KALASALINGAM UNIVERSITY

(KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION)

(Under Section 3 of the UGC Act 1956)

Anand Nagar, Krishnankoil – 626 126

Srivilliputtur(via), Virudhunagar(Dt.), Tamil Nadu, INDIA

M.Sc. (Mathematics) PROGRAMME CURRICULUM & SYLLABUS – 2017 UGC MODEL

DEPARTMENT OF MATHEMATICS

KALASALINGAM UNIVERSITY

First year

I Semester

Course Code	Course Name	Course Type	L	T	P	C
MSM4001	Groups and Rings	Theory	6	1	0	5
MSM4002	Real Analysis - I	Theory	6	1	0	5
MSM4003	Differential Equations	Theory	6	1	0	5
MSM4***	Elective - I	Theory	6	1	0	5
	TOTAL		**24**	**4**	**0**	**20**

L - Lecture, T – Tutorial, P – Practical, C – Credit

II Semester

Course Code	Course Name	Course Type	L	T	P	C
MSM4004	Linear Algebra	Theory	6	1	0	5
MSM4005	Real Analysis - II	Theory	6	1	0	5
MSM4006	Complex Analysis	Theory	6	1	0	5
MSM4***	Elective - II	Theory	6	1	0	5
	TOTAL		**24**	**4**	**0**	**20**

SECOND YEAR

III Semester

Course Code	Course Name	Course Type	L	T	P	C
MSM5001	Fields and Lattices	Theory	6	1	0	5
MSM5002	Topology	Theory	6	1	0	5
MSM5003	Mechanics	Theory	6	1	0	5
MSM5***	Elective - III	Theory	6	1	0	5
	TOTAL		**24**	**4**	**0**	**20**

IV Semester

Course Code	Course Name	Course Type	L	T	P	C
MSM5004	Functional Analysis	Theory	6	1	0	5
MSM5005	Numerical Analysis	Theory	6	1	0	5
MSM5006	Probability and Statistics	Theory	6	1	0	5
MSM5***	Elective - IV	Theory / Theory with Practical	6	1	0	5
	TOTAL		**24**	**4**	**0**	**20**

ELECTIVES

Electives I

Course Code	Course Name	Course Type	L	T	P	C
MSM4007	Number Theory	Theory	6	1	0	5
MSM4008	Design Theory	Theory	6	1	0	5

Elective II

Course Code	Course Name	Course Type	L	T	P	C
MSM4009	Graph Theory	Theory	6	1	0	5
MSM4010	Coding Theory	Theory	6	1	0	5

Electives III

Course Code	Course Name	Course Type	L	T	P	C
MSM5007	Combinatorial Mathematics	Theory	6	1	0	5
MSM5008	Differential Geometry	Theory	6	1	0	5

Electives IV

Course Code	Course Name	Course Type	L	T	P	C
MSM5009	Operations Research	Theory	6	1	0	5
MSM5010	Programming in C++	Theory with Practical	6	1	0	5
MSM5011	Graph Algorithms	Theory	6	1	0	5

Consolidated CGPA Credits

Semester	Credits
I – Semester	20
II – Semester	20
III – Semester	20
IV – Semester	20
Total Credits	80

M.Sc. (Mathematics) PROGRAMME

DEPARTMENT OF MATHEMATICS
KALASALINGAM UNIVERSITY

(Kalasalingam Academy of Research and Education)
Anand Nagar, Krishnankoil – 626 126.

VISION OF THE UNIVERSITY

To be a Centre of Excellence of International repute in education and research

MISSION OF THE UNIVERSITY

To produce technically competent, socially committed technocrats and administrators through quality education and research

VISION OF THE DEPARTMENT

To be a global centre of excellence in mathematics for the growth of science and technology.

MISSION OF THE DEPARTMENT

- To provide quality education and research in Mathematics through updated curriculum, effective teaching learning process.
- To inculcate innovative skills, team-work, ethical practices among students so as to meet societal expectations

PROGRAMME OUTCOMES (PO):

POs describe what students are expected to know or be able to do by the time of graduation. The Program Outcomes of PG in Mathematics are:

At the end of the programme, the students will be able to:

1. Apply knowledge of Mathematics, in all the fields of learning including higher research and its extensions.
2. Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.
3. To solve one dimensional Wave and Heat equations employing the methods in Partial Differential equations.

4. Utilize Number Theory in the field of Cryptography that helps in hiding information and maintaining secrecy in Military information transmission, computer password and electronic commerce.
5. Facilitate in the study of crystallographic groups in chemistry and Lie symmetry groups in physics.
6. Demonstrate risk assessment in Financial markets, Disease spread in Biology and Punnett squares in Ecology.
7. Identify Simulation of ground freezing and water evaporation, Heat transfer analysis due to solar radiation, Calculation of temperatures and heat flow under steady-state or transient boundary conditions.
8. Explain the knowledge of contemporary issues in the field of Mathematics and applied sciences.
9. Work effectively as an individual, and also as a member or leader in multi-linguistic and multi-disciplinary teams.
10. Adjust themselves completely to the demands of the growing field of Mathematics by life-long learning.
11. Effectively communicate about their field of expertise on their activities, with their peer and society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations
12. Crack lectureship and fellowship exams approved by UGC like CSIR – NET and SET.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO):

PEO 1: Technical Proficiency:

Victorious in getting employment in different areas, such as industries, laboratories, Banks, Insurance Companies, Educational/Research institutions, Administrative positions, since the impact of the subject concerned is very wide.

PEO 2: Professional Growth:

Keep on discovering new avenues in the chosen field and exploring areas that remain conducive for research and development.

PEO 3: Management Skills:

Encourage personality development skills like time management, crisis management, stress interviews and working as a team.

PROGRAM SPECIFIC OUTCOMES (PSO):

PSO 1: To develop problem-solving skills and apply them independently to problems in pure and applied mathematics.

PSO 2: To assimilate complex mathematical ideas and arguments.

PSO 3: To improve your own learning and performance.

PSO 4: To develop abstract mathematical thinking.

MSM4001 - GROUPS AND RINGS	L	T	P	Credit
	6	1	0	5
Pre-requisite: NIL	**Course Category:** Core **Course Type**: Theory			

Course Objective(s):

To introduce the concepts and to develop working knowledge on Groups, Normal Subgroups, Automorphism groups, Finite groups and Rings.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Identify the concept of Normal groups and Quotients groups.
CO2: Analyze Permutation groups and Counting principle.
CO3: Explain Sylow theorem and its applications.
CO4: Provide information on ideals and Quotient rings, Field of Quotient of an integral domain.
CO5: Concentrate on a particular Euclidean ring and other forms of Polynomial rings.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		S										
CO3					M							
CO4								M				
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Normal subgroups and Quotient groups **(12 Hours)**
Group theory - an introduction - Normal subgroups and Quotient groups - Homomorphisms - Automorphisms.

Unit II - Permutation groups **(12 Hours)**
Cayleys Theorem - Permutation groups - Another counting Principle.

Unit III - Sylow's Theorem and Direct Products **(12 Hours)**
Sylow's Theorem - Direct products and Finite Abelian Groups.

Unit IV - Basics of Rings **(12 Hours)**
Ring Theory - an Introduction- Ideals and Quotient Rings - More Ideals and Quotient Rings - Field of Quotients of an Integral Domain - Euclidean Rings.

Unit V - Euclidean rings and Polynomial rings **(12 Hours)**
A particular Euclidean Ring - Polynomial Rings - Polynomials Over the Rational Field – Polynomial Rings Over Commutative Rings.

Text Book : I. N. Herstein, Topics in Algebra, Second Edition, Wiley Eastern Edition, New Delhi, 1975.

Contents : Unit I: Chapter 2, Sections 2.6 to 2.8.
Unit II: Chapter 2, Sections 2.9 to 2.11
Unit III: Chapter 2, Sections 2.12 and 2.14
Unit IV: Chapter 3, Sections 3.4 to 3.7
Unit V: Chapter 3, Sections 3.8 to 3.11

References :
1) D. S. Dummit and R. M. Foote, Abstract Algebra, Wiley 2004.
2) Hall, Marshal, Theory of Groups, Macmillan, New York, 1961.
3) John B Fraleigh, A First Course in Abstract Algebra, Pearson Education India, 2003.
4) Jacobson, Nathan, Basic Algebra, Vol.1, Hindustan Publishing Corporation, 1991.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Normal subgroups and Quotient groups		
1	Group theory, an introduction	1	1
2	Normal subgroups	2	3
3	Quotient groups	3	6
4	Homomorphisms	3	9
5	Automorphisms.	3	12
	Unit II - Permutation groups		
7	Cayleys Theorem	3	15
8	Permutation groups	4	19
9	Vector integration	2	21
10	Another counting Principle.	3	24
	Unit III - Sylow's Theorem and Direct Products		
13	Sylow's Theorem	4	28
14	Direct products	4	32

15	Finite Abelian Groups	4	36
	Unit IV - Basics of Rings		
19	Ring Theory, an Introduction	3	39
20	Ideals and Quotient Rings	2	41
21	More Ideals and Quotient Rings	2	43
22	Field of Quotients of an Integral Domain	2	45
23	Euclidean Rings	3	48
	Unit V - Euclidean rings and Polynomial rings		
24	A particular Euclidean Ring	3	51
25	Polynomial Rings	3	54
26	Polynomials Over the Rational Field	3	57
27	Polynomial Rings Over Commutative Rings	3	60

MSM4002 - REAL ANALYSIS – 1	L	T	P	Credit
	6	1	0	5

Pre-requisite: NIL	**Course Category:** Core **Course Type**: Theory

Course Objective(s):

To learn the concepts of basic topological objects such as open sets, closed sets, compact sets and the concept of convergence and also to work comfortably with continuous, differentiable and Riemann integrable functions.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Attain mastery in Archimedean property, Perfect sets and Connected sets.
CO2: Locate Sequence and Series comprising convergence sequences, upper and lower limits.
CO3: Enumerate the limits of functions, infinite limits and limit at infinity.
CO4: Study in detail the Mean value theorem and Taylor's theorem.
CO5: Define properties of integration and Differentiation.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S											
CO2		M										
CO3								M				
CO4										S		
CO5											M	

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Basic Topology (12 Hours)

Real number System as a Complete Ordered Field - Archimedean Property - Supremum and Infimum - Finite, Countable and Uncountable Sets - Metric Spaces - Compact Sets - Perfect Sets and Connected Sets.

