SAMBALPUR UNIVERSITY

STRUCTURE OF THE BA/BSC MATHEMATICS PASS 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		
			Theory	Practical(P)/ Tutorial((T)	Total Credits
DISCIPLINE SPECIFIC CORE COURSES(4 PAPERS)(DSC)					
1st	**DSC- MATH-P -1**	Differential Calculus	5	1	6
2nd	**DSC- MATH-P -2**	Differential equations	5	1	6 AKT
3rd	**DSC- MATH-P -3**	Real Analysis	5	1	6
4th	**DSC- MATH-P -4**	Algebra	5	1	6
DISCIPLINE SPECIFIC ELECTIVE COURSES(2 PAPERS)(DSE)					
5Th	**DSE- MATH-P-1A**	Matrices Or Mechanics Or Linear Algebra	5 5 5	1 1 1	6 6 6
6th	**DSE- MATH-P-1B**	Numerical Methods Or Complex Analysis or Linear Programming	5 5 5	1 1 1	6 6 6 AKT
ABILITY ENHANCEMENT COURSES(AEC)TWO TYPES(AECC+SEC)					
ABILITY ENHANCEMENT COMPULSORY COURSES(AECC) 2 papers					
1st	**AECC-MATH-P-1**	Environmental science	2		2
2nd	**AECC-MATH-P-2**	English/MIL/Hindi communication	2		2
SKILL ENHANCEMENT COURSES(SEC) 4 papers					
3rd	**SEC- MATH-P-1**	Logic and Sets or Analytical Geometry OR Integral Calculus	2 2 2		2 2 2
4th	**SEC-MATH-P-2**	Vector Calculus or Theory of Equations OR Number Theory	2 2 2		2 2 2
5th	**SEC-MATH- P-3**	Probability and Statistics Or Mathematical Finance OR Mathematical Modeling	2 2 2		2 2 2 AKT
6th	**SEC-MATH- P-4**	Boolean Algebra OR Transportation and Game Theory OR Graph Theory	2 2 2		2 2 AKT 2

		Total credits for Pass Mathematics(DSC+DSE+AEC)	**120 credits**

DETAILED SYLLABUS FOR HONOURS MATHEMATICS COURSES

B.A./B.SC.(PASS) MATHEMATICS

SEMESTER-I
(CORE COURSES)

DSC-MATH-P1

DIFFERENTIAL CALCULUS - 6 credits

Theory (Credits-4)

Objective: Differential calculus and integral calculus are the basics for development of one of the main branch of mathematics, i.e. analysis, which has its application in other branches of science. The objective of the course is to introduce students to the main topics of differential calculus namely, limits, continuity, and differentiation and their applications in tracing of curves, series expansion of algebraic, trigonometric, logarithmic functions etc.

Expected Outcomes: Training in this course will not only open way to enter the branch of analysis in mathematics but also help students to handle problems in different branches of science i.e. physics, computer science, statistics, etc..

UNIT-I

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

UNIT-II

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

UNIT-III

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder,

UNIT-IV

Taylor's series, Maclaurin's series of sin x, cos x, e^x, log(l+x), $(l+x)^m$, Maxima and Minima, Indeterminate forms.

BOOKS FOR RECOMMENDED:

1. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.

2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.
3. Gorakh Prasad, *Text book of Differential Calculus*, Pothisala Pvt. Ltd. , Allahabad.
4. Shanti Narayan, *Differential Calculus*, S. Chand

SEMESTER-II
CORE COURSES

DSC-MATH-P2

DIFFERENTIAL EQUATIONS - 6 credits

Theory (Credits-5)

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 deals 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 RECOMMENDED

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. J. Sinha Roy & S. Padhi, *A Course on Ordinary and Partial Differential Equations*, Kalyani Publishers, New Delhi.
4. M. Braun, *Differential Equations & Their Applications*, Springer Student Edn.
5. G. F. Simmons, Differential Equations & Applications, McGRAW-HILL Int. Edition.

