A

SYLLABI

For

B.Sc.\B.A.

I, II, III, IV, V, VI Semester

COURSE

IN

MATHEMATICS

2020 - 2021 , onwards

DR. H. S. GOUR VISHWAVIDYALAYA

(A CENTRAL UNIVERSITY)

SAGAR (M.P.)

Chairman, B.O.S
Department of Mathematics & Statistics
Dr. Harisingh Gour Vishwavidyalaya, Sagar

Mathematics Profession

Mathematics is the backbone of all sciences. 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. 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. 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. 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. Completion of this programme will also enable the learners to join teaching profession in primary and secondary schools.This programme will also help students to enhance their employability for government jobs, jobs in banking, insurance and investment sectors, data analyst jobs and jobs in various other public and private enterprise. They can also get administrative jobs through UPSC and PSC. This course is designing in a manner that the student can get employment worldwide.

1. Name of the Programme: B.Sc./B.A.
2. Duration of Programme: The duration of the programme is six semesters spread over a period of not less than 90 working days for each semester.
3. Structure of Programme: The course (elective and core) of study for B.Sc./B.A., includes the subject. The number of hours per week devoted to each subject and credits for its theory practical as per scheme attached.
4. The medium of instruction: English.
5. Each course of B.Sc./B.A. is marked as a core/compulsory/elective course etc.
6. **CreditsDistribution:**
   Credit allotted followed throughout of scheme of programme (Total credits:44)

S.No.	Nature of Papers	Total No. of Papers	Credits in Theory + Tutorial	Total Credits
1.	Core Papers	04	06	24
2.	DSE (Discipline Specific Elective) Papers	02	06	12
3.	Skill Enhancement Papers	04	02	08
Total Papers/Credits		10		44

7. **Scheme of Examination:**
   (a) Mid Semester Examination : 20 Marks
   (b) Internal Assessment : 20 Marks
   (c) End Semester Examination : 60 Marks
   Total : 100 Marks

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Department of Mathematics and Statistics
Academic Session 2020-2021 onwards
B.Sc.\ B.A. with Mathematics

Semester	Code	Course Title	Credit	Contact Hours
1	MTS CC 111	Calculus	6	90
2	MTS CC 211	Algebra	6	90
3	MTS CC 311	Differential Equations	6	90
	MTS SE 311	Logic and Sets	2	30
	MTS SE 312	Analytical Geometry	2	30
	MTS SE 313	Integral Calculus	2	30
4	MTS CC 411	Real Analysis	6	90
	MTS SE 411	Vector Calculus	2	30
	MTS SE 412	Theory of Equations	2	30
	MTS SE 413	Number Theory, Elementary	2	30
5	MTS EC 511	Mechanics	6	90
	MTS EC 512	Probability and Statistics	6	90
	MTS EC 513	Numerical Methods	6	90
	MTS EC 514	Complex Variables	6	90
	MTS EC 515	Linear Algebra	6	90
	MTS EC 516	Integral Transforms and Fourier Analysis	6	90
	MTS SE 511	Portfolio Optimization	2	30
	MTS SE 512	Mathematical Modeling	2	30
	MTS SE 513	Boolean Algebra	2	30
6	MTS EC 611	Discrete Mathematics	6	90
	MTS EC 612	Linear Programming and Game Theory	6	90
	MTS EC 613	Tensors and Differential Geometry	6	90
	MTS EC 614	Number Theory	6	90
	MTS EC 615	Advanced Mechanics	6	90
	MTS EC 616	Information Theory and Coding	6	90
	MTS EC 617	Special Theory of Relativity	6	90
	MTS EC 618	C++ Programming for Mathematics	6	90
	MTS SE 611	Mathematical Finance	2	30
	MTS SE 612	MATLAB	2	30
	MTS SE 613	Graph Theory	2	30

NOTE :-

1. Papers of CODE CC are compulsory in Semesters 1 to 4.
2. Choose any one paper of CODE SE in semesters 3 to 6.
3. Choose any one paper of CODE EC in semesters 5 and 6.

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Department of Mathematics and Statistics

B.Sc.\ B.A.–I Semester

MTS CC 111	Calculus	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

i) Calculate the limit and examine the continuity and understand the geometrical interpretation of differentiability.
ii) Understand the consequences of various mean value theorems.
iii) Draw curves in Cartesian and polar coordinate systems.
iv) Understand conceptual variations while advancing from one variable to several variables.
v) Inter-relationship amongst the line integral, double and triple integral formulations.
vi) Realize importance of Green, Gauss and Stokes' theorems in other branches of mathematics.

Unit-I: Sequences, Continuity and Differentiability: Notion of convergence of sequences and series of real numbers, ε-δ definition of limit and continuity of a real valued function; Differentiability and its geometrical interpretation; Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem and their geometrical interpretations, Darboux's theorem. **(18 hours)**
Unit-II: Expansion of Functions: Successive differentiation and Leibnitz theorem, Maclaurins and Taylors theorems for expansion of a function, Taylor's theorem in finite form with Lagrange, Cauchy and Roche–Schlömilch forms of remainder. **(18 hours)**
Unit-III: Curvature, Asymptotes and Curve Tracing: Curvature; Asymptotes of general algebraic curves, Parallel asymptotes, Asymptotes parallel to axes; Symmetry, Concavity and convexity, Points of inflection, Tangents at origin, Multiple points, Position and nature of double points; Tracing of Cartesian, polar and parametric curves. **(18 hours)**
Unit-IV: Functions of Several Variables: Limit, continuity and first order partial derivatives, Higher order partial derivatives, Change of variables, Euler's theorem for homogeneous functions, Taylor's theorem, Total differentiation and Jacobians. **(18 hours)**
Unit-V: 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, Line integrals, Green's theorem, Area as a line integral, Surface integrals, Stokes' theorem, The Gauss divergence theorem. **(18 hours)**

Suggested Readings and links:

1. Howard Anton, I. Bivens & Stephan Davis (2016). *Calculus* (10th edition). Wiley India.
2. 2. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
3. Link-https://www.youtube.com/watch?v=vEZsuZd9s88
4. Link-https://www.youtube.com/watch?v=5uT1jbgwFqs

Essential Readings:

1. Wieslaw Krawcewicz & Bindhyachal Rai (2003). *Calculus with Maple Labs*. Narosa.
2. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd.
3. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas' Calculus* (14th edition). Pearson Education.
4. Jerrold Marsden, Anthony J. Tromba & Alan Weinstein (2009). *Basic Multivariable Calculus*, Springer, India Pvt. Limited.

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B.Sc.\ B.A.–II Semester

MTS CC 211	Algebra	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

i) Employ De Moivre's theorem in a number of applications to solve numerical problems.
ii) Learn about the fundamental concepts of groups, subgroups, normal subgroups, isomorphism theorems, cyclic and permutation groups.
iii) Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
iv) Find eigen values and corresponding eigenvectors for a square matrix.
v) Understand real vector spaces, subspaces, basis, dimension and their properties.

