VINAYAKA MISSION'S RESEARCH FOUNDATION

(Deemed to be University)

FACULTY OF ARTS & SCIENCE

Curriculum and Syllabus

For

B.Sc. Mathematics

(Regular)

LOCF

(For the Academic Year starting from 2020-2021 onwards)

VINAYAKA MISSION'S RESEARCH FOUNDATION
(Deemed to be University under section 3 of the UGC Act 1956)

FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF

PROGRAMME LEARNING OUTCOMES

The Bachelor of Science with Mathematics (B.Sc. Mathematics) program enables students to accomplish, by the time of graduation:

PLO-A. Bachelor's degree in mathematics is the culmination of in-depth knowledge of algebra, calculus, geometry, differential equations and several other branches of mathematics. This also leads to study of related areas like computer science and statistics. Thus, this programme helps learners in building a solid foundation for higher studies in mathematics.

PLO-B. The skills and knowledge gained has intrinsic beauty, which also leads to proficiency in analytical reasoning. This can be utilised in modelling and solving real life problems.

PLO-C. Students undergoing this programme learn to logically question assertions, to recognise patterns and to distinguish between essential and irrelevant aspects of problems. They also share ideas and insights while seeking and benefitting from knowledge and insight of others. This helps them to learn behave responsibly in a rapidly changing interdependent society.

PLO-D. Students completing this programme will be able to present mathematics clearly and precisely, make vague ideas precise by formulating them in the language of mathematics, describe mathematical ideas from multiple perspectives and explain fundamental concepts of mathematics to non-mathematicians.

PLO-E. Completion of this programme will also enable the learners to join teaching profession in primary and secondary schools.

PLO-F. This programme will also help students to enhance their employability for government jobs, jobs in banking, insurance and investment sector

and jobs in various other public and private enterprises.

PLO-G. Demonstrate fundamental systematic knowledge of mathematics and its applications in engineering, science, technology and mathematical sciences. It should also enhance the subject specific knowledge and help in creating jobs in various sectors.

PLO-H. demonstrate educational skills in areas of analysis, geometry, algebra, mechanics, differential equations etc.

PLO-I. Apply knowledge, understanding and skills to identify the difficult/unsolved problems in mathematics and to collect the required information in possible range of sources and try to analyse and evaluate these problems using appropriate methodologies.

PLO-J. Ability to communicate various concepts of mathematics effectively using examples and their geometrical visualizations.

Additional PLOs

The Bachelor of Science in with Mathematics (B.Sc. Mathematics) program enables students to achieve following additional features besides the above-mentioned attributes, by the time of graduation:

PLO-K. Ability to use mathematics as a precise language of communication in other branches of human knowledge.

VINAYAKA MISSION'S RESEARCH FOUNDATION
(Deemed to be University under section 3 of the UGC Act 1956)

FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF

PLO-L. Ability to communicate long standing unsolved problems in mathematics.

PLO-M. Ability to show the importance of mathematics as precursor to various scientific developments since the beginning of the civilization.

PLO-N. Ability to explain the development of mathematics in the civilizational context and its role as queen of all sciences.

COURSE WITH CREDITS

Semester	**Compulsory Core Courses (CC)**	**Discipline Specific Elective (DSE)**	**Ability Enhancement Compulsory Courses (AECC)**	**Skill Enhancement Course (SEC)**	**Total Credits**
Sem I	18 + 2 (for Tamil/Hindi)		4 (English for Communication)		24
Sem II	6 + 4 (2 for Tamil/Hindi&2 for English)	1X6=6	4 (will be selected from list)	1X4=4	24
Sem III	6 + 4 (2 for English & 2 for Tamil/Hindi)	1X6=6		1X4 = 4	20
Sem IV	12+ 2 (2 for English & 2 for Tamil/Hindi)	1X6=6		1 X 4= 4	24
Sem V	2X6=12	1 x 6 =6		1 X4 = 4	22
Sem VI	3 x 6 =18	1 x 6 =6 (Project)			24
Total	**84**	**30**	**8**	**16**	**138**

VINAYAKA MISSION'S RESEARCH FOUNDATION
(Deemed to be University under section 3 of the UGC Act 1956)

FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF

Core course credit	12*6= 72
Tamil/Hindi course credit	4*2 = 8
English as language core course credit	2*2 = 4
Discipline specific elective credit	6*5 = 30
Ability Enhancement compulsory course credit	2*4 = 8
Skill enhancement course credit	4*4 = 16
Total credits	= **138**

Core Courses (CC)

S. No.	Name of the course	Type of course	L	T	P	Credits
CC 1.	Calculus	Core course	5	1	0	**6**
CC 2.	Algebra and Geometry	Core course	5	1	0	**6**
CC 3.	Multi-variable Calculus	Core course	5	1	0	**6**
CC 4.	Ordinary Differential Equations	Core course	5	1	0	**6**
CC 5.	Real Analysis	Core course	5	1	0	**6**
CC 6	Group Theory	Core course	5	1	0	**6**
CC 7.	Probability and statistics	Core course	5	1	0	**6**
CC 8.	Mechanics	Core course	5	1	0	**6**
CC 9.	Linear Algebra	Core course	5	1	0	**6**
CC 10	Partial Differential Equations and Calculus of Variations	Core course	5	1	0	**6**
CC 11	Advanced Algebra	Core course	5	1	0	**6**

CC 12.	Complex Analysis	Core course	5	1	0	**6**

VINAYAKA MISSION'S RESEARCH FOUNDATION
(Deemed to be University under section 3 of the UGC Act 1956)

FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF

Discipline Specific Elective (DSE) Course

S. No.	Name of the course	Type of course	L	T	P	Credits
1	General Physics-I	Discipline Specific Elective Course	4	0	2	**6**
2	General Physics-II	Discipline Specific Elective Course	4	0	2	**6**
3	General Chemistry-I	Discipline Specific Elective Course	4	0	2	**6**
4	General Chemistry-II	Discipline Specific Elective Course	4	0	2	**6**
5	Integral Transforms and Fourier Analysis	Discipline Specific Elective Course	5	1	0	**6**
6	Discrete Mathematics	Discipline Specific Elective course	5	1	0	**6**
7	Linear Programming	Discipline Specific Elective Course	5	1	0	**6**
8	Information Theory and Coding	Discipline Specific Elective Course	5	1	0	**6**
9	Graph Theory	Discipline Specific Elective Course	5	1	0	**6**
10	Special Theory and Relativity	Discipline Specific Elective Course	5	1	0	**6**
11	Mathematical Logic	Discipline Specific Elective Course	5	1	0	**6**
12	Number Theory	Discipline Specific Elective Course	5	1	0	**6**
13	Mathematical Finance	Discipline Specific Elective Course	5	1	0	**6**
14	C++Programming for Mathematics	Discipline Specific Elective Course	5	1	0	**6**
15	Cryptography	Discipline Specific Elective Course	5	1	0	**6**
16	Advanced Mechanics	Discipline Specific Elective Course	5	1	0	**6**

VINAYAKA MISSION'S RESEARCH FOUNDATION
(Deemed to be University under section 3 of the UGC Act 1956)

FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF

Ability Enhancement Courses

Sr. No.	Name of the course	Type of course	L	T	P	Credits
1	English for communication	Ability Enhancement Courses	3	1	0	4
2	Environmental Science	Ability Enhancement Courses	3	1	0	4

VINAYAKA MISSION'S RESEARCH FOUNDATION
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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

Skill Enhancement Courses

Sr. No.	Name of the course	Type of course	L/ P	T	P	Credits
1	Theory of Equations	Skill Enhancement Courses	4	0	0	**4**
2	Matrices	Skill Enhancement Courses	4	0	0	**4**
3	Transportation and Game theory	Skill Enhancement Courses	4	0	0	**4**
4	Integral Calculus	Skill Enhancement Courses	4	0	0	**4**
5	Vector Calculus	Skill Enhancement Courses	4	0	0	**4**
6	Boolean Algebra	Skill Enhancement Courses	4	0	0	**4**
7	Logic and Sets	Skill Enhancement Courses	4	0	0	**4**
8	Mathematical Modeling	Skill Enhancement Courses	4	0	0	**4**
9	Fuzzy set and Fuzzy logic	Skill Enhancement Courses	4	0	0	**4**
10	Computer Graphics	Skill Enhancement Courses	4	0	0	**4**
11	Operating System: Linux	Skill Enhancement Courses	4	0	0	**4**

VINAYAKA MISSION'S RESEARCH FOUNDATION
(Deemed to be University under section 3 of the UGC Act 1956)

FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

COURSE LEARNING OUTCOMES

The course learning outcomes are aligned with program learning outcomes but these are specific-to-specific courses offered in a program. The course level learning shall be reflected as program level learning. The core courses shall be the backbone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic excellence in the subject together with multi-dimensional and multidisciplinary approach.

VINAYAKA MISSION'S RESEARCH FOUNDATION
(Deemed to be University under section 3 of the UGC Act 1956)

FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER Discipline Specific Core Course: Calculus	L	T	P	C
I	I		B.Sc-Mathematics	5	1	0	6

Objectives;

1. Compute limits, derivatives, and integrals.
2. Analyze functions using limits, derivatives, and integrals
3. Recognize the appropriate tools of calculus to solve applied problems.

Course Learning Outcomes:

This course will enable the students to:

i) Assimilate the notions of limit of a sequence and convergence of a series of real numbers.

ii) Calculate the limit and examine the continuity of a function at a point.

iii) Understand the consequences of various mean value theorems for differentiable functions.

iv) Sketch curves in Cartesian and polar coordinate systems.

v) Apply derivative tests in optimization problems appearing in social sciences, physical sciences, life sciences and a host of other disciplines.

Unit-I:

Real numbers, Sequences of real numbers, Convergence of sequences and series, Bounded and monotonic sequences; Definite integral as a limit of sum, Integration of irrational algebraic functions and transcendental functions, Reduction formulae, Definite integrals.

Unit-II: Limit and Continuity

ε-δ definition of limit of a real valued function, Limit at infinity and infinite limits; Continuity of a real valued function, Properties of continuous functions, Intermediate value theorem, Geometrical interpretation of continuity, Types of discontinuity; Uniform continuity.

Unit-III: Differentiability

Differentiability of a real valued function, Geometrical interpretation of differentiability, Relation between differentiability and continuity, Differentiability and monotonicity, Chain rule of differentiation; Darboux's theorem, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Geometrical interpretation of mean value theorems; Successive differentiation, Leibnitz's theorem.

Unit-IV: Expansions of Functions

Maclaurin's and Taylor's theorems for expansion of a function in an infinite series, Taylor's theorem in finite form with Lagrange, Cauchy and Roche–Schlomilch forms of remainder; Maxima and minima.

Unit-V: Curvature, Asymptotes and Curve Tracing Curvature;

Asymptotes of general algebraic curves, Parallel asymptotes, Asymptotes parallel to axes; Symmetry, Concavity and convexity, Symmetry, Concavity and convexity, Multiple points, Position and nature of double points; Tracing of Cartesian, polar and parametric curves.

References:

1. Howard Anton, I. Bivens & Stephan Davis (2016). Calculus (10th edition). Wiley India.
2. Gabriel Klambauer (1986). Aspects of Calculus. Springer-Verlag.
3. Wieslaw Krawcewicz & Bindhyachal Rai (2003). Calculus with Maple Labs. Narosa.
4. Gorakh Prasad (2016). Differential Calculus (19th edition). Pothishala Pvt. Ltd.
5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). Thomas' Calculus (14th edition). Pearson Education.

VINAYAKA MISSION'S RESEARCH FOUNDATION
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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Core Course:** **Algebra and Geometry**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

In this Course students are exposed to topics like Theory of Equations, Summation of Series, Matrices, Continued Fractions and Elementary Number Theory. The stress is on the development of problem-solving skills.

Course Learning Outcomes:

This course will enable the students to:

i) Understand the importance of roots of real and complex polynomials and learn various methods of obtaining roots.

ii) Familiarize with relations, equivalence relations and partitions.

iii) Employ De Moivre's theorem in a number of applications to solve numerical problems.

iv) Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.

v) Find eigenvalues and corresponding eigenvectors for a square matrix.

vi) Explain the properties of three-dimensional shapes.

Unit-I: Theory of Equations and Complex Numbers

Elementary theorems on the roots of an equations including Cardan's method, The remainder and factor theorems, Synthetic division, Factored form of a polynomial, The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, Imaginary roots, Integral and rational roots; Polar representation of complex numbers, The nth roots of unity, De Moivre's theorem for integer and rational indices and its applications.

Unit-II: Relations and Basic Number Theory

Relations, Equivalence relations, Equivalence classes; Functions, Composition of functions, Inverse of a function; Finite, countable and uncountable sets; The division algorithm, Divisibility and the Euclidean algorithm, The fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruences; Principles of mathematical induction and well ordering.

Unit-III: Row Echelon Form of Matrices and Applications

Systems of linear equations, Row reduction and echelon forms, Linear independence, The rank of a matrix and applications; Introduction to linear transformations, The matrix of a linear transformation, Matrix operations, Determinants, The inverse of a matrix, Characterizations of invertible matrices;

Applications to Computer Graphics; Eigenvalues and eigenvectors, The characteristic equation and the Cayley–Hamilton theorem.

Unit-IV: Planes, Straight Lines and Spheres

Planes: Distance of a point from a plane, Angle between two planes, pair of planes, Bisectors of angles between two planes; Straight lines: Equations of straight lines, Distance of a point from a straight line, Distance between two straight lines, Distance between a straight line and a plane; Spheres: Different forms, Intersection of two spheres, Orthogonal intersection, Tangents and normal, Radical plane, Radical line, Coaxial system of spheres, Pole, Polar and Conjugacy.

Unit-V: Locus, Surfaces, Curves and Conicoids

Space curves, Algebraic curves, Ruled surfaces, Some standard surfaces, Classification of quadric surfaces, Cone, Cylinder, Central conicoids, Tangent plane, Normal, Polar planes, and Polar lines.