Unit II - Sequences and Series (12 Hours)

Convergent Sequences - Subsequences - Cauchy Sequenes - Upper and Lower Limits - Some Special Sequences - Series - Series of Nonnegative Terms - The Number *e* - The Root and Ratio Tests - Power Series- Summation by Parts - Absolute Convergence - Addition and Multiplication of Series - Rearrangements.

Unit III – Continuity **(12 Hours)**
Limits of Functions - Continuous Functions - Continuity and Compactness - Continuity and Connectedness - Discontinuities - Monotonic Functions - Infinite Limits and Limits at Infinity.

Unit IV – Differentiability **(12 Hours)**
The Derivative of a Real Function - Mean Value Theorems - The Continuity of Derivatives - L'Hospital'sRule - Derivatives of Higher Order - Taylor's Theorem.

Unit V - The Riemann - Stieltjes Integral **(12 Hours)**
Definition and Existence of the Riemann - Stieltjes Integral - Properties of the Integral - Integration and Differentiation.

Text Book: Walter Rudin, Principles of Mathematical Analysis, Third Edition, McGraw-Hill, 1964.

Contents: Chapters 2, 3, 4, 5 and 6 Full.

References:
1) Tom M Apostol, Mathematical Analysis, Second Edition, Narosa Publishing House, 1985.
2) Tom M Apostol, Calculus Volume 1, Wiley Student Edition, New Delhi, 2009.
3) Richard R Goldberg, Methods of Real Analysis, Blaisdell Publishing Company, 2009.
4) S. C. Malik and SavitaArora, Mathematical Analysis, Second Edition, New Age International,2009

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Basic Topology		
1.	Real number System as a Complete Ordered Field, Archimedean Property	2	2
2.	Supremum and Infimum	3	5
3.	Finite, Countable and Uncountable Sets	3	8
4.	Metric Spaces, Compact Sets	2	10
5.	Perfect Sets and Connected Sets	2	12
	Unit II - Sequences and Series		
6.	Convergent Sequences	1	13
7.	Subsequences	1	14
8.	Cauchy Sequenes	2	16

MSM4003 - DIFFERENTIAL EQUATIONS	L	T	P	Credit
	6	1	0	5
Pre-requisite: NIL	**Course Category:** Core **Course Type**: Theory			

Course Objective(s):

To study Linear Equations with Regular, Linear Equations with Variable Co-efficients, Ordinary Differential Equations in more than two variables, Partial Differential Equations of the First order, Partial Differential Equations of the second order.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Obtain solutions of the Homogenious equation with constant co-efficient and Homogenious equation with analytic co-efficient.

CO2: Comprehend the Euler equations, the Bessel equation and Regular singular points at infinity.

CO3: Study surfaces and curves in three dimension space.

CO4: Analyze the origin of first order partial differential equations and solving them using Charpit's method.

CO5: Identify the second order equations and solve them using separation of variable method.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		S										
CO3										S		
CO4											M	
CO5												M

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Linear Equations with Variable Co-efficients (12 Hours)

Initial value problems for the homogeneous equation - Solutions of the homogeneous equation – The Wronskian and linear independence - Reduction of the order of a homogeneous equation - The nonhomogeneous equation - Homogeneous equations with analytic coefficients - The Legendre equation

Unit II - Linear Equations with Regular Singular Points (12 Hours)

The Euler equation - Second order equations with regular singular points - (an example) - Second orderequations with regular singular points - (the general case) - The Bessel equation - Regular singular points at infinity

Unit III - Ordinary Differential Equations in more than two variables (12 Hours)
Surfaces and Curves in Three Dimensions - Simultaneous Differential Equations of the First Order and First Degree in Three Variables - Methods of Solution of $dx/P = dy/Q = dz/R$ - Orthogonal Trajectories of a System of Curves on a Surface - Pfaffian Differential Forms and Equations - Solution of Pfaffian Differential Equation in Three Variables.

Unit IV - Partial Differential Equations of the First order (12 Hours)
Origins of First-order Partial Differential Equations - Cauchy's Problem for First Order Equations -Linear Equations of the First Order - Cauchy's Method of Characateristics - Compatible Systems of First-order Equations - Charpit's Method - Special Types of First-order Equations.

Unit V - Partial Differential Equations of the second order (12 Hours)
The Origin of Second-order Equations - Linear Partial Differential Equations with Constant Coefficients - Equations with Variable Coefficients - Characteristic Curves of Second-order Equations – Characteristics of Equations in Three Variables - Separation of Variables.

Text Book:
1) Earl A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall of India Private Ltd., New Delhi, 1991 .
2) Ian N. Sneddon, Elements of Partial Differential Equations, Dover Publications, Inc. Mineola, New York, 2006.

Units: I, and II - Refer Book 1.
Contents: Unit I: Chapter 3, Sections 1 to 8.
Unit II: Chapter 4, Sections 1 to 9 (Except 5 and 6)
Units: III, IV and V - Refer Book 2.
Contents: Unit III: Chapter 1, Sections 1 to 6.
Unit IV: Chapter 2, Sections 1 to 4 and Sections 8 to 11.
Unit V: Chapter 3, Sections 1, 4, 5, 6, 7, and 9.

References :
1) George F Simmons, Differential equations with applications and historical notes, Tata McGrawHill, New Delhi, 1974.
2) M.D.Raisinghania, Advanced Differential Equations, S.Chand& Company Ltd. New Delhi, 2001.

LESSON PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Linear Equations with Variable Co-efficients		
1.	Initial value problems for the homogeneous equation	2	2

2.	Solutions of the homogeneous equation	1	3
3.	The Wronskian and linear independence	2	5
4.	Reduction of the order of a homogeneous equation	2	7
5.	The non-homogeneous equation	2	9
6.	Homogeneous equations with analytic coefficients	1	10
7.	The Legendre equation	2	12
	Unit II - Linear Equations with Regular Singular Points		
8.	The Euler equation	2	14
9.	Second order equations with regular singular points - (an example)	3	17
10.	Second order equations with regular singular points - (the general case)	3	20
11.	The Bessel equation	2	22
12.	Regular singular points at infinity	2	24
	Unit III - Ordinary Differential Equations in more than two variables		
13.	Surfaces and Curves in Three Dimensions	2	26
14.	Simultaneous Differential Equations of the First Order and First Degree in Three Variables	2	28
15.	Methods of Solution of $dx/P = dy/Q = dz/R$	2	30
16.	Orthogonal Trajectories of a System of Curves on a Surface	2	32
17.	Pfaffian Differential Forms and Equations	2	34
18.	Solution of Pfaffian Differential Equation in Three Variables	2	36
	Unit IV - Partial Differential Equations of the First order		
19.	Origins of First-order Partial Differential Equations	2	38
20.	Cauchy's Problem for First Order Equations	2	40
21.	Linear Equations of the First Order	1	41
22.	Cauchy's Method of Characteristics	2	43
23.	Compatible Systems of First-order Equations	2	45
24.	Charpit's Method	2	47
25.	Special Types of First-order Equations	1	48
	Unit V - Partial Differential Equations of the second order		
26.	The Origin of Second- order Equations	2	50

27.	Solving non – homogeneous second order equations	2	52
28.	Linear Partial Differential Equations with Constant Coefficients	2	54
29.	Equations with Variable Coefficients	2	56
30.	Characteristic Curves of Second-order Equations	1	57
31.	Characteristics of Equations in Three Variables	1	58
32.	Separation of Variables	2	60

MSM4001 – LINEAR ALGEBRA	L	T	P	Credit
	6	1	0	5

Pre-requisite: NIL **Course Category:** Core
Course Type: Theory

Course Objective(s):

Linear Algebra is a very important branch of Mathematics. In this course the student learns aboutVector Spaces, Inner Product Spaces, Linear Transformation on these spaces and their canonical formsand types of linear transformations.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand the concepts of Liner independence, bases and Dual spaces.
CO2: Discuss Algebra of Linear Transformations and Characteristics roots.
CO3: Study canonical forms and Nilpotent transformations.
CO4: Analyze rational canonical forms and Determinants.
CO5: Understand the Hermitian, Unitary and Normal Transformations.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S											
CO2		M										
CO3					S							
CO4								M				
CO5												M

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Vector Spaces (12 Hours)
Basic concepts - Linear Independence and Bases - Dual spaces - Inner product spaces.

Unit II - Linear Transformations (12 Hours)
Algebra of Linear Transformation - Characteristics Roots - Matrices.

Unit III - Canonical forms (12 Hours)
Canonical forms - Triangular forms - Nilpotent Transformation - Jordan forms.

Unit IV - Rational Canonical Forms (12 Hours)
Rational Canonical forms - Trace and Transpose - Determinants.

Unit V - Types of Linear Transformations **(12 Hours)**
Hermitian, Unitary and Normal Transformation - Real Quadratic forms.

Text Book :

I. N. Herstein, Topics in Algebra, Second Edition, Wiley Eastern Edition, New Delhi, 1975.

Contents : Unit I: Chapter 4: Sections 4.1 to 4.4
Unit II: Chapter 6: Sections 6.1 to 6.3
Unit III: Chapter 6: Sections 6.4 to 6.6
Unit IV: Chapter 6: Sections 6.7 to 6.9
Unit V: Chapter 6: Sections 6.10 and 6.11

References :

1) Paul R. Halmos, Finite-Dimensional Vector Spaces, 2nd ed. Princeton, N.J.:D.VanNostrand Company, 1958.
2) K. Hoffmann and R. Kunze, Linear Algebra, 2nd Edition, Pearson Education Taiwan Limited, 2011.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Vector Spaces		
1.	Basic concepts	3	3
2.	Linear Independence and Bases	3	6
3.	Dual spaces	3	9
4.	Inner product spaces	3	12
	Unit II - Linear Transformations		
5.	Algebra of Linear Transformation	4	16
6.	Characteristics Roots	4	20
7.	Matrices	4	24
	Unit III - Canonical forms		
8.	Canonical forms	3	27
9.	Triangular forms	3	30
10.	Nilpotent Transformation	3	33
11.	Jordan forms	3	36
	Unit IV - Rational Canonical Forms		
12.	Rational Canonical forms	4	40

13.	Trace and Transpose	4	44
14.	Determinants	4	48
	Unit V - Types of Linear Transformations		
15.	Hermitian Transformation	3	51
16.	Unitary Transformation	3	54
17.	Normal Transformation	3	57
18.	Real Quadratic forms	3	60

MSM4005 – REAL ANALYSIS - II	L	T	P	Credit
	3	1	0	5

Pre-requisite: NIL **Course Category:** Core
Course Type: Theory

Course Objective(s):

To introduce the concept of sequences and series of functions, Lebesgue measure and Lebesgue integration and to have a working knowledge on Multi-variable calculus.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand Uniform convergence and continuity.
CO2: Study the Stone-Weierstrass theorem and its applications.
CO3: Analyze measurable sets and Lebesgue measure.
CO4: Describe the Riemann integral and convergence of measure.
CO5: Apply the concept of Mean-value theorem for differentiable functions.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S											
CO2		M										
CO3												
CO4								S		M		
CO5											M	S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I : Sequences and Series of Functions (12 Hours)

Uniform Convergence - Uniform Convergence and Continuity - Uniform Convergence and Integration .

