MANAV RACHNA UNIVERSITY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS

PROGRAM STRUCTURE

&

DETAILED SYLLABUS

M.Sc. Mathematics

BATCH: 2017-2019

MANAV RACHNA UNIVERSITY									
DEPARTMENT OF MATHEMATICS									
M.Sc. MATHEMATICS (2017 - 19)									
SEMESTER - 1									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (HARD/SOFT/WORKSHOP/ NTCC)**	**COURSE TYPE (CORE/ELECTIVE / UNIVERSITY COMPULSORY)**	**L**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MAH501	ABSTRACT ALGEBRA	MA	HARD	CORE	4	0	0	4	4
MAH502	TOPOLOGY-I	MA	HARD	CORE	4	0	0	4	4
MAH503	DIFFERENTIAL EQUATIONS	MA	HARD	CORE	4	0	0	4	4
MAH504	GRAPH THEORY	MA	HARD	ELECTIVE	4	0	0	4	4
MAH505	OPERATIONS RESEARCH	MA							
MAH514	MATHEMATICAL STATISTICS	MA							
MAH507-P	MATHS LAB- I	MA	HARD	CORE	0	4	0	4	2
MAW508	SCILAB	MA	WORKSHOP	ELECTIVE	0	3	0	3	2
MAW509	MATHEMATICA								
MAW231	SPSS								
MAW225	LaTeX								
MAW538	ADVANCED STATISTICS USING EXCEL								
PHS501	RESEARCH METHODOLOGY	PH	SOFT	ELECTIVE	1	2	0	3	2
	TOTAL (L-P-O/CONTACT HOURS/CREDITS)				**17**	**9**		**26**	**22**
SEMESTER - 2									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**COURSE TYPE (Core/Elective / University Compulsory)**	**L**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MAH510	ADVANCED LINEAR ALGEBRA	MA	HARD	CORE	4	0	0	4	4
MAH511	COMPLEX ANALYSIS	MA	HARD	CORE	4	0	0	4	4
MAH512	MEASURE THEORY	MA	HARD	CORE	4	0	0	4	4
MAH513	FUZZY SETS & FUZZY LOGIC	MA	HARD	ELECTIVE	4	0	0	4	4
MAH504	GRAPH THEORY								
MAH505	OPERATIONS RESEARCH								
MAH506	MATHEMATICAL MODELLING & SIMULATION								
MAH515	TOPOLOGY-II								

MAH516	MATHS LAB-II	MA	HARD	CORE	0	4	0	4	2
MAW508	SCILAB	MA	WORKSHOP	ELECTIVE	0	3	0	3	2
MAW509	MATHEMATICA								
MAW231	SPSS								
MAW225	LaTeX								
MAW538	ADVANCED STATISTICS USING EXCEL								
EDS234	PEDAGOGICAL SKILLS	ED	SOFT	ELECTIVE	1	2	0	3	2
	TOTAL (L-P-O/CONTACT HOURS/CREDITS)				**17**	**9**	**0**	**26**	**22**
MAO517	SUMMER TRAINING POST 2nd SEMESTER								**3**
SEMESTER - 3									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**COURSE TYPE (Core/Elective / University Compulsory)**	**L**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MAH618	FUNCTIONAL ANALYSIS	MA	HARD	CORE	4	0	0	4	4
MAH619	DIFFERENTIAL GEOMETRY	MA	HARD	CORE	4	0	0	4	4
MAH620	DYNAMICS OF RIGID BODY	MA	HARD	CORE	4	0	0	4	4
MAH504	GRAPH THEORY	MA	HARD	ELECTIVE	4	0	0	4	4
MAH505	OPERATIONS RESEARCH								
MAH506	MATHEMATICAL MODELLING & SIMULATION								
MAH513	FUZZY SETS & FUZZY LOGIC								
MAH621	CODING THEORY								
MAH624	FOURIER ANALYSIS								

MAH625	MATHS LAB-III	MA	HARD	CORE	0	4	0	4	2
MCS231	BASICS OF ECONOMICS	MC	SOFT	ELECTIVE ALLIED (BASKET OF COURSES BY MANAGEMENT DEPTT)	1	2	0	3	2
MCS232	INTRODUCTION TO FINANCE								
MAN626	SEMINAR	MA	NTCC	CORE	0	0	2	2	2
	TOTAL (L-P-O/CONTACT HOURS/CREDITS)				**17**	**6**	**2**	**25**	**22**
SEMESTER - 4									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**COURSE TYPE (Core/Elective / University Compulsory)**	**L**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MAH635	CALCULUS OF VARIATION & INTEGRAL EQUATIONS	MA	HARD	CORE	4	0	0	4	4
MAH628	FLUID MECHANICS	MA	HARD	CORE	4	0	0	4	4
MAH629	ALGEBRAIC TOPOLOGY	MA	HARD	ELECTIVE	4	0	0	4	4
MAH630	CRYPTOGRAPHY								
MAH627	WAVELET ANALYSIS								
MAH623	ADVANCED OPERATIONS RESEARCH								
MAH636	DIFFERETIABLE MANIFOLDS								
MAH632	THEORY OF ELASTICITY & FRACTURE MECHANICS								
MAH633	MATHS LAB-IV	MA	HARD	CORE	0	4	0	4	2
MAN634	PROJECT	MA	NTCC	CORE	0	0	6	6	6
MAW508	SCILAB	MA	WORKSHOP	ELECTIVE (ANY ONE)	0	3	0	3	2
MAW509	MATHEMATICA								
MAW231	SPSS								
MAW225	LaTeX								
MAW538	ADVANCED STATISTICS USING EXCEL								
	TOTAL (L-P-O/CONTACT HOURS/CREDITS)				**12**	**7**	**6**	**25**	**22**
								GRAND TOTAL OF CREDITS	**91**