References:

1. Titu Andreescu, & Dorin Andrica (2014). Complex Numbers from A to...Z. (2nd edition). Birkhäuser.
2. Robert J. T. Bell (1994). An Elementary Treatise on Coordinate Geometry of Three Dimensions. Macmillan India Ltd.
3. D. Chatterjee (2009). Analytical Geometry: Two and Three Dimensions. Narosa Publishing House.
4. Leonard Eugene Dickson (2009). First Course in the Theory of Equations. The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785)
5. Edgar G. Goodaire & Michael M. Parmenter (2015). Discrete Mathematics with Graph Theory (3rd edition). Pearson Education Pvt. Ltd. India.
6. Bernard Kolman & David R. Hill (2003). Introductory Linear Algebra with Applications (7th edition). Pearson Education Pvt. Ltd. India.
7. David C. Lay, Steven R. Lay & Judi J. McDonald (2016). Linear Algebra and its Applications (5th edition). Pearson Education Pvt. Ltd. India.

VINAYAKA MISSION'S RESEARCH FOUNDATION
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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Core Course:** **Mulltivariable Calculus**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

This course is aimed at providing a concise introduction to the calculus of the vector valued functions of several variables. It is useful for the students who want to study topics like Differential Geometry, Topology, Analysis, Lie groups, Differential Equations, Theory of relativity, Quantum mechanics, Mathematical Biology, etc. The goal is to get the students acquainted with the basic notions of partial and directional derivatives, multiple integrals, line and surface integrals of functions of several variables.

Course Learning Outcomes:

This course will enable the students to:

i) Learn conceptual variations while advancing from one variable to several variables in calculus.

ii) Apply multivariable calculus in optimization problems.

iii) Inter-relationship amongst the line integral, double and triple integral formulations.

iv) Applications of multivariable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.

v) Realize importance of Green, Gauss and Stokes' theorems in other branches of mathematics.

Unit-I: Partial Differentiation

Functions of several variables, Level curves and surfaces, Limits and continuity, Partial differentiation, Tangent planes, Chain rule, Directional derivatives, The gradient, Maximal and normal properties of the gradient, Tangent planes and normal lines.

Unit-II: Differentiation

Higher order partial derivatives, Total differential and differentiability, Jacobians, Change of variables, Euler's theorem for homogeneous functions, Taylor's theorem for functions of two variables and more variables, Envelopes and evolutes.

Unit-III: Extrema of Functions and Vector Field

Extrema of functions of two and more variables, Method of Lagrange multipliers, Constrained optimization problems, Definition of vector field, Divergence, curl, gradient and vector identities

Unit-IV: Double and Triple Integrals

Double integration over rectangular and nonrectangular regions, Double integrals in polar coordinates, Triple integral over a parallelepiped and solid regions, Volume by triple integrals, Triple integration in cylindrical and spherical coordinates, Change of variables in double and triple integrals, Dirichlet integral.

Unit-V: Green's, Stokes' and Gauss Divergence Theorem

Line integrals, Applications of line integrals: Mass and Work, Fundamental theorem for line integrals, Conservative vector fields, Green's theorem, Area as a line integral, Surface integrals, Stokes' theorem, The Gauss divergence theorem.

References:

1. Jerrold Marsden, Anthony J. Tromba & Alan Weinstein (2009). Basic Multivariable Calculus, Springer India Pvt. Limited.

2. James Stewart (2012). Multivariable Calculus (7th edition). Brooks/Cole. Cengage.

3. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). Calculus (3rd edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.

4. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). Thomas' Calculus (14th edition). Pearson Education.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER Discipline Specific Core Course: Ordinary Differential Equations	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

This course aims to provide logical skills in the formation of differential equations, to expose to different techniques of finding solutions to these equations and in addition stress is laid on the application of these equations in geometrical and physical problems.

Course Learning Outcomes:

The course will enable the students to:

i) Understand the genesis of ordinary differential equations.

ii) Learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.

iii) Know Picard's method of obtaining successive approximations of solutions of first order differential equations, passing through a given point in the plane and Power series method for higher order linear equations, especially in cases when there is no method available to solve such equations.

iv) Grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.

v) Formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day to day problems arising in physical, chemical and biological disciplines.

Unit-I: First Order Differential Equations

Basic concepts and genesis of ordinary differential equations, Order and degree of a differential equation, Differential equations of first order and first degree, Equations in which variables are separable, Homogeneous equations, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor, First order higher degree equations solvable for x, y and p. Clairaut's form and singular solutions. Picard's method of successive approximations and

the statement of Picard's theorem for the existence and uniqueness of the solutions of the first order differential equations.

Unit-II: Second Order Linear Differential Equations

Statement of existence and uniqueness theorem for linear differential equations, General theory of linear differential equations of second order with variable coefficients, Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients, Transformations of the equation by changing the dependent/independent variable, Method of variation of parameters and method of undetermined coefficients, Reduction of order, Coupled linear differential equations with constant coefficients.

Unit-III: Higher Order Linear Differential Equations

Principle of superposition for a homogeneous linear differential equation, Linearly dependent and linearly independent solutions on an interval, Wronskian and its properties, Concept of a general solution of a linear differential equation, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler-Cauchy equation, Method of variation of parameters and method of undetermined coefficients, Inverse operator method.

Unit-IV: Series Solutions of Differential Equations

Power series method, Legendre's equation, Legendre polynomials, Rodrigue's formula, Orthogonality of Legendre polynomials, Frobenius method, Bessel's equation, Bessel functions and their properties, Recurrence relations.

Unit-V: Applications

Orthogonal trajectories, Acceleration-velocity model, Minimum velocity of escape from Earth's gravitational field, Growth and decay models, Malthusian and logistic population models, Radioactive decay, Drug assimilation into the blood of a single cold pill; Free and forced mechanical oscillations of a spring suspended vertically carrying a mass at its lowest tip, Phenomena of resonance, LCR circuits, Lotka–Volterra population model.

References:

1. Belinda Barnes & Glenn Robert Fulford (2015). Mathematical Modelling with Case Studies: A Differential Equation Approach Using Maple and MATLAB (2nd edition). Chapman & Hall/CRC Press, Taylor & Francis.

2. H. I. Freedman (1980). Deterministic Mathematical Models in Population Ecology. Marcel Dekker Inc.

3. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.

4. Daniel A. Murray (2003). Introductory Course in Differential Equations, Orient.

5. B. Rai, D. P. Choudhury & H. I. Freedman (2013). A Course in Ordinary Differential Equations (2nd edition). Narosa.

6. Shepley L. Ross (2007). Differential Equations (3rd edition), Wiley India.

7. George F. Simmons (2017). Differential Equations with Applications and Historical Notes (3rd edition). CRC Press. Taylor & Francis.

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(Deemed to be University under section 3 of the UGC Act 1956)

FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Core Course:** **Real Analysis**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

To understand various limiting behavior of sequences and series To explore the various limiting processes viz.continuity, uniform continuity, differentiability and integrability and to enhance the mathematical maturity and to work comfortably with concepts.

Course Learning Outcomes:

This course will enable the students to:

i) Understand many properties of the real line $\mathbb{R}$ and learn to define sequence in terms of functions from $\mathbb{R}$ to a subset of $\mathbb{R}$.

ii) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.

iii) Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

iv) Learn some of the properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.

Unit-I: Real Number System

Algebraic and order properties of $\mathbb{R}$, Absolute value of a real number; Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of $\mathbb{R}$,The completeness property of $\mathbb{R}$, Archimedean property, Density of rational numbers in $\mathbb{R}$, Definition and types of intervals, Nested intervals property; Neighborhood of a point in $\mathbb{R}$, Open, closed and perfect sets in $\mathbb{R}$, Connected subsets of $\mathbb{R}$, Cantor set and Cantor function.

Unit-II: Sequences of Real Numbers

Convergent sequence, Limit of a sequence, Bounded sequence, Limit theorems, Monotone sequences, Monotone convergence theorem, Subsequences, Bolzano–Weierstrass theorem for

sequences, Limit superior and limit inferior of a sequence of real numbers, Cauchy sequence, Cauchy's convergence criterion.

Unit-III: Infinite Series

Convergence and divergence of infinite series of positive real numbers, Necessary condition for convergence, Cauchy criterion for convergence; Tests for convergence of positive term series; Basic comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's nth root test, Integral test; Alternating series, Leibniz test, Absolute and conditional convergence, Rearrangement of series and Riemann's theorem.

Unit-IV: Riemann Integration

Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, First mean value theorem, Bonnet and Weierstrass forms of second mean value theorems.

Unit-V: Uniform convergence and Improper integral:

Pointwise and uniform convergence of sequence and series of functions, Weierstrass's M-test, Dirichlet test and Abel's test for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiability, Improper integrals, Dirichlet test and Abel's test for improper integrals.

References:

1. Robert G. Bartle & Donald R. Sherbert (2015). Introduction to Real Analysis (4th edition).Wiley India.

2. Gerald G. Bilodeau, Paul R. Thie & G. E. Keough (2015). An Introduction to Analysis (2nd edition), Jones and Bartlett India Pvt. Ltd.

3. K. A. Ross (2013). Elementary Analysis: The Theory of Calculus (2nd edition). Springer.

VINAYAKA MISSION'S RESEARCH FOUNDATION
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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Core Course:** **Group Theory**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

Group Theory is the mathematical application of symmetry to an object to obtain knowledge of its physical properties. What group theory brings to the table, is how the symmetry of a molecule is related to its physical properties and provides a quick simple method to determine the relevant physical information of the molecule. The symmetry of a molecule provides you with the information of what energy levels the orbitals will be, what the orbitals symmetries are, what transitions can occur between energy levels, even bond order to name a few can be found, all without rigorous calculations. The fact that so many important physical aspects can be derived from symmetry is a very profound statement and this is what makes group theory so powerful.

Course Learning Outcomes:

The course will enable the students to:

i) Recognize the mathematical objects called groups.

ii) Link the fundamental concepts of groups and symmetries of geometrical objects.

iii) Explain the significance of the notions of cosets, normal subgroups, and factor groups.

iv) Analyze consequences of Lagrange's theorem.

v) Learn about structure preserving maps between groups and their consequences.

Unit-I: Groups and its Elementary Properties

Symmetries of a square, Definition and examples of groups including dihedral, permutation and quaternion groups, Elementary properties of groups.

Unit-II: Subgroups and Cyclic

Groups Subgroups and examples of subgroups, Cyclic groups, Properties of cyclic groups, Lagrange's theorem, Euler phi function, Euler's theorem, Fermat's little theorem.

Unit-III: Normal Subgroups

Properties of cosets, Normal subgroups, Simple groups, Factor groups, Cauchy's theorem for finite abelian groups; Centralizer, Normalizer, Center of a group, Product of two subgroups; Classification of subgroups of cyclic groups.

Unit-IV: Permutation Groups

Cycle notation for permutations, Properties of permutations, Even and odd permutations, alternating groups, Cayley's theorem and its applications.

Unit-V: Group Homomorphisms, Rings and Fields

Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Properties of isomorphisms; First, second and third isomorphism theorems for groups; Definitions and elementary properties of rings and fields.

References:

1. Michael Artin (2014). Algebra (2nd edition). Pearson.
2. John B. Fraleigh (2007). A First Course in Abstract Algebra (7th edition). Pearson.
3. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition). Cengage.
4. I. N. Herstein (2006). Topics in Algebra (2nd edition). Wiley India.
5. Nathan Jacobson (2009). Basic Algebra I (2nd edition). Dover Publications.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER Discipline Specific Core Course: Probabillity and Statistics	L	T	P	C
I	I		B.Sc-Mathematics	5	1	0	6

Objectives:

The main objective of this course is to provide students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science like disease modeling, climate prediction and computer networks etc.

Course Learning Outcomes:

This course will enable the students to:

i) Understand distributions in the study of the joint behaviour of two random variables.

ii) Establish a formulation helping to predict one variable in terms of the other that is, correlation and linear regression.

iii) Understand central limit theorem, which establish the remarkable fact that the empirical frequencies of so many natural populations, exhibit a bell-shaped curve.

Unit-I: Probability Functions and Moment Generating Function

Basic notions of probability, Conditional probability and independence, Baye's theorem; Random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions; Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

Unit-II: Univariate Discrete and Continuous Distributions

Discrete distributions: Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions: Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.

Unit-III: Bivariate Distribution

Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations.

Unit-IV: Correlation, Regression and Central Limit Theorem

The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers.

Unit-V: Modeling Uncertainty

Uncertainty, Information and entropy, Uniform Priors, Polya's urn model and random graphs.

References:

1.Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013).
Introduction to Mathematical Statistics (7th edition), Pearson Education.

2. Irwin Miller &Marylees Miller (2014). John E. Freund's Mathematical Statistics with Applications (8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.

3. Jim Pitman (1993). Probability, Springer-Verlag.

4. Sheldon M. Ross (2014). Introduction to Probability Models (11th edition). Elsevier

5. A. M. Yaglom and I. M. Yaglom (1983). Probability and Information. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Core Course: Mechanics**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

The primary purpose of the study of engineering mechanics is to develop the capacity to predict the effects of force and motion while carrying out the creative design functions of engineering. This capacity requires more than a mere knowledge of the physical and mathematical principles of mechanics; also required is the ability to visualize physical configurations in terms of real materials, actual constraints ,and the practical limitations which govern the behavior of machines and structures. One of the primary objectives in a mechanics course is to help the student develop this ability to visualize, which is so vital to problem formulation. Indeed, the construction of a meaningful mathematical model is often a more important experience than its solution. Maximum progress is mad e when the principles and heir limitations are learned together within the context of engineering application.

Course Learning Outcomes:

This course will enable the students to:

i) Familiarize with subject matter, which has been the single centre, to which were drawn mathematicians, physicists, astronomers, and engineers together.

ii) Understand necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body.

iii) Determine the centre of gravity of some materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight.

iv) Deal with the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.

v) Learn that a particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions, which were deduced by him long before the mathematical theory given by Newton.

Unit-I: Statics

Equilibrium of a particle, Equilibrium of a system of particles, Necessary conditions of equilibrium, Moment of a force about a point, Moment of a force about a line, Couples, Moment of a couple, Equipollent system of forces, Work and potential energy, Principle of virtual work for a system of coplanar forces acting on a particle or at different points of a rigid body, Forces which can be omitted in forming the equations of virtual work.

