Course Name : Master of Science
Discipline : Mathematics
CHOICE BASED CREDIT SYSTEM
(For those who joined in June 2022 and after)

COURSE OBJECTIVES:

The syllabus for M.Sc. Mathematics degree under semester system has been designed on the basis of Choice Based Credit System, (CBCS) which will help the students to get adequate knowledge in Mathematics to do Research in Mathematics in any reputed institutions as well as give enough background to prepare for various National level tests conducted by Tamil Nadu Government, UGC-CSIR, NBHM etc.

To enable the students to understand various applications of Mathematics in Real life as well as in any other allied subjects like Physics, Chemistry etc.

ELIGIBILITY FOR ADMISSION:

Candidate should have passed the B.Sc. / B.Sc. (CA) Degree Examination with mathematics as Major subject conducted by various Universities and colleges accepted by the Syndicate.

DURATION OF THE COURSE: Two Years

COURSE SCHEME:

VIRUDHUNAGAR HINDU NADARS' SENTHIKUMARA NADAR COLLEGE
(An Autonomous Institution Affiliated to Madurai Kamaraj University)
[Re-accredited with 'A' Grade by NAAC]
Virudhunagar – 626 001.

Semester	Part	Subject	Hour	Credit	Int+Ext = Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code	Revised / New / No Change / Interchanged & Percentage of revision
I	Core 1	Abstract Algebra-I	6	5	40+60=100				✓	✓							**P22MAC11**	Revised 20%
	Core 2	Real Analysis - I	6	4	40+60=100				✓	✓							**P22MAC12**	Revised 10%
	Core 3	Differential Equations	6	4	40+60=100				✓	✓							**P22MAC13/** P19MAC13	No change
	Core 4	Probability and Statistics	6	4	40+60=100				✓				✓				**P22MAC14/** P19MAC14	No change
	Elective 1	a) Differential Geometry b) Fuzzy sets and Logics c) Java and Web Designing	6	5	40+60=100				✓				✓				**P22MAE11** **P22MAE12/** P19MAE12/ **P22MAE13/** P19MAE13	Revised 10% No change No change
II	**Core 5**	Abstract Algebra – II	6	5	40+60=100				✓	✓							P22MAC21/ P19MAC21	No change
	Core 6	Real Analysis - II	5	4	40+60=100				✓	✓							P22MAC22/ P19MAC22	No change
	Core 7	Topology	5	4	40+60=100				✓	✓							P22MAC23/ P19MAC23	No change
	Core 8	Advanced Graph Theory	5	4	40+60=100				✓	✓							P22MAC24/ P19MAC24	No change
	Core 9	Number Theory and Cryptography	5	4	40+60=100				✓	✓							P22MAC25	Revised 20%
	NME	Industrial Statistics	4	4	40+60=100				✓				✓				P22MAN21/ P19MAN21	No change

I SEMESTER

Course Title: Core 1 - ABSTRACT ALGEBRA – I	**Total Hours: 90** **Contact Hours per Week : 6**
Course Code: P22MAC11	**Total Credits: 5**

Objective(s):

- To study in detail how to apply the Abstract structures to a concrete realization.

Course Outcomes
On completing this course, students can/are

Cos	CO Statements
CO1:	Learn the concept of group theory.
CO2:	Construct new groups from some groups already on hand.
CO3:	Learn the symmetry to analyse the object using group theoretic methods.
CO4:	Know about the concept of group, the algebraic structure such as rings, fields and modules.
CO5:	Use group theory as a powerful tool for research in robotics, computer vision, computer graphics and medical image analysis.

Unit I **[18 Hours]**

Group - Cayley's theorem - Permutation groups - Another counting principle.

Unit II **[18 Hours]**

Sylow's theorem - Direct products - Finite abelian groups.

Unit III **[18 Hours]**

Euclidean Rings - A Particular Euclidean Ring - Polynomial Rings.

Unit IV **[18 Hours]**

Polynomials over the Rational Field - Polynomial Rings over commutative Rings - Modules.

Unit V **[18 Hours]**

Rings with chain conditions: Noetherian rings – Artinian rings – Examples and counter examples.

Text Books :

1. I. N. Herstein, Topics in Algebra, Second Edition, John Wiley & Sons Inc. (Reprint 2006).
2. Surjeet Singh, Qazi Zameeruddin, Modern Algebra, Eighth Edition, Vikas Publishing House Pvt Ltd, 2005.

Course Contents :

Unit I : Text Book 1: Chapter : 2 - Sections 2.9, 2.10, 2.11.
Unit II : Text Book 1: Chapter : 2 - Sections 2.12, 2.13, 2.14. [Supplementary Problems Excluded]
Unit III : Text Book 1: Chapter : 3 - Sections 3.7, 3.8, 3.9.

Unit IV : Text Book 1: Chapter : 3 - Sections 3.10, 3.11; Chapter : 4 - Section 4.5.
Unit V: Text Book 2: Chapter: 15 – Section 15.1, 15.2, 15.3.

Reference Books :

1. N. S. Gopala Krishnan, University Algebra, New age International Publishers, 2008.
2. Joseph A. Gallian, Contemporary Abstract Algebra, Eighth Edition, Brooks/Cole Cengage Learning, 2013.

Course Title: Core 2 - REAL ANALYSIS – I	**Total Hours: 90** **Contact Hours per Week : 6**
Course Code: P22MAC12	**Total Credits: 4**

Objectives:

- To train the students to move from the concrete structure of Real and Complex number systems to a Topological structure of sets.
- To study in detail about the continuity and differentiability of Real and Complex valued functions.

Course Outcomes:
On completing this course, students can/are

Cos	CO Statements
CO1:	Know how to connect abstract statement with concrete examples.
CO2:	Get experience in reading and writing proofs.
CO3:	Acquire more ideas about Calculus and Linear Algebra.
CO4:	Analyze the technical proofs and intuitive ideas.
CO5:	Learn how the principles and theory of Real Analysis can be applied in a variety of fields.

Unit I: Basic Topology [18 Hours]

Finite, countable and uncountable sets – Metric spaces.

Unit II: Basic Topology - Numerical sequences [18 Hours]

Compact sets – Perfect sets – Connected sets – Convergent sequences – Subsequences – Cauchy sequences – Upper and lower limits – Some special sequences.

Unit III: Series [18 Hours]

Series of Non-negative Terms – The number e – The Root and Ratio tests – Power series – Summation by parts – Absolute convergence.

Unit IV: Continuity [18 Hours]

Limits of Functions – Continuous Functions – Continuity and Compactness – Continuity and connectedness – Discontinuities – Monotonic Functions – Infinite limits and limits at infinity.

Unit V: Differentiation [18 Hours]

The derivative of a Real Function – Mean value Theorems – The continuity of Derivatives –L'

Hospital's Rule - Derivatives of Higher order – Taylor's theorem.

Text Book(s):

1. Walter Rudin, Principles of Mathematical Analysis, Third Edition, Mc-Graw Hill Inc, 1976.

Course Contents :

Unit I : Chapter : 2 – Sections 2.1 – 2.30.
Unit II : Chapter : 2 – Sections 2.31 – 2.47.
Chapter : 3 – Sections 3.1 – 3.20.
Unit III : Chapter : 3 – Sections 3.21 – 3.46.
Unit IV : Chapter : 4 – Sections 4.1 – 4.34.
Unit V : Chapter : 5 – Sections 5.1 – 5.15.

Reference Books :

1. V.Karunakaran, Real Analysis, Pearson 2012.
2. Richard R. Goldberg, Methods of Real Analysis, Oxford & IBH publications, New Delhi, 1964.
3. Tom M. Apostol, Mathematical Analysis, Second Edition (Indian Student Edition), Narosa Publishing House, 1985.