SEMESTER-III
CORE COURSES

DSC-MATH-P-3

REAL ANALYSIS- 6 credits

Theory – 5 Credits; Tutorial - 1 Credit

Objective: The objective of the course is to have knowledge on basic properties of the field of real numbers and studying Bolzano-Weiersstrass Theorem , sequences and convergence of sequences, series of real numbers and its convergence, differentiation and integration of functions.

Expected Outcome: On successful completion of this course, students will able to test convergence of sequence and series of real numbers. They will learn basic theorems in differentiation and integration. Students will appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.

UNIT-I

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

Unit-II

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

UNIT-III

Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, Alternating series, Leibnitz's test (Tests of Convergence without proof).

UNIT-IV

Definition and examples of absolute and conditional convergence, Sequences and series of functions, Differentiability of functions, integrability of functions, Power series and radius of convergence.

BOOKS RECOMMENDED

1. T. M. Apostol, *Calculus* (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
2. R.G. Bartle and D. R Sherbert, *Introduction to Real Analysis*, John Wiley and Sons (Asia) P. Ltd., 2000.
3. E. Fischer, *Intermediate Real Analysis*, Springer Verlag, 1983.
4. K.A. Ross, *Elementary Analysis- The Theory of Calculus Series*- Undergraduate Texts in Mathematics, Springer Verlag, 2003.
5. G. Das and S. Pattanayak, *Fundamentals of Mathematical Analysis*, TMH Publishing Co., 2007.
6. S.C. Mallik and S. Arora, *Mathematical Analysis*, New Age International Publications, 5th Ed., 2017.

SKILL ENHANCEMENT COURSES

SEC- MATH-P-1(i)

LOGIC AND SETS (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.

SEC- MATH-P-1(ii)

ANALYTICAL GEOMETRY (2 Credits)

Objective: The objective of the course is to get idea on basic concepts in analytic geometry, lines, circles, and other conic sections, polar coordinates and parametric equations.

Expected Outcome: On successful completion of the course students will be able to know about parametrize curves, sketch conic sections, identify conic sections and able to classify quadratic equations.

UNIT-I

Conic sections and quadratic equations, Classifying conic sections by eccentricity, Techniques for sketching parabola, ellipse and hyperbola.

UNIT-II

Quadratic equations and rotations, Reflection properties of parabola, ellipse and hyperbola, Classification of quadratic equations representing lines, parabola, ellipse, hyperbola, Spheres and Cylindrical surfaces

UNIT-III

Parametrization of plane curves, Calculus with parametrized curves, Polar co-ordinates, Graphing in polar co-ordinates.

UNIT-IV

Polar equations for conic sections, Illustrations of graphing standard quadric surfaces like cone, ellipsoid, Integrations in Polar co-ordinates.

BOOKS RECOMMENDED

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) Pvt. Ltd., 2002.
3. S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company, London, 2016.
4. R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillan India Ltd., 1994.
5. S. Narayan, *Analytical Soilid Geometry*, S. Chand & Co, 2007.

SEC- MATH-P-1(iii)

INTEGRAL CALCULUS (2 Credits)

Objectives: The course is framed to introduce the concept of integration, study various techniques of integration and illustrate some applications of integration.

Expected Outcomes: On successful completion of the course, students will able to evaluate definite and indefinite integrals using a variety of integration formulas and techniques including the evaluation of improper integrals, apply integration to areas and volumes, and other applications such as work or length of a curve, apply convergence tests to sequences and series and represent functions as power series, graph, differentiate and integrate functions in polar and parametric form.

UNIT-I

Integration by partial fractions, integration of rational and irrational functions, properties of definite integrals.

UNIT-II

Reduction formulae for integrals of rational, trigonometric, exponential and logarithmic functions and of their combinations.

UNIT-III

Areas and lengths of curves in the plane.

UNIT-IV

Double and triple integrals, volumes and surfaces of solids of revolution.

