties of the derived functions. Symmetric functions of the roots, Newton's theorem on the sums of powers of roots.

Unit-IV

Homogeneous products, limits of the roots of equations. Separation of the roots of equations, Strums theorem, Applications of Strum's theorem, Conditions for reality of the roots of an equation and biquadratic. Solution of numerical equations.

REFERENCES:

1. W.S. Burnside and A. W. Panton, *The Theory of Equations,* Dublin University Press, 1954.
2. C. C. MacDuffee, *Theory of Equations,* John Wiley & Sons Inc., 1954.

SEMESTER-VI

CORE COURSES

DSC-MATH-H13

METRIC SPACE AND COMPLEX ANALYSIS

Theory- 5 Credits, Tutorial – 1 Credits

Objectives: The objective of this course is to teach students the concepts in both metric spaces and complex analysis. The topology of metric spaces is explained starting with basic concepts of open and closed sets, convergent and Cauchy convergent sequences, complete spaces, compactness and connectedness etc. The metric space structure of complex number system and the concepts of analyticity and mapping properties of function of a complex variable along with geometric interpretation of limits and derivatives will be illustrated. Complex integration and complex power series are also introduced.

Expected Outcomes: Upon successful completion of this course, the student learns the language of metric spaces and its topological properties. He will know many examples of metric spaces and can test analyticity of complex functions. He can find radius of convergence of a power series,can evaluate complex integrals , can find the Taylor series of a function and determine its circle or annulus of convergence. He can compute the residue of a function and use the residue theory to evaluate a contour integral. This course is prerequisite to many othr analysis courses.

UNIT-I

Metric spaces: definition and examples, sequences in metric spaces, Cauchy sequences, complete metric spaces, open and closed balls, neighborhood, open set, interior of a set, limit point of a set, closed set, diameter of a set, Cantor's theorem,

UNIT-II

Subspaces, dense sets, separable spaces, continuous mappings, sequential criterion and other characterizations of continuity, uniform continuity, homeomorphism, contraction mappings, Banach Fixed point theorem, connectedness, connected subsets of R, Limits involving the point at infinity, continuity,

UNIT-III

Properties of complex numbers, regions in the complex plane, functions of complex variable, derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability, analytic function, harmonic functions, exponential function, logarithmic function, trigonometric function,

UNIT-IV

Derivatives and definite integrals of the complex functions: contour integrals and its examples. Anti derivatives, Cauchy-Goursat theorem, Cauchy integral formula. An extension of Cauchy integral formula, consequences of Cauchy integral formula, Liouville's theorem and the fundamental theorem of algebra, convergence of sequences and series, Taylor series and its examples, Laurent series and its examples, absolute and uniform convergence of power series.

BOOKS FOR REFERENCE:

1. Satish Shirali & Harikishan L. Vasudeva, *Metric Spaces*, Springer Verlag London (2006) (First Indian Reprint 2009)
2. S. Kumaresan, *Topology of Metric Spaces*, Narosa Publishing House, Second Edition 2011.
3. G. F. Simmons, *Introduction to Topology and Modern Analysis*, Mcgraw-Hill, Edition 2004.
4. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications* (Eighth Edition), McGraw - Hill International Edition, 2009.
5. Joseph Bak and Donald 1. Newman, *Complex analysis* (2ndEdition), Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

DSC-MATH-H14

RING THEORY AND LINEAR ALGEBRA-II

Theory- 5 Credits, Tutorial – 1 Credits

Objective: The prerequisite course for this is Ring Theory and Linear Algebra-I**.** Different kinds of rings like polynomial ring, Principal deal domain, unique factorization domain, Euclidean domain are introduced. Dual of vector space and its basis, inner product space and linear operators on it are introduced here in linear algebra.

Expected outcomes: Students can know reducibility and irreducibility of polynomials. Knowledge on dual space and inner product space will lead to study on different spaces like Hilbert space, Banach space, etc. in functional analysis later.

UNIT-I

Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, Unique factorization in Z[x].