Unit II : Equicontinuity (12 Hours)

Uniform Convergence and Differentiation - Equicontinuous Families of Functions - The Stone-Weierstrass Theorem.

Unit III : Lebesgue Measure (12 Hours)

Introduction - Outer measure - Measurable sets and Lebesgue measure - A nonmeasurable set - Measurable functions - Littlewood's three principles.

Unit IV : The Lebesgue Integral (12 Hours)

The Riemann Integral - The Lebesgue integral of a bounded function over a set of finite measure

– The integral of a nonnegative function - The general Lebesgue integral - Convergence in measure.

Unit V : Multivariable Calculus (12 Hours)
Introduction - The directional derivative - Directional derivatives and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of a linear function – The Jacobian matrix - The chain rule - Matrix form of the chain rule - The Mean-Value Theorem for differentiable functions - A Sufficient condition for differentiability – A sufficient condition for equality of mixed partial derivatives - Taylor's formula for functions from R_n to R_1.

Text Books:
1) Walter Rudin, Principles of Mathematical Analysis, Third Edition, McGraw-Hill, 1964.
2) H. L. Royden, Real Analysis, Third Edition, Prentice-Hall Of India Pvt. Limited, 1988.
3) Tom M Apostol, Mathematical Analysis, Second Edition, Narosa Publishing House, 1985.

Contents : Unit I: Chapter 7, First four sections from 1).
Unit II: Chapter 7, Last three sections from 1)
Unit III: Chapter 3, Full from 2)
Unit IV: Chapter 4, Full from 2)
Unit V: Chapter 12, Full from 3)

References :
1) G. Debarra, Measure Theory and Integration, New Age International, 1981.
2) S. C. Malik and SavitaArora, Mathematical Analysis, Second Edition, New Age International, 2009.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I : Sequences and Series of Functions		
1	Uniform Convergence	4	4
2	Uniform Convergence and Continuity	4	8
3	Uniform Convergence and Integration	4	12
	Unit II : Equicontinuity		
7	Uniform Convergence and Differentiation	4	16
8	Equicontinuous Families of Functions	4	20
9	The Stone-Weierstrass Theorem	4	24

	Unit III : Lebesgue Measure		
13	Introduction - Outer measure	3	27
14	Measurable sets and Lebesgue measure	3	30
15	A nonmeasurable set - Measurable functions	3	33
16	Littlewood's three principles	3	36
	Unit IV : The Lebesgue Integral		
19	The Riemann Integral	3	39
20	The Lebesgue integral of a bounded function over a set of finite measure	3	42
21	The integral of a nonnegative function	2	44
22	The general Lebesgue integral	2	46
23	Convergence in measure	2	48
	Unit V : Multivariable Calculus		
24	Introduction - The directional derivative	3	51
25	Directional derivatives and continuity	1	52
26	The total derivative - The total derivative expressed in terms of partial derivatives	1	53
27	The matrix of a linear function – The Jacobian matrix	1	54
28	The chain rule - Matrix form of the chain rule	2	56
29	The Mean-Value Theorem for differentiable functions	2	58
30	A Sufficient condition for differentiability	1	59
31	A sufficient condition for equality of mixed partial derivatives - Taylor's formula for functions from R_n to R_1	1	60

MSM4006 - COMPLEX ANALYSIS	L	T	P	Credit
	6	1	0	5
Pre-requisite: NIL	**Course Category:** Core **Course Type**: Theory			

Course Objective(s):

To study Cauchy integral formula, local properties of analytic functions, general form of Cauchy's theorem and evaluation of definite integrals and harmonic functions .

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Analyze Analytic functions and exponential functions.
CO2: Apply Cauchy's theorem for disk and the Integral formula.
CO3: Understand Local properties of Analytic functions.
CO4: Study Residue theorem and the argument principle.
CO5: Differentiate the Taylor's series and Laurent series.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		S										
CO3										S		
CO4								M				
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I : Analytic Functions (12 Hours)

Complex Numbers - Spherical representation - Analytic Functions - Polynomials - Power Series – The Exponential and Trigonometric Functions -Conformality - Linear Transformations.

Unit II : Complex Integration (12 Hours)

Line Integrals - Rectifiable arcs - Cauchy's Theoerem for disk and rectangle - The Index of a point with respect to a closed curve - The Integral formula - Higher derivatives.

Unit III : Local Properties of Analytic Functions (12 Hours)

Removable Singularities - Taylor's Theorem - Zeros and poles - The local Mapping - The Maximum Principle - Chains and cycles - Simple Connectivity - Homology - The General statement of Cauchy's Theorem (Without Proof).

Unit IV : Residue Calculus **(12 Hours)**
Residue theorem - The argument principle - Evaluation of definite integrals.

Unit V : Power Series Expansions **(12 Hours)**
Weierstrass theorem - Taylor's Series - Laurent series.

Text Book:
1) Lars V. Ahlfors, Complex Analysis, (3rd edition) McGraw Hill Company, New York, 1979.

Contents : Unit I: : Chapter 1 and Chapter 2 Full
: Chapter 3 : Section 3 : 3.1, 3.2 and 3.3
Unit II : Chapter 4 : Section 1 : Full, Section 2 : Full
Unit III : Chapter 4 : Section 3 : Full, Section 4 : 4.1 to 4.4
Unit IV : Chapter 4 : Sections 5 : Full and 1.1 to 1.3
Unit V :Chapter 5 : Section1 : Full

References :
1) S. Ponnusamy and H. Silverman, Complex Variables with Applications, Birkhauser, Boston, 2006.
2) J. B. Conway, Functions of one complex variables Springer - Verlag, International student Edition,Naroser Publishing Co., 1978.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I : Analytic Functions		
1.	Complex Numbers	2	2
2.	Spherical representation	2	4
3.	Analytic Functions	2	6
4.	Polynomials	1	7
5.	Power Series	1	8
6.	The Exponential and Trigonometric Functions	2	10
7.	Conformality - Linear Transformations	2	12
	Unit II : Complex Integration		
8.	Line Integrals	2	14
9.	Rectifiable arcs	2	16
10.	Cauchy's Theoerem for disk and rectangle	2	18
11.	The Index of a point with respect to a closed curve	2	20

12.	The Integral formula	2	22
13.	Higher derivatives	2	24
	Unit III : Local Properties of Analytic Functions		
14.	Removable Singularities	2	26
15.	Taylor's Theorem	2	28
16.	Zeros and poles	2	30
17.	The local Mapping	1	31
18.	The Maximum Principle, Chains and cycles	1	32
19.	Simple Connectivity - Homology	2	34
20.	The General statement of Cauchy's Theorem (Without Proof).	2	36
	Unit IV : Residue Calculus		
21.	Residue theorem	4	40
22.	The argument principle	4	44
23.	Evaluation of definite integrals	4	48
	Unit V : Power Series Expansions		
24.	Weierstrass theorem	4	52
25.	Taylor's Series	4	56
26.	Laurent series	4	60

MSM4007 - NUMBER THEORY	L	T	P	Credit
	6	1	0	5

Pre-requisite: NIL **Course Category:** Elective
Course Type: Theory

Course Objective(s):

Number theory is one of the oldest branches of Mathematics. In this course we introduce the basic concepts of Number theory such as Divisibility, Congruences, Congruences with Prime Modulus, Quadratic reciprocity and some functions of Number Theory.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand the concepts of divisibility and Primes.
CO2: Solve congruences.
CO3: Describe power residue, multiplicative groups.
CO4: Discuss Quadratic residues and Jocobi symbol.
CO5: Study greatest integer function and recurrence functions.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		S										
CO3				M								
CO4								S				
CO5											S	

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Divisibility **(12 Hours)**
Divisibility-Primes.

Unit II - Congruences **(12 Hours)**
Congruences - Solutions of Congruences - Congruences of Degree I - The Function $\varphi(n)$- Congruences of Higher Degree - Prime Power Moduli

Unit III - Congruences with Prime Modulus **(12 Hours)**
Prime Modulus - Congruences of Degree Two, Prime Modulus - Power Residues - Number Theory from an Algebraic Viewpoint - Multiplicative Groups, Rings and Fields.

Unit IV - Quadratic Reciprocity **(12 Hours)**
Quadratic Residues - Quadratic Reciprocity - The Jacobi Symbol.

Unit V - Some Functions of Number Theory **(12 Hours)**
Greatest Integer Function - Arithmetic Functions - The Moebius Inversion Formula - The Multiplication of Arithmetic Functions - Recurrence Functions.

Text Book :I. Niven and H.S. Zuckerman, An Introduction to the Theory of Numbers, Wiley Eastern Limited, New Delhi, 1976.