MANAV RACHNA
Vidyanatariksha

MANAV RACHNA UNIVERSITY
(FORMERLY MANAV RACHNA COLLEGE OF ENGINEERING
NAAC ACCREDITED 'A' GRADE INSTITUTION)
Declared as State Private University under section 2f of the UGC act, 1956

PROGRAMME BOOKLET

M.Sc. Mathematics (MAP01)

(Batch: 2017-2020)

Department of Mathematics

Faculty of Applied Sciences

Manav Rachna University

MANAV RACHNA UNIVERSITY

Vision

To educate students in frontier areas of knowledge enabling them to take up challenges as ethical and responsible global citizens

Mission

- **To impart Course outcomes based holistic education**
- **To disseminate education in frontier areas**
- **To produce globally competitive, ethical and socially responsible human resources**
- **To produce human resources sensitive to issues of Environment and Sustainable Development**
- **To develop Environment and Sustainable development as a thrust area of research and development.**

Quality Policy

To continuously learn from the best practices, study role models and develop transparent procedures for empowerment of stakeholders.

Strategic Objectives

- **To facilitate, enhance & promote innovation in curriculum design and delivery and have Course outcomes-oriented Learning Culture.**
- **To promote Research Environment and Management Practices.**
- **To enhance the quality of the student learning experience.**
- **To provide Resources and Infrastructure for Academic Excellence.**

DEPARTMENT OF MATHEMATICS

Vision

To create an integrated teaching and research department to enhance the impact of mathematics.

Mission

- **To provide a niche where students can learn, apply and become proficient in mathematical concepts and their applications.**
- **To facilitate mathematical research and develop lifelong learners.**
- **To produce human resources that excels in their chosen profession and function as responsible citizens.**
- **To assist in application of Mathematical Sciences in different disciplines.**

M.Sc.(MATHEMATICS)

PEO's of Department of Mathematic:

PEO1: Preparation: To prepare graduates with strong fundamentals required for higher education, teaching or other jobs.
PEO2: Core Competence: Ability to approach problems in an analytical and rigorous way and apply appropriate mathematical skills in solving them.
PEO3: Breadth: To utilize the wide range of mathematical concepts along with pure, applied, mathematical statistics and numerical techniques equipped with mathematical software.
PEO4: Professionalism: To work as team with professional ethical practices.
PEO5: Learning Environment: To develop confidence for lifelong learning.

Program Course outcomess (POs)

PO1: Knowledge &Abstract thinking: Ability to absorb and understand the abstract concepts that lead to various advanced theories in mathematical sciences and their applications in real life problems.
PO2: PO2: Modelling and solving: Ability in modelling and solving problems by identifying and employing the appropriate existing theories and methods.
PO3: PO3: Advanced theories and methods: Understand advanced theories and methods to design solutions for complex mathematical problems and results.
PO4: PO4: Applications in Engineering and Sciences: Understand the role of mathematical sciences and apply the same to solve the real-life problems in various fields of study.
PO5: PO5: Modern software tool usage: Acquire the skills in handling scientific tools towards problem solving and solution analysis.
PO6: PO6: Ethics: Imbibe ethical, moral and social values in personal and social life. Continue to enhance the knowledge and skills in mathematical sciences for constructive activities and demonstrate highest standards of professional ethics.
PO7: PO7: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO8: PO8: Communication: Develop various communication skills such as reading, listening, and speaking which will help in expressing ideas and views clearly and effectively.
PO9: PO9: Research: Demonstrate knowledge, understand mathematical & scientific theories and apply these to one's own work, as a member/ leader in a team to manage projects and multidisciplinary research environments. Also use the research-based knowledge to analyse and solve advanced problems in mathematical sciences.
PO10: PO10: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning .
PO11: PO11: Professional Growth: Keep on discovering new avenues in the chosen field and exploring areas that remain conducive for research and development