Unit-I: Set Theory and Theory of Equations:
Sets, Relations, Equivalence relations, Equivalence classes; Finite, countable and uncountable sets; The division algorithm, Divisibility and the Euclidean algorithm, Modular arithmetic and basic properties of congruences; Elementary theorems on the roots of polynomial equations, Imaginary roots, The fundamental theorem of algebra (statement only); The n^{th} roots of unity, De Moivre's theorem for integer and rational indices and its applications. **(18 hours)**

Unit-II: Groups, Subgroups, Normal Subgroups and Isomorphism Theorems:
Definition and properties of a group, Abelian groups, Examples of groups including D_n(dihedral groups),Q_8(quarternian group), $GL(n,\mathbb{R})$ (general linear groups) and $SL(n,\mathbb{R})$(special linear groups); Subgroups and examples, Cosets and their properties, Lagrange's theorem and its applications, Normal subgroups and their properties, Simple groups, Factors groups; Group homomorphisms and isomorphisms with properties; First, second and third isomorphism theorems for groups. **(18 hours)**

Unit-III: Cyclic and Permutation Groups:
Cyclic groups and properties, Classifications of subgroup of cyclic groups, Cauchy theorem for finite Abelian groups; Centralizer, Normalizer, Center of a group, Product of two subgroups, Permutation group and properties, Even and odd permutations, Cayley's theorem. **(18 hours)**

Unit-IV: Row Echelon Form of Matrices and Applications:
Systems of linear equations, Row reduction and echelon forms, The rank of a matrix and its applications in solving system of linear equations; Matrix operations, Symmetric, skew- symmetric, self-adjoint, orthogonal, Hermitian, skew-Hermitian and unitary matrices; Determinant of a square matrix, The inverse of a square matrix, Eigenvectors and eigen values, The characteristic equation and the Cayley-Hamilton theorem, Applications of matrices to computer graphics and search engines. **(18 hours)**

Unit-V: Vector Spaces and Linear Transformations:
Definitions of field and vector space with examples, Subspaces, Linear span, Quotient space and direct sum, linearly independent and dependent sets, Bases and dimension, Linear transformation and matrix of a linear transformation, Change of coordinates, Rank and nullity of linear transformation, Rank-nullity theorem. **(18 hours)**

Suggested Readings:

1. Michael Artin (2014). Algebra (2nd edition). Pearson.
2. John B. Fraleigh (2007). A First Course in Abstract Algebra (7th edition). Pearson.
3. Stephen H. Friedberg, Arnold J.Insel& Lawrence E. Spence (2003). Linear Algebra (4thedition). Prentice-Hall of India Pvt. Ltd.

Essential Readings:

1. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition). Cengage.
2. Kenneth Hoffman & Ray Kunze (2015). Linear Algebra (2nd edition). Prentice-Hall.
3. I. N. Herstein (2006). Topics in Algebra (2nd edition). Wiley India.
4. Nathan Jacobson (2009). Basic Algebra I (2nd edition). Dover Publications.
5. J.S. Luthar& I.B.S. Passi (2013). Algebra: Volume 1: Groups. Narosa.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
B.Sc.\ B.A.–III Semester

MTS CC 311	Differential Equations	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

i) Understand the genesis of ordinary as well as partial differential equations.
ii) Learn various techniques of getting exact solutions of certain solvable first order differential equations and linear differential equations of second order.
iii) Know Picard's method of obtaining successive approximations of solutions of first order ordinary differential equations, passing through a given point in the plane.
iv) Learn about solution of first order linear partial differential equations using Lagrange's method.
v) Know how to solve second order linear partial differential equations with constant coefficients.
vi) Formulate mathematical models in the form of ordinary and partial differential equations to 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. **(18 hours)**

Unit-II: Second Order Linear Differential Equations Statement of existence and uniqueness theorem for the solution of 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, Method of variation of parameters and method of undetermined coefficients, Reduction of order, Euler-Cauchy equations, Coupled linear differential equations with constant coefficients. **(18 hours)**

Unit-III: First Order Partial Differential Equations Genesis of Partial differential equations (PDE), Concept of linear and non-linear PDEs, Methods of solution of Simultaneous differential equations of the form: $dx/P(x,y,z) = dy/Q(x,y,z) = dz/R(x,y,z)$, Lagrange's method for PDEs of the form: $P(x,y,z)p+Q(x,y,z)q=R(x,y,z)$, where $p=\partial z/\partial x$ and $q=\partial z/\partial y$; Solutions passing through a given curve. **(18 hours)**

Unit-IV: Second Order Partial Differential Equations with Constant Coefficients Principle of superposition for homogeneous linear PDEs, Relation between solution sets of non-homogeneous linear PDEs and their corresponding homogeneous equations, Reducible and irreducible homogeneous equations and their solutions in various possible cases, Solution of non-homogeneous reducible equations using Lagrange's method for first order equations. **(18 hours)**

Unit-V: Applications Orthogonal trajectories of one-parameter families of curves in a plane, Minimum velocity of escape from Earth's gravitational field, Newton's law of cooling, Malthusian and logistic population models, Radioactive decay, Free and forced mechanical oscillations of a spring suspended vertically carrying a mass at its lowest tip, Phenomena of resonance, LCR circuits, Surfaces orthogonal to a given system of surfaces. **(18 hours)**

Suggested Readings:

1. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). J. Wiley & Sons
2. B. Rai & D. P. Choudhury (2006). Ordinary Differential Equations - An Introduction. Narosa Publishing House Pvt. Ltd. New Delhi.
3. Shepley L. Ross (2007). Differential Equations (3rd edition). Wiley.

Essential Readings:

1. George F. Simmons (2017). Differential Equations with Applications and Historical Notes (3rd edition). CRC Press. Taylor & Francis.
2. Ian N. Sneddon (2006). Elements of Partial Differential Equations. Dover Publications.

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B.Sc.\ B.A.–III Semester

MTS SE 311	Logic and Sets	L	T	P	C
		2	0	0	2
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

(i) Employ truth table in various logical situations.
(ii) Learn about the fundamental concepts Propositional equivalence
(iii) Understand counting principle

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

(6 hours)

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

(6 hours)

Unit – III:
Sets, subsets, Set operations, the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations.

(6 hours)

Unit – IV:
Classes of sets. Power set of a set. Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. **(6 hours)**

Unit – V:
Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation.

(6 hours)

Suggested Readings:

1. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.
2. P.R. Halmos, *Naive Set Theory*, Springer, 1974.