Unit-II: Centres of Gravity and Common Catenary

Centres of gravity of plane area including a uniform thin straight rod, triangle, circular arc, semicircular area and quadrant of a circle, Centre of gravity of a plane area bounded by a curve, Centre of gravity of a volume of revolution; Flexible strings, Common catenary, Intrinsic and Cartesian equations of the common catenary, Approximations of the catenary.

Unit-III: Rectilinear Motion

Simple harmonic motion (SHM) and its geometrical representation, SHM under elastic forces, Motion under inverse square law, Motion in resisting media, Concept of terminal velocity, Motion of varying mass.

Unit-IV: Motion in a Plane

Kinematics and kinetics of the motion, Expressions for velocity and acceleration in Cartesian, polar and intrinsic coordinates; Motion in a vertical circle, projectiles in a vertical plane and cycloidal motion.

Unit-V: Central Orbits

Equation of motion under a central force, Differential equation of the orbit, (p, r) equation of the orbit, Apses and apsidal distances, Areal velocity, Characteristics of central orbits, Kepler's laws of planetary motion

References:

1. S. L. Loney (2006). An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies.

2. P. L. Srivatava (1964). Elementary Dynamics. Ram Narin Lal, Beni Prasad Publishers Allahabad.

3. J. L. Synge & B. A. Griffith (1949). Principles of Mechanics. McGraw-Hill.

4. A. S. Ramsey (2009). Statics. Cambridge University Press.

5. A. S. Ramsey (2009). Dynamics. Cambridge University Press. 6. R. S. Varma (1962). A Text Book of Statics. Pothishala Pvt. Ltd.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Core Course:** **Linear Alggebra**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

1. To use mathematically correct language and notation for Linear Algebra.
2. To become computational proficiency involving procedures in Linear Algebra.
3. To understand the axiomatic structure of a modern mathematical subject and learn to construct simple proofs.
4. To solve problems that apply Linear Algebra to Chemistry, Economics and Engineering.

Course Learning Outcomes:

This course will enable the students to:

i) Understand the concepts of vector spaces, subspaces, bases, dimension and their properties.

ii) Relate matrices and linear transformations, compute eigen values and eigen vectors of linear transformations.

iii) Learn properties of inner product spaces and determine orthogonality in inner product spaces.

iv) Realize importance of adjoint of a linear transformation and its canonical form.

Unit-I: Vector Spaces

Definition and examples, Subspace, Linear span, Quotient space and direct sum of subspaces, Linearly independent and dependent sets, Bases and dimension.

Unit-II: Linear Transformations

Definition and examples, Algebra of linear transformations, Matrix of a linear transformation, Change of coordinates, Rank and nullity of a linear transformation and rank-nullity theorem.

Unit-III: Further Properties of Linear Transformations

Isomorphism of vector spaces, Isomorphism theorems, Dual and second dual of a vector space, Transpose of a linear transformation, Eigen vectors and eigen values of a linear transformation, Characteristic polynomial and Cayley–Hamilton theorem, Minimal polynomial.

Unit-IV: Inner Product Spaces Inner product spaces and orthogonality, Cauchy–Schwarz inequality, Gram–Schmidt orthogonalisation, Diagonalisation of symmetric matrices.

Unit-V: Adjoint of a Linear Transformation and Canonical Forms

Adjoint of a linear operator; Hermitian, unitary and normal linear transformations; Jordan canonical form, Triangular form, Trace and transpose, Invariant subspaces.

References

1. Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003). Linear Algebra (4thedition). Prentice-Hall of India Pvt. Ltd.
2. Kenneth Hoffman & Ray Kunze (2015). Linear Algebra (2nd edition). Prentice-Hall.
3. I. M. Gel'fand (1989). Lectures on Linear Algebra. Dover Publications.
4. Nathan Jacobson (2009). Basic Algebra I & II (2nd edition). Dover Publications.
5. Serge Lang (2005). Introduction to Linear Algebra (2nd edition). Springer India.
6. Vivek Sahai & Vikas Bist (2013). Linear Algebra (2nd Edition). Narosa Publishing House.
7. Gilbert Strang (2014). Linear Algebra and its Applications (2nd edition). Elsevier.

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B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Core Course:** **Partial Differential Equations and Calculus of Variations**	L	T	P	C
I	I		**B.Sc-Mathematics**	5	1	0	6

Objectives:

1. Variational methods for partial differential equations, linear and nonlinear eigenvalue problems, bifurcation theory
2. Variational problems in differential and complex geometry
3. Variational methods in global analysis and topology
4. Dynamical systems, symplectic geometry, periodic solutions of Hamiltonian systems
5. Variational methods in mathematical physics, nonlinear elasticity, crystals, asymptotic variational problems, homogenization, capillarity phenomena, free boundary problems and phase transitions
6. Monge-Ampère equations and other fully nonlinear partial differential equations related to problems in differential geometry, complex geometry, and physics.

Course Learning Outcomes:

This course will enable the students to:

i) Apply a range of techniques to solve first & second order partial differential equations.

ii) Model physical phenomena using partial differential equations such as the heat and wave equations.

iii). Understand problems, methods and techniques of calculus of variations.

Unit-I: First Order Partial Differential Equations

Order and degree of Partial differential equations (PDE), Concept of linear and non-linear partial differential equations, Partial differential equations of the first order, Lagrange's method, Some special type of equation which can be solved easily by methods other than the general method, Charpit's general method.

Unit-II: Second Order Partial Differential Equations with Constant Coefficients

Classification of linear partial differential equations of second order, Homogeneous and nonhomogeneous equations with constant coefficients.

Unit-III: Second Order Partial Differential Equations with Variable Coefficients

Partial differential equations reducible to equations with constant coefficient, Second order PDE with variable coefficients, Classification of second order PDE, Reduction to canonical or normal form;

Monge's method; Solution of heat and wave equations in one and two dimensions by method of separation of variables.

Unit-IV: Calculus of Variations-Variational Problems with Fixed Boundaries

Euler's equation for functional containing first order and higher order total derivatives, Functionals containing first order partial derivatives, Variational problems in parametric form, Invariance of Euler's equation under coordinates transformation.

Unit-V: Calculus of Variations-Variational Problems with Moving Boundaries

Variational problems with moving boundaries, Functionals dependent on one and two variables, One sided variations. Sufficient conditions for an extremum-Jacobi and Legendre conditions, Second variation.

References:

1. A. S. Gupta (2004). Calculus of Variations with Applications. PHI Learning.
2. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.
3. TynMyint-U & Lokenath Debnath (2013). Linear Partial Differential Equation for Scientists and Engineers (4th edition). Springer India.
4. H. T. H. Piaggio (2004). An Elementary Treatise on Differential Equations and Their Applications. CBS Publishers.
5. S. B. Rao & H. R. Anuradha (1996). Differential Equations with Applications. University Press.
6. Ian N. Sneddon (2006). Elements of Partial Differential Equations. Dover Publications.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Core Course:** **Advanced Algebra**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

(1) Make sense of problems and persevere in solving them
. (2) Reason abstractly and quantitatively.
(3) Construct viable arguments and critique the reasoning of others.
(4) Model with mathematics.
(5) Use appropriate tools strategically.
(6) Attend to precision.
(7) Look for and make use of structure.
(8) Look for and express regularity in repeated reasoning

Course Learning Outcomes:

This course will enable the students to:

i) Understand the basic concepts of group actions and their applications.

ii) Recognize and use the Sylow theorems to characterize certain finite groups.

iii) Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains, and fields.

iv) Learn in detail about polynomial rings, fundamental properties of finite field extensions, and classification of finite fields.

Unit-I: Group Actions

Group actions, Orbits and stabilizers, Conjugacy classes, Orbit-stabilizer theorem, Normalizer of an element of a group, Center of a group, Class equation of a group, Inner and outer automorphisms of a group.

Unit-II: Sylow Theorems

Cauchy's theorem for finite abelian groups, Finite simple groups, Sylow theorems and applications including nonsimplicity tests.

Unit-III: Rings and Fields

Definition, examples and elementary properties of rings, Commutative rings, Integral domain, Division rings and fields, Characteristic of a ring, Ring homomorphisms and isomorphisms, Ideals and quotient rings. Prime, principal and maximal ideals, Relation between integral domain and field, Euclidean rings and their properties, Wilson and Fermat's theorems.

Unit-IV: Polynomial Rings

Polynomial rings over commutative ring and their basic properties, The division algorithm; Polynomial rings over rational field, Gauss lemma and Eisenstein's criterion, Euclidean domain, principal ideal domain, and unique factorization domain.

Unit-V: Field Extensions and Finite Fields

Extension of a field, Algebraic element of a field, Algebraic and transcendental numbers, Perfect field, Classification of finite fields.

References:

1. Michael Artin (2014). Algebra (2nd edition). Pearson.
2. P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul (2003). Basic Abstract Algebra (2nd edition). Cambridge University Press.
3. David S. Dummit & Richard M. Foote (2008). Abstract Algebra (2nd edition). Wiley.
4. John B. Fraleigh (2007). A First Course in Abstract Algebra (7th edition). Pearson.
5. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition). Cengage.
6. N. S. Gopalakrishnan (1986). University Algebra, New Age International Publishers.
7. I. N. Herstein (2006). Topics in Algebra (2nd edition). Wiley India.
8. Thomas W. Hungerford (2004). Algebra (8th edition). Springer.
9. Nathan Jacobson (2009). Basic Algebra I & II (2nd edition). Dover Publications.
10. Serge Lang (2002). Algebra (3rd edition). Springer-Verlag.
11. I. S. Luthar & I. B. S. Passi (2013). Algebra: Volume 1: Groups. Narosa.
12. I. S. Luthar & I. B. S. Passi (2012). Algebra: Volume 2: Rings. Narosa.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Core Course:** **Complex analysis**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

1.Extensively understand algebraic and transcendental functions;

2. Describe and parameterize curves and regions in two-dimensional space;

3. Understand and evaluate partial derivatives and integrals of multivariable functions;

4. Understand and find Taylor series and determine their intervals of convergence;

5. Solve boundary value problems.

Course Learning Outcomes:
This course will enable the students to:

i) Visualize complex numbers as points of $\mathbb{R}$ and stereographic projection of complex plane on the Riemann sphere.

ii) Understand the significance of differentiability and analyticity of complex functions leading to the Cauchy Riemann equations.

iii) Learn the role of Cauchy Goursat theorem and Cauchy integral formula in evaluation of contour integrals.

iv) Apply Liouville's theorem in fundamental theorem of algebra.

v) Understand the convergence, term by term integration and differentiation of a power series.

vi) Learn Taylor and Laurent series expansions of analytic functions, classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.

Unit-I: Complex Plane and functions

. Complex numbers and their representation, algebra of complex numbers; Complex plane, Open set, Domain and region in complex plane; Stereographic projection and Riemann sphere; Complex functions and their limits including limit at infinity; Continuity, Linear fractional transformations and their geometrical properties

. Unit-II: Analytic Functions and Cauchy–Riemann Equations

Differentiability of a complex valued function, Cauchy–Riemann equations, Harmonic functions, necessary and sufficient conditions for differentiability, Analytic functions; Analyticity and zeros of exponential, trigonometric and logarithmic functions; Branch cut and branch of multi-valued functions.

Unit-III: Cauchy's Theorems and Fundamental Theorem of Algebra

Line integral, Path independence, Complex integration, Green's theorem, Anti-derivative theorem, Cauchy–Goursat theorem, Cauchy integral formula, Cauchy's inequality, Derivative of analytic function, Liouville's theorem, Fundamental theorem of algebra, Maximum modulus theorem and its consequences.

Unit-IV: Power Series Sequences

series and their convergence, Taylor series and Laurent series of analytic functions, Power series, Radius of convergence, Integration and differentiation of power series, Absolute and uniform convergence of power series.

Unit-V: Singularities and Contour Integration

Meromorphic functions, Zeros and poles of meromorphic functions, Nature of singularities, Picard's theorem, Residues, Cauchy's residue theorem, Argument principle, Rouche's theorem, Jordan's lemma, Evaluation of proper and improper integrals.

References:

1. Lars V. Ahlfors (2017). Complex Analysis (3rd edition). McGraw-Hill Education.
2. Joseph Bak & Donald J. Newman (2010). Complex Analysis (3rd edition). Springer.
3. James Ward Brown & Ruel V. Churchill (2009). Complex Variables and Applications (9th edition). McGraw-Hill Education.
4. John B. Conway (1973). Functions of One Complex Variable. Springer-Verlag.
5. E.T. Copson (1970). Introduction to Theory of Functions of Complex Variable. Oxford University Press. 6. Theodore W. Gamelin (2001). Complex Analysis. Springer-Verlag
. 7. George Polya & Gordon Latta (1974). Complex Variables. Wiley.
8. H. A. Priestley (2003). Introduction to Complex Analysis. Oxford University Press

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020
Elective Courses

YR	SEM	SUB.CODE	TITLE OF PAPER Discipline Specific Elective Course: Mathematical Logic	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

1. To provide a formal language for mathematical statements that is easily translatable into the natural language and that allows compact and convenient notation.
2. To offer clear and unambiguous interpretation of such statements that is at the same time simple and close to the natural mathematical concepts.

Course Learning Outcomes:
This course will enable the students to:

i) Learn the syntax of first-order logic and semantics of first-order languages.

ii) Understand the propositional logic and basic theorems like compactness theorem, meta theorem and post-tautology theorem.

iii) Assimilate the concept of completeness interpretations and their applications with special emphasis on applications in algebra.

Unit-I: Syntax of First-order Logic

First-order languages, Terms of language, Formulas of language, First order theory.

Unit-II: Semantics of First-order

Languages Structures of first order languages, Truth in a structure, Model of a theory, Embeddings and isomorphism.

Unit-III: Propositional Logics

Syntax of propositional logic, Semantics of propositional logic, Compactness theorem for propositional logic, Proof in propositional logic, Meta theorem in propositional logic, Post tautology theorem.

Unit-IV: Proof and Meta Theorems in First-order Logic

Proof in first-order logic, Meta theorems in first-order logic, Some meta theorem in arithmetic, Consistency and completeness.