DEPARTMENT OF MATHEMATICS									
M.SC IN MATHEMATICS									
M.Sc-MAP01 SESSION -2018-2021									
SEMESTER-I									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (HARD/SOFT/WORKSHOP/ NTCC)**	**COURSE TYPE (CORE/ELECTIVE / UNIVERSITY COMPULSORY)**	**L**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MAH501	ABSTRACT ALGEBRA	MA	HARD	CORE	4	0	0	4	4
MAH502	TOPOLOGY-I	MA	HARD	CORE	4	0	0	4	4
MAH503	DIFFERENTIAL EQUATIONS	MA	HARD	CORE	4	0	0	4	4
MAH504	GRAPH THEORY	MA	HARD	ELECTIVE	4	0	0	4	4
MAH505	OPERATIONS RESEARCH	MA							
MAH514	MATHEMATICAL STATISTICS	MA							
MAH507-P	MATHS LAB- I	MA	HARD	CORE	0	4	0	4	2
MAW508	SCILAB	MA	WORKSHOP	ELECTIVE	0	3	0	3	2
MAW509	MATHEMATICA								
MAW231	SPSS								
MAW225	LaTeX								
MAW538	ADVANCED STATISTICS USING EXCEL								
PHS501	RESEARCH METHODOLOGY	PH	SOFT	ELECTIVE	1	2	0	3	2
TOTAL (L-P-O/CONTACT HOURS/CREDITS)					**17**	**9**		**26**	**22**
SEMESTER - 2									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**COURSE TYPE (Core/Elective / University Compulsory)**	**L**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MAH510	ADVANCED LINEAR ALGEBRA	MA	HARD	CORE	4	0	0	4	4
MAH511	COMPLEX ANALYSIS	MA	HARD	CORE	4	0	0	4	4
MAH512	MEASURE THEORY	MA	HARD	CORE	4	0	0	4	4
MAH513	FUZZY SETS & FUZZY LOGIC	MA	HARD	ELECTIVE	4	0	0	4	4

MAH504	GRAPH THEORY								
MAH505	OPERATIONS RESEARCH								
MAH506	MATHEMATICAL MODELLING & SIMULATION								
MAH515	TOPOLOGY-II								
MAH516	MATHS LAB-II	MA	HARD	CORE	0	4	0	4	2
MAW508	SCILAB	MA	WORKSHOP	ELECTIVE	0	3	0	3	2
MAW509	MATHEMATICA								
MAW231	SPSS								
MAW225	LaTeX								
MAW538	ADVANCED STATISTICS USING EXCEL								
EDS234	PEDAGOGICAL SKILLS	ED	SOFT	ELECTIVE	1	2	0	3	2
TOTAL (L-P-O/CONTACT HOURS/CREDITS)					**17**	**9**	**0**	**26**	**22**
MAO517	SUMMER TRAINING POST 2nd SEMESTER							60	**3**
SEMESTER - 3									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**COURSE TYPE (Core/Elective / University Compulsory)**	**L**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MAH618	FUNCTIONAL ANALYSIS	MA	HARD	CORE	4	0	0	4	4
MAH619	DIFFERENTIAL GEOMETRY	MA	HARD	CORE	4	0	0	4	4
MAH620	DYNAMICS OF RIGID BODY	MA	HARD	CORE	4	0	0	4	4
MAH504	GRAPH THEORY	MA	HARD	ELECTIVE	4	0	0	4	4
MAH505	OPERATIONS RESEARCH								
MAH506	MATHEMATICAL MODELLING & SIMULATION								
MAH513	FUZZY SETS & FUZZY LOGIC								
MAH621	CODING THEORY								
MAH624	FOURIER ANALYSIS								
MAH625	MATHS LAB-III	MA	HARD	CORE	0	4	0	4	2
MCS231	BASICS OF ECONOMICS	MC	SOFT	ELECTIVE	1	2	0	3	2

MCS232	INTRODUCTION TO FINANCE			ALLIED (BASKET OF COURSES BY MANAGEMENT DEPTT)					
MAN626	SEMINAR	MA	NTCC	CORE	0	0	2	2	2
TOTAL (L-P-O/CONTACT HOURS/CREDITS)					**17**	**6**	**2**	**25**	**22**
SEMESTER - 4									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**COURSE TYPE (Core/Elective / University Compulsory)**	**L**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MAH635	CALCULUS OF VARIATION & INTEGRAL EQUATIONS	MA	HARD	CORE	4	0	0	4	4
MAH628	FLUID MECHANICS	MA	HARD	CORE	4	0	0	4	4
MAH629	ALGEBRAIC TOPOLOGY	MA	HARD	ELECTIVE	4	0	0	4	4
MAH630	CRYPTOGRAPHY								
MAH627	WAVELET ANALYSIS								
MAH623	ADVANCED OPERATIONS RESEARCH								
MAH636	DIFFERETIABLE MANIFOLDS								
MAH632	THEORY OF ELASTICITY & FRACTURE MECHANICS								
MAH633	MATHS LAB-IV	MA	HARD	CORE	0	4	0	4	2
MAN634	PROJECT	MA	NTCC	CORE	0	0	6	6	6
MAW508	SCILAB	MA	WORKSHOP	ELECTIVE (ANY ONE)	0	3	0	3	2
MAW509	MATHEMATICA								
MAW231	SPSS								
MAW225	LaTeX								
MAW538	ADVANCED STATISTICS USING EXCEL								
	TOTAL (L-P-O/CONTACT HOURS/CREDITS)				**12**	**7**	**6**	**25**	**22**
GRAND TOTAL OF CREDITS									**91**