Essential Readings:

1. E. Kamke, *Theory of Sets*, Dover Publishers, 1950.

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B.Sc.\ B.A.–III Semester

MTS SE 312	**Analytical Geometry**	L	T	P	C
		2	0	0	2
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

Course Learning Outcomes: After completion of this course the students will be able to:

(i) Be able to basic properties of various conic sections.
(ii) Learn about the fundamental concepts of quadratic equations
(iii) Understand quadratic surfaces

Unit – I: Techniques for sketching parabola, ellipse and hyperbola. **(6 hours)**
Unit – II: Reflection properties of parabola, ellipse and hyperbola. **(6 hours)**
Unit – III: Classification of quadratic equations representing lines, parabola, ellipse and hyperbola. **(6 hours)**
Unit – IV: Spheres, Cylindrical surfaces. **(6 hours)**
Unit – V: Illustrations of graphing standard quadric surfaces like cone, ellipsoid **(6 hours)**

Suggested Readings:

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) Pvt. Ltd., 2002.

Additional Readings:

1. S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company, London.
2. R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillan India Ltd., 1994.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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B.Sc.\ B.A.–III Semester

MTS SE 313	**Integral Calculus**	L	T	P	C
		2	0	0	2
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

Course Learning Outcomes: After completion of this course the students will be able to:

(i) Be able to basic properties of Integration by Partial fractions.
(ii) Learn Properties of definite integrals
(iii) Understand Double and Triple integrals and be able to apply them in various applications

Unit – I: Integration by Partial fractions, integration of rational and irrational functions. **(6 hours)**
Unit – II: Properties of definite integrals. Reduction formulae for integrals of rational, trigonometric, exponential functions. **(6 hours)**
Unit – III: Reduction formulae for logarithmic functions and others. **(6 hours)**
Unit – IV: Areas and lengths of curves in the plane, volumes and surfaces of solids of revolution. **(6 hours)**
Unit – V: Double and Triple integrals. **(6 hours)**

Suggested Readings:

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.

Essential Readings:

1. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd., 2002.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
B.Sc.\ B.A.–IV Semester

MTS CC 411	Real Analysis	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

(i) Understand basic properties of real number system such as least upper bound property and Order property.

(ii) Realize importance of bounded, convergent, Cauchy and monotonic sequences of real numbers, find their limit superior and limit inferior.

(iii) Apply various tests to determine convergence and absolute convergence of a series of real numbers.

(iv) Learn about Riemann integrability of bounded functions and algebra of R-integrable functions.

(v) Determine various applications of the fundamental theorem of integral calculus.

(vi) Relate concepts of uniform continuity, differentiation, integration and uniform convergence.

Unit-I: Real Numbers

The set of real numbers $(\mathbb{R})$ as an ordered field, Least upper bound properties of $\mathbb{R}$, Metric property and completeness of $\mathbb{R}$, Archimedean property of $\mathbb{R}$, Dense subsets of $\mathbb{R}$, Nested intervals property; Neighborhood of a point in $\mathbb{R}$, Open sets, limit point of a set, closed and perfect sets in $\mathbb{R}$, connected and compact subsets of $\mathbb{R}$, Heine-Borel theorem. **(18 hours)**

Unit-II: Convergence of Sequences in $\mathbb{R}$

Bounded and monotonic sequences, Convergent sequence and its limit, Limit theorems, Monotone convergence theorem, Subsequences, Bolzano-Weierstrass theorem, Limit superior and limit inferior, Cauchy sequence, Cauchy's convergence criterion. **(18 hours)**

Unit-III: Infinite Series

Convergence of a series of positive real numbers, Necessary condition for convergence, Cauchy criterion for convergence; Tests for convergence: Comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's *n*th root test, Abel's test, Integral test; Alternating series, Absolute and conditional convergence, Leibniz theorem, Rearrangements of series, Riemann's rearrangement theorem. **(18 hours)**

Unit-IV: Riemann Integration

Riemann integrability of bounded functions, Examples of R-integrable and non-integrable functions, Algebra of Riemann integrable functions, Integrability of continuous and monotonic functions, Darboux theorems, Fundamental theorem of integral calculus, First mean value theorem and second mean value theorems (Bonnet and Weierstrass forms). Necessary and sufficient condition for Riemann integrable function (Statement only). **(18 hours)**

Unit-V: Uniform Convergence, Continuity and Improper Integrals

Pointwise and uniform convergence of sequence and series of functions, Uniform continuity, Weierstrass's M-test, Uniform convergence and continuity, Uniform convergence and differentiability, Improper integrals and tests for improper integrals, Beta and Gamma functions. **(18 hours)**

Suggested Readings:

1. T. M. Apostol (2008). *Mathematical Analysis: A Modern Approach to AdvancedCalculus*. Pearson Education.
2. Charalambos D. Aliprantis &) Owen Burkinshaw1998). *Principles of Real Analysis*(3rd edition). Academic Press.
3. Robert G. Bartle & Donald R. Sherbert (2015). *Introduction to Real Analysis* (4th edition).Wiley India.
4. Gerald G. Bilodeau, Paul R. Thie & G. E. Keough (2015). *An Introduction to Analysis*(2nd edition), Jones and Bartlett India Pvt. Ltd.

Essential Readings:

1. E. Hewitt & K. Stromberg (2013). *Real and Abstract Analysis*. Springer-Verlag.
2. K. A. Ross (2013). *Elementary Analysis*: *The Theory of Calculus* (2nd edition). Springer.
3. Walter Rudin. *Principles of Mathematical Analysis* (3rd edition), Tata McGraw

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Department of Mathematics and Statistics
B.Sc.\ B.A.–IV Semester

MTS SE 411	Vector Calculus	L	T	P	C
		2	0	0	2
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

1. Learn the concept of vectors and their differentiation.
2. Understand the derivative of sum dot and cross product of vector functions.
3. Optimize the application of vector functions in form of Gradient, divergence and curl.

Unit – I: Differentiation of a vector function. **(6 hours)**
Unit – II: Partial differentiation of a vector function **(6 hours)**
Unit – III: Derivative of sum and dot product of two vectors and their properties. **(6 hours)**
Unit – IV: Derivative of cross product of two vectors and their properties. **(6 hours)**
Unit – V: Gradient, divergence and curl. **(6 hours)**

Suggested Readings :

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.

Essential Readings:

1. P.C. Matthew's, *Vector Calculus*, Springer Verlag London Limited, 1998.

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B.Sc.\ B.A.–IV Semester

MTS SE 412	**Theory of Equations**	L	T	P	C
		2	0	0	2
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

1. Learn the basic concept of polynomial.
2. Explore polynomial using graphical representation.
3. Find the maximum and minimum value of polynomials.
4. Understand the equations and their solutions.