BOOKS RECOMMENDED

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd., 2002
3. Gorakh Prasad, *Text book of Integral Calculus*, Pothisala Pvt. Ltd., Allahabad

SEMESTER-IV
CORE COURSES

DSC-MATH-P-4

ALGEBRA- 6 credits

Theory – 5 Credits; Tutorial - 1 Credit

Objective: The concept of groups, rings, fields and vector spaces are essential building blocks of Modern algebra. The objective of the present course Algebra is to introduce students some basic concepts of modern algebra like group theory and ring theory which is an essential part of general mathematics and is a basis for further study of more advanced mathematics. This course not only play a fundamental role in mathematics but also has applications to other areas of science and engineering.

Expected Outcomes: Students will observe how so much theory can be developed from just a few simple axioms that define group and ring. They will understand the importance of algebraic properties with regard to working within various areas like number systems, matrices, class of functions etc. This course will help to study more on group theory and ring theory in next semesters.

UNIT-I

Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn of integers under addition modulo n and the group U(n) of units under multiplication modulo n. Cyclic groups from number systems, complex roots of unity, circle group.

UNIT-II

The general linear group GLn (n,R), Groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle,(iii) a rectangle, and (iv) a square, the permutation group Sym (n), Group of quaternions, Subgroups, cyclic subgroups.

UNIT-III

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

UNIT-IV

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

BOOKS FOR REFERENCE:

1. I. N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, India, 1975.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
4. Joseph A Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa, 1999.
5. George E Andrews, *Number Theory*, Hindustan Publishing Corporation, 1984.

SKILL ENHANCEMENT COURSES

SEC- MATH-P-2(i)

VECTOR CALCULUS - 2 credits

Objective: The notion of point, vector and their differences and similarities will be introduced. Main focus will be to recognize the use of a point and/or a vector in problem solving. To introduce them to vector algebra and directional derivatives and to solve Double and Triple Integrals

Expected Outcome: On successful completion of the course students will able to Compute dot product, cross product, length of vectors, derivatives of vector-valued functions, gradient functions, able to evaluate integrals of functions or vector-related quantities over curves, surfaces, and domains in two- and three-dimensional space.

UNIT-I

Vectors in the Plane, Cartesian co-ordinates and vectors in space, Dot product and Cross product of two vectors, Properties of products.

UNIT-II

Differentiation and partial differentiation of a vector function, curves, tangent and arc length.

UNIT-III

Curvature and Torsion of a curve,Gradient of a scalar field, Directional derivative,

UNIT-IV

Divergence of a vector field, curl of a vector filed.

BOOKS RECOMMENDED

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.
3. P.C. Matthew's, *Vector Calculus*, Springer Verlag London Limited, 1998.
4. S.C. Mallik and S. Arora, *Mathematical Analysis*, New Age International Publications, 2017.

SEC- MATH-P-2(ii)

THEORY OF EQUATIONS - 2 Credits

Objective: The main objectives of this course are to give knowledge about the polynomials and their graphical representations, to solve algebraic cubic and bi quadratic equations, 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 polynomial, General properties of equations,

UNIT-II

Descarte's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.

UNIT-III

Symmetric functions, Applications symmetric function of the roots, Transformation of equations.

UNIT-IV

Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Properties of the derived functions.

BOOKS RECOMMENDED

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.

SEC- MATH-P-2(iii)

NUMBER THEORY - 2 Credits

Objective: The main objective of this course is to acquaint students with the fundamental properties of numbers, basic number theoretic results and number theoretic functions like, fundamental theorem of arithmetic, prime number theorem, Euler phi-function etc. .

Expected Outcomes: Upon successful completion of this course students will able to opt for advance courses in number theory like analytic number theory, algebraic number theory, cryptography etc.

UNIT-I

Division algorithm, Lame's theorem, linear Diophantine equation, fundamental theorem of arithmetic,

UNIT-II

prime counting function, statement of prime number theorem, Goldbach conjecture,

Binary and decimal representation of integers,.

UNIT-III

Linear congruences, complete set of residues, number theoretic functions, sum and number of divisors, totally multiplicative functions,

UNIT-IV

Definition and properties of the Dirichlet product, the Möbius inversion formula, the greatest integer function, Euler's phi-function.