Unit-V: Completeness Theorem and Model Theory

Completeness theorem, Interpretation in a theory, Extension by definitions, Compactness theorem and applications, Complete theories, Applications in algebra.

References:

1. Richard E. Hodel (2013). An Introduction to Mathematical Logic. Dover Publications.
2. Yu I. Manin (2010). A Course in Mathematical Logic for Mathematicians (2nd edition). Springer
3. Elliott Mendelson (2015). Introduction to Mathematical Logic (6th edition). Chapman & Hall/CRC.
4. Shashi Mohan Srivastava (2013). A Course on Mathematical Logic (2nd edition). Springer.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER Discipline Specific Elective Course: Integral Transform and Fourier Analysis	L	T	P	C
I	I		B.Sc-Mathematics	5	1	0	6

Objectives:

The course is aimed at exposing the students to learn the Laplace transforms and Fourier transforms. To equip with the methods of finding Laplace transform and Fourier Transforms of different functions. To make them familiar with the methods of solving differential equations, partial differential equations, IVP and BVP using Laplace transforms and Fourier transforms

Course Learning Outcomes:

This course will enable the students to:

i) Know about piecewise continuous functions, Dirac delta function, Laplace transforms and its properties.

ii) Solve ordinary differential equations using Laplace transforms.

iii) Familiarise with Fourier transforms of functions belonging to class, relation between Laplace and Fourier transforms.

iv) Explain Parseval's identity, Plancherel's theorem and applications of Fourier transforms to boundary value problems.

v) Learn Fourier series, Bessel's inequality, term by term differentiation and integration of Fourier series.

vi) Apply the concepts of the course in real life problems.

Unit-I: Laplace Transforms

Laplace transform, Linearity, Existence theorem, Laplace transforms of derivatives and integrals, Shifting theorems, Change of scale property, Laplace transforms of periodic functions, Dirac's delta function.

Unit-II: Further Properties of Laplace Transforms and Applications

Differentiation and integration of transforms, Convolution theorem, Integral equations, Inverse Laplace transform, Lerch's theorem, Linearity property of inverse Laplace transform, Translations theorems of inverse Laplace transform, Inverse transform of derivatives, Applications of Laplace transform in obtaining solutions of ordinary differential equations and integral equations.

Unit-III: Fourier Transforms

Fourier and inverse Fourier transforms, Fourier sine and cosine transforms, Inverse Fourier sine and cosine transforms, Linearity property, Change of scale property, Shifting property, Modulation theorem, Relation between Fourier and Laplace transforms

Unit-IV: Solution of Equations by Fourier Transforms

Solution of integral equation by Fourier sine and cosine transforms, Convolution theorem for Fourier transform, Parseval's identity for Fourier transform, Plancherel's theorem, Fourier transform of derivatives, Applications of infinite Fourier transforms to boundary value problems, Finite Fourier transform, Inversion formula for finite Fourier transforms.

Unit-V: Fourier Series

Fourier cosine and sine series, Fourier series, Differentiation and integration of Fourier series, Absolute and uniform convergence of Fourier series, Bessel's inequality, The complex form of Fourier series.

References:

1. James Ward Brown & Ruel V. Churchill (2011). Fourier Series and Boundary Value Problems. McGraw-Hill Education.
2. Charles K. Chui (1992). An Introduction to Wavelets. Academic Press.
3. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.
4. Walter Rudin (2017). Fourier Analysis on Groups. Dover Publications
. 5. A. Zygmund (2002).Trigonometric Series (3rd edition). Cambridge University Press.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Elective Course:** **Linear programming**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

maximize or to minimize some numerical value. This value may be the expected net present value of a project or a forest property; or it may be the cost of a project; it could also be the amount of wood produced, the expected number of visitor-days at a park, the number of endangered species that will be saved, or the amount of a particular type of habitat to be maintained."

Course Learning Outcomes:

This course will enable the students to:

i) Analyze and solve linear programming models of real life situations.

ii) Provide graphical solutions of linear programming problems with two variables, and illustrate the concept of convex set and extreme points.

iii) Understand the theory of the simplex method.

iv) Know about the relationships between the primal and dual problems, and to understand sensitivity analysis.

v) Learn about the applications to transportation, assignment and two-person zero-sum game problems.

Unit-I: Linear Programming Problem

Convexity and Basic Feasible Solutions Formulation, Canonical and standard forms, Graphical method; Convex and polyhedral sets, Hyperplanes, Extreme points; Basic solutions, Basic Feasible Solutions, Reduction of feasible solution to basic feasible solution, Correspondence between basic feasible solutions and extreme points.

Unit-II: Simplex Method

Optimality criterion, Improving a basic feasible solution, Unboundedness, Unique and alternate optimal solutions; Simplex algorithm and its tableau format; Artificial variables, Two-phase method, Big-M method.

Unit-III: Duality

Formulation of the dual problem, Duality theorems, Complimentary slackness theorem, Economic interpretation of the dual, Dual-simplex method.

Unit-IV: Sensitivity

Analysis Changes in the cost vector, right-hand side vector and the constraint matrix of the linear programming problem.

Unit-V: Applications Transportation Problem:

Definition and formulation, Methods of finding initial basic feasible solutions: Northwest-corner rule, Least- cost method, Vogel approximation method; Algorithm for obtaining optimal solution. Assignment Problem: Mathematical formulation and Hungarian method.

Game Theory: Formulation and solution of two-person zero-sum games, Games with mixed strategies, Linear programming method for solving a game.

References:

1.Mokhtar S. Bazaraa, John J. Jarvis & Hanif D. Sherali (2010). Linear Programming and Network Flows (4th edition). John Wiley & Sons

2.. G. Hadley (2002). Linear Programming. Narosa Publishing House.

3. Frederick S. Hillier & Gerald J. Lieberman (2015). Introduction to Operations Research (10th edition). McGraw-Hill Education.

4. Hamdy A. Taha (2017). Operations Research: An Introduction (10th edition). Pearson.

5. Paul R. Thie & Gerard E. Keough (2014). An Introduction to Linear Programming and Game Theory (3rd edition). Wiley India Pvt. Ltd.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Core Course:** **Information Theory and Coding**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

1. Introduce the principles and applications of information theory.
2. To teach study how information is measured in terms of probability and entropy, and the relationships among conditional and joint entropies.
3. To teach coding schemes, including error correcting codes.
4. Explain how this quantitative measure of information may be used in order to build efficient solutions to multitudinous engineering problems.

Course Learning Outcomes:

This course will enable the students to:

i) Study simple ideal statistical communication models.

ii) Understand the development of codes for transmission and detection of information.

iii) Learn about the input and output of a signal via transmission channel.

iv) Study detection and correction of errors during transmission.

v) Represent a linear code by matrices - encoding and decoding.

Unit-I: Concepts of Information Theory

Communication processes, A model of communication system, A quantitative measure of information, Binary unit of information, A measure of uncertainty, H function as a measure of uncertainty, Sources and binary sources, Measure of information for two-dimensional discrete finite probability schemes.

Unit-II: Entropy Function

A sketch of communication network, Entropy, Basic relationship among different entropies, A measure of mutual information, Interpretation of Shannon's fundamental inequalities; Redundancy, efficiency, and channel capacity; Binary symmetric channel, Binary erasure channel, Uniqueness of the entropy function, Joint entropy and conditional entropy, Relative entropy and mutual information, Chain rules for entropy, Conditional relative entropy and conditional mutual information, Jensen's inequality and its characterizations, The log sum inequality and its applications.

Unit-III: Concepts of Coding

Block codes, Hamming distance, Maximum likelihood decoding, Levels of error handling, Error correction, Error detection, Erasure correction, Construction of finite fields, Linear codes, Matrix representation of linear codes, Hamming codes

Unit-IV: Bounds of Codes

Orthogonality relation, Encoding and decoding of linear codes, The singleton bound and maximum distance separable codes, The sphere-packing bound and perfect codes, The Gilbert–Varshamov bound, MacWilliams' identities.

Unit-V: Cyclic Codes

Definition and examples of cyclic codes, Generator polynomial and check polynomial, Generator matrix and check matrix, Bose–Chaudhuri–Hocquenghem (BCH) code as a cyclic code.

References:

1. Robert B. Ash, (2014). Information Theory. Dover Publications.
2. Thomas M. Cover & Joy A. Thomas (2013). Elements of Information Theory (2nd edition). Wiley India Pvt. Ltd.
3. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition), Cengage.
4. Fazlollah M. Reza, (2003). An Introduction to Information Theory. Dover Publications.
5. Ron M. Roth (2007). Introduction to Coding Theory. Cambridge University Press.
6. Claude E. Shannon & Warren Weaver (1969). The Mathematical Theory of Communication. The University of Illinios Press.

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B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Elective Course:** **Graph Theory**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

1. To understand and apply the fundamental concepts in graph theory
2. To apply graph theory, based tools in solving practical problems
3. To improve the proof writing skills.

Course Learning Outcomes:

This course will enable the students to:

i) Appreciate the definition and basics of graphs along with types and their examples.

ii) Understand the definition of a tree and learn its applications to fundamental circuits.

iii) Know the applications of graph theory to network flows.

iv) Understand the notion of planarity and coloring of a graph.

v) Relate the graph theory to the real-world problems.

Unit-I: Paths, Circuits and Graph Isomorphisms

Definition and examples of a graph, Subgraph, Walks, Paths and circuits; Connected graphs, disconnected graphs and components of a graph; Euler and Hamiltonian graphs, Graph isomorphisms, Adjacency matrix and incidence matrix of a graph, Directed graphs and their elementary properties.

Unit-II: Trees and Fundamental Circuits

Definition and properties of trees, Rooted and binary trees, Cayley's theorem on a counting tree, Spanning tree, Fundamental circuits, Minimal spanning trees in a connected graph.

Unit-III: Cut-Sets and Cut-Vertices

Cut-set of a graph and its properties, Fundamental circuits and cut-sets, Cut-vertices, Connectivity and separability, Network flows, 1- isomorphism and 2- isomorphism.

Unit-IV: Planar Graphs

Planar graph, Euler theorem for a planar graph, Various representations of a planar graph, Dual of a planar graph, Detection of planarity, Kuratowski's theorem.

Unit-V: Graph Coloring

Chromatic number of a graph, Chromatic partition, Chromatic polynomial, Matching and coverings, Four color problem.

References:

1. R. Balakrishnan & K. Ranganathan (2012). A Textbook of Graph Theory. Springer.
2. Narsingh Deo (2016). Graph Theory with Applications to Engineering and Computer Science. Dover Publications.
3. Reinhard Diestel (2017). Graph Theory (5th edition). Springer.

4. Edgar G. Goodaire & Michael M. Parmenter (2018). Discrete Mathematics with Graph Theory (3rd edition). Pearson.
5. Douglas West (2017). Introduction to Graph Theory (2nd edition). Pearson.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Elective Course:** **Special Theory of Relativity**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

Relativity has profoundly changed the whole physics. By the analysis of the fundamental concepts of space and time, of mass and of force, it has given a new orientation not only to science but also to our approach to philosophical problems in general. It is the theory which says that concepts like space, time, mass, simultaneity, motion etc., are not absolute but relative; absolute to frame of reference.

Course Learning Outcomes:

This course will enable the students to:

i) Understand the basic elements of Newtonian mechanics including Michelson Morley experiment and geometrical interpretations of Lorentz transformation equations.

ii) Learn about length contraction, time dilation and Lorentz contraction factor.

iii) Study 4-dimensional Minkowskian space-time and its consequences.

iv) Understand equations of motion as a part of relativistic mechanics.

v) Imbibe connections between relativistic mechanics and electromagnetism.

Unit-I: Newtonian Mechanics

Inertial frames, Speed of light and Gallilean relativity, Michelson–Morley experiment, Lorentz–Fitzgerold contraction hypothesis, Relative character of space and time, Postulates of special theory of relativity, Lorentz transformation equations and its geometrical interpretation, Group properties of Lorentz transformations.

Unit-II: Relativistic Kinematics

Composition of parallel velocities, Length contraction, Time dilation, Transformation equations for components of velocity and acceleration of a particle and Lorentz contraction factor.

Unit-III: Geometrical representation of space-time

Four dimensional Minkowskian space-time of special relativity, Time-like, light-like and space-like intervals, Null cone, Proper time, World line of a particle, Four vectors and tensors in Minkowiskian space-time.

Unit-IV: Relativistic Mechanics

Variation of mass with velocity. Equivalence of mass and energy. Transformation equations for mass momentum and energy. Energy-momentum four vector. Relativistic force and Transformation equations for its components. Relativistic equations of motion of a particle.

Unit-V: Electromagnetism

Transformation equations for the densities of electric charge and current. Transformation equations for electric and magnetic field strengths. The Field of a Uniformly Moving Point charge. Forces and fields near a current carrying wire. Forces between moving charges. The invariance of Maxwell`s equations.

References:

1. James L. Anderson (1973). Principles of Relativity Physics. Academic Press.
2. Peter Gabriel Bergmann (1976). Introduction to the Theory of Relativity. Dover Publications.
3. C. Moller (1972). The Theory of Relativity (2nd edition). Oxford University Press.
4. Robert Resnick (2007). Introduction to Special Relativity. Wiley.
5. Wolfgang Rindler (1977). Essential Relativity: Special, General, and Cosmological. Springer-Verlag.
6. V. A. Ugarov (1979). Special Theory of Relativity. Mir Publishers, Moscow.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER Discipline Specific Elective Course: Discrete Mathematics	L	T	P	C
I	I		B.Sc-Mathematics	5	1	0	6

Objectives:

Use mathematically correct terminology and notation.
Construct correct direct and indirect proofs.
Use division into cases in a proof.
Use counterexamples
. Apply logical reasoning to solve a variety of problems.

Course Learning Outcomes:

This course will enable the students to:

i) Learn about partially ordered sets, lattices and their types.

ii) Understand Boolean algebra and Boolean functions, logic gates,switching circuitsand their applications.

iii) Solve real-life problems using finite-state and Turing machines.

iv) Assimilate various graph theoretic concepts and familiarize with their applications.