Course Title: Core 3 - DIFFERENTIAL EQUATIONS	**Total Hours: 90** **Contact Hours per Week : 6**
Course Code: P22MAC13/ P19MAC13	**Total Credits: 4**

Objectives:

To enable the students to

- know the method of solving the ordinary differential equations particularly homogeneous, non homogeneous and homogeneous equations with analytic coefficients.
- be familiar with Legendre, Euler and Bessel equations.
- develop skills to solve partial differential equations using Cauchy, Charpit & Jacobi methods.

Course Outcomes:

On completing this course, students can/are

Cos	CO Statements
CO1:	Understand the method of solving initial value problems.
CO2:	Acquire the knowledge of relationship between Wronskian and independent solutions.
CO3:	Become familiar with Legendre, Euler and Bessel equations.
CO4:	Be able to solve many types of partial differential equations.

Unit I: **[18 Hours]**

Introduction ,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 non-homogeneous equation, Homogeneous equations with analytic coefficients, The Legendre equation. (**Text Book 1:** Chapter 3 Sections 1 to 8)

Unit II: **[18 Hours]**

Introduction, The Euler equation, Second order equations with regular singular points- an example, Second order equations with regular singular points- the general case. A convergence proof, The Exponential cases, The Bessel equation, The Bessel equation (continued) .(**Text Book 1:** Chapter 4, Sections 1 to 8)

Unit III: **[18 Hours]**

Introduction, Equations with variables separated, Exact equations, The method of successive approximations, The Lipschitz condition, Convergence of the successive approximations, Non-local existence of solutions, Approximations to and uniqueness of solutions. (**Text Book 1:** Chapter 5, Sections 1 to 8)

Unit IV: **[18 Hours]**

Partial differential equations –Origins of first order Partial differential equations-Cauchy's problem for first order equations-Linear equations of the first order-Integral surfaces passing through a given curve. (**Text Book 2: Chapter 2:** Sections 2.1 to 2.5)

Unit V: **[18 Hours]**

Non linear Partial differential equations of the first order-Cauchy's method of characteristics-Compatible Systems of first order equations-Charpit's method-Special types of first order equations. (**Text Book 2: Chapter 2:** Sections 2.6 to 2.11)

Text Book(s):

1. E.A.Coddington, An introduction to Ordinary differential equations, 1987, Prentice Hall of India
2. I.N.Sneddon, Elements of Partial differential equations,1986,Tata McGraw Hill Book Company

Reference Book(s):

1. G. F. Simmons and Krantze, Differential Equations, 3rd Edition, Tata McGraw Hill Publishing company, 2006
2. N.Ch.S.N. Iyengar, Differential Equations, Anmol Publications Pvt.Ltd, New Delhi, 2000.

Course Title: Core 4 - PROBABILITY AND STATISTICS	**Total Hours: 90** **Contact Hours per Week : 6**
Course Code: P22MAC14/ P19MAC14	**Total Credits: 4**

Objectives:

- To study in detail about various probability distributions
- To acquire knowledge about sampling techniques.

Course Outcomes:
On completing this course, students can/are

Cos	CO Statements
CO1:	Apply the different statistical measures for any data.

CO2:	Understand Statistics facilitates comparison.
CO3:	Attain several skills to solve various problems in all statistical concepts.
CO4:	Be able to deal with all sciences such as Biology, Zoology, Education, Economics, Planning, industry, Medical sciences.

Unit I: Probability and Distributions [18 Hours]

Introduction - Set theory - The Probability set function - Conditional Probability and Independence - Random variables of the Discrete type - Random variables of the continuous type - Properties of the distribution function.

Unit II: Probability and Distributions [18 Hours]

Expectation of a random variable - Some special expectation - Chebyshev's inequality - Multivariate Distributions - Distribution of two random variables - Conditional distributions and expectations - The Correlation Coefficient.

Unit III: Multivariate Distributions [18 Hours]

Independent Random Variables - Extension to several random variables - Some special distributions - The Binomial and related distributions -The Poisson distribution - The Gamma and Chi-square distributions.

Unit IV*: Some Special Distributions [18 Hours]

The Normal distribution - The Bivariate Normal distribution -Distribution of functions of random variables - Sampling theory - Transformation of variables of the discrete type - Transformation of variables of continuous type.

Unit V*: The Beta , t and F distributions [18 Hours]

Extensions of the change-of-variable technique - Distributions of order Statistics - The moment Generating-function Technique - The distributions of $\bar{X}$ and $\frac{n S^2}{\sigma^2}$.

NOTE: For all the units marked with *, one or more industrial visits may be organized by the Faculty member(s). This will enable the students to understand more about the course contents in relation to real life.

Text Book :

1. R.V.Hogg and A.T.Craig, Introduction to Mathematical Statistics, Fifth Edition, Pearson's Education Asia, 2002.

Course Contents :

Unit I: Chapter : 1 - Sections 1.1 to 1.7.
Unit II: Chapter : 1 - Sections1.8 to 1.10.
Chapter : 2 - Sections 2.1 to 2.3.
Unit III: Chapter : 2 - Sections 2.4 and 2.5.
Chapter : 3 - Sections 3.1 to 3.3.
Unit IV: Chapter : 3 - Sections 3.4 and 3.5.
Chapter : 4 - Sections 4.1 to 4.3.
Unit V: Chapter : 4 - Sections 4.4 to 4.8.

Reference Book :

S.C.Gupta, V.K.Kapoor, Fundamentals of Mathematical Statistics, Eleventh Thoroughly Revised Edition, Sultan Chand & Sons.

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Elective 1(a)

Course Title: Elective - DIFFERENTIAL GEOMETRY	**Total Hours: 90** **Contact Hours per Week : 6**
Course Code:-P22MAE11	**Total Credits: 5**

Objective(s):

To acquire basic knowledge in differential geometry

Course Outcomes:
On completing this course, students can/are

Cos	CO Statements
CO1:	Determine the Arc length, Curvature, Torsion and Osculating Plane for any curve in the Euclidean space.
CO2:	Analyze the behavior of a space curve and its contact with the surfaces.
CO3:	Find the moving triad of a point in the space curve to identify the Evolutes and Involutes of the curve.
CO4:	Parameterize a surface using the local intrinsic properties of a surface.
CO5:	Construct the first and second fundamental forms for any given surface.

Unit I: Theory of space curves (18 hours)

Introduction – Representation of space curves - Unique parametric representation of a space curve-Arc length- Tangent and Osculating plane- Principal normal and Bi-normal- Curvature and Torsion

Unit II: Osculating Circle and Osculating sphere (18 hours)

Behavior of a curve in the neighbourhood of its points- Curvature and torsion of a curve as the intersection of the two surfaces - Contact between curves and surfaces - Osculating circle and Osculating sphere- Locus of centers of spherical curvature

Unit III: Involutes and Evolutes (18 hours)

Tangent surfaces, Involutes and evolutes – Betrand curves – Spherical indicatrix – Intrinsic equations of space curves – Fundamental existence theorem for space curves – Helices.

Unit IV: Local intrinsic properties of a surface (18 hours)

Introduction - Definition of a surface – Nature of points on a surface – Representation of a surface - Curves in surface – Tangent plane and surface normal - General surface of revolution – Helicoids.

Unit V: Metric on a surface (18 hours)

The first fundamental form – Direction coefficients on a surface–Families of curves – Orthogonal trajectories – Double family of curves - Isometric correspondence - Intrinsic properties.

TEXT BOOK:

1. D. Somasundaram, Differential geometry, Narosa publication, 2005.

Course Contents :

Unit I : Chapter 1 Section 1.1 to 1.7
Unit II : Chapter 1 Section 1.8 to 1.12
Unit III: Chapter 1 Section 1.13 to 1.18

Unit IV : Chapter 2 Section 2.1 to 2.8.
Unit V: Chapter 2 Section 2.9 to 2.15.