Total Credits Scheme

S. No.	Semester	Contact Hours	Credits
1	I	26	22
2	II	25	22
3	Summer Training (Post II Sem)	60	03
4	III	25	22
5	IV	25	22
Total		161	91

M.Sc. (MATHEMATICS) – SEMESTER I

SUBJECT CODES	SUBJECT NAME	**OFFERING DEPARTMENT	*COURSE NATURE (HARD/SOFT/WORKSHOP/ NTCC)	COURSE TYPE (CORE/ELECTIVE / UNIVERSITY COMPULSORY)	L	P	O	NO. OF CONTACT HOURS PER WEEK	NO. OF CREDITS
MAH501	ABSTRACT ALGEBRA	MA	HARD	CORE	4	0	0	4	4
MAH502	TOPOLOGY-I	MA	HARD	CORE	4	0	0	4	4
MAH503	DIFFERENTIAL EQUATIONS	MA	HARD	CORE	4	0	0	4	4
MAH504	GRAPH THEORY	MA	HARD	ELECTIVE	4	0	0	4	4
MAH505	OPERATIONS RESEARCH	MA							
MAH514	MATHEMATICAL STATISTICS	MA							
MAH507-P	MATHS LAB- I	MA	HARD	CORE	0	4	0	4	2
MAW508	SCILAB	MA	WORKSHOP	ELECTIVE	0	3	0	3	2
MAW509	MATHEMATICA								
MAW231	SPSS								
MAW225	LaTeX								
MAW538	ADVANCED STATISTICS USING EXCEL								
PHS501	RESEARCH METHODOLOGY	PH	SOFT	ELECTIVE	1	2	0	3	2
TOTAL (L-P-O/CONTACT HOURS/CREDITS)					**17**	**9**		**26**	**22**

BASKET OF WORKSHOP ELECTIVES (ANY ONE):

1) SCILAB —MAW508
2) STATISTICS USING EXCEL —MAW119
3) MATHEMATICA--MAW509
4) SPSS —MAW231
5) LATEX—MAW225
6) HTML5 & CSS-CSW102

DETAILED SYLLABUS
MAPN01-SEMESTER I

Course Title/ Code	ABSTRACT ALGEBRA(MAH501)
Course Type	Core (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	To familiarize students with the concept of group, ring and fields.
Course outcomess	The student would be able to conceptualize and apply the concepts ofModern Algebraic Structures.
Prerequisites (If any)	Students should have a basic knowledge of Modern Algebra

Section A

Introduction of Group, subgroup and Quotient group, Sylow's P-subgroups, Sylow's Theorems, Simple groups, Solvable groups, Nilpotent groups, Simplicity of Alternating Groups, Normal and Subnormal series, Composition series, Jordan-Holder Theorem. Direct product of groups, Structure theorem for finitely generated Abelian Groups.

Section B

Rings, Ring extensions; Polynomial rings, Formal power series rings, Matrix rings, Group rings, Ideals; Prime and Maximal ideals, Rings of fractions, Chinese Remainder Theorem for pairwise comaximal ideals.

Section C

Euclidean Domains, Principal Ideal Domains and Unique Factorizations Domains. Poly-nomial ringsover UFD's.

Section D

Fields, Characteristic and prime subfields, Field extensions, Finite, Algebraic and finitely generated field extensions, Classical ruler and compass constructions, Splitting fields, Finite fields, Cyclotomic fields, Separable and Inseparable extensions.

RecommendedBooks:

1. M. Artin, Algebra, Prentice Hall of India, 1994.
2. D.S. Dummit and R. M. Foote, Abstract Algebra, 2nd Ed., John Wiley, 2002.
3. I.B.S. Passi, Group Theory
4. I.B.S. Passi, Ring Theory
5. J.A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa, 1999.

Course Title/ Code	TOPOLOGY-I(MAH502)
Course Type:	Core (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	To familiarize students with Sets, metric spaces, topological spaces, continuousmappings, connectedness, compactness.
Course outcomess	The student would be able to conceptualize and apply the concepts of Topological Spaces.
Prerequisites (If any)	NA

Section A

Metric spaces , Topological spaces, Closed set, Closure, Dense subset, Neighborhoods, Interior, Exterior and Boundary, Accumulation point and Derived sets, Bases Sub–bases, Sub space and Relativetopology.

Section B

Characterization of topology in terms of base and subbase axioms, Topology generated by a family ofsubsets, Alternate methods of defining a topology in term of Kuratowski closure Operator and Neihbourhood System, Continuous functions and Homomorphism.

Section C

First and Second Countable spaces, Lendelof's theorem, Separable spaces, Second count ability and Separability, Separation axioms T0,T1,T2,T3-1\2,T4, Their Characterizations and basic Properties, Urysohn's lemma, Teitze extension theorem.

Section D

Compactness, Continuous functions and Compact sets, Basic properties of Compactness, Compactness and finite intersection property, Sequentially and countably compact sets, Connected spaces, Connectedness on the real line, Components, Locally connected space.