BOOKS RECOMMENDED:

1. David M. Burton, *Elementary Number Theory* 6th Ed., Tata McGraw-Hill Edition, Indian reprint, 2007.
2. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with Maple*, CRC Press, Boca Raton, 2000.
3. Neville Robinns, *Beginning Number Theory*, 2nd Ed., Narosa Publishing House Pvt. Limited, Delhi, 2007.

SEMESTER-V
DISCIPLINE SPECIFIC ELECTIVE COURSES

DSE- MATH-P-1A(i)

MATRICES (6 Credits)

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 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 all other future courses .

Expected outcomes: On successful completion of this course students will be able to understand the basic ideasof 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.

UNIT-I

R, R2, R3 as vector spaces over R. Standard basis for each of them. Concept of Linear Independence and examples of different bases. Subspaces of R2, R3 ,Translation, Dilation, Rotation, Reflection in a point, line and plane.

UNIT-II

Matrix form of basic geometric transformations. Interpretation of eigen values and eigen vectors for such transformations and eigen spaces as invariant subspaces, Types of matrices. Rank of a matrix. Invariance of rank under elementary transformations.

UNIT-III

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

UNIT-IV

Computation of matrix inverses using elementary row operations. Rank of matrix. Solutions of a system of linear equations using matrices. Illustrative examples of above concepts from Geometry, Physics, Chemistry, Combinatorics and Statistics.

BOOKS RECOMMENDED

1. V Krishna Murthy, V P Mainra, J L Arora , An Introduction to Linear Algebra by, Affiliated East-West Press Pvt. Ltd. ,2105.

BOOK FOR REFERENCES

1. A.I. Kostrikin, *Introduction to Algebra*, Springer Verlag, 1984.
2. S. H. Friedberg, A. L. Insel and L. E. Spence, *Linear Algebra,* Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989.
4. S Kumaresan, *Linear Algebra*, A geometric approach Prentice Hall of India Learning Pvt. Ltd., New Delhi, 1999.

DSE- MATH-P-1A(ii)

MECHANICS (6 Credits)

Theory – 5 Credits; Tutorial - 1 Credit

Objective-The objective of this course is to teach the student the basics of Newtonian mechanics. The laws of statics and dynamics introduced here are fundamental in nature.

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

Conditions of equilibrium of a particle and of coplanar forces acting on a rigid Body, Laws of friction,

UNIT-II

Problems of equilibrium under forces including friction. Centre of gravity, Work and potential energy.

UNIT-III

Velocity and acceleration of a particle along a curve: radial and transverse components (plane curve), tangential and normal components (space curve),

UNIT-IV

Newton's Laws of motion, Simple harmonic motion, Simple Pendulum, Projectile Motion.

BOOKS RECOMMENDED

1. A.S. Ramsay, *Statics*, CBS Publishers and Distributors (Indian Reprint), 1998.
2. A.P. Roberts, *Statics and Dynamics with Background in Mathematics*, Cambridge University Press, 2003.

DSE- MATH-P-1A(ii)

LINEAR ALGEBRA (6 Credits)

Theory – 5 Credits; Tutorial - 1 Credit

Objective: Prerequisite knowledge to study this course is Matrix theory. The subject material is of importance in all fields of mathematics and in science in general. This course will acquaint students with the relation of dimension with rank and nullity of a linear transformation. The algebra of linear transformations and dual space are introduced here.

Expected outcomes: The knowledge on this course will provide the basis for further studies in advanced linear algebra and analysis like, linear groups, functional analysis etc. which forms the basics of higher mathematics.

UNIT-I

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

UNIT-II

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations.

UNIT-III

Dual Space, Dual Basis, Double Dual, Eigen values and Eigen vectors, Characteristic Polynomial.

UNIT-IV

Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

BOOKS RECOMMENDED

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra,* 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.
2. David C. Lay, *Linear Algebra and its Applications,* 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
3. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.
4. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.