REFERENCE BOOKS:

1. T.G.Wilimore, An introduction to Differential Geometry, Oxford university press (1983).
2. D.T Struik, Lectures on Classical Differential Geometry, Addison-Wesely, Mass.1950
3. J.A. Thorpe, Elementary Topics in Differential Geometry, Springer-Verlag, NewYork,1979

Elective 1(b)

Course Title: Elective - FUZZY SETS AND LOGICS	**Total Hours: 90** **Contact Hours per Week : 6**
Course Code: P22MAE12/ P19MAE12	**Total Credits: 5**

Objectives:

- To enable the students to know the fuzzy sets and its applications.

Course Outcomes:

On completing this course, students can/are

COs	CO Statements
CO1:	Gain the main subject of fuzzy sets.
CO2:	Learn crisp set and fuzzy set theory.
CO3:	Decide the difference between crisp set and fuzzy set theory.
CO4:	Make calculation on fuzzy set theory.
CO5:	Gain the methods of fuzzy logic.
CO6:	Recognize fuzzy logic membership function.
CO7:	Recognize fuzzy logic fuzzy inference systems.
CO8:	Make applications on Fuzzy logic membership function and fuzzy inference systems.

Unit I: **[18 Hours]**

Basic Types, Basic Concepts, Additional properties of α-cuts, Representations of fuzzy sets.

Unit II: **[18 Hours]**

Extension Principle for fuzzy sets, Types of operations, fuzzy Complements.

Unit III: **[18 Hours]**

Fuzzy numbers-Linguistic Variables-Arithmetic operations on intervals-Arithmetic operations on Fuzzy numbers.

Unit IV: **[18 Hours]**

Crisp versus fuzzy relations – Projections and Cylindric extensions - Binary fuzzy relations – Binary relations on a single set - Fuzzy equivalence relation - Fuzzy Compatibility relations- Fuzzy ordering relations.

Unit V: **[18 Hours]**

Classical Logic: An Overview-Multivalued logic–Fuzzy Proposition-Fuzzy Quantifiers-Linguistic Hedges-Inference from conditional fuzzy propositions-Inference conditional and qualified propositions-Inference from quantifier propositions.

Text Book:

1. George J.Klir/Bo Yuan, Fuzzy sets and fuzzy logic-2008 Prentice-Hall of India Pvt Ltd.

Reference Book(s):

1. George J Klir and Tina A. Folger, Fuzzy sets, uncertainty and Information, 1994, Prentice-Hall of India Pvt Ltd

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Elective 1(c)

Course Title: Elective - JAVA AND WEB DESIGNING	**Total Hours: 90** **Contact Hours per Week : 6**
Course Code: P22MAE13/ P19MAE13	**Total Credits: 5**

Objectives:

To develop programs using Object Oriented Programming. It is expected to get exposure on the concepts of overloading, inheritance, vectors and overriding to write programs.

Course Outcomes:
On completing this course, students can/are

COs	CO Statements
CO1:	Create Java programs that solve simple business problems.
CO2:	Understand the concept of exception handling and Input / Output operations. Construct a Java class based on a UML class diagram.
CO3:	Perform a test plan to validate a Java program.
CO4:	Document a Java program.
CO5:	Design the applications of Java & Java applet.
CO6:	Analyze & Design the concept of Event Handling and Abstract Window Toolkit.

Unit I: **[18 Hours]**

Fundamentals of Object oriented programming: Introduction – Object oriented paradigm – Basic concepts of OOP – Benefits of OOP – Applications of OOP. **Java evolution:** History – Features – How Java differs from C++. **Overview of Java language:** Simple Java program – Application with two classes – Java program structure – Java tokens – Java statements – Java Virtual Machine – Command line arguments. **Constants, Variables & Data types:** Constants – Variables – Data types – Declaration of variables – Symbolic constants – Type casting.

Unit II: **[18 Hours]**

Operators & Expressions: Arithmetic operators – Relational Operators – Logical Operators – Assignment operators – Increment and Decrement operators – Conditional operator – Bitwise operators – Special operators. **Decision making and Branching:** Simple if statement – if..else statement – Nested if…else statement – else if ladder – Switch statement.

Unit III: **[18 Hours]**

Decision making and Looping: while statement – for statement – do statement – Jump in loops – Labeled loops – continue statement – break statement.

Unit IV: **[18 Hours]**

Classes, Objects and Methods: Defining a class – Fields declaration – Methods declaration – Creating objects – Accessing class members – Constructors – Method overloading – Static members – Final variables and methods – Final classes – Abstract methods and classes – this

keyword.

Unit V: **[18 Hours]**

Arrays, Strings and Vectors: One dimensional array – Creating an array – Two dimensional array – Strings – Vectors – Wrapper classes - **Inheritance:** Single inheritance – Multilevel inheritance – Method overriding – super keyword.

Text Book:

1. E.Balagurusamy, Programming with Java, 4th edition, Tata McGraw Hill Ltd.

Reference Books:

1. Krishnamoorthy and Prabhu, Internet and Java Programming.
2. Herbert Schildt, Java Complete Reference.

SEMESTER – II

Course Title: Core 5 - ABSTRACT ALGEBRA – II	**Total Hours: 90** **Contact Hours per Week : 6**
Course Code: P22MAC21/P19MAC21	**Total Credits: 5**

Objectives:

- To study about geometrical structures in Vector spaces.
- To transform the properties of Linear Transformation into the corresponding properties of Matrices and Determinants.

Course Outcomes:

On completing this course, students can/are

Cos	CO Statements
CO1:	Understand the concept of dual spaces, inner product space.
CO2:	Understand the concept of the types of linear transformation and algebra of transformation
CO3:	Know about main application of the algebra in cryptography area.
CO4:	Learn about the determinants and its properties

Unit I: **[18 Hours]**

Dual spaces – Inner product spaces.

Unit II: **[18 Hours]**

Linear transformations - The algebra of linear transformations – characteristic roots – Matrices.

Unit III: **[18 Hours]**

Linear transformations – canonical forms : Triangular form – Nilpotent transformations – Jordan form.

Unit IV: **[18 Hours]**

Linear transformations – canonical forms : Rational canonical form – Trace and transpose.

Unit V: **[18 Hours]**

Determinants – Hermitian, Unitary and Normal transformations.

Text Book:

1. I. N. Herstein, Topics in Algebra, Second Edition, John Wiley & Sons Inc. (Reprint 2006).

Course Contents :

Unit I : Chapter : 4 - Sections 4.3, 4.4.
Unit II : Chapter : 6 - Sections 6.1, 6.2, 6.3.
Unit III : Chapter : 6 - Section 6.4, 6.5, 6.6.
Unit IV : Chapter : 6 - Sections 6.7, 6.8.
Unit V : Chapter : 6 - Sections 6.9, 6.10.

Reference Book :

1. N. S. Gopala Krishnan, University Algebra, New age International Publishers, 2008.

Course Title: Core 6 - REAL ANALYSIS – II	**Total Hours: 75** **Contact Hours per Week : 5**
Course Code: P22MAC22/P19MAC22	**Total Credits: 4**

Objectives:

- To study the integration of real valued functions and vector valued functions on interval and then on arbitrary sets.
- To study in detail about the convergence and continuity of sequence of functions and to relate convergence with differentiation and integration of functions**.**
- To study some special functions represented by Power series.

Course Outcomes:
On completing this course, students can/are

Cos	CO Statements
CO1:	Understand the analytic properties of functions, sequences, convergence, limit of sequences, continuity, linear transformation, differentiation, etc.,
CO2:	Become familiar with the concept of Riemann integrals.
CO3:	Analyse inverse operations such as integration and differentiation.
CO4:	Try to analyse the problems that arise when limit processes are interchanged.

Unit I: **[15 Hours]**

The Riemann – Stieltjes Integral - Definition and Existence of the Integral - Properties of the Integral- Integration and Differentiation.