Recommended Books:

1. James R. Munkres, Topology (2ndEdition) Pearson Education Pve. Ltd., Delhi-2002
2. George F.Sinmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co.,1963
3. J. Dugundji , Topology , Prentice Hall of India, New Delhi, 1975.
4. K. D. Joshi : Introduction to General Topology (Wiley Eastern Limited).
5. S. Kumaresan: Topology of Metric Spaces, alpha science.

Course Title/ Code	DIFFERENTIAL EQUATIONS(MAH503)
Course Type:	CORE (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	Exposure to Ordinary Differential equations(Existence and Uniqueness), Partial Differential equations, system of differential equations, Applications
Course outcomes	The student would be able to apply the concepts of Differential Equations invarious physical problems.
Prerequisites (If any)	NA

Section-A

Existence and Uniqueness of Ordinary Differential equations, Picard's method, Sturm comparison and separation theorems, System of first order non homogeneous equations, Homogeneous Linear system, Non- homogeneous Linear system, Linear system with constant coefficient, Two point boundary value problems, Green functions, Strum- Lioville System, Eigen value and Eigen functions.

Section-B

Stability of autonomous system of differential equation, Types of critical points, Critical points and Stability of linear systems, stability by Liapunov's Direct method, Simple critical points of nonlinear systems, Nonlinear mechanics, Periodic solutions, The Poincare – Bendixson Theorem.

Section-C

Solution of Cauchy's problem of First order Partial Differential equations, Solution of Non-homogeneous PDE by Jacobi's method, PDE of the Second order (Homogeneous and Non-Homogeneous), Monge's Method, Method of separation of variables, Method of Integral transform.

Section-D

Laplace Equation in two dimension, Green function for Laplace Equation, Drichlet and Newman problemfor Half plane, Drichlet and Newman problem for circle, Drichlet and Newman problem for sphere and semi- infinite space, Wave Equation, Diffusion equation.

Recommended Books:

1. G. F. Simmons: Differential equation with Application and Historical Notes, McGraw-Hill
2. Ian Sneddon: Elements of Partial Differential Equations, McGraw-Hill.
3. S. L. Ross: Differential Equations, Wily India.
4. M. D. Raisinghania : Advance Differential equation, S.Chand India.

Course Title/Code	MATHS LAB-I(MAH507-P)
Course Type:	Core (Departmental)
L-P-O Structure	0-4-0
Credits	2
Objective	To familiarize students with MATLAB - Installation ,practical application in math's and in real world
Course outcomes	The student would be able to apply the tools of MATLAB software for solvingmathematical problems.
Prerequisites (If any)	NA

LAB EXERCISE:

1. Introduction to MATLAB and use of some simple MATLAB commands.
2. Introduction to some of the fundamentals of MATLAB: Variables, operators, expressions andArrays(including vectors and matrices)
3. Introduction to graphics: Basic Two-Dimensional Graphs, Labels, Multiple plots on the sameaxes, Line styles, Markers and color, Axis limits and Subplots.
4. Introduction to graphics: Three-Dimensional Graphs, Labels, Multiple plots on the same axes,Line styles, Markers and color, Axis limits and Subplots.
5. To find the Rank of a matrix, Inverse of a Square matrix and to reduce a matrix into Normal Form.
6. To solve the system of simultaneous linear equations. To find the Eigen values and Eigen vectorsof a square matrix.
7. To find derivatives, partial derivatives & directional derivatives of functions.
8. To find limit, continuity & differentiability of function of single variable.
9. To find limit, continuity & differentiability of function of several variables.

10. To find maxima & minima of function of single & several variables.
11. Evaluation of Single, Double integral and Triple Integration.
12. To find the Surface area and volume of solids of revolution by single & double integration.
13. To solve ODE & LDE & plot the graph of the solution of LDE. Also, solve the linear differential equations with variable coefficients(Cauchy & Legendre Differential equations).
14. To solve & plot solutions the system of two & three ordinary differential equations.
15. To find gradient of a scalar field (through graph also). Also, find directional derivatives, divergence& curl (through graph also).

Recommended Book:

- MATLAB, An introduction with application-Amos Gilat, Welly India

Course Title/Code	RESEARCH METHODOLOGY(PHS501)
Course Type:	Core (Allied)
L-P-O Structure	1-2-0
Credits	2
Objective	Student shall be able to apply the fundamentals of research methodology to a problem and make an informed decision.
Course outcomes	• write hypothesis; generate and choose alternatives; and test hypothesis. • select a sample ; generate data and present it • Calculate averages and dispersion • Calculate correlation and regression.
Prerequisites (If any)	N.A

Section A

Basic Concepts of Research; Formulation & steps of Research: Decision-making: identifying the problem & Steps of decision-making process. Research: Its objectives and types. Formulation of Research Problem; its components and sources. Steps of research & Research ethics. Performance monitoring in research

Research Design: Requirements of Research Design; Types of Research Design; Factors Affecting Research Design; Hypothesis Formulation; Hypothesis Testing

Section B

Sampling Methods and Techniques: Sampling design; Scope of sampling method; Laws of sampling; Determination of sample size; Techniques of sampling**.**

Properties of Data Collection and Measurement : Basic Characteristics of data; Types of data and Scaling measurement. Methods of primary data collection; Editing Raw Data; Coding of Data; Tabulation of Data; Constructing Charts.