UNIT-II

Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains, Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators,

UNIT-III

Eigenspaces of a linear operator, diagonalizability. Invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator, Inner product spaces and norms, Gram-Schmidt orthogonalization process,

UNIT-IV

Orthogonal complements, Bessel's inequality, the adjoint of a linear operator, Least Squares Approximation, minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem.

BOOKS FOR REFERENCE:

1. Joseph A. Gallian, Contemporary Abstract Algebra (4th Ed.), Narosa Publishing House, 1999.
2. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra* (4th Edition), Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
3. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007
4. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
5. John B.Fraleigh, A first course in Abstract Algebra, ih Edition, Pearson Education India, 2003.
6. Herstein, Topics in Algebra (2nd edition), John Wiley & Sons, 2006

DISCIPLINE SPECIFIC ELECTIVE COURSES

DSC-MATH-H3(i)

MATHEMATICAL METHODS

Theory- 5 Credits, Tutorial – 1 Credits

Objective: The objective of this course is to prepare a student in basics of Integral transforms and Integral equations. These tools have engineering applications. Fourier transform and Laplace transform help in studying differential equations and other engineering problems.

Expected outcomes: A student trained in this course can opt for higher studies in digital signal processing and population dynamics modeling. This exposes the application of mathematics to various real life problems.

UNIT-I

Laplace transforms: Definitions, Properties, Laplace transforms of some elementary functions, Convolution Theorem, Inverse Laplace transformation. Application of Laplace transform .

UNIT-II

Fourier transforms: Definitions, Properties, Fourier transforms of some elementary functions, Convolution.

UNIT-III

Volterra Integral Equations: Basic concepts, Relationship between Linear differential equations and Volterra integral equations, Resolvent Kernel of Volterra Integral equations, Solution of Integral equations by Resolvent Kernel, The Method of successive approximations.

UNIT-IV

Fredholm Integral equations: Fredholm equations of the second kind Fundamental, Iterated Kernel, Constructing the resolvent Kernel with the aid of iterated Kernels, Integral equations with degenerate Kernels.

BOOK FOR REFERENCE:

1. Sneddon L, The use of Integral Transformations ,Tata McGraw Hill, 1974.
2. Schaum's Series, Laplace Transforms, McGraw-Hill, 1965.
3. Ram P Kanwa, Linear Integral Equations, Academic Press, 1971.

DSC-MATH-H3(ii)

BIO-MATHEMATICS

Theory- 5 Credits, Tutorial – 1 Credits

Objective: The objective of this course is to introduce basic mathematical models in biology and genetics to students. A student learns how to use basic ideas in differential equations,linear algebra and statistics to understanding problems involving hearts nerve tansmissions and genetics.

Expected outcome: After reading this course the student shall be able to understand the mathematics regulating predator prey model, heart functioning, nerve impulse transmission,CT scan, MRI etc. Some dynamical system model like bifurcation theory and stability will also be taught to him. He will develop idea about simulation and modeling and will be able to take related courses like computational neuro science, Mathematical biology etc.

UNIT-I

Population growth, Administration of drugs, Cell division. Modelling Biological Phenomena: Heart beat, Blood Flow, Nerve Impulse transmission, Chemical Reactions, Predator-prey models. Stability and oscillations: Epidemics, the phase plane, Local Stability, Stability, Limit Cycles, Forced oscillations, Computing trajectories.

UNIT-II

Mathematics of Heart Physiology: The local model, The Threshold effect, The phase plane analysis and the heart beat model, Physiological considerations of the heart beat model, A model of the cardiac pace-maker. Mathematics of Nerve Impulse transmission: Excitability and repetitive firing, travelling waves. Bifurcation and chaos: Bifurcation, Bifurcation of a limit cycle, Discrete bifurcation, Chaos, Stability, The Poincare plane, Computer programs for Iteration Schemes.

UNIT-III

Mathematics of imaging of the Brain: Modelling of computerized tomography(CT, Magnetic resonance Imaging (MRIL Positron emission Tomography (PETL Single Photon Emission Computerized Tomography(SPECTL Discrete analogues and Numerical Implementation. Networks in Biological Sciences: Dynamics of Small world networks, scale-free networks, complex networks, cellular automata.