Unit II: **[15 Hours]**

Integration of vector-valued Functions – Rectifiable Curves - Sequences and series of Functions – Discussion on main problem- Uniform convergence – Uniform convergence and continuity.

Unit III: **[15 Hours]**

Uniform convergence and Integration - Uniform convergence and Differentiation – Equicontinuous Families of Functions.

[15 Hours]

Unit IV:

Some special Functions : Power series – The Exponential and Logarithmic Functions – Trigonometric Functions – The algebraic completeness of the complex field.

Unit V: **[15 Hours]**

Fourier series - The Gamma Function - Functions of several variables : Differentiation – The contraction principle – The inverse Function theorem.

Text Book :

1. Principles of Mathematical Analysis, Third Edition by Walter Rudin, Mc-Graw Hill Inc, 1976.

Course Contents :

Unit I : Chapter : 6 – Sections 6.1 - 6.22
Unit II : Chapter : 6 – Sections 6.23 – 6.27.
Chapter : 7 – Sections 7.1 – 7.15.
Unit III : Chapter : 7 – Sections 7.16 – 7.32.
Unit IV : Chapter : 8 – Sections 8.1 – 8.8.
Unit V : Chapter : 8 – Sections 8.9 – 8.22.
Chapter : 9 – Sections 9.10 – 9.25.

Reference Books :

1. V. Karunakaran, Real Analysis, Pearson Education India, 2012.
2. Tom M. Apostol, Mathematical Analysis, Second Edition, Narosa Publications House,1985.

Course Title: Core 7 - TOPOLOGY	**Total Hours: 75** **Contact Hours per Week : 5**
Course Code: P22MAC23/P19MAC23	**Total Credits: 4**

Objectives:

- To enable the students to understand topological spaces.
- To enable the students to understand the concept of continuous functions.
- To enable the students to know about connected spaces.
- To enable the students to know about compact spaces.
- To study countability and separations axioms.

Course Outcomes:

On completing this course, students can/are

Cos	CO Statements
CO1:	Understand the terms and definitions of Topological Spaces, Accumulation Points, Interior, Closure, Boundary and exterior of sets, Coarser and Finer Topologies – Subspace and theorems related to topology.
CO2:	Be motivated to unify the basics like open set, closed sets, components, continuity, completeness and so on, that are learnt through one semester course on Real and complex analysis.
CO3:	Elaborate the knowledge of concepts such as connectedness and compactness.

CO4:	Recognize Bases and Subbases for topologies and write Topologies generated by classes of sets.
CO5:	Understand the importance of Metrizable topological spaces and know sufficient conditions for metrizability of a topological space.
CO6:	Use the concept of homeomorphism to identify the spaces that are having similar geometrical structures.

Unit I: Topological spaces [15 Hours]

Topological spaces - Basis for a topology - The order topology - The product topology on $X \times Y$ – The sub space topology - Closed sets and limit points.

Unit II: Continuous Functions [15 Hours]

Continuous functions -The product topology - The metric topology- The metric topology (continued)

Unit III: Connectedness [15 Hours]

Connected spaces - Connected Subspaces of the Real line – Components – Local connectedness.

Unit IV: Compactness [15 Hours]

Compact spaces - Compact subspaces of the Real line - Limit point compactness.

Unit V: Separation Axioms [15 Hours]

The separation axioms – Normal spaces - The Urysohn lemma - The Urysohn metrization theorem.

Text Book :

1. James R. Munkres, Topology, Second Edition, PHI Edition Private Ltd, New Delhi (2012).

Course Contents :

Unit I : Chapter : 2 – § 12, 13, 14, 15, 16, 17.
Unit II : Chapter : 2 – § 18, 19, 20, 21.
Unit III : Chapter : 3 – § 23, 24, 25.
Unit IV : Chapter : 3 – § 26, 27, 28.
Unit V : Chapter : 4 – § 31, 32, 33, 34.

Reference Books :

1. Dugundji, J., Topology, PHI Edition Private Ltd., New Delhi,1975.
2. J. L. Kelly, General Topology, Dover Publications Inc, New York, 2017.
3. G. F. Simmons, Introduction to Topology and Modern Analysis, Tata McGraw-Hill Edition, India, 2004.

Course Title: Core 8 - ADVANCED GRAPH THEORY	**Total Hours: 75** **Contact Hours per Week : 5**
Course Code: P22MAC24/P19MAC24	**Total Credits: 4**

Objectives:

- To learn advanced topics in Graph Theory.
- To acquire more knowledge in Factorization and decomposition.
- To understand the concept of Ramsey Numbers.

Course Outcomes:
On completing this course, students can/are

Cos	CO Statements
CO1:	Know basic definitions in Graph theory.
CO2:	Use mathematical definitions to identify, construct examples and to distinguish the existence and non-existence of certain properties.
CO3:	Gather the graph theoretical knowledge and its applications through algorithm.
CO4:	Identify special graphs and know related theorems.
CO5:	Solve some real time problems using the concepts of Graph theory.
CO6:	Apply graph as models for many standard problems.

Unit I: Connectivity **[15 Hours]**

Cut Vertices - Blocks - Connectivity -Menger's theorem.

Unit II: Factorization and Decomposition **[15 Hours]**

Factorization - Decomposition and graceful labelings- Instant insanity - The Petersen graph.

Unit III: Ramsey Numbers **[15 Hours]**

The Ramsey number of graphs -Turan's theorem - Rainbow Ramsey numbers.

Unit IV: Distance **[15 Hours]**

The centre of a graph - Distant vertices - Locating numbers.

Unit V: Domination number and Digraphs **[15 Hours]**

The Domination number of a graph - Strong digraphs - Tournaments.

Text Book :

1. Gary Chartrand and Ping Zhang, Introduction to Graph Theory, McGraw-Hill Education (India) Edition 2006.

Course Contents :

Unit I - Chapter : 5 - Sections 5.1 to 5.4.
Unit II - Chapter : 8 - Sections 8.2 to 8.5.
Unit III - Chapter : 11 - Sections 11.1 to 11.3
Unit IV - Chapter : 12 - Sections12.1 – 12.3.
Unit V - Chapter : 7 - Sections 7.1 to 7.2; Chapter : 13 - Section 13.1.

Reference Books :

1. J. A.Bondy and U.S.R. Murty, Graph Thoery with Applications, North –Holland, New York, 1976.
2. Gary Chartrand, Linda Lesniak, Ping Zhang, Graphs and Digraphs, Chapman and Hall (CRC), 2015.

Course Title: Core 9 - NUMBER THEORY AND CRYPTOGRAPHY	**Total Hours: 75** **Contact Hours per Week : 5**
Course Code: P22MAC25	**Total Credits: 4**

Objectives:

- To introduce several arithmetical functions which play an important role in the study of divisibility properties of integers.
- To enable the students to understand the concept of congruences
- To equip the students to understand the concept of Residues
- To get a basic knowledge in Cryptography

Course Outcomes:
On completing this course, students can/are

Cos	CO Statements
CO1:	Apply the concept of different number theoretic functions.
CO2:	Understand the application of congruences in solving number theoretic problems.
CO3:	Learn more things on arithmetic functions and primitive roots.
CO4:	Have introduction in cryptography.
CO5:	Be Enriched with the knowledge of doing research in number theory

Unit I: Arithmetic functions and Dirichlet Multiplication [15 Hours]

Introduction-The Mobius function $\mu(n)$- The Euler totient function $\varphi(n)$- A relation connecting φ *and* μ- A product formula for $\varphi(n)$- The Dirichlet product of arithmetical functions – Dirichlet inverses and the Mobius inversion formula – The Mangoldt function $\wedge(n)$- Multiplicative functions- Multiplicative functions and Dirichlet Multiplication – The inverse of a completely multiplicative function- Liouville's function $\lambda(n)$- The divisor functions $\sigma_\alpha(n)$- Generalized convolutions- Formal power series- The Bell series of an arithmetical function- Bell series and Dirichlet multiplication- Derivatives of arithmetical functions- The Seldberg identity.