Unit – I: General properties of polynomials, Graphical representation of a polynomials, maximum and minimum values of a polynomials. **(6 hours)**
Unit – II: General properties of equations, Descarte's rule of signs positive and negative rule. **(6 hours)**
Unit – III: Relation between the roots and the coefficients of equations. Symmetric functions, Applications of symmetric function of the roots. **(6 hours)**
Unit – IV: Transformation of equations. Solutions of reciprocal and binomial equations. **(6 hours)**
Unit – V: Algebraic solutions of the cubic and biquadratic. Properties of the derived functions. **(6 hours)**

Suggested Readings :

1. W.S. Burnside and A.W. Panton, *The Theory of Equations*, Dublin University Press, 1954.

Essential Readings :

1. C. C. MacDuffee, *Theory of Equations*, John Wiley & Sons Inc., 1954.

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B.Sc.\ B.A.–IV Semester

MTS SE 413	Elementary Number Theory	L	T	P	C
		2	0	0	2
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

1. Understand the concept of numbers and impact of algorithm on it.
2. Familiar with several theorems used for numbers.
3. Explore the Möbius inversion formula, the greatest integer function, Euler's phi-function for numbers.

Unit – I: Division algorithm, Lame's theorem, linear Diophantine equation, fundamental theorem of arithmetic. **(6 hours)**
Unit – II: Prime counting function, statement of prime number theorem, Goldbach conjecture. Binary and decimal representation of integers, linear congruences. **(6 hours)**
Unit – III: Complete set of residues. Number theoretic functions, sum and number of divisors. **(6 hours)**
Unit – IV: Totally multiplicative functions. Definition and properties of the Dirichlet product. **(6 hours)**
Unit – V: The Möbius inversion formula, the greatest integer function, Euler's phi-function. **(6 hours)**

Suggested Readings :

1. David M. Burton, *Elementary Number Theory* 6th Ed., Tata McGraw-Hill Edition, Indian reprint, 2007.

Essential Readings:

1. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with Maple*, CRC Press, Boca Raton, 2000.
2. Neville Robinns, *Beginning Number Theory,* 2nd Ed., Narosa Publishing House Pvt. Limited, Delhi, 2007.

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Department of Mathematics and Statistics
B.Sc.\ B.A.–V Semester

MTS EC 511	Mechanics	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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 particle.
iii) Determine the centre of gravity of 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: Coplanar forces, Couples, Moment of force and a couple about a point and a line, Equilibrium of a particle and of a system of particles; Work and potential energy, Principle of virtual work for a system of coplanar forces acting on a particle, Forces which can be omitted in forming the equations of virtual work. **(18 hours)**
Unit-II: Centre of Gravity and Common Catenary: Concepts of Centre of mass and Centre of gravity, Centre of gravity of an uniform arc, plane area and solids of revolution; Common catenary, Approximations of a catenary. **(18 hours)**
Unit-III: Rectilinear Motion: Simple harmonic motion and its geometrical representation, Motion under inverse square law, Motion in resisting media, Concept of terminal velocity, Motion of varying mass. **(18 hours)**
Unit-IV: Motion in a Plane: Kinematics and kinetics of motion, Expressions for velocity and acceleration in Cartesian, polar and intrinsic coordinates; Motion in a vertical circle, projectile and cycloidal motion. **(18 hours)**
Unit-V: Central Orbits: Equation of motion under a central force, Differential equation of an orbit, (p, r) equation of an orbit, Apses and apsidal distances, Areal velocity, Characteristics of central orbits, Kepler's laws of planetary motion. **(18 hours)**

Suggested Readings and links:

1.Linkhttps://ndl.iitkgp.ac.in/document/uSAwYFRVw9ZnGn03qA9G2hwNTfl72kYwH7fFqIybm4Nrv6Zk90da6JxgW9bOZ7_uP3wGh7LXTRrFIkbkEMGQ

Essential Readings:

1. R. S. Varma (1962). A Text Book of Statics. Pothishala Pvt. Ltd.
2. P.L. Srivastava (1964). Elementary Dynamics. Ram Narain Lal, Beni Prasad Publishers Allahabad.
3. J. L. Synge & B. A. Griffith (1949). Principles of Mechanics. McGraw-Hill.
4. S.L. Loney (2006). An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies. Read Books.
5. A. S. Ramsey (2009). Statics. Cambridge University Press.
6. A. S. Ramsey (2009). Dynamics. Cambridge University Press.

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(A Central University)
Department of Mathematics and Statistics
B.Sc.\ B.A.–V Semester

		L	T	P	C
MTS EC 512	Probability and Statistics	5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

i) Understand the basic concepts of probability.
ii) Appreciate the importance of probability distribution of random variables and to know the notion of central tendency.
iii) Establish the joint distribution of two random variables in terms their correlation and regression.
iv) Understand central limit theorem which shows that the empirical frequencies of so many natural populations exhibit normal distribution.
v) Study entropy and information theory in the framework of probabilistic models.

Unit-I: Probability and Random Variables: Axiomatic and empirical definitions of probability, Independent and dependent events, Conditional probability and Baye's theorem; Discrete and continuous random variables and their probability distributions, Cumulative distribution function, nth Moments, Moment generating function, Characteristic function. **(18 hours)**

Unit-II: Univariate Distributions: Discrete distributions: Bernoulli trials and Bernoulli distribution, Binomial and Poisson distributions; Continuous distributions: Uniform, Geometric, Gamma, Exponential, Chi-square, Beta and normal distributions; Normal approximation to the binomial distribution, Central limit theorem. **(18 hours)**

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, Independence of bivariate random variables. **(18 hours)**

Unit-IV: Correlation and Regression: The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Markov theorem, Chebyshev's theorem, Weak and strong laws of large numbers. **(18 hours)**

Unit-V: Information Theory: Uncertainty, Information and entropy, Conditional and joint entropy, Uniform Priors, Polya's urn model and random graphs, Applications of random graphs. **(18 hours)**

Suggested Readings and links:

1. Link-https://ndl.iitkgp.ac.in/document/xttk-4kfhvUwVlXBW-YWRG-_qI1D91n-tT0yETKYX-kme0iMh2fuGO45NzzRjIiG4yVe9aX4I_JbIp-ICuBPKA#0
2. Link-http://ndl.iitkgp.ac.in/document/-h-4TdbrZEOYNABN8aBf6SYVpUlzGjM5hQe-hTOdE1l3qUqaVlojPC4YB6AgxI3mSHt66lOVUgzL5LWPYaW3HA

Essential Readings:

1. David Applebaum (1996). Probability and Information: An Integrated Approach. Cambridge University Press.
2. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). Introduction to Mathematical Statistics (7th edition), Pearson Education.
3. Irwin Miller & Marylees Miller (2014). John E. Freund's Mathematical Statistics with Applications (8th edition). Pearson. Dorling Kindersley Pvt. Ltd. India.
4. Jim Pitman (1993). Probability, Springer-Verlag.
5. Sheldon M. Ross (2014). Introduction to Probability Models (11th edition). Elsevier.
6. 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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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR

(A Central University)

Department of Mathematics and Statistics

B.Sc.\ B.A.–V Semester

MTS EC 513	Numerical Methods	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

i) Obtain numerical solutions of algebraic and transcendental equations.
ii) Find numerical solutions of system of linear equations and to check the accuracy of the solutions.
iii) Learn about various interpolating and extrapolating methods to find numerical solutions.
iv) Solve initial and boundary value problems in differential equations using numerical methods.
v) Apply various numerical methods in real life problems.