UNIT-IV

Modelling Molecular Evolution: Matrix models of base substitutions for DNA sequences, The Jukes-Cantor Model, the Kimura Models, Phylogenetic distances. Constructing Phylogenetic trees: Unweighted pair-group method with arithmetic means (UPGMA), Neighbour- Joining Method, Maximum Likelihood approaches. Genetics: Mendelian Genetics, Probability distributions in Genetics, Linked genes and Genetic Mapping, Statistical Methods and Prediction techniques.

BOOK FOR REFERENCES:

1. Elizabeth S. Allman and John a. Rhodes, Mathematical Models in Biology, Cambridge University Press, 2004.
2. C. Epstein, The Mathematics of Medical Imaging, Prentice Hall, 2003 (copyright Pearson Education, 2005).
3. S. Helgason, The Radon transform, Second Edition, Birkhauser, 1997.
4. D. S. Jones and B. D. Sleeman, Differential Equations and Mathematical Biology, Cahapman & Hall, CRC Press, London, UK, 2003.
5. James Keener and James Sneyd, Mathematical Physiology, Springer Verlag, 1998, Corrected 2nd printing, 2001.

DSC-MATH-H3(iii)

LINEAR PROGRAMMING

Theory- 5 Credits, Tutorial – 1 Credits

Objective: The objective of this course is to familiarize industrial problems to students with various methods of solving Linear Programming Problems, Transportation Problems, Assignment Problems and their applications. Also, this topic will encourage to students for Game Theory applying Linear Programming method.

Expected Outcomes: This topic is industrial job friendly. More knowledge on this topic in higher studies will help students to deal industrial models. This is also prerequisite for studying advanced courses in Nonlinear Programming Problems, Inventory Control Problem and Queuing Theory etc.

UNIT-I

Introduction to linear programming problem, Theory of simplex method, 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-II

Duality, formulation of the dual problem, primal-dual relationships, Fundamental theorem of duality, economic interpretation of the dual.

UNIT-III

Transportation problem and its mathematical formulation, northwest-comer 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-IV

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

BOOK FOR REFERENCE:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows* (2nd edition), John Wiley and Sons, India, 2002 .
2. F. S. Hillier and G. J. Lieberman, *Introduction to Operations Research- Concepts and Cases* (9th Edition), Tata McGraw Hill, 2010.
3. Hamdy A. Taha, *Operations Research, An Introduction* (9th edition), Prentice-Hall, 2010.
4. G. Hadley, *Linear Programming*, Narosa Publishing House, New Delhi, 2002.

DSC-MATH-H4(i)

MATHEMATICAL MODELING

Theory- 5 Credits, Tutorial – 1 Credits

Objective: Apart from getting exposed to pure forms of mathematical abstractions, the objective of the course is to expose the students to state- of- the- art methods in modeling, like queuing models and linear programming models. The course also teaches use of differential equation in modeling.

Expected Outcomes: After taking this course A students learns how to use elementary mathematics and differential equations and linear programming in modeling a real life problem . This can lead to more modeling courses using stochastic process, Discrete dynamical system, Optimization methods, finite elements, wavelets etc.

UNIT-I

Power series solution of a differential equation about an ordinary point, solution about a regular singular point, Bessel's equation and Legendre's equation.

UNIT-II

Laplace transform and inverse transform, application to initial value problem up to second order .

UNIT-III

Queuing Models: harbor system, morning rush hour, Overview of optimization modeling.

UNIT-IV

Linear Programming Model: geometric solution algebraic solution, simplex method, sensitivity analysis

BOOK FOR REFERENCES:

l. TynMyint-U and Lokenath Debnath, *Linear Partial Differential Equation/or Scientists and Engineers,* Springer, Indian reprint, 2006.
2. Frank R. Giordano, Maurice D. Weir and William P. Fox, *A First Course in Mathematical Modeling,* Thomson Learning, London and New York,2003.
3. Joan M. Aldous and Robin J. Wilson, *Graphs and Applications: An Introductory Approach,* Springer, Indian reprint, 2007.