Contents : Unit I: Chapter 1, Sections 1.1 to 1.3
Unit II: Chapter 2, Sections 2.1 to 2.6
Unit III: Chapter 2, Sections 2.7 to 2.11
Unit IV: Chapter 3, Sections 3.1 to 3.3
Unit V: Chapter 4, Sections 4.1 to 4.5

References :
1) Tom M. Apostol, Introduction to Analytic Number Theory, Springer Science & Business Media,1998.
2) David M. Burton, Elementary Number Theory, Tata McGraw-Hill Education, 2006.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Divisibility		
1.	Divisibility	5	5
2.	Primes	7	12
	Unit II - Congruences		
3.	Congruences	2	14
4.	Solutions of Congruences	2	16
5.	Congruences of Degree I	2	18
6.	The Function $\varphi(n)$	2	20
7.	Congruences of Higher Degree	2	22
8.	Prime Power Moduli	2	24
	Unit III - Congruences with Prime Modulus		
9.	Prime Modulus	2	26
10.	Congruences of Degree Two, Prime Modulus	2	28

11.	Power Residues	2	30
12.	Number Theory from an Algebraic Viewpoint	3	33
13.	Multiplicative Groups, Rings and Fields	3	36
	Unit IV - Quadratic Reciprocity		
14.	Quadratic Residues	4	40
15.	Quadratic Reciprocity	4	44
16.	The Jacobi Symbol	4	48
	Unit V - Some Functions of Number Theory		
17.	Greatest Integer Function	3	51
18.	Arithmetic Functions	3	54
19.	The Moebius Inversion Formula	3	57
20.	The Multiplication of Arithmetic Functions, Recurrence Functions	3	60

MSM4008 - DESIGN THEORY	L	T	P	Credit
	6	1	0	5

Pre-requisite: NIL **Course Category:** Elective
Course Type: Theory

Course Objective(s):

A Combinatorial Design is one of the fastest growing branches of Mathematics. Its finds applications in various areas including Coding Theory. In this Course we introduced the basic concepts of Balanced Designs, Difference sets, Finite Geometrices and Block designs, Hadamard matrices and Latin squares.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Identify the basic concept of Balanced Designs.
CO2: Analyze Finite algebra, Difference sets and Difference method.
CO3: Understand Finite Geometrices and Block Designs
CO4: Apply Hadamard Matrices and find its applications.
CO5: Understand the concept of Latin Squares

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		S										
CO3					M							
CO4								M				
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Basic concepts and Balanced Designs (12 Hours)

Combinatorial Designs - Some Examples of Designs - Block Designs - System of Distinct Representatives - Pairwise Balanced Designs - Balanced Incomplete Block Designs.

Unit II - Finite algebra, Difference sets and Difference method (12 Hours)

Finite Fields - Quadratic Elements - Sums of Squares - Difference sets - Properties of Difference sets - General Methods.

Unit III - Finite Geometrices and Block Designs (12 Hours)

Finite affine planes - Construction of finite affine Geometries - Finite pro jective Geometries – Residual and derived designs - Existence theorem.

Unit IV - Hadamard Matrices (12 Hours)

Hadamard Matrices and Block Designs - Kronecker Product Constructions - Williamson's Method - Regular Hadamard Matrices

Unit V - Latin Squares (12 Hours)

Latin Square and Subsquares - Orthogonality - Idempotent Latin Squares- Transversal Designs – Spouse - Avoiding Mixed - Double Tournaments - Three Orthogonal Latin Squares.

Text Book : W. D. Wallis, Combinatorial Designs, Marcel Dekker, INC, New York, 1988.

Contents :
Unit I: Chapters 1 and 2 (Full)
Unit II: Chapters 3 and 4 (Full)
Unit III: Chapters 5 and 6: Section 5.1 to 5.3, 6.1 and 6.2
Unit IV: Chapter 8 (Full)
Unit V: Chapter 10 (Full)

References :

1) M. Hall, Combinatorial Theory, Second Edition, Wiley-Interscience, New York, 1986.

2) D.R. Stinson, Combinatorial Designs: Constructions and Analysis, Springer, 2004.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Normal subgroups and Quotient groups		
1.	Combinatorial Designs - Some Examples of Designs	3	3

2.	Block Designs	3	6
3.	System of Distinct Representatives	2	8
4.	Pairwise Balanced Designs	2	10
5.	Balanced Incomplete Block Designs.	2	12
	Unit II - Finite algebra, Difference sets and Difference method		
6.	Finite Fields - Quadratic Elements	3	15
7.	Sums of Squares	3	18
8.	Difference sets - Properties of Difference sets	3	21
9.	General Methods	3	24
	Unit III - Finite Geometrices and Block Designs		
10.	Finite affine planes	3	27
11.	Construction of finite affine Geometries	3	30
12.	Finite pro jective Geometries	3	33
13.	Residual and derived designs - Existence theorem.	3	36
	Unit IV - Hadamard Matrices		
14.	Hadamard Matrices and Block Designs	3	39
15.	Kronecker Product Constructions	3	42
16.	Williamson's Method	2	44
17.	Regular Hadamard Matrices	2	46
18.	Euclidean Rings	2	48

	Unit V - Latin Squares		
19.	Latin Square and Subsquares	3	51
20.	Orthogonality - Idempotent Latin Squares	3	54
21.	Transversal Designs – Spouse - Avoiding Mixed	2	56
22.	Double Tournaments	2	58
23.	Three Orthogonal Latin Squares.	2	60

MSM4009 - GRAPH THEORY	L	T	P	Credit
	6	1	0	5

Pre-requisite: NIL	**Course Category:** Elective **Course Type**: Theory

Course Objective(s):

Graph Theory is an integral part of Discrete Mathematics and has applications in diversified areas such as Electrical Engineering, Computer science, Linguistics. In this course basic concepts of Graph theory such as Trees, Eulerian Graphs, Matching, Vertex colorings, Edge colourings, Planarity, are introduced.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand the definitions namely, cut vertex, bridge, blocks and Automorphism group of a graph.
CO2: Study the properties of trees and connectivity.
CO3: Idetify Eulerian graphs and apply results to identify Hamiltonian graphs.
CO4: Understand the concepts Planarity including Euler identity.
CO5: Discuss and understand the importantance of the concepts Matchings and Colorings.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S											
CO2		M										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I : Elementary Concepts of Graphs and Digraphs (12 Hours)

Graphs - Degree sequences - Connected graphs and Distance -Digraphs and Multigraphs - Cut vertices - Bridges - Blocks - Automorphism group of a graph.

Unit II : Trees and Connectivity (12 Hours)

Properties of Trees - Connectivity - Edge connectivity - Strong Digraphs.

Unit III : Eulerian and Hamiltonian Graphs (12 Hours)

Eulerian Graphs and Digraphs - Hamiltonian Graphs and Digraphs - Line Graphs and Powers of Graphs.

Unit IV : Planar Graphs **(12 Hours)**
The Euler Identity - Characterization of Planar Graphs.

Unit V : Matchings and Colorings **(12 Hours)**
Matchings and Independence in Graphs - Vertex Colorings.

Text Book:
1) G. Chartrand and L. Lesniak, Graphs and Digraphs, Chapman and Hall, CRC, fourth edition, 2005.

Contents : Unit I: Chapter 1 and 2, Sections 1.1 to 1.4 and 2.1 to 2.2
Unit II: Chapter 3 and 5, Sections 3.1, 3.3 and 5.1
Unit III: Chapter 4, Sections 4.1 to 4.3
Unit IV: Chapter 6, Sections 6.1 and 6.2
Unit V: Chapter 8 and 9, Sections 8.1 and 9.1

References :
1) J.A.Bondy and U.S.R. Murthy, Graph Theory and Applications, Macmillan, London, 1976.
2) S. Arumugam and S. Ramachandran, Invitation to Graph Theory, Scitech Publication Pvt Ltd, India, 2006.
3) J.Clark and D.A.Holton , A First look at Graph Theory, Allied Publishers, New Delhi, 1995.
4) R. Balakrishnan and K. Ranganathan, A Text Book of Graph Theory, Springer, Second Edition, 2012.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I : Elementary Concepts of Graphs and Digraphs		
1.	Graphs	2	2
2.	Degree sequences	2	4
3.	Connected graphs and Distance	2	6
4.	Digraphs and Multigraphs	1	1
5.	Cut vertices - Bridges	1	8
6.	Blocks	2	10
7.	Automorphism group of a graph	2	12
	Unit II : Trees and Connectivity		
8.	Properties of Trees	3	15
9.	Connectivity	3	18
10.	Edge connectivity	3	21

11.	Strong Digraphs	3	24
	Unit III : Eulerian and Hamiltonian Graphs		
12.	Eulerian Graphs and Digraphs	4	28
13.	Hamiltonian Graphs and Digraphs	4	32
14.	Line Graphs and Powers of Graphs	4	36
	Unit IV : Planar Graphs		
15.	The Euler Identity	6	42
16.	Characterization of Planar Graphs	6	48
	Unit V : Matchings and Colorings		
17.	Matchings and Independence in Graphs	6	54
18.	Vertex Colorings	6	60

MSM4010 - CODING THEORY	L	T	P	Credit
	6	1	0	5

Pre-requisite: NIL	**Course Category:** Elective **Course Type**: Theory

Course Objective(s):

Coding Theory helps to detects errors in Transmission of messages. In this course we introduce the basic concepts of Coding Theory such as, Double Error-Correcting B.C.H. code, Cyclic codes, The Group of a code, Quadratic residue codes and Bose-Chaudhuri-Hocquenghem codes.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand the concept of Maximum-Likelihood Decoding and Syndrome Decoding.
CO2: Analyze Double Error-Correcting B.C.H. code and Finite Fields Polynomials
CO3: Understand Cyclic Codes
CO4: Apply Quadratic Residue (*Q.R.*) Codes and find its applications.
CO5: Study the concept of Bose-Chaudhuri-Hocquenghem (*B.C.H.*) Codes and Weight distributions

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		S										
CO3				M								
CO4							M				L	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Introductory concepts and Background (12 Hours)

Introduction - Basic Definitions - Weight, Minimum Weight and Maximum-Likelihood Decoding - Syndrome Decoding - Perfect Codes, Hamming Codes, Sphere-Packing Bound -General Facts - Self-Dual Codes, the Golay Codes.

Unit II - Double Error-Correcting B.C.H. code and Finite Fields Polynomials **(12 Hours)**

A Finite Field of 16 Elements - The Double-Error-Correcting Bose-Chaudhuri-Hocquenhem (B.C.H.) Code Problems - Groups - The Structure of a Finite Field - Minimal Polynomials - Factoring $x^n - 1$.

Unit III - Cyclic Codes **(12 Hours)**

The Origin and Definition of Cyclic Codes - How to Find Cyclic Codes: The Generator Polynomial - The Generator Polynomial of the Dual Code - Idempotents and Minimal Ideals for Binary Cyclic Codes Problems.

Unit IV - The Group of a code and Quadratic Residue (*Q.R.*) Codes **(12 Hours)**

Some Cyclic Codes We Know - Permutation Groups - The Group of a Code - Definition of Quadratic Residue (*Q.R.*) Codes - Extended Q. R. Codes, Square Root Bound and Groups of *Q.R.* Codes - Permutation Decoding.