SKILL ENHANCEMENT COURSES

SEC- MATH-P-3(i)

PROBABILITY AND STATISTICS - 2 credits

Objective: The objective of the course is to expertise the student to the extensive role of probability and 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, discrete and continuous distributions, multivariate distributions, etc..

UNIT-I

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions,

UNIT-II

Mathematical expectation, moments, moment generating function, characteristic function,

UNIT-III

Discrete distributions: uniform, binomial, Poisson, continuous distributions: uniform, normal, exponential.

UNIT-IV

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.

BOOKS RECOMMENDED:

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, John E. Freund, *Mathematical Statistics with Application,*7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, *Introduction to Probability Model,* 9th Ed., Academic Press, Indian Reprint, 2007.

SEC- MATH-P-3(ii)

MATHEMATICAL FINANCE- 2 Credits

Objective: The objective of this course is to learn the mathematical tools used for understanding the financial dynamics and stock exchange.

Expected Outcome: A student well versed in this course learns good statistical methods,computing and simulation methods and is able to pursue courses in computational finance later. This course has market value helping a student in employment also.

UNIT-I

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods),

UNIT-II

Comparison of NPV and IRR. Bonds, bond prices and yields. Floating-rate bonds, immunization.

Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation),

UNIT-III

Random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints).

BOOKS RECOMMENDED:

1. David G. Luenberger, *Investment Science*, Oxford University Press, Delhi, 1998.
2. John C. Hull, Options, *Futures and Other Derivatives*, 6th Ed., Prentice-Hall India, Indian reprint, 2006.
3. Sheldon Ross, *An Elementary Introduction to Mathematical Finance*, 2nd Ed., Cambridge University Press, USA, 2003.

SEC- MATH-P-3(iii)

MATHEMATICAL MODELING- 2 Credits

Objective: The course is designed to impart knowledge on application of differential equations in different physical problems like, electric circuit problem, conduction of heat in solids, vibrating string, etc.

Expected Outcomes: This course is based on modelling using elementary mathematics and differential equations. This will lead to advance modeling courses involving queuing models and linear programming models, etc. Students can opt for more modelling courses using stochastic process, Discrete dynamical system, Optimization methods, finite elements, wavelets learning techniques etc.

UNIT-I

First order and second order differential equation and methods to find their solutions, solution of partial differential equations by variable separable method**.**

UNIT-II

Applications of differential equations: the vibrations of a mass on a spring, mixture problem, free damped motion, forced motion, resonance phenomena,

UNIT-III

Electric circuit problem, mechanics of simultaneous differential equations, Applications to Traffic Flow.

UNIT-IV

Vibrating string, vibrating membrane, conduction of heat in solids, gravitational potential, conservation laws.

BOOKS RECOMMENDED:

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.

SEMESTER-VI
DISCIPLINE SPECIFIC ELECTIVE COURSES

DSE- MATH-P-1B(i)

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 some 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.

UNIT-I

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

UNIT-II

LU decomposition, Gauss-Jacobi, Gauss-Siedel and SOR iterative methods.

UNIT-III

Lagrange and Newton interpolation: linear and higher order, finite difference operators. Numerical differentiation: forward difference, backward difference and central Difference.

UNIT-IV

Integration: trapezoidal rule, Simpson's rule, Euler's method.

BOOKS FOR REFERENCE:

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*, 5th Ed., New age International Publisher, India, 2007.
3. S. S. Sastry, *Introductory method for Numerical Analysis*, PHI New Delhi, 2012.
4. S. D. Conte and Carl De Boor, *Elementary Numerical Analysis*, Mc Graw Hill, 1980.

DSE- MATH-P-1B(ii)

COMPLEX ANALYSIS (6 Credits)

Theory – 5 Credits; Tutorial - 1 Credit

Objective: This course is aimed to provide an introduction to the theories for functions of a complex variable. It begins with quick review on the exploration of the algebraic, geometric and topological structures of the complex number field. The concepts of analyticity and mapping properties of function of a complex variable will be illustrated. The notion of the Riemann sheet is presented to help student visualize multi-valued complex functions. Complex integration and complex power series are presented. We then discuss the classification of isolated singularities and examine the theory and illustrate the applications of the calculus of residues in the evaluation of integrals.