Presentation of Results : Report writing: Purpose of a Report; Essentials of a Good Report; Format of a Report; Types of Report Presentation.

Section C

Measures of Central Tendency: Types of Averages: The Arithmetic Mean; The Weighted Arithmetic Mean; The Median; The Mode; The Geometric Mean; The Harmonic Mean

Measures of Dispersion: Definition; Methods of Measuring Dispersion; The Range; The Inter-quartile Range; The Mean/Average Deviation ; The Standard Deviation; The Coefficient of Variation; The Gini Coefficient and the Lorenz Curve

Matrix Algebra : Matrix Multiplication; Matrix Addition; Matrix Substitution; Transpose of the Product of Two Matrices; Inverse of a Square Matrix; Matrix

Notation in Case of Regression Analysis

Section D

Multivariate Analysis; Correlation & Regression Analysis: Factor Analysis; Discriminant Analysis; Cluster Analysis; Dimensional Analysis; Meta Analysis; Conjoint Analysis. Introduction to Correlation Analysis; Rank Correlation; Linear Regression Analysis; Multiple Regression Analysis

Laboratory Work:

1. Identifying the hypothesis; alternatives and situations in given abstracts/reports.
2. Writing a research proposal as per research design fundamentals.
3. Coding, tabulating and drawing charts for a given data.
4. Calculating & plotting averages for the given data
5. Measuring dispersion for the given data.
6. Calculating correlation for the given data.
7. Calculating regression for a given data.

Mini Project: Identify a problem in given environment and apply the concepts of research methodology to conduct research and present the results.

Teaching Methodology: The course shall be a mix of lecture and self study mode. The main stress shall be on application of concepts by students in laboratory and shall culminate in submission of a brief project report on a problem identified by the student.

Evaluation scheme:

Course Course outcomes	Demonstration of Achievement of Course Course outcomes	Level of performance expected from student	*Measurement of success (For faculty reference)
write hypothesis; generate and choose alternatives; and test hypothesis.	Test T 3	70%	70%
	Laboratory exercises 1 & 2		
	PT1		
select a sample ; generate data and present it	Test T 3 Laboratory exercises 3 PT1		
Calculate averages and dispersion	Test T3 Laboratory exercises 4 & 5 PT2		
Calculate correlation and regression	Test T3 Laboratory exercises 6 & 7 PT3		

* *Course coordinator shall define the expected % of students who shall demonstrate the achievement of course Course outcomes.*

Text Books:

1. Research Methodology by Dr. Prashant Sarangi. Taxmann Publications Pvt Ltd

MAPN01- Semester II

SUBJECT CODES	SUBJECT NAME	**OFFERING DEPARTMENT	*COURSE NATURE (Hard/Soft/ Workshop/ NTCC)	COURSE TYPE (Core/Elective / University Compulsory)	L	P	O	NO. OF CONTACT HOURS PER WEEK	NO. OF CREDITS
MAH510	ADVANCED LINEAR ALGEBRA	MA	HARD	CORE	4	0	0	4	4
MAH511	COMPLEX ANALYSIS	MA	HARD	CORE	4	0	0	4	4
MAH512	MEASURE THEORY	MA	HARD	CORE	4	0	0	4	4
MAH513	FUZZY SETS & FUZZY LOGIC	MA	HARD	ELECTIVE	4	0	0	4	4
MAH504	GRAPH THEORY								
MAH505	OPERATIONS RESEARCH								
MAH506	MATHEMATICAL MODELLING & SIMULATION								
MAH515	TOPOLOGY-II								
MAH516	MATHS LAB-II	MA	HARD	CORE	0	4	0	4	2
MAW508	SCILAB	MA	WORKSHOP	ELECTIVE	0	3	0	3	2
MAW509	MATHEMATICA								
MAW231	SPSS								
MAW225	LaTeX								
MAW538	ADVANCED STATISTICS USING EXCEL								
EDS234	PEDAGOGICAL SKILLS	ED	SOFT	ELECTIVE	1	2	0	3	2
TOTAL (L-P-O/CONTACT HOURS/CREDITS)					**17**	**9**	**0**	**26**	**22**

BASKET OF WORKSHOP ELECTIVES (ANY ONE): 1) SCILAB —MAW508
2) STATISTICS USING EXCEL —MAW119
3) MATHEMATICA--MAW509
4) SPSS —MAW231
5) LATEX—MAW225
6) HTML5 & CSS-CSW102

** MAW517---SUMMER TRAINING

DETAILED SYLLABUS

MAPN01-SEMESTER II

Course Title/ Code	ADVANCED LINEAR ALGEBRA(MAH510)
Course Type	Core(Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	The student would be able to conceptualize and apply the concepts of Advanced Liner Algebra.
Objective	The students would be able to apply the concepts of Vector Space, Linear Transformation and inner product Space required for solving the mathematical problems and their applications.
Course Course outcomes	• understand the concepts of vector spaces, subspaces, bases, dimension and their properties. • relate matrices and linear transformations, compute eigen values and eigen vectors of linear transformations. • learn properties of inner product spaces and determine orthogonality in inner product spaces. • realise importance of adjoint of a linear transformation and its canonical form.
Prerequisite (If any)	NA

Section A

Vector Spaces, Subspaces, Basis and dimension, Linear Transformations, Rank and nullity of a linear transformation, Sylvester's Law of nullity, Quotient spaces, direct sum, The matrix of a linear transformation,Duality.