DSC-MATH-H4(ii)

MECHANICS

Theory- 5 Credits, Tutorial – 1 Credits

Objective-The objective of this course is to teach the student the basics of Newtonian mechanics and the the laws of statics and dynamics. The student is expected to solve problems of mechanics.

Outcome-A student trained in this course will be able to pursue course work on Lagrangian mechanics, Hamiltonian mechanics, Foundations of Mechanics and celestial mechanics courses. He will be able to take courses in ballistics and projectile dynamics also.

UNIT-I

Moment of a force about a point and an axis, couple and couple moment, Moment of a couple about a line, resultant of a force system, distributed force system, free body diagram, free body involving interior sections, general equations of equilibrium

UNIT-II

Two point equivalent loading, problems arising from structures, static indeterminacy. Laws of Coulomb friction, application to simple and complex surface contact friction problems, Transmission of power through belts, screw jack, wedge, first moment of an area and the centroid, other centers,

UNIT-III

Theorem of Pappus-Guldinus, second moments and the product of area of a plane area, transfer theorems, relation between second moments and products of area, polar moment of area, principal axes. Conservative force field, conservation for mechanical energy, work energy equation, kinetic energy and work kinetic energy expression based on center of mass,

UNIT-IV

Moment of momentum equation for a single particle and a system of particles, translation and rotation of rigid bodies, Chasles' theorem, general relationship between time derivatives of a vector for different references, relationship between velocities of a particle for different references, acceleration of particle for different references.

BOOK FOR REFERENCES:

1. I.H. Shames and G. Krishna Mohan Rao, *Engineering Mechanics: Statics and Dynamics* (4th Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
2. R.C. Hibbeler and Ashok Gupta, *Engineering Mechanics: Statics and Dynamics* (11 th Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.

DSC-MATH-H4(iii)

DIFFERENTIAL GEOMETRY

Theory- 5 Credits, Tutorial – 1 Credits

Objective: After learning methods on curve tracing and Analytic Geometry, the objective of this course is to teach Differential geometry of curves and surfaces which trains a student using tools in calculus to derive intrinsic properties of plain curves and space curves.

Expected Outcome: After completing this course a student will learn on serret-Frenet formulae, relation between tangent, normal and binormals, first and second fundamental forms and ideas on various curvatures. He has scope to take more advanced courses in surface theory and geometry.

UNIT-I

Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae. Osculating circles, Osculating circles and spheres. Existence of space curves.

UNIT-II

Evolutes and involutes of curves. Theory of Surfaces: Parametric curves on surfaces, surfaces of revolution, helicoids, Direction coefficients. First and second Fundamental forms.

UNIT-III

Principal and Gaussian curvatures. Lines of curvature, Euler's theorem. Rodrigue's formula,

Conjugate and Asymptotic lines. Developables: Developable associated with space curves and curves on surfaces, Minimal surfaces.

UNIT-IV

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. Surfaces of constant curvature.

BOOK FOR REFERENCES:

1. T.J. Willmore, *An Introduction to Differential Geometry*, Dover Publications, 2012.
2. A. Pressley, Elementary Differential Geometry, Springer Internationl Edition, 2014.
3. O'Neill, *Elementary Differential Geometry*, 2nd Ed., Academic Press, 2006.
4. C.E. Weatherburn, *Differential Geometry of Three Dimensions*, Cambridge University Press 2003.
5. D.J. Struik, *Lectures on Classical Differential Geometry*, Dover Publications, 1988.
6. S. Lang, *Fundamentals of Differential Geometry*, Springer, 1999.

DSC-MATH-H4(iv)

PROJECTS

Total Marks:100 (Project: 80 Marks + Viva-Voice: 20 Marks)

Identification of problem-	10
Review of Literature-	10
Methodology-	10
Finding-	25
Analysis-	25
Viva-Voce-	20