Unit-I: Partially Ordered Sets

Definitions, examples and basic properties of partially ordered sets (poset), Order isomorphism, Hasse diagrams, Dual of a poset, Duality principle, Maximal and minimal elements, Least upper bound and greatest upper bound, Building new poset, Maps between posets.

Unit-II: Lattices

Lattices as posets, Lattices as algebraic structures, Sublattices, Products and homomorphisms; Definitions, examples and properties of modular and distributive lattices; Complemented, relatively complemented and sectionally complemented lattices.

Unit-III:Boolean Algebras and Switching Circuits

Boolean algebras, De Morgan's laws, Boolean homomorphism, Representation theorem; Boolean polynomials, Boolean polynomial functions, Disjunctive and conjunctive normal forms, Minimal forms of Boolean polynomials, Quine–McCluskey method, Karnaugh diagrams, Switching circuits and applications.

Unit-IV: Finite-State and Turing Machines

Finite-state machines with outputs, and with no output; Deterministic and nodeterministic finite-state automaton; Turing machines: Definition, examples, and computations.

Unit-V: Graphs

Definition, examples and basic properties of graphs, Königsberg bridge problem; Subgraphs, Pseudographs, Complete graphs, Bipartite graphs, Isomorphism of graphs, Paths and circuits, Eulerian circuits, Hamiltonian cycles, Adjacency matrix, Weighted graph, Travellingsalesman problem, Shortest path and Dijkstra's algorithm.

References:

1. B. A. Davey & H. A. Priestley (2002). Introduction to Lattices and Order (2nd edition). Cambridge University Press.
2. Edgar G. Goodaire & Michael M. Parmenter (2018). Discrete Mathematics with Graph Theory (3rd edition). Pearson Education.
3. Rudolf Lidl & Günter Pilz (1998). Applied Abstract Algebra (2nd edition). Springer.
4. Kenneth H. Rosen (2012). Discrete Mathematics and its Applications: With Combinatorics and Graph Theory (7th edition). McGraw-Hill.
5. C. L. Liu (1985). Elements of Discrete Mathematics (2nd edition). McGraw-Hill.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Elective Course: Number Theory**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

1. Identify and apply various properties of and relating to the integers including the Well-Ordering Principle, primes, unique factorization, the division algorithm, and greatest common divisors.
2. Identify certain number theoretic functions and their properties.
3. Understand the concept of a congruence and use various results related to congruences including the Chinese Remainder Theorem.
4. Solve certain types of Diophantine equations.
5. Identify how number theory is related to and used in cryptography.

Course Learning Outcomes:

This course will enable the students to:

i) Learn about some important results in the theory of numbers including the prime number theorem, Chinese remainder theorem, Wilson's theorem and their consequences.

ii) Learn about number theoretic functions, modular arithmetic and their applications.

iii) Familiarise with modular arithmetic and find primitive roots of prime and composite numbers.

iv) Know about open problems in number theory, namely, the Goldbach conjecture and twin-prime conjecture.

v) Apply public crypto systems, in particular, RSA.

Unit-I: Distribution of Primes and Theory of Congruencies

Linear Diophantine equation, Prime counting function, Prime number theorem, Goldbach conjecture, Twin-prime conjecture, Odd perfect numbers conjecture, Fermat and Mersenne primes, Congruence relation and its properties, Linear congruence and Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

Unit-II: Number Theoretic Functions

Number theoretic functions for sum and number of divisors, Multiplicative function, The Möbius inversion formula, Greatest integer function, Euler's phi-function and properties, Euler's theorem.

Unit-III: Primitive Roots

Order of an integer modulo n, Primitive roots for primes, Composite numbers having primitive roots; Definition of quadratic residue of an odd prime, Euler's criterion.

Unit-IV: Quadratic Reciprocity Law

The Legendre symbol and its properties, Quadratic reciprocity, Quadratic congruencies with composite moduli.

Unit-V: Applications

Public key encryption, RSA encryption and decryption with applications in security systems.

References:

1.David M. Burton (2007). Elementary Number Theory (7th edition). McGraw-Hill.
2.Gareth A. Jones & J. Mary Jones (2005). Elementary Number Theory. Springer.
3. Neville Robbins (2007). Beginning Number Theory (2nd edition). Narosa.
4.I.Niven (2012). An Introduction to the Theory of Numbers (5th edition). John Wiley & Sons.
5. Neal Koblitz (1994). A Course in Number Theory and Cryptography (2nd edition). Springer-Verlag.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Elective Course:** **Mathematical Finance**	L	T	P	C
I	I		**B.Sc-Mathematics**	5	1	0	6

Objectives;

Interest rates, annuities and mortgages, bonds and bond market structure.

Course Learning Outcomes:

This course will enable the students to:

i) Understand financial markets and derivatives including options and futures.

ii) Appreciate pricing and hedging of options, interest rate swaps and no-arbitrage pricing concepts.

iii) Learn stochastic analysis, Ito's formula, Ito integral and the Black–Scholes model.

iv) Study and use Hedging parameters, trading strategies and currency swaps.

Unit-I: Basic Theory of Interest and Fixed-Income Securities

Principal and interest: simple, compound and continuous; Present and future value of cash flow streams; Net present value, Internal rates of return and their comparison; Inflation, Annuities; Bonds, Bond prices and yields, Macaulay duration and modified duration.

Unit-II: Term Structure of Interest Rates, Bonds and Derivatives

Spot rates, forward rates and explanations of term structure; Running present value, Floatingrate bonds, Immunization, Convexity; Putable and callable bonds; Exchange-traded markets and over-the-counter markets; Derivatives: Forward contracts, Future contracts, Options, Types of traders, Hedging, Speculation, Arbitrage.

Unit-III: Mechanics of Options Markets

No-arbitrage principle, Short selling, Forward price for an investment asset; Types of options: Call and put options, Option positions, Underlying assets, Factors affecting option prices, Upper and lower bounds for option prices, Put-call parity, Effect of dividends.

Unit-IV: Stochastic Analysis of Stock Prices and Black–Scholes

Model Binomial option pricing model, Risk neutral valuation: European and American options on assets following binomial tree model; Lognormal property of stock prices, Distribution of rate of return, Expected return, Volatility, Estimating volatility from historical data, Extension of risk-neutral valuation to assets following geometric Brownian motion, Black–Scholes formula for European options.

Unit-V: Hedging Parameters, Trading Strategies and Swaps Hedging parameters:

Delta, gamma, theta, rho and vega; Trading strategies involving options, Swaps, Mechanics of interest rate swaps, Comparative advantage argument, Valuation of interest rate swaps, Currency swaps, Valuation of currency swaps.

References:

1. John C. Hull & Sankarshan Basu (2018). Options, Futures and Other Derivatives (10th edition). Pearson Education
2. David G. Luenberger (2013). Investment Science (2nd edition). Oxford University Press.
3. Sheldon M. Ross (2011). An Elementary Introduction to Mathematical Finance (3rd edition). Cambridge University Press.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Elective Course:** **C++Programming for Mathematics**	L	T	P	C
I	I		**B.Sc-Mathematics**	5	1	0	6

Objectives:

1.Develop a greater understanding of the issues involved in programming language design and implementation
2. Develop an in-depth understanding of functional, logic, and object-oriented programming paradigms
3. Implement several programs in languages other than the one emphasized in the core curriculum (Java/C++)
4. Understand design/implementation issues involved with variable allocation and binding, control flow, types, subroutines, parameter passing
5. Develop an understanding of the compilation process

Course Learning Outcomes:

This course will enable the students to:

i) Understand and apply the programming concepts of C++ which is important for mathematical investigation and problem solving.

ii) Use mathematical libraries for computational objectives.

iii) Represent the outputs of programs visually in terms of well formatted text and plots.

Unit-I: C++ Essentials Fundamentals of programming

Organization of logic flow in stored program model of computation, C++ as a general purpose programming language, Structure of a C++ program, Common compilers and IDE's, Basic data-types, Variables and literals in C++, Operators, Expressions, Evaluation precedence and type compatibility; Outline of program development in C++, Debugging and testing; Applications: Greatest common divisor and random number generation.

Unit-II: Structured Data

Structured data-types in C++, Arrays and manipulating data in arrays; Objects and classes: Information hiding, modularity, constructors and destructors, methods and polymorphism; Applications: Factorization of an integer, Euler's totient, Images in Cartesian geometry using points in two & three dimensions, Pythagorean triples.

Unit-III: Containers and Templates

Containers and Template Libraries: Sets, iterators, multisets, vectors, maps, lists, stacks and queues; Applications: Basic set algebra, modulo arithmetic and congruences, projective plane, permutations, monotone sequences and polynomials.

Unit-IV: Libraries and Packages

Libraries and Packages for arbitrary precision arithmetic and linear algebra; Features of C++ for input/output and visualization: Strings, streams, formatting methods, processing files in a batch, command-line arguments, visualization packages and their uses; Applications: Arbitrary precision arithmetic using GMP, BOOST; Finding nullity, rank, eigen values, eigen vectors, linear transformations, systems of linear equations; Plots.

Unit-V: Odds and Ends

Runtime errors and graceful degradation, Robustness in a program; Exception handling: Trycatch and throw; Defining and deploying suitable exception handlers in programs; Compileroptions; Conditional compilation; Understanding and defining suitable pragmas; Applications: Identification and description of install parameters of mathematical libraries, debugging installation, working with multiple libraries simultaneously and maintaining correctness and consistency of data.

References:

1. Nell Dale & Chip Weems (2013).Programming and Problem Solving with C++ (6th edition). Jones & Bartlett Learning.
2. Peter Gottschling (2016). Discovering Modern C++: An Intensive Course for Scientists, Engineers, and Programmers. Pearson.
3. Nicolai M. Josuttis (2012). The C++ Standard Library: A Tutorial and Reference (2nd edition). Addison-Wesley, Pearson.
4. Donald E. Knuth (1968). The Art of Computer Programming. Addison-Wesley.
5. Edward Scheinerman (2006). C++ for Mathematicians: An Introduction for Students and Professionals. Chapman & Hall/CRC. Taylor & Francis.
6. B. Stroustrup (2013). The C++ Programming Language (4th edition). AddisonWesley.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Elective Course: Cryptography**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives;

It is also referred to as the privacy or secrecy of information. It maintains information and keeps it safe from unauthorized people. This can be attained through various means, such as by physical methods or through mathematical algorithms. Confidentiality in cryptography can be achieved by using scrambled text, cipher text, or encrypted text.

Course Learning Outcomes:

This course will enable the students to:

i) Understand the difference between classical and modern cryptography.

ii) Learn the fundamentals of cryptography, including Data and Advanced Encryption Standards (DES & AES) and RSA.

iii) Encrypt and decrypt messages using block ciphers, sign and verify messages using well-known signature generation and verification algorithms.

iv) Know about the aspects of number theory which are relevant to cryptography.

Unit I: **Introduction to Cryptography and Classical Cryptography**

Cryptosystems and basic cryptographic tools: Secret-key cryptosystems, Public-key cryptosystems, Block and stream ciphers, Hybrid cryptography, Message integrity: Message authentication codes, Signature schemes, Nonrepudiation, Certificates, Hash functions, Cryptographic protocols, Security; Hybrid cryptography: Message integrity, Cryptographic protocols, Security, Some simple cryptosystems, Shift cipher, Substitution cipher, Affine cipher, Vigenère cipher, Hill cipher, Permutation cipher, Stream ciphers, Cryptanalysis of affine, substitution, Vigenère, Hill and LFSR stream ciphers.

Unit-II: Cryptographic Security, Pseudo Randomness and Symmetric Key Ciphers

Shannon's theory, Perfect secrecy, Entropy, Spurious keys and unicity distance; Bit generators, Security of pseudorandom bit generators. Substitution-permutation networks, Data encryption standard (DES), Description and analysis of DES; Advanced encryption standard (AES), Description and analysis of AES; Stream ciphers, Trivium.

Unit-III: Basics of Number Theory and Public-Key Cryptography

Basics of number theory; Introduction to public-key cryptography, RSA cryptosystem, Implementing RSA; Primality testing, Legendre and Jacobi symbols, Solovay–Strassen algorithm, Miller–Rabin algorithm; Square roots modulo n, Factoring algorithms, Pollard p − 1 algorithm, Pollard rho algorithm, Dixon's random squares algorithm, Factoring algorithms in practice; Rabin cryptosystem and its security.

Unit-IV: More on Public-Key Cryptography

Basics of finite fields; ElGamal cryptosystem, Algorithms for the discrete logarithm problem, Shanks' algorithm, Pollard rho discrete logarithm algorithm, Pohlig–Hellman algorithm; Discrete logarithm algorithms in practice, Security of ElGamal systems, Bit security of discrete logarithms.

Unit-V: Hash Functions and Signature Schemes

Hash functions and data integrity, SHA-3; RSA signature scheme, Security requirements for signature schemes, Signatures and Hash functions, ElGamal signature scheme, Security of ElGamal signature scheme, Certificates.

References:

1. Jeffrey Hoffstein, Jill Pipher & Joseph H. Silverman (2014). An Introduction to Mathematical Cryptography (2nd edition). Springer.
2. Neal Koblitz (1994). A Course in Number Theory and Cryptography (2nd edition). Springer-Verlag.
3. Christof Paar & Jan Pelzl (2014). Understanding Cryptography. Springer.
4. Simon Rubinstein-Salzedo (2018). Cryptography. Springer
5. Douglas R. Stinson & Maura B. Paterson (2019). Cryptography Theory and Practice (4th edition). Chapman & Hall/CRC Press, Taylor & Francis.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Elective Course:** **Advanced Mechanics**	L	T	P	C
			B.Sc-Mathematics	5	1	0	6

Objectives:

The course is designed to give fundamental knowledge of mechanics of deformable solids including stress, strain, stress – strain relations, theories of failure and energy methods.

Course Learning Outcomes:

This course will enable the students to:

i) Understand the reduction of force system in three dimensions to a resultant force acting at a base point and a resultant couple, which is independent of the choice of base of reduction.

ii) Learn about a nul point, a nul line, and a nul plane with respect to a system of forces acting on a rigid body together with the idea of central axis.

iii) Know the inertia constants for a rigid body and the equation of momental ellipsoid together with the idea of principal axes and principal moments of inertia and to derive Euler's equations of motion of a rigid body, moving about a point which is kept fixed.

iv) Study the kinematics and kinetics of fluid motions to understand the equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates which are used to derive Euler's equations and Bernoulli's equation.

v) Deal with two-dimensional fluid motion using the complex potential and also to understand the concepts of sources, sinks, doublets and the image systems of these with regard to a line and a circle.