Unit II: Averages of Arithmetical functions [15 Hours]

Introduction-The big Oh notation- Asymptotic equality of functions- Euler's summation formula- some elementary asymptotic formulas- The average order of *d(n)* – The average order divisor functions $\sigma_\alpha(n)$- The average order of $\varphi(n)$- An application to the distribution of lattice points visible from the origin – The Average order of $\mu(n)$ and of $\wedge(n)$ - The partial sums of a Dirichlet product- Applications to $\mu(n)$ and $\wedge(n)$- Another identity for the partial sums of a Dirichlet product.

Unit III: Congruences [15 Hours]

Definition and basic properties of congruences- Residue classes and complete residue systems- Linear congruences- Reduced residue systems and the Euler-Fermat theorem- Polynomial congruences modulo p, Lagrange's theorem-Applications of Lagrange's theorem- Simultaneous linear congruences- The Chinese remainder theorem- Applications of the Chinese remainder theorem- Polynomial congruences with prime power moduli.

Unit IV: Quadratic Residues [15 Hours]

Quadratic residues- Legendre's symbol and its properties-Evaluation of $(-1|p)$ *and* $(2|p)$ - Guass' Lemma – The quadratic reciprocity law- the Jacobi symbol – Applications to Diophantine equations.

Unit V: Cryptology [15 Hours]

Introduction – Character Ciphers- Block Ciphers- One time Pads: Exponential Ciphers- Public key cryptography- Signatures.

Text books:

1. Tom M. Apostol, Introduction to Analytic Number Theory, Narosa Publishing House , 1989.
2. Neville Robbins, Beginning Number Theory, Second Edition, Narosa Publishing House, 2007.

Course Contents :

Unit-I: Text book-1 Chapter-2, Sections: 2.1 to 2.19
Unit-II: Text book-1 Chapter-3, Sections: 3.1 to 3.12
Unit-III: Text book-1 Chapter-5, Sections: 5.1 to 5.9
Unit-IV: Text book-1 Chapter-9, Sections: 9.1 to 9.8
Unit-V: Text book-2 Chapter-12, Sections: 12.1 to 12.3

Reference books:

1. Ivan Nivan, H.S. Zuckerman and H.L.Montgomery, An introduction to the Theory of Numbers, 5th Ed paperback-International Edition, 1991.
2. Neal Koblitz, A course in Number theory and Cryptography, Second edition, Springer-Verlag Newyork, 1994.

Course Title: NME - INDUSTRIAL STATISTICS	**Total Hours: 60** **Contact Hours per Week : 4**
Course Code: P22MAN21/ P19MAN21	**Total Credits: 4**

Objectives:

- Statistics deals with all sciences such as Biology, Zoology, Education, Economics, Planning, Industry, Medical Sciences, an Index Number is widely used Statistical device for comparing the level of a certain phenomenon with the level of same phenomenon at some standard period.

Course Outcomes:
On completing this course, students can/are

COs	CO Statements
CO1:	Understand the concept of statistical inference by testing hypothesis.
CO2:	Apply t-test for small samples.
CO3:	Understand the concept of control chart, types of control chart.

CO4:	Learn the construction of index numbers and uses of index numbers.
CO5:	Utilize the concept of time series to fit a given straight line and parabola.

Unit I: Statistical Inference [12 Hours]

Introduction-Procedure of testing hypothesis-standard error and sampling distribution-estimation (P.No : 881-894).

Unit II: Test of significance for small samples [12 Hours]

Student's t-distribution-To test the significance of the mean of a random sample-Testing difference between means and two samples (independent)-Testing difference between means and two samples (dependent samples) - (P.No:910-923) (exercise problems not included) Illustration-28,29,30,31,32,33,34,35,36,37.

Unit III: Statistical Quality Control [12 Hours]

Introduction-Control charts-x charts-R charts-Control charts for c(no. of defects per unit)-control chart for *p*(Fraction Defective). (P.No:1051-1072)(exercise problems not included). Illustration-1,2,3,4,5,6,7,8,9,10,11,12.

Unit IV: Index Numbers [12 Hours]

Introduction-Uses of index numbers-problems in the construction of index numbers-Weighted Aggregative Indices(P.No:515-522 & 529-534). Illustration-5,6,7(Exercise problems not included).

Unit V: Analysis of Time Series [12 Hours]

Introduction-Time series defined-utility of time series-Components of time series-Preliminary adjustment before analyzing time series-Method of least squares-Fitting straight line trend-Second degree parabola.(P.No:589-600 & 613-622). Illustration-10,11,12,13,14(Exercise problems not included)

Text Book(s):

1. S.P.Gupta, Statistical Methods, Thirty-Seventh Revised Edition 2008, Sultan Chand & sons

Reference Book(s):

1. K.Alagar, Business Mathematics, Tata McGraw Hill company.

Course Name : Master of Science
Discipline : Mathematics
Rules and regulations, Course Scheme and Scheme of Examinations
(For those who join in June 2018 and after)
COURSE SCHEME:

Semester	Part	Subject	Hours	Credit	Int +Ext = 100	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code	Revised / New / No Change / Interchanged & Percentage of revision
III	Core 10	Field Theory	6	5	40+60=100				✓	✓							P19MAC31	Revised/ 40%
	Core 11	Complex Analysis	6	4	40+60=100				✓	✓							P19MAC32	Revised/ 50%
	Core 12	Numerical Methods	6	4	40+60=100				✓	✓							P19MAC33	No Change
	Core 13	Measure Theory	6	4	40+60=100				✓	✓							P19MAC34	Revised/ 30%
	Elective 2	a)Integral Equations b)Classical Mechanics	6	5	40+60=100				✓				✓				P19MAE31 P19MAE32 / P19MAE41	New/100% Inter Changed
IV	Core 14	Optimization Techniques	6	4	40+60=100				✓				✓				P19MAC41	No Change
	Core 15	Functional Analysis	6	4	40+60=100				✓	✓							P19MAC42	Revised/ 5%
	Core 16	Combinatorics	6	4	40+60=100				✓	✓							P19MAC43	No Change
		PROJECT	6	4	50+50=100				✓				✓				P19MA4PV	New / 100%
	Elective 3	a)Applications of Graph Theory b)Advanced Topology c)Stochastic Processes	6	5	40+60=100				✓								P19MAE41/ P19MAE31 P19MAE42 P19MAE43	Inter Changed/ No Change/ No Change

Self-Learning Course:

Subject	Credit	Ext =Tot	Subject Code
Research Topics in Mathematics	5	100 = 100	P19MASL31

SEMESTER III
CORE : 10 FIELD THEORY

Contact Hours per semester : 90 — Subject Code : P19MAC31
Contact Hours per week : 6 — Credit : 5

Objectives:

- To enable the students to understand the concept of Field
- To enable the students to understand the concept of Galois theory
- To enable the students to understand the concept of chain conditions

Unit I : (18 hours)
Extension fields - Roots of Polynomials.
Unit II :(18 hours)
Construction with straightedge and compass – More about roots.
Unit III :(18 hours)
The elements of Galois Theory
Unit IV :(18 hours)
Solvability by Radicals – Galois groups over the rationals.
Unit V :(18 hours)
Finite fields - Wedderburns's theorem on finite division rings.
Text Book : Topics in Algebra by I.N.HERSTEIN Second Edition.
Unit I : 5.1 and 5.3
Unit II : 5.4 and 5.5
Unit III : 5.6
Unit IV : 5.7 and 5.8
Unit V : 7.1 and 7.2
Reference Books :

1. Surjeet Singh, Qazi Zameeruddin ; Modern Algebra.
2. Vijay K.Khanna, S.K.Bhambri; A Course in Abstract Algebra

CORE 11 - Complex Analysis

Contact Hours per Semester: 90 — Subject code: P19MAC32
Contact Hours per week: 6 — Credit: 4

Course objectives:

- To lay the foundation for this subject, to develop clear thinking and analyzing capacity for further study.
- To learn about Cauchy's Theorem which leads to useful techniques for evaluating real integrals based on the 'calculus of residues'.
- To learn more about normal families in the context of families of analytic functions.