Section B

Minimal polynomial, Invariant Subspaces, Eigen values and eigenvectors, Similarity of linear transformations, Diagonalizable operator, Cyclic subspaces and Annihilators, Canonical Forms, The Rational Form, The Jordan Form.

Section C

Definition of inner product spaces, Euclidean space, Unitary space, norm or length of a vector, Cauchy- Schwarz inequality, Orthogonal and Orthonormal set, Orthogonal complement, Gram-Schmidtorthogonalization theorem, Linear functionals and Adjoints, Self-adjoint (Hermitian), Unitary operators, Normal operators , Operators on inner product spaces ,Forms on inner product spaces, Positive form, Spectral theorem.

Section D

Blinear form, Non-degenerate bilinear form, Symmetric bilinear form and Skew-symmetric bilinear form, Group preserving bilinear forms. Quadratic forms, Real quadratic forms, Orthogonal matrices, Reduction of real quadratic forms, Nilpotent forms, Classification of real quadratic forms.

Recommended Books:

1. K. Hoffman and R. Kunze, Linear Algebra, Pearson Education (India), 2003. Prentice-Hall ofIndia,1991.
2. S. Lang, Linear Algebra, Undergraduate Texts in Mathematics, Springer-Verlag, NewYork, 1989.
3. I. N. Herstein, Topic in Abstract Algebra, Wiley Eastern Limtd.
4. A.G. Hamilton, Linear Algebra, Cambridge University Press (1989)

Course Title/Code	COMPLEX ANALYSIS(MAH511)
Course Type:	Core (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	The objective of this course is to introduce the fundamental ideas of developinga clear understanding of the fundamental concepts of Complex Analysis such as analyticfunctions, complex integrals and conformal mapping.
Course outcomes	The student would be able to evaluate questions on complex integration, integral formula, Taylor's and Laurent's series, analytical continuation, conformal mapping.
Prerequisites (If any)	NA

Section A

Complex Integration, Cauchy-Goursat Theorem, Cauchy's Integral Theorem, Cauchy's Integral Formula, Cauchy's Integral Formula for Higher order derivatives, Morera's Theorem, Cauchy's Inequality and Liouville's theorem, The Fundamental theorem of algebra.

Section B

Taylor & Laurent's Series Expansion, Isolated Singularities, Casporati-Weierstress theorem, Meromorphic functions, The argument principle, Rouche's theorem, Inverse function theorem. Residues, Cauchy's residue theorem, Evaluation of integrals, Branches of many valued functions with special reference to arg Z, Log Z, and Z^a.

Section C

Analytic continuation, Uniqueness of direct analytic continuation, Uniqueness of analytic continuation along a curve, Power series method of analytic continuation, Schwarzreflection principle, Monodromy theorem and its consequences.

Section D

Conformal Mapping, general linear transformations, Analytic- continuation, Principle of reflection, Principle of maximum modulus, Sewarz's lemma, Vitali's convergence theorem, Hadamard's three circle theorem functions.

Recommended Books:

1. Prof R.Y. Dennis, Complex- Variable & integral transform.
2. S. Ponnusamy, Complex Analysis.
3. E. T. Copson, Complex Variables, Oxford University Press.
4. J. B. Conway, Functions of one complex variable, Narosa Publication House.

Course Title/Code	MEASURE THEORY(MAH512)
Course Type	Core (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	To gain understanding of the abstract measure theory and definition and mainproperties of the integral. To construct Lebesgue's measure on the real line..
Course outcomes	The student would be able to conceptualize measure and integral with respect to ameasure and apply the concepts of measure theory for further studies in Analysis,probability and dynamical systems etc.
Prerequisites (If any)	NA

Section A

Boolean algebra, Borel field, Counting measure, Outer measure, Measurable sets, Lebesguemeasure, non-measurable sets, Measurable functions, Littlewood's Threeprinciples.

Section B

Riemann Integral, Lebesgue Integral of a Bounded functions over a set of Finite Measure, Fatou's Lemma, Monotone Convergence Theorem, Lebesgue Convergence Theorem and Convergence inMeasure.

Section C

Vitali's Lemma Functions of Bounded variation, Absolute continuity, Converse functions, Jensen Inequality, Measure spaces, -finite measure, Semifinite measure, General convergence Theorems, Signed Measures, Hahn Decomposition Theorem, Jordan decomposition, Radon- Nikodym Theorem, Lebesgue decomposition, Product measure, Fubini's Theorem.

Section D

The L^p spaces where $1 \leq p < \infty$, Holder and Minkowski inequalities, Completeness of L_p spaces.