Unit-I: Statics in Space

Forces in three dimensions, Reduction to a force and a couple, Equilibrium of a system of particles, Central axis and Wrench, Equation of the central axis, Resultant wrench of two wrenches; Nul points, lines and planes with respect to a system of forces, Conjugate forces and conjugate lines.

Unit-II: Motion of a Rigid

Body Moments and products of inertia of some standard bodies, Momental ellipsoid, Principal axes and moments of inertia; Motion of a rigid body with a fixed point, Kinetic energy of a rigid body with a fixed point and angular momentum of a rigid body, Euler's equations of motion for a rigid body with a fixed point, Velocity and acceleration of a moving particle in cylindrical and spherical polar coordinates, Motion about a fixed axis, Compound pendulum.

Unit-III: Kinematics of Fluid Motion

Lagrangian and Eulerian approaches, Material and convective derivatives, Velocity of a fluid at a point, Equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates, Cylindrical and spherical symmetry, Boundary surface, Streamlines and pathlines, Steady and unsteady flows, Velocity potential, Rotational and irrotational motion, Vorticity vector and vortex lines.

Unit-IV: Kinetics of Fluid Motion

Euler's equations of motion in Cartesian, cylindrical polar and spherical polar coordinates; Bernoulli's equation, Impulsive motion.

Unit-V: Motion in Two-Dimensions

Stream function, Complex potential, Basic singularities: Sources, sinks, doublets, complex potential due to these basic singularities; Image system of a simple source and a simple doublet with regard to a line and a circle, Milne–Thomson circle theorem.

References:

1. A. S. Ramsay (1960). A Treatise on Hydromechanics, Part-II Hydrodynamics. G. Bell & Sons.
2. F. Chorlton (1967). A Textbook of Fluid Dynamics. CBS Publishers.
3. Michel Rieutord (2015). Fluid Dynamics An Introduction. Springer.
4. E. A. Milne (1965). Vectorial Mechanics, Methuen & Co.Limited. London

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YEAR	SEMESTER	TITLE OF PAPER Skill Enhancement Course **THEORY OF EQUATIONS**	L	T	P	C
		(B.Sc-Mathematics)	5	1	0	4

Objectives;

1.Use the fact that the derivative is the slope of the tangent line to the curve at a given point to help determine the derivatives of simple linear functions.

2. Determine whether the equation of a function given is differentiable or continuous at a particular value of x.

3. Determine the information from a graph that when the second derivative is positive the graph is concave upward, when the second derivative is negative the graph is concave downward, and when there is a switch in sign there is an inflection point.

4. Understand the various forms of a line including: standard form, point slope form, and slope intercept form.

5. Calculate definite integrals that may involve logarithms, exponentials, polynomials, and powers by using the Fundamental Theorem of Calculus.

Course Learning Outcomes:

This course will enable the students to:

i) Describe the relation between roots and coefficients
ii) Find the sum of the power of the roots of an equation using Newton's Method.
iii) Transform the equation through roots multiplied by a given number, increase the roots, decrease the roots, removal of terms
iv) Solve the reciprocal equations.
v) Analyse the location and describe the nature of the roots of an equation.
vi) Obtain integral roots of an equation by using Newton's Method.
vii) Compute a real root of an equation by Horner's method.

UNIT – I

Theory of Equations – Remainder Theorem - Imaginary roots – Irrational roots – Relation between the roots and the coefficients – Symmetric functions of the roots. Chapter 6(Sections 1 to 12)

UNIT – II

Sum of the powers of the roots of an equation – Newton's Theorem – Transformation of equations – Roots multiplied by a given number. Chapter 6(Sections 13 to 15.2)

UNIT – III

Reciprocal roots – Reciprocal equations – Standard forms - To increase and decrease the roots of a given equation by a given constant – Removal of terms and consequent problems. Chapter 6(Sections 15.3 to 19)

UNIT – IV

Transformation in general – Descartes'rule of signs – Roll's theorem – Multiple roots – Strum's theorem – Horner's method. Chapter 6(Sections 21 to 28, 30)

UNIT – V

General solution of cubic equations – Cardon's method –Ferrari's method of solving biquadratic equations. Chapter 6(Sections 34, 35)

Text Book(s):

1. Algebra Volume I, T.K.Manicavachagom Pillay T. Natarajan & K.S. Ganapathy, S. Viswanathan Pvt. Ltd., 2010.

Reference Book:

1. ALGEBRA: Theory of Equation, Theory of Numbers and Trigonometry, Dr. S. Arumugam and A.T. Isaac. New Gamma Publishing House, Edition Jan 2011

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YEAR	SEMESTER	TITLE OF PAPER Skill Enhancement Course **Mathematical Modelling**	L	T	P	C
		(B.Sc-Mathematics)	5	1	0	4

Objectives:

1.Understand the reasons why models are developed and used.
2. Understand how models can summarise or 'compress' data.
3. Understand how models can be used to study pharmacokinetic mechanisms.
4. Understand how models can be used to predict concentrations or dosage regimens.

Course Learning Outcomes:

This course will enable the students to:

i) Assess and articulate what type of modeling techniques are appropriate for a given physical system.
ii) Construct a mathematical model of a given physical system and analyze it.
iii) Make predictions of the behavior of a given physical system based on the analysis of its mathematical model.
iv) Solve mathematical problems using analytical methods.
v) Solve mathematical problems using computational methods.
vi) Recognize the relationships between different areas of mathematics and the connections between mathematics and other disciplines.
vii) Give clear and organized written and verbal explanations of mathematical ideas to a variety of audiences.

Unit- I:

Introduction, Basic Steps of Mathematical Modeling, its needs, types pf models, limitations, Elementary ideas of dynamical systems, autonomous dynamical systems in the plane- linear theory, Equilibrium point, node, saddle point, focus, centre and limitcycle idea with simple illustrations and figures, Linearization of non-linear plane autonomous systems.

Unit-II:

Population Models: Basic concepts, Exponential growth model, formulation , solution, interpretation and limitations. Compensation and depensation, Logistic growth model, formulation, solution, interpretation and limitations. Lotka- Volterra model of two competing species, formulation, solution, interpretation and limitations.

Unit-III:

Epidemic Models: Basic concepts, Simple epidemic model, formulation, solution, interpretation, and limitation, General epidemic model, formulation, solution, interpretation and limitations.

Unit-IV:

Economic models: Production and supply functions, price-elasticities, utility of consumption and consumer surplus, pure competition, competitive equilibrium, monopoly versus competition, duopoly, oligopoly, conjectural variation, theory of production, production function , Cobb-Douglas production function and its properties , Costs of production and related models .

Unit-V:

Mathematical modeling in Bio-logical Environment: Blood flow and oxygen transfer, Modeling blood flow, viscousity, Poiseuille law, mathematical formulation of the problem, solution and interpretation, oxygen transfer in red cells, mathematical formulation, solution, interpretation and limitations.

References:

1. Mark M. Meerschaert, Mathematical Modeling, Academic Press, New Work, 1993
2. W. Meyer , Concepts of Mathematical Modeling, McGraw Hill, New York, 1994
3. E. Beltrami , Mathematics for Dynamic Modeling, Academic Press, Orlando, Florida, 1987
4. N. Bailey, The Mathematical Theory of Infectious Diseases, Haftier press, New York, 1975

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FACULTY OF ARTS AND SCIENCE
B.Sc. Mathemaatics- LOCF-2020

YEAR	SEMESTER	TITLE OF PAPER Skill Enhancement Course **Logic and Sets**	L	T	P	C
		(B.Sc-Mathematics)	5	1	0	4

Objectives:

1.Construct a truth table for a conditional.
2. Construct a truth table for a biconditional.
3. Construct a truth table for a compound statement involving negations, conjunctions, disjunctions, conditionals, and biconditionals.
4. Indicate sets by the description method, roster method, and by using set builder notation.
5. Determine if a set is well defined.
6. Determine if a set is finite or infinite.

Course Learning Outcomes:

This course will enable the students to:

i) Learn about the logical foundations of such mathematical concepts as number, continuity and set.

ii) Gain an appreciation of the usefulness and limitations of the development of theories from axioms

iii) Understand the concept of infinity and its role in mathematics.

iv) Describe memberships of sets, including the empty set, using proper notation, and decide whether given items are members and determine the cardinality of a given set.

v) Describe the relations between sets regarding membership, equality, subset, and proper subset, using proper notation.

vi) Perform the operations of union, intersection, complement, and difference on sets using proper notation.

vii) Be able to draw and interpret Venn diagrams of set relations and operations and use Venn diagrams to solve problems.

viii) Recognize when set theory is applicable to real-life situations, solve real-life problems, and communicate real-life problems and solutions to others.

Unit 1 : Set Theory :

Fundamentals - Sets and subsets, Venn Diagrams, Operations on sets, Laws of Set Theory, Power Sets and Products, Partition of sets, The Principle of Inclusion - Exclusion. Logic : Propositions and Logical operations, Truth tables, Equivalence, Implications, Laws of Logic, Normal forms, Predicates and quantifiers, Mathematical Induction.

Unit 2 : Relations, diagraphs and lattices :

Product sets and partitions, relations and diagraphs, paths in relations and diagraphs, properties of relations, equivalence and partially ordered relations, computer representation of relations and

diagraphs, manipulation of relations, Transitive closure and Warshall's algorithm, Posets and Hasse Diagrams, Lattice.

Unit 3 : Functions and Pigeon Hole Principle :

Definitions and types of functions : injective, subjective and bijective, Composition, identity and inverse, Pigeon hole principle.

Unit 4 : Graphs and Trees :

Graphs, Euler paths and circuits, Hamiltonian paths and circuits, Planner graphs, coloring graphs, Isomorphism of Graphs. Trees : Trees, rooted trees and path length in rooted trees, Spanning tree and Minimal Spanning tree, Isomorphism of trees, Weighted trees and Prefix Codes.

Unit 5 : Algebric Structures :

Algebraic structures with one binary operation - semi groups, monoids and groups, Product and quotient of algebraic structures, Isomorphism, homomorphism, automorphism, Cyclic groups, Normal sub group, codes and group codes, Algebraic structures with two binary operations - rings, integral domains and fields. Ring homomorphism and Isomorphism.

Reference:

1.Discrete structures by Liu, Tata McGraw -Hill. Digital Logic John M Yarbrough Brooks / cole, Thompson Learning

2. Discrete Mathematics and its Applications, Kenneth H. Rosen, Tata McGraw - Hill.

3. Discrete Mathematics for computer scientists and Mathematicians, Joe L. Mott, Abraham Kandel Theodore P. Baker, Prentice - Hall of India Pvt. Ltd.

4. Discrete Mathematics With Applications, Susanna S. Epp, Books / Cole Publishing Company.

5. Discrete Mathematics, Schaum's Outlines Series, Seymour Lipschutz, Marc Lipson, Tata McGraw - Hill.

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FACULTY OF ARTS AND SCIENCE
B.Sc. Mathemaatics- LOCF-2020

YEAR	SEMESTER	TITLE OF PAPER Skill Enhancement Course **Integral calculus**	L	T	P	C
		(B.Sc-Mathematics)	5	1	0	4

Objectives:

1.Computation of Riemann sums using left, right, and midpoint evaluation points.

2.Use of the Fundamental Theorem to evaluate definite integrals.

3.Use of the Fundamental Theorem to represent a particular antiderivative, and the analytical and graphical analysis of functions so defined.

4. Definite integral as a limit of Riemann sums over equal subdivisions

Course Learning Outcomes:

This course will enable the students to:

i) Evaluate indefinite and definite integrals.

ii) Use definite integrals to solve application problems.

iii) Use various integration techniques to evaluate integrals.

iv) Communicate mathematical ideas using correct and appropriate notation.

v) Compute the anti-derivative of a basic form (linear combinations of x n for any rational n, sin x, cos x and without use of formulas or a calculator.

vi) Compute an anti-derivative like those in (a) but which requires a step of algebraic manipulation prior to integration.

vii) Compute an anti-derivative using u-substitution.

viii). Compute an anti-derivative using partial fractions, for a quadratic denominator without repeated linear factors.

Unit-1

Volumes using Cross-Section, Volumes using Cylindrical shells, Arc lengths, Areas of surfaces of Revolution.

Unit- 2

Multiple Integrals- definition of the double integrals- evaluation of the double integrals- double integrals in polar coordinates – triple integrals – applications of multiple integrals – volumes of solids of revolution – areas of curved surfaces.

Unit- 3

Beta and Gamma functions- indefinite integral – definitions – convergence of Γ (n) – recurrence formula of Γ functions – properties of β-function- relation between β and Γ functions Chapter

Unit-4

Introduction, Gradient, divergence, curl, directional derivative, unit normal to a surface. Solenoidal and irrotational. Laplacian Differential Operator.

Unit-5

Line, surface and volume integrals; Theorems of Gauss, Stokes and Green. (Without proof) – Problems.

Reference

1. Integral Calculus and differential equations : Dipak Chatterjee (TATA McGraw Hill Publishing company Ltd.)

2. Vector Algebra and Analysis by Narayanan and T.K.Manickvachagam Pillay S .Viswanathan Publishers.

3. Vector Analysis: Murray Spiegel (Schaum Publishing Company, New York).

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FACULTY OF ARTS AND SCIENCE
B.Sc. Mathemaatics- LOCF-2020

YEAR	SEMESTER	TITLE OF PAPER Skill Enhancement Course **Vector calculus**	L	T	P	C
		(B.Sc-Mathematics)	5	1	0	4

Objectives;

1. Perform vector operations, including addition, subtraction, scalar multiplication, dot product, and cross product.

2.. Analyze the algebraic and geometric properties of vector operations.

3.. Determine a unit vector in the direction of a nonzero vector.