Unit V - Bose-Chaudhuri-Hocquenghem (*B.C.H.*) Codes and Weight distributions **(12 Hours)**

Cyclic Codes Given in Terms of Roots - Vandermonde Determinants - Definition and Properties of *B.C.H.* Codes - Preliminary Concepts and a Theorem on Weights in Homogeneous Codes - The MacWilliams Equations - Pless Power Moments - Gleason Polynomials.

Text Book: Vera Pless, Introduction to the Theory of Error-Correcting Codes, John Wiley & Sons, New York, 1982.

Contents: Unit I: Chapters 1 and 2 (Full)
Unit II: Chapters 3 and 4 (Full)
Unit III: Chapters 5 (Full)
Unit IV: Chapter 6 (Full)
Unit V: Chapter 7 and 8 (Full)

References :

1) I.F. Blake and R.C. Mullin, Introduction to Algebraic and Combinatorial Coding Theory, Academic Press, INC, New York, 1977.

2) F.J. MacWilliams and N.J.A. Sloane, The Theory of Error-Correcting Codes, Vols. I and II, North-Holland, Amsterdam, 1977.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Introductory concepts and Background		
1.	Introduction - Basic Definitions - Weight, Minimum Weight and Maximum-Likelihood Decoding	3	3
2.	Syndrome Decoding	3	6
3.	Perfect Codes, Hamming Codes, Sphere-Packing Bound	2	8
4.	General Facts	2	10
5.	Self-Dual Codes, the Golay Codes.	2	12
	Unit II - Double Error-Correcting B.C.H. code and Finite Fields Polynomials		
6.	Double Error-Correcting B.C.H. code	3	15
7.	A Finite Field of 16 Elements - The Double-Error-Correcting Bose-Chaudhuri-Hocquenhem (B.C.H.) Code Problems	3	18
8.	Groups - The Structure of a Finite Field	3	21
9.	Minimal Polynomials - Factoring $x^n - 1$	3	24
	Unit III - Cyclic Codes		
10.	The Origin and Definition of Cyclic Codes	3	27
11.	How to Find Cyclic Codes: The Generator Polynomial	3	30
12.	The Generator Polynomial of the Dual Code	3	33
13.	Idempotents and Minimal Ideals for Binary Cyclic Codes Problems.	3	36
	Unit IV - The Group of a code and Quadratic Residue (*Q.R.*) Codes		
14.	Some Cyclic Codes - Permutation Groups	3	39

15.	The Group of a Code	3	42
16.	Definition of Quadratic Residue (*Q.R.*) Codes	2	44
17.	Extended Q. R. Codes, Square Root Bound and Groups of *Q.R.* Codes	2	46
18.	Permutation Decoding.	2	48
	Unit V - Bose-Chaudhuri-Hocquenghem (*B.C.H.*) Codes and Weight distributions		
19.	Cyclic Codes Given in Terms of Roots	3	51
20.	Vandermonde Determinants - Definition and Properties of *B.C.H.* Codes	3	54
21.	Preliminary Concepts and a Theorem on Weights in Homogeneous Codes	2	56
22.	The MacWilliams Equations - Pless Power Moments	2	58
23.	Gleason Polynomials.	2	60

MSM5001 - FIELDS AND LATTICES	L	T	P	Credit
	6	1	0	5

Pre-requisite: NIL **Course Category:** Core
Course Type: Theory

Course Objective(s):
In this course we discuss about Extension Fields, Roots of Polynomials, Finite Fields and their related concepts. We introduce Galois theory, Lattices, Boolean Algebra and Modules.

Course Outcome(s):
After completing this course, the student will be able to:

CO1: Discuss Extension fields and Roots of polynomials.
CO2: Understand the elements of Galois Theory.
CO3: Know about Wedderburns theorem on finite division rings.
CO4: Study the theorem of Jordan Holder and Dedekind.
CO5: Know about partial order and Boolean Algebras.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		S										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:
Unit I - Fields **(12 Hours)**
Extension Fields - Roots of Polynomials - More about roots.

Unit II - Galois Theory **(12 Hours)**
Elements of Galois Theory - Solvability by Radicals.
Unit III - Finite Fields **(12 Hours)**
Finite fields - Wedderburns theorem on finite division rings - A theorem of Frobenius.

Unit IV - Lattices **(12 Hours)**
Partially ordered sets and Lattices - Distributivity and Modularity - The Theorem of Jordan Holder and Dedekind.

Unit V - Boolean Algebra and Modules **(12 Hours)**
Boolean Algebras - Modules.

Text Book :

1) I. N. Herstein, Topics in Algebra, Second Edition, Wiley Eastern Edition, New Delhi, 2015.
2) N.Jacobson, Basic Algebra, Vol. I, Hindustan Publishing Company, New Delhi.

Contents :

Unit I: Chapter 5: Sections 5.1, 5.3 and 5.5 (Refer Book 1))
Unit II: Chapter 5: Sections 5.6 and 5.7 (Refer Book 1))
Unit III: Chapter 7: Sections 7.1 to 7.3 (Refer Book 1))
Unit IV: Chapter 8: Sections 8.1 to 8.3 (Refer Book 2))
Unit V: Chapter 8: Sections 8.5 (Refer Book 2))
Chapter 4 : Section 4.5 (Refer Book 1)

References :

1) N.Jacobson, Basic Algebra, Vol. II, Hindustan Publishing Company, New Delhi.
2) D. S. Dummit and R. M. Foote, Abstract Algebra, Wiley 2004.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Fields		
1.	Extension Fields	4	4
2.	Roots of Polynomials	4	8
3.	More about roots	4	12
	Unit II - Galois Theory		
4.	Elements of Galois Theory	6	18
5.	Solvability by Radicals	6	24
	Unit III - Finite Fields		
6.	Finite fields	4	28
7.	Wedderburns theorem on finite division rings	4	32
8.	A theorem of Frobenius	4	36
	Unit IV - Lattices		
9.	Partially ordered sets and Lattices, Distributivity and Modularity	6	42
10.	The Theorem of Jordan Holder and Dedekind	6	48

	Unit V - Boolean Algebra and Modules		
11.	Boolean Algebras	6	54
12.	Modules	6	60

MSM5002 - TOPOLOGY	L	T	P	Credit
	6	1	0	5
Pre-requisite: NIL	**Course Category:** Core **Course Type**: Theory			

Course Objective(s):
To study topological spaces, continuous functions, connectedness, compactness, countability and separation axioms.

Course Outcome(s):
After completing this course, the student will be able to:

CO1: Understand Open bases and open sub bases, Weak topologies , the function algebras C(X, R) and C(X, C).
CO2: Discuss Tychonoff's theorem, locally compact spaces, Compactness of metric spaces and Ascoli's theorem.
CO3: Distinguish Urysohn's lemma and the Tietze extension theorem.
CO4: Discuss connected spaces, the components of a space and Totally disconnected spaces.
CO5: Study Stone-Weierstrass theorems and its applications.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		S										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I : Topological spaces **(12 Hours)**
The definition and some examples - Elementary concepts - Open bases and open subbases - Weak topologies - The function algebras $C(X,$ R) and $C(X,$ C).

Unit II : Compactness **(12 Hours)**
Compact spaces - Products of spaces - Tychonoff's theorem and locally compact spaces – Compactness for metric spaces - Ascoli's theorem.

Unit III : Separation **(12 Hours)**
$T1$ spaces and Hausdorff spaces - Completely regular spaces and Normal spaces - Urysohn's lemma and the Tietze extension theorem - The Urysohn imbedding theorem - The Stone - Cech compactification. ˇ

Unit IV : Connectedness **(12 Hours)**
Connected spaces - The components of a space - Totally disconnected spaces - Locally connected spaces.

Unit V : Approximation **(12 Hours)**
The Weierstrass approximation theorem - The Stone-Weierstrass theorems - Locally compact Hausdorffspaces - The extended Stone-Weierstrass theorems.

Text Book:
1) George F.Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Company,1963.

Contents : Chapters 3 to 7 full(One chapter for each unit)

References :
1) James R. Munkres, Topology (2nd Edition) Pearson Education Private Limited Delhi, 2002 (ThirdIndian Reprint) .
2) J. L. Kelly, General Topology, Springer, 1975.
3) L. A. Steen and J. A. Seebach, Counterexamples in Topology, Springer-Verlag , New York, 1978.
4) S.Willard, General Topology, Addison - Wesley, 1970.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I : Topological spaces		
1.	The definition and some examples	3	3
2.	Elementary concepts	2	5
3.	Open bases and open sub bases	3	8
4.	Weak topologies	1	9
5.	The function algebras $C(X, \mathrm{R})$ and $C(X, \mathrm{C})$	3	12
	Unit II : Compactness		
6.	Compact spaces	3	15
7.	Products of spaces	2	17
8.	Tychonoff's theorem and locally compact spaces	2	19
9.	Compactness for metric spaces	3	22
10.	Ascoli's theorem	2	24

	Unit III : Separation		
11.	*T*1 spaces and Hausdorff spaces	3	27
12.	Completely regular spaces and Normal spaces	3	30
13.	Urysohn's lemma and the Tietze extension theorem	3	33
14.	The Urysohn imbedding theorem	2	35
15.	The Stone - Cech compactification	1	36
	Unit IV : Connectedness		
16.	Connected spaces	3	39
17.	The components of a space	3	42
18.	Totally disconnected spaces	3	45
19.	Locally connected spaces	3	48
	Unit V : Approximation		
20.	The Weierstrass approximation theorem	3	51
21.	The Stone-Weierstrass theorems	3	54
22.	Locally compact Hausdorff spaces	4	58
23.	The extended Stone-Weierstrass theorems	2	60

MSM5003 - MECHANICS	L	T	P	Credit
	6	1	0	5

Pre-requisite: NIL	**Course Category:** Core **Course Type**: Theory

Course Objective(s):

To study mechanical systems under generalized coordinate systems, virtual work, energy and momentum, to study mechanics developed by Newton, Langrange, Hamilton and Jacobi.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand D' Alembert's Principle and simple applications of the Lagrangian Formulation.
CO2: Analyze the Derivation of Lagrange's Equations from Hamilton's Principle and Extension of Hamilton's Principle to Non-holonomic Systems.
CO3: Study the concept of the Equations of Motion and the Equivalent One-Dimensional Problems.
CO4: Understand the Kepler Problem and Inverse-Square Law of Force.
CO5: Distinguish the concept of the Hamilton Equations of Motion and the Principle of Least Action.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		S										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Survey of the Elementary Principles (12 Hours)

Mechanics of a Particle - Mechanics of a System of Particles - Constraints - D' Alembert's Principle and Lagrange's Equations - Velocity-Dependent Potentials and the Dissipation Function - Simple Applications of the Lagrangian Formulation.