Unit-I: Numerical Methods for Solving Algebraic and Transcendental Equations: Round-off error and computer arithmetic, Local and global truncation errors, Algorithms and convergence; Bisection method, false position method, fixed point iteration method, Newton's method and secant method for solving equations. **(18 hours)**

Unit-II: Numerical Methods for Solving Linear Systems: Partial and scaled partial pivoting, LU decomposition and its applications, Thomas method for tri diagonal systems; Gauss-Jacobi, Gauss-Seidel and successive over-relaxation (SOR) methods. **(18 hours)**

Unit-III: Interpolation: Lagrange and Newton interpolations, Piecewise linear interpolation, Cubic spline interpolation, Finite difference operators, Gregory-Newton forward and backward difference interpolations. **(18 hours)**

Unit-IV: Numerical Differentiation and Integration: First order and higher order approximation for first derivative, Approximation for second derivative; Numerical integration: Trapezoidal rule, Simpson's rule and its error analysis, Bulirsch-Stoer extrapolation methods, Richardson extrapolation. **(18 hours)**

Unit-V: Initial and Boundary Value Problems of Differential Equations: Euler's method, Runge-Kutta methods, Higher order one step method, Multi-step methods; Finite difference method, Shooting method, Real life examples: Google search engine, 1D and 2D simulations, Weather forecasting. **(18 hours)**

Suggested Readings and links:

1. Link-https://ndl.iitkgp.ac.in/document/L9ZmpWxG9HiRaLDQpQJHWJnDJIf6DjYt7MaNPfFdLEJVMumy8n0VMPsA_nKw1H1zivDd4WwvET3SI9Jd_A
2. Link-https://ndl.iitkgp.ac.in/document/Whwv7-koPv15daAkpL2nv15hf5jK5RpH3bkee0q1KOAelJDYDDEhtLoC09_NOCsqvYGNm9HtckuDJ_rd0fZi0A

Essential Readings:

1. Brian Bradie (2006), A Friendly Introduction to Numerical Analysis. Pearson.
2. C. F. Gerald & P. O. Wheatley (2008). Applied Numerical Analysis (7th edition), Pearson Education, India.
3. M.K. Jain, S. R. K. Iyengar & R. K. Jain (2012). Numerical Methods for Scientific and Engineering Computation (6th edition). New Age International Publishers.
4. Robert J. Schilling & Sandra L. Harris (1999). Applied Numerical Methods for Engineers Using MATLAB and C. Thomson-Brooks/Cole.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
B.Sc.\ B.A.–V Semester

MTS EC 514	Complex Variables	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

i) Visualize complex numbers as points of □2, stereographic projection of complex plane on the Riemann sphere and various geometric properties of linear fractional transformations.
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
vii) of singularities, poles and residues and application of Cauchy Residue theorem.

Unit-I: Complex Plane: 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, Möbius transformations and their geometrical properties. **(18 hours)**

Unit-II: Analytic Functions and Cauchy-Riemann Equations: Complex functions and their limits including limit at infinity; Continuity, differentiability and analyticity; Cauchy-Riemann equations, Harmonic functions, Sufficient conditions for differentiability and analyticity, Analyticity and zeros of exponential, trigonometric and logarithmic functions; Branch cut and branch of multi-valued functions. **(18 hours)**

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. **(18 hours)**

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. **(18 hours)**

Unit-V: Singularities and Contour Integration: 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. **(18 hours)**

Suggested Readings and links:

1. Link-https://ndl.iitkgp.ac.in/document/MrqD2-IEQNkqeO2oRVl_4DbCJz6kOMUPxS70W5iLNa4Krs7LL0nSn0QogCwHrWgA
2. Link-https://ndl.iitkgp.ac.in/document/aJ7ue2f14ocncwX9XxZ1GnhKS1gJkwKVhiO0pByeCLOeFrUi9UoRiKdVs_MI-

Essential Readings:

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.
9. E. C. Titchmarsh (1976). Theory of Functions (2nd edition). Oxford University Press.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR

(A Central University)

Department of Mathematics and Statistics

B.Sc.\ B.A.–V Semester

MTS EC 515	Linear Algebra	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

i) Learn about properties of linear transformation and isomorphism theorems.
ii) Understand the concept of polynomials and their prime factorization.
iii) Find canonical form of linear transformations.
iv) Obtain various variants of diagonalization of linear transformations.
v) Apply Cauchy-Schwarz inequality for deriving metric on inner product spaces and obtain orthonormal basis using Gram-Schmidt orthogonalization.

Unit-I: Properties of Linear Transformation: Vector spaces, Linearly independent and dependent sets, Bases and dimension, Linear transformation, Linear functional, Dual spaces and second dual space, transpose of linear transformation, Algebra of linear transformations, Isomorphism theorems. **(18 hours)**

Unit-II: Polynomials: Algebras, The algebra of polynomials, Lagrange interpolation, Vandermonde matrix, Polynomial ideals, Taylor's formula, The prime factorization of a polynomial, Algebraically closed fields. **(18 hours)**

Unit-III: Elementary Canonical Forms: Determinant functions, Characteristic values of a linear transformation, Cayley-Hamilton theorem for linear transformations, Annihilating polynomials, Invariant subspaces, Minimal and characteristic polynomials. **(18 hours)**

Unit-IV: Diagonalization and Jordan Canonical Form: Diagonalizability of linear transformations, Direct sum decomposition, Invariant direct sums, The primary decomposition theorem, Triangular form, Jordan canonical form, trace and transpose. **(18 hours)**

Unit-V: Inner Product Spaces: Definition and examples of inner product space, orthogonality, Cauchy-Schwarz inequality, Gram-Schmidt orthogonalization, Diagonalization of symmetric matrices, Hermitian, Unitary and normal operators. **(18 hours)**

Suggested Readings and links:

1. Link- https://ndl.iitkgp.ac.in/document/xttk-4kfhvUwVlXBW-YWRFs97-_c1hMRSIsKTNO-Xf1NaJ3gfmD6mtMGoeNWVysG7ph7MJqCrVt2qnh-jRngcQ#1

2. Link- http://ndl.iitkgp.ac.in/document/1d-yWvs9XHC0DgImIML-8bRdarj9Y6ufvfRSXxiSQq_rC2-dw1wsc5iEpF7ZbgBWKhshR8bJyLnXE_C21nD7iA

Essential Readings:

1. Stephen H.Friedberg, Arnold J.Insel& Lawrence E. Spence (2003). Linear Algebra (4thedition). Prentice-Hall of India Pvt. Ltd.
UGC DOCUMENT ON LOCF MATHEMATICS 85
2. I. M. Gel'fand (1989). Lectures on Linear Algebra. Dover Publications.
3. Kenneth Hoffman & Ray Kunze (2015). Linear Algebra (2nd edition). Prentice-Hall.
4. Nathan Jacobson (2009). Basic Algebra I (2nd edition). Dover Publications.
5. Nathan Jacobson (2009). Basic Algebra II (2nd edition). Dover Publications.
6. Serge Lang (2005). Introduction to Linear Algebra (2nd edition). Springer India.
7. Gilbert Strang (2014). Linear Algebra and its Applications (2ndedition). Elsevier.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
B.Sc.\ B.A.–V Semester

MTS EC 516	Integral Transforms and Fourier Analysis	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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 , 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.