Unit–I: Polynomials – Rational functions –Elementary theory of power series: Sequences – Series – Uniform convergence – Power series – Abel's limit theorem – The exponential – The trigonometry functions.

Unit-II: Complex Integrations:Line integrals - Rectifiable arcs – Line integrals as functions of arcs - Cauchy's theorem for a rectangle - Cauchy's theorem in a circular disk - Cauchy's integral formula: The index of a point with respect to a closed curve – The integral formula – Higher derivatives.

Unit-III: Local properties of analytical functions: Removable singularities. Taylor's theorem – Zeros and poles – The local mapping – The General form of Cauchy's theorem: Chains and Cycles - Simple connectivity – Homology – The statement and proof of General form of Cauchy's theorem.

Unit –IV: The calculus of residues: The residue theorem – The argument principle – Harmonic functions: Definition and basic properties – The mean-value property – Poisson's formula – Schwarz's theorem - The reflection principle.

Unit-V: Weierstrass theorem – The Taylor series – The Laurent series - Equicontinuity – Normality and compactness – Arzela's theorem – Families of analytic functions – The classical definition.

Text Book:

Lars V. Ahlfors - Complex Analysis - Third Edition - McGraw- Hill International Company, Singapore, 1979.

Unit I ; **Chapter 2:** Sections - 1.3, 1.4, 2.1 to 2.5, and 3.1, 3.2.
Unit II : **Chapter 4:** Sections – 1.1 to 1.5 and 2.1 to 2.3.
Unit III: **Chapter 4:** Sections – 3.1 to 3.3 and 4.1 to 4.5.
Unit IV: **Chapter 4:** Sections – 5.1, 5.2 and 6.1 to 6.5.
Unit V: **Chapter 5:** Sections: 1.1 to 1.3 and 5.1 to 5.5.

Reference Books:

1. John B.Conway, Functions of one complex variable, Second Edition, Springer 1978
2. V.Karunakaran, Complex Analysis, Second Edition, Alpha science International Limited,U.K.
3. R.Roopkumar, Complex Analysis, First Edition, Published by Pearson, Delhi.

Core 12 - NUMERICAL METHODS

Contact Hours per Semester: 90 hrs — Subject code: P19MAC33
Contact Hours per week: 6hrs — Credit: 4

Objectives:

- To know about the direct and indirect methods for finding the roots of transcendental and polynomial equations
- To know various methods for finding eigen values and eigen vectors.
- To discuss the single step and multistep methods for solving first order initial value problems.
- To discuss several methods of differentiation
- To discuss several methods of integration

Unit: I Transcendental and Polynomial Equations (18 hours)

Bisection method – Iteration Methods based on First degree Equation – Iteration Methods based on Second degree Equation – Rate of convergence

Unit : II System of Linear Equations and Eigen value Problems (18 hours)
Introduction – Direct Methods – Iteration methods- Eigen value and Eigen vectors

Unit : III System of Linear Equations and Eigen value Problems(cond…) (18 hours)
Jacobi method for symmetric matrices – Givens Methods for symmetric matrices – Householder's Method for symmetric matrices – Rutishauser Method for Arbitary Matrices- Power Method- Inverse Power method

Unit : IV Interpolation (18 hours)
Introduction – Lagrange and Newton interpolation-Finite difference operator-Interpolation polynomials using finite differences-Hermite interpolations.

Unit : V Differentiation and Integration (18 hours)
Introduction-Numerical Differentiation-Extrapolation Methods-Partial Differentiations –Numerical Integration- Methods Based on interpolation- Composite integration methods-Romberg Integration-Double Integration

Text Book:
NUMERICAL METHODS for Scientific and Engineering Computation
5th Edition –M.K.JAIN, S.R.K.IYENGAR, R.K.JAIN - 2007

UNIT 1: SECTION - 2.2, 2.3, 2.4, 2.5
UNIT II: SECTION – 3.1, 3.2, 3.4, 3.5
UNIT III: SECTION- 3.7 to 3.12
UNIT IV: SECTION – 4.1 to 4.5
UNIT V: SECTION -5.1, 5.2, 5.4, 5.5, 5.6, 5.7, 5.9, 5.10, 5.11

Reference Books:
1. Hilderbrond, F-B Introduction of Numerical Analysis. McGraw-Hill New York, 1953
2. Sastory, Numerical Methods
3. S. Arumugom, Numerical methods Scitech, publications, 2001

CORE 13 MEASURE THEORY

Contact Hours per semester : 90 Subject Code : P19MAC34
Contact Hours per week : 6 Credit : 4

Objectives:

- Enable the students to know about the concept of measure on the real line
- To get the knowledge about integration measurable functions
- Enable the students to know about the extension of measure and integration to more abstract spaces and their consequences.

Unit I: (18 hours)
Measure on the real line:Lebesgue outer measure – Measurable sets – Regularity.

Unit II: (18 hours)

Measure on the real line (contd…):Measurable functions – Borel and Lebesgue measurability – Integration of functions of a real variable:Integration of non-negative functions.

Unit III: (18 hours)

Integration of functions of a real variable (contd…):The general integral – Integration of series – Riemann and Lebesgue integrals

Unit IV: (18 hours)

Abstract measure spaces: Measures and outer measures **–** Extension of a measure **–** Uniqueness of the extension – Completion of a measure - Measure spaces – Integration with respect to a measure.

Unit V: (18 hours)

Inequalities and the L^p Spaces**:** The L^p spaces –Convex functions - Jenson's inequality – The inequalities of Holder and Minkowski – Completeness of $L^p(\mu)$.

Text Book:

G. de. Barra, Measure theory and integration, New Age International (P) Limited, Publishers (Formerly Wiley Eastern Limited), 2008, New Delhi

Unit I : Chapter 2 : Sections 2.1, 2.2 and 2.3
Unit II : Chapter 2 : Sections 2.4, 2.5; Chapter 3: Section 3.1
Unit III : Chapter 3 : Sections: 3.2, 3.3 and 3.4
Unit IV : Chapter 5 : All Sections
Unit V : Chapter 6 : All Sections

Reference Books

1. H.L. Royden, Real analysis, Second Edition, Macmillan, New York, 1968
2. W. Rudin, Principles of Mathematical Analysis, McGraw-Hill, New York, 1966.
3. B. V. Limaye, Functional Analysis, New age international (P) Ltd, New Delhi, 2002.

ELECTIVE 2 (a) - INTEGRAL EQUATIONS

Contact Hours per semester : 90 Subject Code : P19MAE31

Contact Hours per week : 6 Credit : 5

Objective:

- Develop the ability to solve the problems involving integral equations.
- To know the method of converting initial and boundary value problems into integral equations.
- To understand the Classical Fredholm theory in solving problems
- To practice the application of Green's function in the conversion of initial and boundary value problems.

Unit I: (18 hours)

Integral equation – Definition – types – Solution – initial value problem – converting initial value problem into a volterra integral equation – boundary value problem – converting boundary value problem into a Fredholm integral equation.