4. Determine the angle between two nonzero vectors.

5. Determine if two nonzero vectors are parallel, orthogonal, or neither.

Course Learning Outcomes:

This course will enable the students to:
i). Define concepts of point and vector and explain differences and similarities between them.

ii). Recognize when it is appropriate to use a point and when to use a vector in problem solving.

iii). Memorize formulae for length and direction of vector.

iv). Memorize algebraic definitions and explain geometric meanings of dot and cross products.

v). Compute dot and cross products given either algebraic or geometric information.

vi). Apply dot or cross product to determine angles between vectors, orientation of axes, areas of triangles and parallelograms in space, scalar and vector projections, and volumes of parallelipipeds. Reproduce sketches and written explanations deriving these formulae.

Unit-1 Vectors:

Introduction, Definition of vectors, cartesian coordinates, dot product, cross product, analytical geometry of lines, analytical geometry off planes.

Unit-2 Function of two variables

Introduction, limits and continuity, partial derivatives, the gradient and directional derivatives, tangent planes and differential, the chain rule for function of two variables.

Unit-3 Vector integration

Double integration in rectangular coordinates, Double integration in polar coordinates, triple integration, triple integration in cylindrical and spherical coordinates, surface area.

Unit-4 Vector functions

Introduction, the derivative, unit tangent vector and arc length, curvature, velocity and acceleration gradient and direction derivatives, maximization and minimization of two variables, change of variables for multiple integrals.

Unit-5 Vector field

Introduction, example of gravitational electric fields, divergence and curl, line integral of vector field, fundamental theorem for vector field, green's theorem, stokes theorem and Gauss divergence theorem.

References

1. Anton, Bivens and Davis, Calculus (10th Edition) International Student Version, John Wiley & sons 2015

2. David M. Burton, Elementary Number Theory (7th Edition), Mc Graw Hill Education

3. H.F. Davis and A.D. Snider: Introduction to Vector Analysis, 6th ed., Universal Book Stall, New Delhi.

4. Shanti Narayan, P.K Mittal – Vector Calculus (S. Chand)

5. Merle C. Potter, J. L. Goldberg, E. F. Aboufadel – Advanced Engineering Mathematics (Oxford)

6. Ghosh, Maity – Vector Analysis (New Central books)

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FACULTY OF ARTS AND SCIENCE
B.Sc. Mathemaatics- LOCF-2020

YEAR	SEMESTER	TITLE OF PAPER	L	T	P	C
		Skill Enhancement Course BOOLEAN ALGEBRA & AUTOMATA THEORY				
		(B.Sc-Mathematics)	**5**	**1**	**0**	**4**

Objectives:

Boolean algebra is a mathematical system for the manipulation of variables that can have one of two values. –In formal logic, these values are "true" and "false." –In digital systems, these values are "on" and "off," 1 and 0, or "high" and "low." Boolean expressions are created by performing operations on Boolean variables. –Common Boolean operators include AND, OR, and NOT

Course Learning Outcomes:

This course will enable the students to:

i). To study the basic philosophy underlying the various number systems, negative number representation, binary arithmetic, binary codes and error detecting and correcting binary codes.

ii). To study the theory of Boolean algebra and to study representation of switching functions using Boolean expressions and their minimization techniques.

iii). To study the combinational logic design of various logic and switching devices and their realization.

iv). To study the sequential logic circuits design both in synchronous and Asynchronous modes for various complex logic and switching devices, their minimization techniques and their realizations.

v). To study some of the programmable logic devices and their use in realization of switching functions.

Unit-1

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms.

Unit-2

Definition, examples and properties of modular and distributive lattices, Boolean algebra, Boolean polynomials, minimal and maximal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, Logic gates, switching circuits and applications of switching circuits.

Unit 3

Introduction: Alphabets, strings and languages. Finite automata and regular languages: deterministic and non deterministic finite automata, regular expressions, regular languages and their relationship with finite automata, pumping lemma and closure properties of regular languages.

Unit 4

Context free grammars and pushdown automata: context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, deterministic PDA, Non deterministic PDA, properties of context free languages, normal forms, pumping lemma, closure properties, decision properties.

Unit 5 Turing Machines: Turing machine as a model of computation, programming with a Turing machine, variants of Turing machine and their equivalence.

References Books:

1. B. A. Davey and H. A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge 1990.

2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, (2nd Ed.), Pearson Education (Singapore) P. Ltd., Indian Reprint 2003. 26 .

3.Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Edition, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

4.J. E. Hopcroft, R. Motwani and J. D. Ullman, Introduction to Automata Theory, Languages and Computation, 2nd Ed., Addison-Wesley, 2001.

5.H. R. Lewis, C. H. Papadimitriou, C. Papadimitriou, Elements of the Theory of Computation, 2nd Ed., Prentice-Hall, NJ, 1997.

6. J. A. Anderson, Automata Theory with Modern Applications, Cambridge University Press, 2006.

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FACULTY OF ARTS AND SCIENCE
B.Sc. Mathemaatics- LOCF-2020

YEAR	SEMESTER	TITLE OF PAPER Skill Enhancement Course **Transportation and Game theory**	L	T	P	C
		(B.Sc-Mathematics)	5	1	0	4

Objectives;

1 To impart knowledge in concepts and tools of Operations Research

2. To understand mathematical models used in Operations Research

3. To apply these techniques constructively to make effective business decisions

Course Learning Outcomes:

This course will enable the students to:

i)Understanding the issues & challenges in the Transportation Sector

ii). To develop skills required for Transport planning & formulation.

iii). Understand optimization techniques for Transport Planning & Pricing.

iv). Analyzing the processes for Transport project execution and control.

v). Demonstrating contracting process as applied in Transport projects.

Unit-1Transportation and Assignment

Transportation Problems definition, Linear form, Solution methods: North west corner method, least cost method, Vogel's approximation method. Degeneracy in transportation, Modified Distribution method, Unbalanced problems and profit maximization problems. Transshipment Problems. Assignment Problems and Travelling sales man Problem.

Unit-2 Game Theory

Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and graphical methods.

Unit-3 Queueing Theory

Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models, Preliminary examples of M/M/1:8/FCFA.

Unit-4 Replacement theory

Introduction, Replacement of capital equipment which depreciated with time, replacement by alternative equipment, Group and individual replacement policy

Unit-5 Decision Theory

Introduction, Decision under certainty, Decision under risk, Decision under uncertainty: Laplace criterion, MaxiMin criterion, MiniMax criterion, savage MiniMax regret criterion, hurwicz criterion, Decision tree

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FACULTY OF ARTS AND SCIENCE
B.Sc. Mathemaatics- LOCF-2020

YEAR	SEMESTER	TITLE OF PAPER Skill Enhancement Course **Matrices**	L	T	P	C
		(B.Sc-Mathematics)	5	1	0	4

Objectives:

1.Know what is meant by a system of linear equations (or linear system) and its solution set

2. Know how to write down the coefficient matrix and augmented matrix of a linear system

3. Use elementary row operations to reduce matrices to echelon forms

4. Make use of echelon forms in finding the solution sets of linear systems

5. Know how to manipulate with vectors in Euclidean space

6. Understand the meaning of linear independence/dependence and span

Course Learning Outcomes:

This course will enable the students to:

1. Work with matrices and determine if a given square matrix is invertible.

2. Learn to solve systems of linear equations and application problems requiring them.

3. Learn to compute determinants and know their properties.

4. Learn to find and use eigenvalues and eigenvectors of a matrix.

5. Learn about and work with vector spaces and subspaces.

6. Find the inverse of a square matrix.

7. Solve the matrix equation $Ax = b$ using row operations and matrix operations.

8. Find the determinant of a product of square matrices, of the transpose of a square matrix, and of the inverse of an invertible matrix

9. Find the characteristic equation, eigenvalues and corresponding eigenvectors of a given matrix.

10. Determine if a given matrix is diagonalizable.

Unit I: Introduction of matrices, Different types of matrices, Operations on matrices, Properties of operations of matrices.

Unit II: Elementary row operations, Row-reduced echelon form, Linear independence of rows, Row rank, Rank of a matrix, Inverse of matrix by row-reduced echelon form.

Unit III: Method of diagonalization, Trace of matrix and its properties,Solving a system of homogenous & non homogenous linear equations using row-reduced echelon form.

Unit IV: Eigen values&Eigen vectors of a matrix, characteristic equation of a matrix, Application of Cayley- Hamilton theorem to find an inverse of a matrix.

Unit-V

Diagonalization and Powers of a Matrix, Applications of Matrices to Engineering Problems, Linear Transformation Orthogonal Transformation, Quadratic Forms.

References:

1. Krishnamurthy, Mainra, Arora : An Introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd., N.Delhi.

2. Erwin Kreyszig : Advanced Engineering Mathematics, Wiley India (P) Ltd., 2009. 3 Santinarayan : Text book of Matrices, S. Chand and Co., New Delhi..

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FACULTY OF ARTS AND SCIENCE
B.Sc. Mathemaatics- LOCF-2020

YEAR	SEMESTER	TITLE OF PAPER Skill Enhancement Course **Fuzzy set and Fuzzy logic**	L	T	P	C
		(B.Sc-Mathematics)	5	1	0	4

Objectives:

Provide an understanding of the basic mathematical elements of the theory of fuzzy sets. Provide an emphasis on the differences and similarities between fuzzy sets and classical sets theories. The main objective of this course is to establish thorough background knowledge on evolutionary algorithms in post graduate students and enable them to pursue individual research in solving real world optimization problems like Constrained, Multimodal, Multi objective and Combinatorial Optimizations.

Course Learning Outcomes:

This course will enable the students to:

i). Comprehend the concepts of feed forward neural networks

ii). Analyze the various feedback networks.

iii). Understand the concept of fuzziness involved in various systems and fuzzy set theory.

iv). Comprehend the fuzzy logic control and adaptive fuzzy logic and to design the fuzzy control using genetic algorithm.

v). Analyze the application of fuzzy logic control to real time systems.

UNIT I

FUNDAMENTALS OF FUZZY LOGIC

Basic concepts: fuzzy set theory- basic concept of crisp sets and fuzzy sets- complements-unionintersection- combination of operation- general aggregation operations- fuzzy relations-compatibility relations-orderings- morphisms- fuzzy relational equations-fuzzy set and systems
UNIT II

ARCHITECTURE OF NEURAL NETWORKS

Architectures: motivation for the development of natural networks-artificial neural networks-biological neural networks-area of applications-typical Architecture-setting weights-common activations functionsBasic learning rules- Mcculloch-Pitts neuron- Architecture, algorithm,

applications-single layer net for Page 1 of 7 pattern classification- Biases and thresholds, linear separability - Hebb'srule- algorithm -perceptron - Convergence theorem-Delta rule

UNIT III BASIC NEURAL NETWORK TECHNIQUES

Back propagation neural net:standard back propagation-architecture algorithm- derivation of learning rulesnumber of hidden layers--associative and other neural networks- hetro associative memory neural net, auto associative net- Bidirectional associative memory-applications-Hopfield nets-Boltzman machine

UNIT IV

COMPETITIVE NEURAL NETWORKS

Neural network based on competition: fixed weight competitive nets- Kohonenself organizing maps and applications-learning vector quantization-counter propagation nets and applications adaptive resonance theory: basic architecture and operation-architecture, algorithm, application and analysis of ART1 & ART2

UNIT V

SPECIAL NEURAL NETWORKS

Cognitron and Neocognitron - Architecture, training algorithm and application-fuzzy associate memories, fuzzy system architecture- comparison of fuzzy and neural systems.

References:

1. Bart Kosko, ―Neural network and Fuzzy System‖ - Prentice Hall-1994.

2. J.Klin and T.A.Folger, ―Fuzzy sets‖ University and information- Prentice Hall -1996.

3. J.M.Zurada, ―Introduction to artificial neural systems‖-Jaico Publication house,Delhi 1994.

4. VallusuRao and HayagvnaRao , ―C++ Neural network and fuzzy logic‖-BPB and Publication, New Delhi,1996.

5. Intelligent Systems and Control-http://nptel.ac.in/courses/108104049/16.

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FACULTY OF ARTS AND SCIENCE
B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Elective Course:** **Computer Graphics**	L	T	P	C
I	I		**B.Sc-Mathematics**	5	1	0	6

Objectives:

Making the student understand how graphics created in computer world is the main goal of this course. Using colors in different places and for different objects is also one of the goals of the course. Learning how to rescale, transmit (shift), shear (skew), and rotate different graphical objects is another goal. Animating some simple graphics is the last aim of the course.

10. Computer Graphics;

Course Learning Outcomes:

This course will enable the students to:

i). Understand the basics of computer graphics, different graphics systems and applications of computer graphics.

ii). Discuss various algorithms for scan conversion and filling of basic objects and their comparative analysis.

iii). Use of geometric transformations on graphics objects and their application in composite form.

iv). Extract scene with different clipping methods and its transformation to graphics display device.

v). Explore projections and visible surface detection techniques for display of 3D scene on 2D screen.

vi). Render projected objects to naturalize the scene in 2D view and use of illumination models for this.

Unit-I

OVERVIEW OF COMPUTER GRAPHICS SYSTEM

Over View of Computer Graphics System – Video display devices – Raster Scan and random scan system – Input devices – Hard copy devices

Unit –II

OUTPUT PRIMITIVES AND ATTRIBUTES

Drawing line, circle and ellipse generating algorithms – Scan line algorithm – Character generation – attributes of lines, curves and characters – Antialiasing.

Unit –III

TWO-DIMENSIONAL GRAPHICS TRANSFORMATIONS AND VIEWING

Two-dimensional Geometric Transformations – Windowing and Clipping – Clipping of lines and clipping of polygons.

Unit –IV

THREE-DIMENSIONAL GRAPHICS AND VIEWING

Three-dimensional concepts – Object representations- Polygon table, Quadric surfaces, Splines Bezier curves and surfaces – Geometric and Modelling transformations – Viewing - Parallel and perspective projections.

Unit –V

REMOVAL OF HIDDEN SURFACES

Visible Surface Detection Methods – Computer Animation.