Unit-I: Laplace Transforms: Integral transform, Kernel of an integral transform, Reduction of integral transform into 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. **(18 hours)**

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. **(18 hours)**

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. **(18 hours)**

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. **(18 hours)**

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. **(18 hours)**

Suggested Readings and links:

1. Link-http://ndl.iitkgp.ac.in/document/kNoIubvVfIoDob717suHDJA6v3KbsR2oqQ4Hy--OLBUsVr72AssNmjtAzYGo_DEb0iptYsSRke-cyx3bkpnUrQ
2. Link- http://ndl.iitkgp.ac.in/document/1d-yWvs9XHC0DgImIML-8Q3tayeM0CSljpbx_qwgEX1N6DcfnAeB0-Jn3h0q2Un0gy5_EL5VaSo9UxMXxJ_WzA

Essential Readings:

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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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
B.Sc.\ B.A.–V Semester

MTS SE 511	**Portfolio Optimization**	L	T	P	C
		2	0	0	2
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

Course Learning Outcomes: This course will enable the students to:
(i)Understand basic principles of arbitrage and time value of money.
ii) Realize the importance of mean and variance in portfolio optimization.
iii) Study Markowitz model and its applications.

Unit – I: Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money. **(6 hours)**
Unit – II: Inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), Comparison of NPV and IRR. Bonds, bond prices and yields. **(6 hours)**
Unit – III: Floating-rate bonds, immunization, Asset return, short selling, portfolio return. **(6 hours)**
Unit – IV: Brief introduction to expectation, variance, covariance and correlation, Random returns, portfolio mean return and variance. **(6 hours)**
Unit – V: Diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints). **(6 hours)**

Suggested Readings:

1. David G. Luenberger, *Investment Science*, Oxford University Press, Delhi, 1998.

Essential Readings:

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

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B.Sc.\ B.A.–V Semester

MTS SE 512	Mathematical Modeling	L	T	P	C
		2	0	0	2
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

Course Learning Outcomes: This course will enable the students to:
(i)Understand the basic principles and applications of differential equations.
ii) Understand the use of simultaneous differential equations in Physical sciences.
iii) Study gravitational potential.

Unit – I: Applications of differential equations: the vibrations of a mass on a spring, mixture problem. **(6 hours)**
Unit – II: Free damped motion, forced motion, resonance phenomena. **(6 hours)**
Unit – III: Electric circuit problem, mechanics of simultaneous differential equations. **(6 hours)**
Unit – IV: Applications to Traffic Flow. Vibrating string, vibrating membrane. **(6 hours)**
Unit – V: Conduction of heat in solids, gravitational potential, conservation laws. **(6 hours)**

Suggested Readings:
1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.

Essential Readings:
1. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
B.Sc.\ B.A.–VI Semester

MTS SE 513	Boolean Algebra	L	T	P	C
		2	0	0	2
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

i) Appreciate the basic principles and applications of Boolean Algebra.
ii) Understand the use of lattices as algebraic structures.
iii) Study applications of switching circuits.

Unit – I:
Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, maximal and minimal elements.
(6 hours)

Unit – II:
Lattices as ordered sets, complete lattices, lattices as algebraic structures, sub lattices. Products and homomorphisms.
(6 hours)

Unit – III:
Definition, examples and properties of modular and distributive lattices, Boolean algebras.
(6 hours)

Unit – IV:
Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskey method.
(6 hours)

Unit – V:
Karnaugh diagrams, switching circuits and applications of switching circuits.
(6 hours)

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

Essential Readings:

1. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra,* 2nd Ed., Undergraduate Texts inMathematics, Springer (SIE), Indian reprint, 2004.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
B.Sc.\ B.A.–VI Semester

MTS EC 611	Discrete Mathematics	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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 circuits and 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. **(18 hours)**

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. **(18 hours)**

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. **(18 hours)**

Unit-IV: Finite-State and Turing Machines: Finite-state machines with outputs, and with no output; Deterministic and no deterministic finite-state automaton; Turing machines: Definition, examples, and computations. **(18 hours)**

Unit-V: Graphs: Definition, examples and basic properties of graphs, Königsberg bridge problem; Sub graphs, Pseudo graphs, Complete graphs, Bipartite graphs, Isomorphism of graphs, Paths and circuits, Eulerian circuits, Hamiltonian cycles, Adjacency matrix, Weighted graph, Travelling salesman problem, Shortest path, Dijkstra's algorithm. **(18 hours)**

Suggested Readings:

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.

Essential Readings:

1. Kenneth H. Rosen (2012). *Discrete Mathematics and its Applications*: *With Combinatorics and Graph Theory* (7th edition). McGraw-Hill.
2. C. L. Liu (1985). *Elements of Discrete Mathematics* (2nd edition). McGraw-Hill.
3. e-book:(i) Akerkar; Akerkar (2005), *Discrete Mathematics,* Pearson Education India is available in MHRD wi-fi.
   (ii) Gupta (2014), Discrete Mathematical Structures,Pearson India is available in MHRD wi-fi.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR

(A Central University)

Department of Mathematics and Statistics

B.Sc.\ B.A.–VI Semester

MTS EC 612	Linear Programming and Game Theory	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

i) Analyze and solve linear programming models of real life situations.
ii) Provide graphical solution of linear programming problems with two variables, and illustrate the concept of convex set and extreme points.
iii) Solve linear programming problems using simplex method.
iv) Learn techniques to solve transportation and assignment problems.
v) Solve two-person zero sum game problems.

Unit-I: Linear Programming Problem, Convexity and Basic Feasible Solutions: Formulation and examples, Canonical and Standard forms, Graphical solution, Convex and polyhedral sets, Extreme points, Basic solutions, Basic Feasible Solutions, Correspondence between basic feasible solutions and extreme points.

(18 hours)

Unit-II: Simplex Method: Optimality criterion, Improving a basic feasible solution, Unboundedness; Simplex algorithm and its tableau format; Artificial variables, Two-phase method, Big-*M* method.