Unit II: (18 hours)
Characteristic values – characteristic functions - solution to homogeneous Fredholm integral equations of second kind with separable kernel – examples.
Unit III: (18 hours)
Iterated kernels – iterative method – solution to Fredholm integral equations of second kind – Reciprocal function – solution to Volterra integral equation of second kind – Problems.
Unit IV: (18 hours)
Classical Fredholm theory – Fredholm first fundamental theorem – resolvent kernel –solution of integral equations.
Unit V: (18 hours)
Green's function – definition – conversion and solution of boundary value problems – special case – solution based on construction of green's function – problems.
Text Book:
Integral Equations and Boundary value problemsby M.D.Raisinghania, 3rd Edition,S. Chand & Company Ltd., Ram Nagar, New Delhi
Unit I Chapter 1 : Sections 1.1 to 1.18 and Chapter 2 : Sections 2.1 to 2.6
Unit II Chapter 3 Sections 3.1 to 3.3
Unit III Chapter 5 Sections 5.1 to 5.8 (Statement only) , 5.9 to 5.13
Unit IV Chapter 6 Sections 6.1 to 6.3
Unit V Chapter 11 Sections 11.1 to 11.6
Reference Books:
1. R. P. Kanwal, *Linear Integral Equations. Theory and techniques.* Academic Press, New York, 1971.
2. I.N. Sneddon, *Mixed boundary value problems in potential theory,* North Holland, 1966.

Elective 2b - CLASSICAL MECHANICS

Contact Hours per Semester: 90 hrs Subject code: P19MAE32 / P19MAE41
Contact Hours per week: 6hrs Credit: 5

OBJECTIVES:
- To enable the students to understand the concept of generalized co-ordinates and Lagrange's equation for holonomic system.
- To enable the students to understand the different variational principles.
- To derive the equation of motion.
- To enable the students to deal with the canonical transformation.

UNIT-I **(18 hours)**
D'Alembert's principle and Lagrange's equations. (Examples 1.1, 1.2, 1.3, 1.4, 1.5 and 1.6 only).
UNIT-II **(18 hours)**
Variational Principle and Lagrange's equations. (Examples 2.1, 2.2, 2.3, 2.4 and 2.5 only).
UNIT-III **(18 hours)**
Equations of Motions of Rigid body. (Examples: 3.1, 3.2 only).
UNIT-IV **(18 hours)**
Hamilton's Equations of Motions. (Examples: 4.1, 4.2, 4.3, 4.4 and 4.5 only)
UNIT-V **(18 hours)**
Canonical Transformations. (Examples: 5.1 and 5.2 only)

TEXT BOOK:
CLASSICAL MECHANICS (Revised Edition) by C.R.MONDAL, PHI,NEW DELHI:2011
UNIT-I : Chapter-I UNIT-II : Chapter-II
UNIT-III: Chapter-III UNIT-IV: Chapter-IV
UNIT-V: Chapter-V
(Exercise Problems are excluded)

REFERENCE BOOK :
1.CLASSICAL MECHANICS by Goldstein
2. MECHANICS by Synge and Giriffith
3. Green Wood, Classical Dynamics

SEMESTER IV
CORE 14 - OPTIMIZATION TECHNIQUES

Contact hours per semester: 90 Subject Code: P19MAC41
Contact hours per week: 6 Credits: 4

Objectives:
- To know the techniques of network models and classical optimizations
- To give the tools of solving non-linear programming

Unit I: Network Models: Minimal spanning tree algorithm – Shortest route algorithms – maximal flow Problems – critical path calculations – Tree and total floats. (18 hours)
Unit II: Advanced linear programming : simplex method using the restricted basis – banded variables Algorithm – Revised Simplex method. (18 hours)
Unit III: Game Theory : Optimal solution of two person zero sum games – solution of mixed strategy games - Linear programming solution of games. (18 hours)
Unit IV: Classical Optimization Theory: Jocobian Method - Lagrangin Method – The Newton Raphson –Kuhn – Tucker conditions. (18 hours)
Unit V: Unconstrained algorithms – Non Linear Programming Algorithms: Separable Programming – Quadratic Programming. (18 hours)
Text Book: Operations Research, H.A. Taha, 8th edition, prentice Hall, New Delhi, 2008.
UNIT 1: Chapter 6 – Sections 6.2, 6.3.2, 6.4.2, 6.5.2, 6.5.3.
UNIT 2: Chapter 7- Sections 7.1 to 7.3.
UNIT 3: Chapter 13- Sections 13.4
UNIT 4: Chapter 18 – Sections 18.1 & 18.2.
UNIT 5: Chapter 19 – Sections 19.1, 19.2.1 and 19.2.2.
Note: Computer Programming portions are excluded.

Reference Book:
1. **Operations Research, 12th Thoroughly Revised Edition** by Kanti Swarup,P.K.Gupta,Man Mohan
2. **Resource Management Techniques (Operations Research)** Prof.V.Sundaresan,K.S.Ganapathy Subramanian,K.Ganesan, -A.R.Publications.

CORE 15 - FUNCTIONAL ANALYSIS

Contact Hours per Semester: 90 hrs — Subject code:P19MAC42
Contact Hours per week: 6hrs — Credit: 4

Objectives:

To enable the students to

- Understand the basic concepts of Normed linear Spaces and continuity of linear maps
- Know the two important theorems on Banach spaces
- Understand the three fundamental theorems in functional analysis and how to use this theorems in problems

Unit I: (18 Hours)

Banach spaces – Definition and examples – Continuous linear transformations – Hahn Banach theorem

Unit II: (18 Hours)

Open mapping theorem – The conjugate of an operator – Hilbert spaces – Definition, Examples and simple properties – Orthogonal complements.

Unit III: (18 Hours)

Orthonormal sets – Conjugate space H* - The adjoint operator – Self adjoint operators – Projections.

Unit IV: (18 Hours)

Banach algebras- Definition and some examples – Regular and singular elements – Topological divisors of zero.

Unit V: (18 Hours)

The spectrum – The formula for spectral radius

Text Book:

G.F. Simmons , Introduction to Topology and Modern Analysis; Tata McGraw Hill International Company, International Student Edition, 2004.

Unit I: Chapter 9: **S**ections – 46,47,48
Unit II : Chapter 9:Sections – 50,51 ; **Chapter 10:** Sections – 52 and 53
Unit III : Chapter-10:Sections – 54 (example 4 is excluded); 55, 56, 57, 59
Unit IV : Chapter 12**:** Sections – 64, 65, 66
Unit V : Chapter 12:Sections – 67 and 68

Reference:

B. V. Limaye, Functional Analysis, New age international (P)Ltd, New Delhi, 2002.

CORE 16 - COMBINATORICS

Contact Hours per Semester: 90 hrs — Subject code: P19MAC43
Contact Hours per week: 6hrs — Credit: 4

Objectives:

To enable the students to

(iii) Understand the basic concepts of permutations and combinations
(iv) Be familiar with generating functions and techniques
(iii) Develop skills to obtain solutions of recurrence relations by generating functions
(iv) Solve problems using the principle of inclusion and exclusion

(v) know the applications of Polya's fundamental theorem in Combinatorics

Unit : I PERMUTATION AND COMBINATION **(**18 hours)

r-permutations and r-combinations with and without Repetition- The rules of sums and products- Permutations-Combinations-Distributions of Distinct objects - Distributions of non-Distinct objects-Stirling's formula.

Unit : II GENERATING FUNCTIONS **(**18 hours)

Generating functions for Combinations-Enumerators for Permutations- Distributions of Distinct objects into non distinct cells – Partitions of Integers-Elementary Relations.

Unit : III RECURRENCE RELATIONS **(**18 hours)

Linear recurrence Relations with constant coefficients-Solutions by the technique of Generating Functions

Unit : IV THE PRINCIPLE OF INCLUSION AND EXCLUSION **(**18 hours)

The general formula – Derangements – Permutations with restrictions on relative positions

Unit : V POLYA'S THEORY OF COUNTING **(**18 hours)

Equivalence classes under a permutations group – Burnside theorem-Equivalence classes of functions- weights and inventories of functions-Polya's Fundamental Theorem

Text Book:

Liu.C.L.., "Introduction to Combinatorial Mathematics",MCGraw Hill Book Co..New York 1968.