Expected Outcomes: After completing this course, students are expected to be able to work with functions and multi-valued functions (logarithmic, complex power) and determine branches of these functions; evaluate a contour integral using parameterization, fundamental theorem of calculus and Cauchy's integral formula; find the Taylor series of a function and determine its circle or annulus of convergence; compute the residue of a function and use the residue theory to evaluate a contour integral;

UNIT-I

Analytic functions: Properties of complex numbers, regions in the complex plane, functions of complex variable, Limits, Limits involving the point at infinity, continuity, derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

UNIT-II

Elementary functions: The exponential function, logarithmic function, trigonometric function, definite integrals of functions, contours, contour integrals and its examples, upper bounds for moduli of contour integrals.

UNIT-III

Cauchy-Goursat theorem, Cauchy integral formula, Morera's theorem, derivatives of analytic functions, Liouville's theorem and the fundamental theorem of algebra,

UNIT-IV

Convergence of sequences and series, Taylor series and its examples, Laurent series and its examples, absolute and uniform convergence of power series.

BOOKS RECOMMENDED

1. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications,* 8th Ed., McGraw – Hill International Edition, 2009.
2. Joseph Bak and Donald J. Newman, *Complex analysis,* 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.
3. S. Ponnusamy, *Foundation of complex analysis,* 2nd Ed., Narosa Publishing house, 2011

DSE- MATH-P-1B(iii)

Linear Programming (6 Credits)

Theory – 5 Credits; Tutorial - 1 Credit

Objective: The objective of this course is to familiarize students with various methods of solving Linear Programming Problems like, graphical method, simplex method, big-M method, etc.. Also, students will know the formulation of dual problem and its economic interpretation.

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

Linear Programming Problems, Graphical Approach for Solving some Linear Programs. Convex Sets, Supporting and Separating Hyperplanes.

UNIT-II

Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format,

UNIT-III

Introduction to artificial variables, two-phase method, Big-M method and their comparison.

UNIT-IV

Duality, formulation of the dual problem, primal- dual relationships, economic interpretation of the dual, sensitivity analysis.

BOOKS FOR REFERECE:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear programming and Network Flows,* 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research,* 8th Ed., Tata McGraw Hill, Singapore, 2004.
3. Hamdy A. Taha, *Operations Research, An Introduction,* 8th Ed., Prentice-Hall India, 2006.

SKILL ENHANCEMENT COURSES

SEC- MATH-P-4(i)

BOOLEAN ALGEBRA - 2 Credits

Objective: The objective of the course is to have knowledge on understanding of Boolean algebra and simplifying a logic circuit/expression using Boolean algebra.

Expected Outcome: On successful completion of the course, students can apply Boolean Algebra in Digital Electronis**.**

UNIT-I

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, Maximal and minimal elements.

UNIT-II

Lattices as ordered sets, complete lattices, Lattices as algebraic structures, Sublattices, products and homomorphisms.

UNIT-III

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials.

UNIT-IV

Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

BOOKS RECOMMENDED:

1. B A. Davey and H. A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
2. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

SEC- MATH-P-4(ii)

TRANSPORTATION AND GAME THEORY- 2 credits

Objective: The objective of this course is to train students to solve transportation problem and assignment problems by various methods. Formulation of games and its solution are also introduced.

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

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,

UNIT-II

Aassignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

UNIT-III

Special cases of transportation problems, and travelling salesman problems.

UNIT-IV

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

BOOKS RECOMMENDED:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows,* 2nd Ed., John Wiley and Sons, India, 2004.
2. F. S. Hillier and G. J. Lieberman, *Introduction to Operations Research,* 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, *Operations Research, An Introduction,* 8th Ed., Prentice-Hall India, 2006.

SEC- MATH-P-4(iii)

GRAPH 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.

BOOKS FOR REFERENCE:

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.