(18 hours)

Unit-III: Duality: Formulation of the dual problem, Duality theorems, Unbounded and infeasible solutions in the primal, Solving the primal problem using duality theory.

(18 hours)

Unit-IV: Transportation and Assignment Problems: Formulation of transportation problems, Methods of finding initial basic feasible solutions: North-west corner rule, Least cost method, Vogel approximation method, Algorithm for obtaining optimal solution; Formulation of assignment problems, Hungarian method.

(18 hours)

Unit-V: Game Theory: Formulation of two-person zero-sum games, Games with mixed strategies, Graphical method for solving matrix game, Dominance principle, Solution of game problem, Linear programming method of solving a game.

(18 hours)

Suggested Readings:

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.

Essential Readings:

1. Hamdy A. Taha (2017). *Operations Research: An Introduction* (10th edition). Pearson.
2. 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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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
B.Sc.\ B.A.–VI Semester

MTS EC 613	Tensors and Differential Geometry	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

i) Explain the basic concepts of tensors.
ii) Understand role of tensors in differential geometry.
iii) Learn various properties of curves including Frenet-Serret formulae and their applications.
iv) Know the Interpretation of the curvature tensor, Geodesic curvature, Gauss and Weingarten formulae.
v) Understand the role of Gauss's Theorem a Egregium and its consequences.
vi) Apply problem-solving with differential geometry to diverse situations in physics, engineering and in other mathematical contexts.

Unit-I: Tensors: Contra variant and covariant vectors, Transformation formulae, Tensor product of two vector spaces, Tensor of type (r, s), Symmetric and skew-symmetric properties, Contraction of tensors, Quotient law, Inner product of vectors. **(18 hours)**

Unit-II: Further Properties of Tensors: Fundamental tensors, Associated covariant and contra variant vectors, Inclination of two vectors and orthogonal vectors, Christoffel symbols, Law of transformation of Christoffel symbols, Covariant derivatives of covariant and contra variant vectors, Covariant differentiation of tensors, Curvature tensor, Ricci tensor, Curvature tensor identities. **(18 hours)**

Unit-III: Curves in R^2 and R^3: Basic definitions and examples, Arc length, Curvature and the Frenet-Serret formulae, Fundamental existence and uniqueness theorem for curves, Non-unit speed curves. **(18 hours)**

Unit-IV: Surfaces in R^3: Basic definitions and examples, The first fundamental form, Arc length of curves on surfaces, Normal curvature, Geodesic curvature, Gauss and Weingarten formulae, Geodesics, Parallel vector fields along a curve and parallelism. **(18 hours)**

Unit-V: Geometry of Surfaces: The second fundamental form and the Weingarten map; Principal, Gauss and mean curvatures; Isometries of surfaces, Gauss's Theorem a Egregium, The fundamental theorem of surfaces, Surfaces of constant Gauss curvature, Exponential map, Gauss lemma, Geodesic coordinates, The Gauss-Bonnet formula and theorem. **(18 hours)**

Suggested Readings:

1. Christian Bär (2010). *Elementary Differential Geometry*. Cambridge University Press.
2. Manfredo P. do Carmo (2016). *Differential Geometry of Curves & Surfaces* (Revised and updated 2nd edition). Dover Publications.
3. Alferd Gray (2018). *Modern Differential Geometry of Curves and Surfaces with Mathematica* (4th edition). Chapman & Hall/CRC Press, Taylor & Francis.
4. Richard S. Millman & George D. Parkar (1977). *Elements of Differential Geometry*. Prentice-Hall.

Essential Readings:

1. R. S. Mishra (1965). *A Course in Tensors with Applications to Riemannian Geometry*. Pothishala Pvt. Ltd.
2. Sebastián Montiel & Antonio Ross (2009). *Curves and Surfaces*.American Mathematical society.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
B.Sc.\ B.A.–VI Semester

MTS EC 614	Number Theory	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

i) Some of the open problems related to prime numbers, viz., Goldbach conjecture etc.
ii) About number theoretic functions and modular arithmetic.
iii) 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, Fermat and Mersenne primes, Congruence relation and its properties, Linear congruence and Chinese remainder theorem, Fermat's little theorem, Wilson's theorem. **(18 hours)**
Unit-II: Number Theoretic Functions: Number theoretic functions for sum and number of divisors, Multiplicative function, The Mobius inversion formula, The greatest integer function. Euler's phi-function and properties, Euler's theorem. **(18 hours)**
Unit-III: Primitive Roots: The order of an integer modulo n, Primitive roots for primes, Composite numbers having primitive roots; Definition of quadratic residue of an odd prime, and Euler's criterion. **(18 hours)**
Unit-IV: Quadratic Reciprocity Law and Public Key Encryption: The Legendre symbol and its properties, Quadratic reciprocity, Quadratic congruencies with composite moduli. **(18 hours)**
Unit-V: Applications: Public key encryption, RSA encryption and decryption, Some important application. **(18 hours)**

Suggested Readings:

1. David M. Burton (2007). *Elementary Number Theory* (7th edition). McGraw-Hill.
2. Gareth A. Jones & J. Mary Jones (2005). *Elementary Number Theo*ry. Springer.

Essential Readings:

1. Neville Robbins (2007). *Beginning Number Theory* (2nd edition). Narosa.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
B.Sc.\ B.A.–VI Semester

MTS EC 615	Advanced Mechanics	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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.
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 to derive Euler's dynamical equations.
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, Nul points, nul lines and nul planes with respect to a given system of forces. **(18 hours)**
Unit-II: Motion of a Rigid Body: Definition of rigid body as a system of particles and condition of rigidity, Moments and products of inertia of standard bodies, Momental ellipsoid, Principal axes and principal moments of inertia; The momentum of a rigid body in terms of linear momentum and angular momentum about any point, Equations of motion in terms of linear and angular momenta, Motion of a rigid body with a fixed point, Existence of an angular velocity, Kinetic energy and angular momentum of a rigid body in terms of inertia constants, Euler's dynamical equations and the motion under no forces. **(18 hours)**
Unit-III: Kinematics of Fluid Motion: Lagrangian and Eulerian approaches, Acceleration of fluid at a point, Equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates, Boundary surface, Streamlines and path lines, Velocity potential, Rotational and irrotational motion, Vorticity vector and vortex lines. **(18 hours)**
Unit-IV: Kinetics of Fluid Motion: Euler's equations of motion in Cartesian, cylindrical polar and spherical polar coordinates, Bernoulli's equation, Impulsive motion. **(18 hours)**
Unit-V: Motion in Two-Dimensions: Stream function, Complex potential, Basic singularities: Sources, sinks, doublets and complex potentials due to these basic singularities; Image system of a simple source and a simple doublet with regard to a line and a circle. **(18 hours)**

Suggested Readings:

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.