Contents:

Chapter 1:Sections 1.1 to 1.7
Chapter 2:Sections 2.1 to2.5 and 2.7
Chapter 3:Sections 3.1 to 3.3
Chapter 4:Sections 4.1 to 4.5
Chapter 5:Sections 5.3 to 5.6

Reference Books:

1. Bala Krishnan,V.K.,"Combinatorics",Tata McGraw Hill publishing Co., New Delhi, 2005.
2. Daniel I.A.Cohen, "Basic Techniques of Combinatorial Theory and Applications", John Wiley and Sons., New Delhi,1978.
3. Krishnamurthy.V.," Combinatorics Theory and Applications", Affiliated East West Press Pvt.Ltd.,Chennai,1985.

Elective 3A - APPLICATIONS OF GRAPH THEORY

Contact hours per semester: 90 **Subject Code: P19MAE41 / P19MAE31**
Contact hours per week: 6 **Credits: 5**

Objectives:

To help the students to know various applications of Graph theory and motivate them towards research on Graph theory

Unit I: The Shortest path problem – Sperner's lemma – Cayley's formula. (18 hours)

Unit II: The connector problem – construction of reliable communication networks – The Chinese Postman problem. (18 hours)

Unit III: The Travelling Salesman problem – The Personnel Assignment problem – The Optimal Assignment problem. (18 hours)

Unit IV: The Time Tabling problem – Ramsey's theorem (18 hours)

Unit V: Dominating Sets in Graphs – Sets of Representatives – School Bus Routing – Computer Communication networks – Radio stations – Social Network Theory (18 hours)

Text Books:

1. J.A. Bondy and U.S.R. Murty - Graph Theory with Applications- North Holland, New York, 1976.

Unit I – Sections – 1.8, 1.9, 2.4
Unit II- Sections – 2.5, 3.3, 4.3
Unit III-Sections – 4.4, 5.4, 5.5
Unit IV – Sections – 6.3, 7.2

1. Fundamentals of Domination in Graphs' by Tenasa W. Haynes, Stephen T. Hedetniemi and P.J. Slater, Marcel Dekker, Inc 1998Unit V – Sections – 1.2, 1.5, 1.7, 1.8

Reference Books:

1. John Clark, A First Look at Graph Theory, Allied Publishers, 1995
2. M. Murugan, Topics in Graph Theory and Algorithms, Muthali Publishing house, Chennai, 2003

Elective 3B - ADVANCED TOPOLOGY

Contact Hours per Semester: 90 Subject code:P19MAE42
Contact Hours per week: 6 Credit: 5

Objectives:

To get deep knowledge about various compactifications and metrization and theorems on completeness.

Unit I: The Tychonoff theorem: The Tychonoff theorem- The Stone-Cech compactification **(18 hours)**

Unit II: Metrization theorem: Local finiteness – The Nagata-Smirnov Metrization theorem **(18 hours)**

Unit III: Paracompactness : Paracompactness – The Smirnov metrization theorem **(18 hours)**

Unit IV: Complete metric spaces: Complete metric spaces – A space filling curves – compactness in metric spaces **(18 hours)**

Unit V: Baire spaces: Pointwise and compact convergence – Ascoli's theorem – Baire spaces **(18 hours)**

Text Books:

James R. Munkres, Topology, Second Edition, Pearson Education, Singapore, 2001

Unit I: Chapter 5: Sections 37, 38
Unit II: Chapter 6: Sections 39,40
Unit III: Chapter 6: Sections 41, 42
Unit IV: Chapter 7: Sections 43, 44 and 45
Unit V: Chapter 7: Sections 46, 47 and 48

Reference(s)

1. J.L. Kelley, General Topology, Springer-Verlag, New York, 1991
2. S. Willard, General Topology, Addition-Wesley publishing Company Inc., Reading, 1970

Elective 3C - Stochastic Processes

Contact Hours per Semester: 90 hrs — Subject code: P19MAE43
Contact Hours per week: 6hrs — Credit: 5

Objectives

□ □ To introduce the basic concepts in stochastic process.
□ □ To motivate preliminary definitions in Markov Chain, Markov, Process, Poisson Process etc.

Unit I: **(18 hours)**

Stochastic Process: Introduction – Specification of Stochastic Processes, Stationary processes, Martingales, Markov Chains: Definitions and Examples, Higher transition probabilities, classification of states and chains.

Unit II: **(18 hours)**

Stability of Markov chain, Markov chains with denumerable number of states, Poisson process.

Unit III: **(18 hours)**

Poisson process and related distributions – Markov chain with discrete state space.

Unit IV: **(18 hours)**

Renewal process: Renewal process-Renewal process in continuous time – Renewal equation – Stopping time: Wald's equation – Renewal theorems.

Unit V: **(18 hours)**

Markov Renewal and semi-markov processes: Introduction – Definitions and Preliminaries results – Markov renewal equations – Limiting behaviours.

Text Book:

" Stochastic Processes", Prof. J. Medhi
Unit I: Chapter2: 2.1 to 2.4; Chapter3: 3.1, 3.2, 3.4 (3.3 is not included)
Unit II: Chapter3: 3.6, 3.8, 4.1 (pages 157-169)
Unit III: Chapter4: 4.2 to 4.5 (pages 170-206)
Unit IV: Chapter6: 6.1 to 6.5 (pages 242 – 272)
Unit V: Chapter7: 7.1 to 7.4 (pages 313 – 331) (example problems only)

Reference Book:

"Modelling and Analysis of Stochastic Systems", V. G. Kulkarni, CRC Press (2nd Edition)

Course Name : Master of Science
Discipline : Mathematics
CHOICE BASED CREDIT SYSTEM
(For those who joined in June 2018 and after)
Course Scheme:

Self-Learning Course:

Subject	Credit	Ext =Tot	Subject Code
Research Topics in Mathematics	5	100 = 100	P19MASL31

SELF LEARNING
RESEARCH TOPICS IN MATHEMATICS

Credit: 5 Subject code: P19MASL31
TOTAL MARKS : 100

Objectives:

- To motivate the students to learn about completeness in functions spaces and the notion of various convergence in the topological spaces.
- To motivate the students to learn about the regular and semi regular graphs and some interesting properties of switching in graphs

Unit I: Regular and Semi regular graphs: Basic definitions – Semi regular graphs – Results.
(Text Book 1: Chapter 1)

Unit II: Switching in Graphs: Basic Definitions – Self vertex Switching – Results.
(Text Book 1: Chapter 2)

Unit III: Copairs and Dual copairs: Definition – Examples - Characterisation and Enumeration.
(Text Book 1: Chapter 5)

Unit IV:Complete Metric Spaces and Function Spaces: Complete metric spaces – A space-Filling curve
(Text Book 2: Chapter 7: Sections 43, 44)

Unit V: Complete Metric Spaces and Function Spaces: Compactness in metric spaces – Pointwise and compact convergence
(Text Book 2: Chapter 7: Sections 45 and 46)

Text Book(s)

1. Selvam Avadayappan and M. Bhuvaneshwari, An introduction to research in Mathematics 2015
2. James R. Munkres, Topology, Second Edition, Pearson Education, India, 2001

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1 Selvam Avadayappan and M. Bhuvaneshwari, Characterization of Copair Integers, Journal of Modern Science, Vol.4- No.1, 45-47, February 2012.
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3 R.Balakrishnan and K. Ranganathan A Text Book of graph Theory, Springer-verlag, New York, Inc(1999) .
4 C. Jayasekaran, *Self vertex switchings of connected graphs*, Proceedings of the national conference on the emerging trends in Pure and Applied Mathematics held at St. Xavier's College, Palayamkottai, Tamilnadu, India 2005, pp. 154-160.
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8 James Dugunji, Topology, Printice-Hall of India Pvt Ltd, 1975
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