Unit II - Variational Principles and Lagrange's Equations **(12 Hours)**
Hamilton's Principle - Some Techniques of the Calculus of Variations - Derivation of Lagrange's Equations from Hamilton's Pnnciple - Extension of Hamilton's Principle to Nonholonomic Systems .

Unit III - The Central Force Problem **(12 Hours)**
Reduction to the Equivalent One-Body Problem - The Equations of Motion and First Integrals – The Equivalent One-Dimensional Problem, and Classification of Orbits - The Virial Theorem - The Differential Equation for the Orbit, and Integrable Power-Law Potentials - Conditions for Closed Orbits (Bertrand's Theorem) .

Unit IV - The Kepler Problem **(12 Hours)**
The Kepler Problem: Inverse-Square Law of Force - The Motion in Time in the Kepler Problem – The Laplace-Runge-Lenz Vector

Unit V - The Hamilton Equations of Motion **(12 Hours)**
Legendre Transformations and the Hamilton Equations of Motion - Cyclic Coordinates and Conservation Theorems - Derivation of Hamilton's Equations from a Variational Principle - The Principle of Least Action.

Text Book : H. Goldstein, C. Poole and J. Safko, Classical Mechanics, Third Edition, Addison-Wesley,2001.

Contents : Unit I: Chapter 1: Full
Unit II: Chapter 2: Sections 2.1 to 2.4
Unit III: Chapter 3: Sections 3.1 to 3.6
Unit IV: Chapter 3: Sections 3.7 to 3.9
Unit V: Chapter 8: Sections 8.1, 8.2, 8.5 and 8.6

References :
1) F. Chorlton, Textbook of Dynamics, second edition, Ellis Horwood Series: Mathematics and itsApplications, Halsted Press (John Wiley & Sons, Inc.), New York, 1983.
2) D. T. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.
3) John A. Synge and Byron A. Griffith, Principles of Mechanics, McGraw-Hill Book Company, INC,Second Edition, Newyork, 1949.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Survey of the Elementary Principles		
1.	Mechanics of a Particle	3	3

2.	Mechanics of a System of Particles	2	5
3.	Constraints - D' Alembert's Principle and Lagrange's Equations	3	8
4.	Velocity-Dependent Potentials and the Dissipation Function	2	10
5.	Simple Applications of the Lagrangian Formulation	2	12
	Unit II - Variational Principles and Lagrange's Equations		
6.	Hamilton's Principle	3	15
7.	Some Techniques of the Calculus of Variations	3	18
8.	Derivation of Lagrange's Equations from Hamilton's Pnnciple	3	21
9.	Extension of Hamilton's Principle to Nonholonomic Systems .	3	24
	Unit III - The Central Force Problem		
10.	Reduction to the Equivalent One-Body Problem	1	25
11.	The Equations of Motion and First Integrals	1	26
12.	The Equivalent One-Dimensional Problem, and Classification of Orbits	3	29
13.	The Virial Theorem	1	30
14.	The Differential Equation for the Orbit, and Integrable Power-Law Potentials	3	33
15.	Conditions for Closed Orbits (Bertrand's Theorem)	3	36
	Unit IV - The Kepler Problem		
16.	The Kepler Problem: Inverse-Square Law of Force	6	42
17.	The Motion in Time in the Kepler Problem	4	46
18.	The Laplace-Runge-Lenz Vector	2	48
	Unit V - The Hamilton Equations of Motion		
19.	Legendre Transformations and the Hamilton Equations of Motion	3	51
20.	Cyclic Coordinates and Conservation Theorems	3	54
21.	Derivation of Hamilton's Equations from a Variational Principle	4	58
22.	The Principle of Least Action	2	60

MSM5004 - FUNCTIONAL ANALYSIS	L	T	P	Credit
	6	1	0	5
Pre-requisite: NIL	**Course Category:** Core **Course Type:** Theory			

Course Objective(s):
To study Normed linear spaces, Banach spaces, Hilbert Spaces, and operators on these spaces.

Course Outcome(s):
After completing this course, the student will be able to:

CO1: Study Continuous linear transformations and the Hahn-Banach theorem.
CO2: Understand the Open Mapping Theorem and its applications.
CO3: Obtain Orthogonal complements, Orthonormal sets and conjugate space.
CO4: Understand the relevance of Operator Theory.
CO5: Discuss Determinants and the spectrum of an operator.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		S										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Banach Spaces **(12 Hours)**
The definition and some examples - Continuous linear transformations - The Hahn-Banach theorem

Unit II - The Open Mapping Theorem **(12 Hours)**
The natural imbedding of N in N^{**}- The open mapping theorem - The conjugate of an operator.

Unit III - Hilbert Spaces **(12 Hours)**
The definition and some simple properties - Orthogonal complements - Orthonormal sets - The conjugate space H*.

Unit IV - Operator Theory **(12 Hours)**
The adjoint of an operator - Self-adjoint operators - Normal and unitary operators - Projections.

Unit V - Finite - Dimensional Spectral Theory (12 Hours)
Matrices - Determinants and the spectrum of an operator - The spectral theorem - A survey of the situation.

Text Book :
1) George F.Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 1963.

Contents: Chapters 9, 10 and 11 Full.

References :
1) B. V.Limaye, Functional Analysis, New Age International, 1996.
2) G. Bachman and L. Narici, Functional Analysis, Dover Publications, 2000.
3) A. E. Taylor and D. C. Lay, Introduction to Functional Analysis, John Wiley and Sons, 1980.
4) Walter Rudin, Functional Analysis, Tata McGraw-Hill Education, 2006.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Banach Spaces		
1.	The definition and some examples	4	4
2.	Continuous linear transformations	4	8
3.	The Hahn-Banach theorem	4	12
	Unit II - The Open Mapping Theorem		
4.	The natural imbedding of N in N^{**}	4	16
5.	The open mapping theorem	4	20
6.	The conjugate of an operator	4	24
	Unit III - Hilbert Spaces		
7.	The definition and some simple properties	3	27
8.	Orthogonal complements	3	30
9.	Orthonormal sets	3	33
10.	The conjugate space H*.	3	36
	Unit IV - Operator Theory		
11.	The adjoint of an operator	4	40
12.	Self-adjoint operators	4	44
13.	Normal and unitary operators – Projections	4	48

	Unit V - Finite - Dimensional Spectral Theory		
14.	Matrices	3	51
15.	Determinants and the spectrum of an operator	3	54
16.	The spectral theorem	3	57
17.	A survey of the situation	3	60

MSM5005 - NUMERICAL ANALYSIS	L	T	P	Credit
	6	1	0	5

Pre-requisite: NIL

Course Category: Core
Course Type: Theory

Course Objective(s):

Numerical Analysis deals with numerical solutions of certain problems of Mathematics. In this course we study iterative methods to solve nonlinear equations in one variable, methods to solve system of equations, interpolation problems and Numerical solutions of differential equations.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Obtain the solutions of Transcedental and Polynomial Equations.
CO2: Solve by Direct methods and Iteration methods for solving system of equations.
CO3: Apply Hermite Interpolation, Piecewise and Spline interpolation.
CO4: Solve problems using interpolation.
CO5: Solve Ordinary Differential Equations using Numerical methods.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		S										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Transcedental and Polynomial Equations (12 Hours)

Bisection method - Iteration method based on first and second degree equations - Rate of convergence - General Iteration method - Methods of complex root.

Unit II - Eigen Value Problems (12 Hours)

Direct methods - Iteration methods - Eigen Values and Eigen Vectors.

Unit III - Interpolation (12 Hours)

Finite Difference operators - Interpolating Polynomials using finite differences - Hermite Interpolation - Piecewise and Spline interpolation.

Unit IV - Numerical Integrations **(12 Hours)**
Numerical Integration - Method based on interpolation - Method based on undetermined coefficient - Composite integration methods - Romberg's integration - Double integration.

Unit V - Numerical Methods for Solving Ordinary Differential Equations (12 Hours)
Numerical method- Single step method - Multistep method - Predictor - Corrector method.

Text Books:
1) M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, 4th Edition, New Delhi, 2003.

Contents : Unit I: Chapter 2: Sections 2.1 to 2.8
Unit II: Chapter 3: Sections 3.1 to 3.5 (Except 3.3)
Unit III: Chapter 4: Sections 4.1 to 4.6
Unit IV: Chapter 5: Sections 5.6 to 5.11
Unit V: Chapter 6: Sections 6.1 to 6.7

References :
1) R.L. Burden, D.J. Faires and A.M. Burden, Numerical Analysis, Cenage Learning Publishers, 10th Edition, USA, 2004.
2) E. Isaacson and H.B. Kellar, Analysis of Numerical Methods, John Wiley & Sons, 1966.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Transcedental and Polynomial Equations		
1.	Bisection method	3	3
2.	Iteration method based on first and second degree equations	2	5
3.	Rate of convergence	3	8
4.	General Iteration method	2	10
5.	Methods of complex root	2	12
	Unit II - Eigen Value Problems		
6.	Direct methods	3	15
7.	Iteration methods	3	18
8.	Eigen Values	3	21
9.	Eigen Vectors	3	24

	Unit III - Interpolation		
10.	Finite Difference operators	3	27
11.	Interpolating Polynomials using finite differences	3	30
12.	Hermite Interpolation	3	33
13.	Piecewise and Spline interpolation	3	36
	Unit IV - Numerical Integrations		
14.	Numerical Integration	2	38
15.	Method based on interpolation	2	40
16.	Method based on undetermined coefficient	2	42
17.	Composite integration methods	2	44
18.	Romberg's integration	2	46
19.	Double integration	2	48
	Unit V - Numerical Methods for Solving Ordinary Differential Equations		
20.	Numerical method	3	51
21.	Single step method	3	54
22.	Multistep method - Predictor	3	57
23.	Corrector method	3	60

MSM5006 - PROBABILITY AND STATISTICS	L	T	P	Credit
	6	1	0	5
Pre-requisite: NIL	**Course Category:** Core **Course Type**: Theory			

Course Objective(s):

To study probability density function, Mathematical Expectation, Marginal and Conditional distributions, Some Special Distributions and The Central Limit Theorem.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand Some special mathematical expectations and Chebyshev's inequality.
CO2: Study Marginal and conditional distributions, the correlation co-efficient and Stochastic independence.
CO3: Apply the Trinomial and Multinomial Distributions, The Poisson Distribution and The Gamma and Chi-square distributions to solve problems.
CO4: Study the t & F distributions and their applications.
CO5: Understand MGF Technique and the Central Limit Theorem.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		S										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - PDF and Some special mathematical expectations (12 Hours)

Random variables - The probability density functions - The distribution function - Certain probably models - Mathematical expectation - Some special mathematical expectation - Chebyshev's inequality.