Essential Readings:

1. E. A. Milne (1965). *Vectorial Mechanics*, Methuen & Co.Limited.London.
2. F. Chorlton (1969). *A Text Book of Dynamics*, D Van Nosterand Co. Ltd.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
B.Sc.\ B.A.–VI Semester

MTS EC 616	Information Theory and Coding	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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. **(18 hours)**
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. **(18 hours)**
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. **(18 hours)**
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. **(18 hours)**
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. **(18 hours)**

Suggested Readings:

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.

Essential Readings:

1. Ron M. Roth (2007). *Introduction to Coding Theory*. Cambridge University Press.
2. Claude E. Shannon & Warren Weaver (1969). *The Mathematical Theory of Communication*. The University of Illinios Press.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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B.Sc.\ B.A.–VI Semester

MTS EC 617	**Special Theory of Relativity**	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

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. **(18 hours)**

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. **(18 hours)**

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. **(18 hours)**

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. **(18 hours)**

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. **(18 hours)**

Suggested Readings:

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.

Essential Readings:

5. Wolfgang Rindler (1977). *Essential Relativity: Special, General, and Cosmological*. Springer-Verlag.
6. V. A. Ugarov (1979). *Special Theory of Relativity*. Mir Publishers, Moscow.

DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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B.Sc.\ B.A.–VI Semester

MTS EC 618	C++ Programming for Mathematics	L	T	P	C
		5	1	0	6
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

i) Understand and apply the programming concepts of C++ for solving mathematical problems.
ii) Apply to find greatest common divisors, generate random numbers, understand Cartesian Geometry and algebraic concepts through programming.
iii) Represent the outputs of programs visually in terms of well formatted text and plots.

Unit-I: Essentials of C++: Basics of programming, 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, Type compatibility, Debugging and testing; Finding greatest common divisor, Random number generation. **(18 hours)**

Unit-II: Structured Data: Structured data-types in C++, Arrays and manipulating data in arrays, Factorization of an integer, Compute Euler's totient; Objects and classes: Information hiding, Modularity, Constructors and destructors, Methods, Polymorphism; Cartesian geometry using points (2 & 3-dimensional), Pythagorean triples. **(18 hours)**

Unit-III: Containers and Templates: Containers and Template Libraries: Sets, Iterators, Multisets, Vectors, Maps, Lists, Stacks, Queues; Basic set algebra, Modulo arithmetic, Permutations, and Polynomials. **(18 hours)**

Unit-IV: Mathematical Libraries and Packages: Arbitrary precision arithmetic using the GMP package; Two-dimensional arrays in C++ with applications in finding eigen values, eigenvectors, rank, nullity, and solving system of linear equations in matrices; Features of C++ for input/output and visualization, Strings, Streams, Formatting methods, Processing files in a batch, Command-line arguments, Visualization packages and their use in plots. **(18 hours)**

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; Compiler options; Conditional compilation; Understanding and defining suitable pragmas; Identification and description of install parameters of mathematical libraries, debugging installation, working with multiple libraries simultaneously and maintaining correctness and consistency of data. **(18 hours)**

Suggested Readings:

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.

Essential Readings:

1. Edward Scheinerman (2006). *C++ for Mathematicians: An Introduction for Students and Professionals*. Chapman & Hall/CRC. Taylor & Francis.
2. B. Stroustrup (2013). *The C++ Programming Language* (4th edition). Addison-Wesley.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
B.Sc.\ B.A.–VI Semester

MTS SE 611	Mathematical Finance	L	T	P	C
		2	0	0	2
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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-arbitragepricing 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
Principal and interest: simple, compound and continuous; Net present value, Internal rates of return and their comparison. **(6 hours)**

Unit-II: Bonds and Derivatives
Spot rates, forward rates, Exchange-traded markets and over-the-counter markets; Derivatives: Forward contracts, Future contracts, Options, Types of traders. **(6 hours)**

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. **(6 hours)**

Unit-IV: Stochastic Analysis of Stock Prices
Binomial option pricing model, Risk neutral valuation: European and American options on assets following binomial tree model. **(6 hours)**

Unit-V: Black-Scholes Model and Hedging Parameters
Volatility, Extension of risk-neutral valuation to assets following geometric Brownian motion, Black-Scholes formula for European options.Hedging. **(6 hours)**

Suggested Readings:

1. John C. Hull & Sankarshan Basu (2018). *Options, Futures and Other Derivatives* (10th edition). Pearson Education.
2 Sheldon M. Ross (2011). *An Elementary Introduction to Mathematical Finance.*

Essential Readings:

1. . David G. Luenberger (2013). *Investment Science* (2nd edition). Oxford University Press.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
B.Sc.\ B.A.–VI Semester

MTS SE 612	**MATLAB**	L	T	P	C
		2	0	0	2
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

i) Analyse the data.
ii) Plot 2D and 3D graphs.
iii) Develop the MATLAB code for a particular problem.

Unit – I: Introduction to MATLAB, MATLAB environment, variables and arrays, scalar and array operations. **(6 hours)**
Unit – II: Displaying output data, introduction to plotting, 2-3 dimensional plots. **(6 hours)**
Unit – III: Arithmetic operators, relational operators, logical operators. **(6 hours)**
Unit – IV: Branching statements, if construct, if else construct, switch construct **(6 hours)**
Unit – V: While loop, for loop, nesting loops. Solution of Differential equations. **(6 hours)**

Suggested Readings:

1. Stephen J. Chapman, Matlab Programming for Engineers, 4th edition, Thomson Learning, 2007.
2. Rudra Pratap, Getting started with Matlab 7, oxford university Press, 2009.

Essential Readings:

3. Hunt, Brian R., Ronald L. Lipsman, and Jonathan M. Rosenberg. A guide to MATLAB: for beginners and experienced users. Cambridge university press, 2014.
4. Register, Andy H. A guide to MATLAB object-oriented programming. Chapman and Hall/CRC, 2007.
5. Otto, Steve, and James P. Denier. An introduction to programming and numerical methods in MATLAB. Springer Science & Business Media, 2005.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
B.Sc.\ B.A.–VI Semester

MTS SE 613	Graph Theory	L	T	P	C
		2	0	0	2
		Max. Marks : 100			

Mid Sem-20 **Internal assessment-20** **End Sem-60**

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

i) Learn the basic properties of graphs.
ii) Understand the Travelling salesman's problem.
iii) Form Floyd-Warshall algorithm and apply it in various situations.

Unit – I: Definition, examples and basic properties of graphs, pseudo graphs, complete graphs. **(6 hours)**
Unit – II: Bipartite graphs, Isomorphism of graphs, paths and circuits. **(6 hours)**
Unit – III: Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph. **(6 hours)**
Unit – IV: Travelling salesman's problem, shortest path. **(6 hours)**
Unit – V: Dijkstra's algorithm, Floyd-Warshall algorithm. **(6 hours)**

Suggested Readings:

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

Essential Readings:

1. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

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