References;

1 Hearn, D. and Pauline Baker,M., Computer Graphics (C-Version),2nd Edition, Pearson Education.

2. Neuman, W.M., and Sproull, R.F., Principles of Interactive Computer Graphics, 2nd Edition, McGraw Hill Book Co.

3. http://www.freebookcentre.net/CompuScience/Free-Computer-Graphics-BooksDownload.html https://www.mooc-list.com/tags/computer-graphics.

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FACULTY OF ARTS AND SCIENCE
B.Sc. Mathematics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Elective Course:** **Operating system Linux**	L	T	P	C
I	I		**B.Sc-Mathematics**	5	1	0	6

Objectives:

1.Convenience: An OS makes a computer more convenient to use.

2.Efficiency: An OS allows the computer system resources to be used in an efficient manner.

3.Ability to evolve: An OS should be constructed in such a way as to permit the effective development, testing, and introduction of new system functions without interfering with service.

Course Learning Outcomes:

This course will enable the students to:
i). Describe and explain the fundamental components of a computer operating system.

ii). Describe and explain the fundamental components of a computer operating system.

iii). Define, restate, discuss, and explain the policies for scheduling, deadlocks, memory management, synchronization, system calls, and file systems.

iv). Describe and extrapolate the interactions among the various components of computing systems.

v). Design and construct the following OS components: System calls, Schedulers, Memory management systems, Virtual Memory and Paging systems.

vi). Illustrate, construct, compose and design solutions via C/C++ programs, and through NACHOS.

vii). Measure, evaluate, and compare OS components through instrumentation for performance analysis.

viii). Discuss with fellow students about designing new components of OS.

Unit I

Introduction to Operating System Concept: Types of operating systems, operating systems concepts, operating systems services, Introduction to System call, System call types.

Unit II

Process Management, Process concept, The process, Process State Diagram, Process control block, Process Scheduling, Scheduling Queues, Schedulers, Operations on Processes, Interprocess Communication, Threading Issues, Scheduling, Basic Concepts, Scheduling Criteria, Scheduling Algorithms

Unit III

Memory Management: Swapping, Contiguous Memory Allocation, Paging, the structure of the Page Table, Segmentation
Virtual Memory Management: Virtual Memory, Demand Paging, Page-Replacement Algorithms, Thrashing

Unit IV

Concurrency: ProcessSynchronization, The Critical Section Problem, Synchronization Hardware, Semaphores, Classic Problems of Synchronization, Monitors, Synchronization examples, Principles of deadlock – System Model, Deadlock Characterization, Deadlock Prevention, Detection and Avoidance, Recovery from Deadlock

Unit V

File system Interface- the concept of a file, Access Methods, Directory structure, File system mounting, file sharing, protection.
File System implementation- File system structure, allocation methods, free-space management mass-storage structure overview of Mass-storage structure, Disk scheduling, Device drivers.

References:

1. Modern Operating Systems, Andrew S. Tanenbaum, Second Edition, Addison Wesley, 2001.
2. Operating Systems: A Design-Oriented Approach, Charles Crowley, Tata Mc Graw Hill Education", 1996.
3. The Operating Systems: A Concept-Based Approach, D M Dhamdhere, Second Edition, Tata Mc Graw-Hill Education, 2007.
4. Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin and Greg Gagne 9th Edition, John Wiley and Sons Inc., 2012.
5. The Operating Systems – Internals and Design Principles, William Stallings, 7th Edition, Prentice Hall, 2011.
6. Operating Systems-S Halder, Alex A Aravind Pearson Education Second Edition 2016.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER Discipline Specific Core Course: Tamil-1	L	T	P	C
I	I		B.Sc-Mathematics	2	1	0	2

TAMIL - I

ghl Nehf;fk; :

1.jkpo; kuGf;ftpij> GJf;ftpij Kjyhdtw;iw mwpKfg;gLj;Jjy;.

2.rpWfij> ehty;> fl;Liu Kjyhd ,yf;fpa tbtq;fisf; fw;gpj;jy;.

3.,f;fhy ,yf;fpaj;jpd; kPjhd <h;g;ig kpFtpj;jy;.

4.ftpij> fl;Liu> ehty;> rpWfij ,tw;iw Rakhf gilf;f> gilg;ghw;wiyj; Jhz;ly;.

5.gbkk;> FwpaPL> ,iwr;rp> ctkk; gw;wp mwpa itj;jy;.

6.gf;jp kw;Wk; Md;kPfj;ij gw;wp ,f;fhy ,yf;fpa top mwpKfg;gLj;Jjy;.

fw;wy; gad; :

1.jkpo; ,yf;fpaj;jpd; kPjhd Mh;tk; kpFk;.

2.Gjpa ,yf;fpa tbtq;fis mwpth;

3.ftpij> rpWfij Mfpatw;iw gilf;f Kay;th;.

4.jkpo; ,yf;fpaq;fspd; %ykhf gilg;ghw;wYk;> gd;Kfj;jpwd;fSk; ntspg;gLk;.

5.Kf;fpa cj;jpfis mwpe;J nfhs;th;.

6.jkpo; ,yf;fpa Kd;Ndhbfis mwpth;.

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FACULTY OF ARTS AND SCIENCE
B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Core Course: Calculus**	L	T	P	C
I	I		**B.Sc-Mathematics**	2	1	0	2

TAMIL – II

ghl Nehf;fk; :

1.mz;ikf;fhy ,yf;fpaq;fspd; top r%f epiyghl;bid mwpjy;.
2.,f;fhy ,yf;fpaq;fspd; %ykhf Gjpa gilg;ghspapd; mDgt mwptpid ngwr;nra;jy;.

3.nra;As;> ,yf;fzk; mwpar;nra;jy;

4.,yf;fpa tuyhw;wpid KOikahf fw;gpj;jy;.
5.tho;tpay; gad;ghl;Lf; fy;tpia mwpar; nra;jy;.
6.ciueilia gpioapy;yhky; vOjr;nra;jy;> tbtk; tiffis mwpar;nra;jy;.

fw;wy; gad; :

1.,f;fhy ,yf;fpa kuGfis mwpe;Jf; nfhs;tjd; %yk; jkpo; ,yf;fpa tifik khw;wq;fis Ghpe;Jf; nfhs;Sjy;.
2.,f;fhy ,yf;fpa kuGfs; Fwpj;j tpku;rd ghh;it ngwy;.
3.nra;As; ,aw;WtJ vt;thW vd mwpe;J nfhs;th;.
4.jkpo; ,yf;fpa tuyhW mwpth;.
5.gad;ghl;L fy;tp %yk; tpz;zg;gq;fs; vOjTk;> tpkh;rdk; nra;jy; vd gy jpwd;fis ngWth;.
6.ciueilapid ed;F vOj mwpth;.

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FACULTY OF ARTS AND SCIENCE
B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER Discipline Specific Core Course: Calculus	L	T	P	C
I	I		B.Sc-Mathematics	5	1	0	6

TAMIL – III

ghl Nehf;fk; :

1.jkpo; ,yf;fpa tuyhw;wpy; lk;ngUk;fhg;gpaq;fs;> ehlfq;fs;> gf;jp ,yf;fpak; ngWk; ,lk; Fwpj;J tpsf;Fjy;.

2.fhg;gpar; RitAk; ehlf ,d;gj;ijAk; gf;jp ngUf;ifAk; khzth;fs; mwpar; nra;jy;.

3.ehlf ,yf;fpak; - mf;fhy> ,f;fhy jd;ikapid mwpar; nra;jy.;

4.fhg;gpaq;fspd; top ePjpia czur; nra;jy;> tpOkpa Nfhl;LghLfis mwpa itj;jy;.

5.gy;NtW rkaq;fs; gf;jp ,yf;fpaj;ij tsu nra;j gpd;Gyj;ij mwpar; nra;jy;.

fw;wy; gad; :

1.khzth;fs; jkpo; ,yf;fpa tuyhw;wpd; fhg;gpak;> ehlfk;> gf;jp ,yf;fpak; gf;jp ,yf;fpak; gw;wp mwpjy;.

2.tho;tpd;> topghl;bd; Kf;fpaj;Jtk; czh;e;J filg;gpbg;gh;.

3.ehlfk; %yk; ebg;Gf;fiy gw;wp mwpe;J nfhz;L ebf;f Kay;th;.

4.ehlfk; ,aw;wp mjpy; gilg;ghw;wiy gilf;f Kay;th;.

5.gf;fp ,yf;fpaq;fspd; %yk; ,irNahL ghLtJ gw;wpAk;> Mo;thh;fs;> ehad;khh;fs;> rkzk;> ngsj;jk; Nghd;w gy;NtW tifahd rka mwptpid khzth;fs; ngWthh;fs;.

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(Deemed to be University under section 3 of the UGC Act 1956)

FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Core Course: Calculus**	L	T	P	C
I	I		**B.Sc-Mathematics**	2	1	0	2

TAMIL - IV

ghl Nehf;fk; :

1.gz;ila ,yf;fpaj;jpd; Kf;fpaj;Jtk; czur; nra;jy;.
2.ehl;lhh; tho;tpay; $Wfis mwpar; nra;jy;.
3.,uhkypq;f ts;syhh;> jhAkhdth; MfpNahh;fspd; ghly;fs; top caph;nfhy;yhik> rkur rd;khh;f;fk;> md;G> fUiz Mfpa newpfis mwpa itj;jy;. jpUke;jpu ghly;fisAk; mwpa nra;jy;.
4.xsitahh;> fhsNkhfk;> xl;lf;$j;jh;> ,ul;ilg;Gyth;fs; %yk; ftpeag; ghly;fis mwpa itj;jy;.
5.ehl;Lg;Gw jhyhl;L> xg;ghhp> Fk;kp> njUf;$j;J> goe;jkpoh; czT> iftpid fiyfs;> tpLfijfs;> gonkhopfs; Mfpatw;iw mwpar; nra;jy;.
6.fl;Liu vOJtJ vt;thW vd mwpa itj;jy;;.

fw;wy; gad; :

1.gz;ila ,yf;fpaj;jpid czh;e;J mjd; newpapy; tho Kw;gLjy;.

2.goe;jkpohpd; kugpid gpd;gw;wp mjd; tpOkpaq;fis eilKiwg;gLj;Jjy;.
3.cah; mwq;fs; kw;Wk; tho;tpy; filg;gpbf;f Ntz;ba tpjpKiwfs; ed;ik> jPik vit vd ghFghL czh;jy; Mfpatw;iw khzth;fs; mwpe;J nfhs;thh;fs;.
4.goq;fhy Gyth;fspd; gilg;ghw;wy; vt;thW ,Ue;jJ vd;gijAk;> ftpj;jpwd;fisAk; mwpthh;fs;.
5.ehl;lhh; tof;fhw;wpid mwpe;J> mjid Ma;T nra;a Kw;gLthh;fs;.
6.Rakhf fl;Liufs; vOj Kw;gLthh;fs;.

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B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER **Discipline Specific Core Course: Calculus**	L	T	P	C
I	I		**B.Sc-Mathematics**	2	1	0	2

1. ENGLISH - I

Course Learning Outcomes:

This course will enable the students to:

1. Instigate the significance of various cultures, languages and historic periods, letting the students to appreciate poetry as a literary art and its various elements of poetry, such as diction, tone, form, genre and the use of imagery in day to day life.
2. To explore the 'How' question, where writers use the resources language as a creativity to explore the entire range of human experience through dramas as a literary form.
3. Record the experience of imaginative stories learnt with advanced techno-cum aids, ie: Visual teaching and audio clips respectively.
4. A two- dice platform of teaching and learning is prevailed promoting every student a basement in grammar staging from basics to collective advertising.
5. Implementation of English would concentrate, not just on the subjective credits, but also focus on the objective living from academic to personal endeavours on thorough teaching.
6. Students will hail to be suitable for self-skills through the vital impact of English and its pre-reading to re-learning.

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FACULTY OF ARTS AND SCIENCE
B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER Discipline Specific Core Course:	L	T	P	C
I	I		B.Sc-Mathematics	2	1	0	2

2. ENGLISH II

Course Learning Outcomes:

This course will enable the students to:

1. To understand the nuances of Poetry, Short stories and Plays to have confidence to deal with real life situation.
2. To learn the grammar, this in turn enhances the four skills of LSRW.
3. To be instigated to have an eminent craves on the poems.
4. To Improve Communication Skills to compete with the other students to have better future.
5. To comprehend the various literary writers' style and their depiction of various things in their writing.
6. To practice various methods of second language teaching and to focus on the three components of sound, grammar, vocabulary
7. To understand the use of English language in expression.

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FACULTY OF ARTS AND SCIENCE
BOARD OF STUDIES-SCIENCE-2020
BACHELOR OF MATHEMATICS (Regular)
CURRICULUM – 2020 (CHOICE BASE CREDIT SYSTEM)

YR	SEM	SUB.CODE	TITLE OF PAPER Ability Enhancement Courses:	L	T	P	C
I	I		B.Sc-Mathematics	4	1	0	4

ABILITY ENHANCEMENT COURSES

1. English for communication

Course Learning Outcomes:

This course will enable the students to:

i). To introduce the nuances of language and its purpose in practical and academic life.

ii). To help bridge the mobility of English language through advanced teaching aids and creative ideologies.

iii). Emancipate the correct usage of communication at zones of competence and developed personality globally.

iv). To inculcate the active role play of effective skills verbally and efficient skills non-verbally in discourse.

v). To contextualize new vocabulary, use of reviewing, skimming, scanning and enhance the credibility of reading and writing consciousness in students.

vi). Cross- build learning styles as soft skills, classmate collaborations, group assignments, individual persona levels to utmost productivity in business sectors of work.

vii). Up skill the gut-power of students on scaled platforms through comprehensive moves and casting roles in testing of the four vital communication skills held concurrently at ease.

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FACULTY OF ARTS AND SCIENCE

B.Sc. Mathemaatics- LOCF-2020

YR	SEM	SUB.CODE	TITLE OF PAPER Ability Enhancement Courses:	L	T	P	C
I	I		B.Sc-Mathematics	4	1	0	4

2. Environmental Sciences;

Course Learning Outcomes:

This course will enable the students to:

i). Understand core concepts and methods from ecological and physical sciences and their application in environmental problem-solving.

ii). Realize key concepts from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.

iii). Understand the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.

iv). Appreciate that one can apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.

v). Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.