Unit II - Marginal and conditional distributions (12 Hours)

Conditional probability - Marginal and conditional distribution - The correlation and co-efficient - Stochastic independence.

Unit III - Distributions **(12 Hours)**
The Binomial, The Trinomial and Multinomial Distributions - The Poisson Distribution - The Gamma and Chi-square distribution - The Normal distribution.

Unit IV - The t & F distributions **(12 Hours)**
Sampling theory transformations of variables of the discrete type - Transfermations of variables of continuous type - The t & F distributions - Distribution of order statistics.

Unit V - MGF Technique and the Central Limit Theorem **(12 Hours)**
The moment generating functions technique - The distribution of X and $ns2\ \sigma2$ - Limitting distribution - Stochastic convergence - Limiting moment generating function - The central limit theorem.

Text Book :
R.V. Hogg and A.T. Craig, Introduction to Mathematical Statistics, Macmillan, 1978.

Contents : Unit I: Chapter 1: Sections 1.5 to 1.11
Unit II: Chapter 2: Sections 2.1 to 2.4
Unit III: Chapter 3: Sections 3.1 to 3.4
Unit IV: Chapter 4: Sections 4.1 to 4.4 and 4.6 to 4.8
Unit V: Chapter 5: Sections 5.1 to 5.4

References :
1) R. Bhattacharya and E. C. Waymire , A Basic Course in Probability Theory, Springer 2007
2) W. Feller, An Introduction to Probability Theory and Its Applications, Vol. 1 Third Edition, Vol. 2, Second Edition, Wiley 1968 and 1972, Newyork.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - PDF and Some special mathematical expectations		
1.	Random variables	3	3
2.	The probability density functions	2	5
3.	The distribution function, Certain probably models	3	8
4.	Mathematical expectation - Some special mathematical expectation	2	10
5.	Chebyshev's inequality	2	12
	Unit II - Marginal and conditional distributions		
6.	Conditional probability	3	15

7.	Marginal and conditional distribution	3	18
8.	The correlation and co-efficient	3	21
9.	Stochastic independence	3	24
	Unit III - Distributions		
10.	The Binomial Distributions	2	26
11.	The Trinomial Distributions	2	28
12.	Multinomial Distribution	2	30
13.	The Poisson Distribution	2	32
14.	The Gamma and Chi-square distribution	2	34
15.	The Normal distribution	2	36
	Unit IV - The t & F distributions		
16.	Sampling theory transformations of variables of the discrete type	5	41
17.	Transfermations of variables of continuous type	4	45
18.	The t & F distributions and Distribution of order statistics	3	48
	Unit V - MGF Technique and the Central Limit Theorem		
19.	The moment generating functions technique	3	51
20.	The distribution of X and $ns2\sigma2$	3	54
21.	Limiting distribution - Stochastic convergence	3	57
22.	Limiting moment generating function - The central limit theorem	3	60

MSM5007 - COMBINATORIAL MATHEMATICS	L	T	P	Credit
	6	1	0	5
Pre-requisite: NIL	**Course Category:** Elective **Course Type**: Theory			

Course Objective(s):

Combinatorics deals with the existence of certain configurations in a structure and when it exists it counts the number of such configurations. In this course we deal with the basic concepts such as Permutations and Combinations, Generating Functions, Recurrence Relations, The Principle of Inclusion and Exclusion including Polya's theory.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand the rules of Sum and Product of Permuations and Combinations.
CO2: Discuss distributions of Distinct Objects into Non-distinct Cells and Partitions of Integers.
CO3: Identify Solutions by the technique of Generating Functions and Recurrence Relations with Two Indices.
CO4: Understand the concepts of Permutations with Restrictions on Relative Positions and the Rook Polynomials.
CO5: Enumerate configuration using Polya's Theory.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		S										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Permutations and Combinations (12 Hours)

Introduction - The rules of Sum and Product - Permuations - Combinations - Distributions of DistinctObjects - Distributions of Nondistinct Objects.

Unit II - Generating Functions (12 Hours)

Introduction - Generating Functions for Combinations - Enumerators for Permutations – Distributionsof Distinct Objects into Nondistinct Cells - Partitions of Integers - Elementary Relations.

Unit III - Recurrence Relations **(12 Hours)**
Introduction - Linear Recurrence relations with Constant Coefficients - Solution by the technique ofGenerating Functions - Recurrence Relations with Two Indices.

Unit IV - The Principle of Inclusion and Exclusion **(12 Hours)**
Introduction - The Principle of Inclusion and Exclusion - The General Formula - Derangements - Permutations with Restrictions on Relative Positions - The Rook Polynomials.

Unit V - Polya's Theory of Counting **(12 Hours)**
Introduction - Equivalence Classes under a Permutation Group - Equivalence Classes of Functions -Weights and Inventories of Functions - Polya's Fundamental Theorem - Generalization of Polya's Theorem.

Text Book :C. L. Liu, Introduction to Combinatorial Mathematics, McGraw-Hill Inc., Newyork,1968.

Contents : Unit I: Chapter 1: Sections 1.1 to 1.6
Unit II: Chapter 2: Sections 2.1 to 2.5 and 2.7
Unit III: Chapter 3: Sections 3.1 to 3.5 (Except 3.4)
Unit IV: Chapter 4: Sections 4.1 to 4.6
Unit V: Chapter 5: Sections 5.1 to 5.7 (Except 5.2)

References :
1) J. H. Van Lint and R. M. Wilson, A Course in Combinatorics, Cambridge University Press, 2001.
2) TituAndreescu and ZumingFeng, A Path to Combinatorics, Springer Science & Business Media, 2004.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Permutations and Combinations		
1.	Introduction - The rules of Sum and Product	3	3
2.	Permuations	3	6
3.	Combinations	2	8
4.	Distributions of Distinct Objects	2	10
5.	Distributions of Nondistinct Objects	2	12
	Unit II - Generating Functions		
6.	Introduction - Generating Functions for Combinations	3	15

7.	Enumerators for Permutations	3	18
8.	Distributions of Distinct Objects into Nondistinct Cells	3	21
9.	Partitions of Integers - Elementary Relations	3	24
	Unit III - Recurrence Relations		
10.	Introduction - Linear Recurrence relations with Constant Coefficients	4	28
11.	Solution by the technique of Generating Functions	4	32
12.	Recurrence Relations with Two Indices	4	36
	Unit IV - The Principle of Inclusion and Exclusion		
13.	Introduction - The Principle of Inclusion and Exclusion	3	39
14.	The General Formula	3	42
15.	Derangements	2	44
16.	Permutations with Restrictions on Relative Positions	2	46
17.	The Rook Polynomials	2	48
	Unit V - Polya's Theory of Counting		
18.	Introduction - Equivalence Classes under a Permutation Group	3	51
19.	Equivalence Classes of Functions	3	54
20.	Weights and Inventories of Functions	2	56
21.	Polya's Fundamental Theorem	2	58
22.	Generalization of Polya's Theorem	2	60

MSM5008 - DIFFERENTIAL GEOMETRY	L	T	P	Credit
	6	1	0	5
Pre-requisite: NIL	**Course Category:** Elective **Course Type**: Theory			

Course Objective(s):
In this course the student will learn about tangent spaces, Surfaces, Gauss map, Geodesics on surfaces and curvature of plane curves.

Course Outcome(s):
After completing this course, the student will be able to:

CO6: Understand the concept of Graphs and Level sets-Vector fields.
CO7: Analyze Surfaces and Vector field on surfaces
CO8: Understand Gauss map-Geodesics.
CO9: Apply Parallel Transport and Weingarten map.
CO10: Study the concept of Curvature of plane curves and surface

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO6	M											
CO7		S										
CO8				M								
CO9							M				L	
CO10												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Graphs and Level sets **(12 Hours)**
Graphs and Level sets-Vector fields-Tangent space.

Unit II – Surfaces **(12 Hours)**
Surfaces-Vector field on surfaces.

Unit III - Gauss map **(12 Hours)**
Gauss map - Geodesics.

Unit IV - Parallel Transport **(12 Hours)**
Parallel Transport - Weingarten map.

Unit V – Curvature **(12 Hours)**
Curvature of plane curves - Curvature of surface - Arc length and Line Integrals.

Text Book: J. A. Thorpe, Elementary topics in Differential Geometry, Springer 1994.

Contents: Chapters 1 to 12.

References:

1) T. J. Wilmore, An introduction to Differential Geometry, Courier Corporation 2012.

2) D. Somasudaram, Differential Geometry, Alpha Science International Limited, 2005.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Graphs and Level sets		
1.	Graphs and Level sets	4	4
2.	Vector fields	4	8
3.	Tangent space	4	12
	Unit II - Surfaces		
4.	Surfaces	6	18
5.	Vector field on surfaces	6	24
	Unit III - Gauss map		
6.	Gauss map	6	30
7.	Geodesics	6	36

	Unit IV - Parallel Transport		
8.	Parallel Transport	6	42
9.	Weingarten map.	6	48
	Unit V - Curvature		
10.	Curvature of plane curves	3	51
11.	Curvature of surface	3	54
12.	Arc length	3	57
13.	Line Integrals	3	60

MSM5009 - OPERATIONS RESEARCH	L	T	P	Credit
	6	1	0	5
Pre-requisite: NIL	**Course Category:** Elective **Course Type**: Theory			

Course Objective(s):
In this course basic concepts of Operations Research such as Linear Programming Problem, Duality in Linear Programming, Transportation Problem, Assignment Problem and Queueing Theory are introduced.

Course Outcome(s):
After completing this course, the student will be able to:

CO11: Understand the concept of Graphs and Level sets-Vector fields.
CO12: Analyze Graphical Method, Use of Artificial variables and Inverting a Matrix using Simplex method.
CO13: Apply Duality to solve problems in Linear Programming.
CO14: Understand Test the optimality for Degeneracy by using Transportation Algorithms (MODI method).
CO15: Study Assignment Problem and its applications.
CO16: Study Queueing Theory and its applications.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO11	M											
CO12		S										
CO13								S				
CO14											M	
CO15												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Linear Programming Problem (12 Hours)
Mathematical Formulation of the Problem - Graphical Method - Fundamental properties of solutions - The Computational procedure - Use of Artificial variables - Solutions of simultaneous Linear Equations - Inverting a Matrix using Simplex method.

Unit II - Duality in Linear Programming (12 Hours)
General primal - Dual pair - Formulating a Dual Problem - Primal and Dual pair in Matrix form - Duality Theorems - Complementary Slackness Theorems - Duality and Simplex method.

Unit III - Networks **(12 Hours)**
General Transportation problem - The Transportation table - Duality in Transportation problem – Loopsin Transportation table - LP formulation of the Transportation problem - Solutions of a Transportationproblem - Finding an Initial Basic Feasible Solutions - Test for optimality - Degeneracy in Transportationproblem - Transportation Algorithms (MODI method).

Unit IV - Assignment Problem **(12 Hours)**
Mathematical formulation of the problem - The Assignment method - Special cases in Assignment Problem - A typical Assignment problem - The Traveling Salesman Problem.

Unit V - Queueing Theory **(12 Hours)**
Queueing system - Elements of Queueing system - Operating Characteristics of Queueing systems - Probability Distributions of Queueing systems - Classification of Queueing models - Definition of Transientand steady states - Poisson Queueing system - Non-Poisson Queueing system.

Text Books:
1) KantiSwarup, P.K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, 9thEdition, New Delhi, 2001.

Contents : Unit I: Chapter 2, 3 & 4: Sections 2.2, 3.2 4.1 to 4.6
Unit II: Chapter 5: Sections 5.1 to 5.7
Unit III: Chapter 10: Sections 10.1 to 10.11
Unit IV: Chapter 11: Sections 11.1 to 11.6
Unit V: Chapter 20: Sections 20.1 to 20.9

References :
1) Hamdy A. Taha: Operations Research, Fourth Edition, 1971.
2) J. K. Sharma, Operations Research, Theory and Applications, Third Edition (2007) MacmillanIndia Ltd.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Linear Programming Problem		
23.	Mathematical Formulation of the Problem	3	3
24.	Graphical Method - Fundamental properties of solutions	2	5
25.	The Computational procedure - Use of Artificial variables	2	7
26.	Solutions of simultaneous Linear Equations	3	10
27.	Inverting a Matrix using Simplex method	2	12

	Unit II - Duality in Linear Programming		
28.	General primal - Dual pair - Formulating a Dual Problem	3	15
29.	Primal and Dual pair in Matrix form - Duality Theorems	3	18
30.	Complementary Slackness Theorems	3	21
31.	Duality and Simplex method	3	24
	Unit III - Networks		
32.	General Transportation problem - The Transportation table	2	26
33.	Duality in Transportation problem – Loops in Transportation table	2	28
34.	LP formulation of the Transportation problem - Solutions of a Transportation problem	2	30
35.	Finding an Initial Basic Feasible Solutions - Test for optimality	2	32
36.	Degeneracy in Transportation problem	2	34
37.	Transportation Algorithms (MODI method)	2	36
	Unit IV - Assignment Problem		
38.	Mathematical formulation of the problem	4	40
39.	The Assignment method - Special cases in Assignment Problem, A typical Assignment problem	5	45
40.	The Traveling Salesman Problem	3	48
	Unit V - Queueing Theory		
41.	Queueing system - Elements of Queueing system	3	51
42.	Operating Characteristics of Queueing systems - Probability Distributions of Queueing systems	3	54
43.	Classification of Queueing models - Definition of Transient and steady states	3	57
44.	Poisson Queueing system - Non-Poisson Queueing system.	3	60

MSM5010- Programming in C++	L	T	P	Credit
	6	1	0	5

Pre-requisite: NIL	**Course Category:** Elective **Course Type:** Theory with Practical

Course Objective(s):

In this course we will study the basics of the programming language C++ such as tokens, expressions, Classes and Objects, Constructors and Destructors, Inheritance, Polymorphism and Files.

Course Outcome(s):

After completing this course, the student will be able to:

CO17: Identify the basic concept of Tokens, Expressions and Control structures-Functions in C++

CO18: Analyze Classes and Objects..

CO19: Understand Constructors and Destructors

CO20: Apply the concept of Extending classes-Pointers, Virtual Functions and Polymorphism.

CO21: Study practical course.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO16	M											
CO17		S										
CO18					M							
CO19								M				
CO20												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - **Tokens** **(12 Hours)**

Tokens, Expressions and Control structures-Functions in C++

Unit II - **Classes and Objects** **(12 Hours)**

Classes and Objects.

Unit III - **Constructors and Destructors** **(12 Hours)**

Constructors and Destructors - Operator overloading and type conversions.

Unit IV - **Inheritance** **(12 Hours)**
Inheritance: Extending classes-Pointers, Virtual Functions and Polymorphism.

Unit V - **Practical** **(12 Hours)**
Working with Files.

Text Book : E. Balagurusamy, Objected Oriented Programming with C++, Third Edition, Tata McGraw-Hill Education, 2008

Contents : Chapters 3 to 9 and 11.

References :

1) Steve Oualline, Practical C++ Programming, O'Reilly Media, 2003.

2) Chuck Easttom, C++ Programming Fundamentals, Charles River Media, 2003.

COURSE PLAN:

S. No.	**Topic**	**No. of periods**	**Cum. Hours**
1.	**Unit I - Tokens**		
2.	Tokens	3	3
3.	Expressions	3	6
4.	Control structures	3	9
5.	Functions in C++	3	12
	Unit II – Classes and Objects		
6.	Classes	6	18
7.	Objects	6	24
	Unit III - Constructors and Destructors		
8.	Constructors	3	27
9.	Destructors	3	30
10.	Operator overloading	3	33

11.	Type conversions	3	36
	Unit IV - Inheritance		
12.	Inheritance	3	39
13.	Extending classes-Pointers	3	42
14.	Virtual Functions	3	45
15.	Polymorphism	3	48
	Unit V – Practical		
16.	Working with Files	12	60

MSM5011- GRAPH ALGORITHMS	L	T	P	Credit
	6	1	0	5
Pre-requisite: NIL	**Course Category:** Elective **Course Type:** Theory			

Course Objective(s):

Graph Algorithms are use to solve real world problems. In this course we train the students to find Shortest Paths, Minimum weight Spanning Trees, Matching's, Planarity and Maximum Flows in Net- works.

Course Outcome(s):

After completing this course, the student will be able to:

CO22: Identify the basic concept of Trees and Branchings
CO23: Analyze Matchings and Depth-First Search
CO24: Understand the concept of Strong connectivity and Planarity
CO25: Apply Flows in Networks and find its applications.
CO26: Understand the concept of Connectivity - An Algorithimic Approach

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO21	M											
CO22		S										
CO23					M							
CO24								M				
CO25												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Trees and Branchings (12 Hours)

Transitive closure, Shortest paths, Minimum weight spanning tree, Optimum branchings.

Unit II - Matchings and Depth-First Search (12 Hours)

Perfect matching, Optimal assignment, and Timetable scheduling, The Chinese Postman problem, Depth- First search.

Unit III - Strong connectivity and Planarity (12 Hours)

Biconnectivity - Strong Connectivity - st-Numbering of a Graph - Planarity testing.

Unit IV - Flows in Networks (12 Hours)

The Maximum Flow problem, Maximum Flow Minimum Cut theorem, Ford-Fulkerson labeling algorithm, Edmonds and Karp Modification of the labeling algorithm.

Unit V - Connectivity - An Algorithimic Approach (12 Hours)

Dinic Maximum Flow algorithm, Maximum Flow in 0-1 networks Maximum matching in Bipartite Graphs, Menger's Theorem and Connectivity.

Text Book : K. Thulasiraman and M.N.S. Swamy, Graphs: Theory and Algorithms, John Wiley & Sons, Canada, 1992.

Contents: Unit I: Chapter 11: Sections 11.1 to 11.4
Unit II: Chapter 11: Sections 11.5 to 11.7
Unit III: Chapter 11: Sections 11.8, 11.10, 11.11
Unit IV: Chapter 12: Sections 12.1 to 12.4
Unit V: Chapter 12: Sections 12.5, 12.8, 12.9 and 12.10

References :

1) A. Gibbons, Algorithmic Graph Theory, Cambridge University Press, London, 1985.

2) D. Jungnickel, Graphs, Networks and Algorithms, Springer, 2013.

COURSE PLAN:

S. No.	Topic	No. of periods	Cum. Hours
	Unit I - Trees and Branchings		
17.	Trees and Branchings	3	3
18.	Transitive closure	3	6
19.	Shortest paths	2	8
20.	Minimum weight spanning tree	2	10
21.	Optimum branchings	2	12
	Unit II - Matchings and Depth-First Search		

22.	Matchings and Depth-First Search	3	15
23.	Perfect matching, Optimal assignment	3	18
24.	Timetable scheduling	2	20
25.	The Chinese Postman problem	2	22
26.	Depth- First search	2	24
	Unit III - Strong connectivity and Planarity		
27.	Biconnectivity	3	27
28.	Strong Connectivity	3	30
29.	st-Numbering of a Graph	3	33
30.	Planarity testing	3	36
	Unit IV - Flows in Networks		
31.	The Maximum Flow problem	3	39
32.	Maximum Flow Minimum Cut theorem	3	42
33.	Ford-Fulkerson labeling algorithm,	3	45
34.	Edmonds and Karp Modification of the labeling algorithm	3	48
	Unit V - Connectivity - An Algorithimic Approach		
35.	Dinic Maximum Flow algorithm	3	51
36.	Maximum Flow in 0-1 networks	3	54
37.	Maximum matching in Bipartite Graphs	2	56
38.	Menger's Theorem	2	58
39.	Connectivity	2	60