Recommended Books:

1. Real Analysis : H. L. Royden
2. Mathematical Analysis : T. M. Apostol
3. Real Analysis : Walter Rudin
4. Real and Abstract Analysis : E. Hewitt and K. Stromberg

Course Title/Code	MATHS LAB-II MAH516-P
Course Type:	Core (Departmental)
Course Nature:	Hard
L-P-O Structure	(0-4-0)
Objective	To familiarize students with programming, study of linear algebra in MATLAB
Course outcomes	The student would be able to apply the tools of Matlab software for solving theMathematical problems.
Prerequisites (If any)	MATHS LAB-I(MAH507-p)

LAB EXERCISE:

1. Introduction to programming.
2. Creating script file or m-files
3. Introduction to Conditional statements –if and else using MATLAB.
4. Introduction to Conditional statements –if and else using MATLAB (Continued).
5. Introduction to Loops- for using MATLAB.
6. Introduction to Loops- while using MATLAB.
7. Introduction to switch and break using MATLAB
8. Introduction to functions and function filesusing MATLAB.
9. Introduction to functions and function filesusing MATLAB (continued).
10. Study Linear Algebra using MATLAB.
11. Study Linear Algebra using MATLAB(Continued)

Recommended Book:

- MATLAB, An introduction with application-Amos Gilat, Welly India

.**Course Title/Code**	PEDAGOGICAL SKILLS **(**EDS234**)**
Course Type	Elective (Allied.)
L-T-P Structure	1-0-2
Credits	2
Course Objective	To familiarize students with concepts of topological spaces, separation Axioms, nets and filters
Course Course outcomess	• Compare and contrast between objectives and Course outcomess based on revised Blooms Taxonomy. • Illustrate a concept based on innovative pedagogies. • Exhibit Growth mindset in group activities. • Evaluate projects based on Six Thinking hats. • Design sessions based on collaborative learning, cooperative learning and experiential learning.
Prerequisites (If any)	N.A

SECTION A AIMS AND OBJECTIVES OF TEACHING-

LEARNING PROCESS

Concept of pedagogy, need of pedagogical skills for a professional, Meaning of learning objectives and learning Course outcomess, domains of learning, Developing learning objectives; Anderson and Krathwohl's Taxonomy. Writing learning objectives: Remembering, understanding, Applying, Analyzing, Evaluating, Creating. Learning objectives in Constructivist perspective. Blended learning, Flipped Classroom, Technology Enabled Learning, TPACK model.

SECTION B ROLE OF RESEARCH IN INNOVATIVE

PEDAGOGIES

Concept of STEM AND STEAM

Innovative Pedagogies (Constructivism, Collaborative learning, cooperative learning, experiential learning, project based learning), Action Research, concept mapping and its types. Growth Vs Fixed Mindset, Six Thinking Hats-an approach to problem solving, 4C's of 21st century skills. Concept of measurement, assessment and evaluation. Types of assessment. Designing evaluation rubrics.

Pedagogy Skills Practical (EDS 234)

1. Designing Instructional Objectives.
2. Critical Analysis of Bloom's and Krathwohl Taxonomy.
3. Demonstration of a concept using low or no cost resources.
4. Design rubrics for Evaluation.
5. To conduct Action Research and submit a project report.

Recommended Books:

1. Bono, D. (1999). Six Thinking Hats. England: Penguin Books.
2. Krathwohl, D.R., Bloom B.S. and Maria B.B. (1964). *Taxonomy of Educational Objectives, Handbook II, Affective Domain,* New York: David McKay.
3. Lindfors, J. (1984). *How children learn or how teachers teach?* A Profound confusion: Language Arts, 61 (6), 600-606.

MAPN01- Semester-III

SUBJECT CODES	SUBJECT NAME	**OFFERING DEPARTMENT	*COURSE NATURE (Hard/Soft/ Workshop/ NTCC)	COURSE TYPE (Core/Elective / University Compulsory)	L	P	O	NO. OF CONTACT HOURS PER WEEK	NO. OF CREDITS
MAH618	FUNCTIONAL ANALYSIS	MA	HARD	CORE	4	0	0	4	4
MAH619	DIFFERENTIAL GEOMETRY	MA	HARD	CORE	4	0	0	4	4
MAH620	DYNAMICS OF RIGID BODY	MA	HARD	CORE	4	0	0	4	4
MAH504	GRAPH THEORY	MA	HARD	ELECTIVE	4	0	0	4	4
MAH505	OPERATIONS RESEARCH								
MAH506	MATHEMATICAL MODELLING & SIMULATION								
MAH513	FUZZY SETS & FUZZY LOGIC								
MAH621	CODING THEORY								
MAH624	FOURIER ANALYSIS								
MAH625	MATHS LAB-III	MA	HARD	CORE	0	4	0	4	2
MCS231	BASICS OF ECONOMICS	MC	SOFT	ELECTIVE ALLIED (BASKET OF COURSES BY MANAGEMENT DEPTT)	1	2	0	3	2
MCS232	INTRODUCTION TO FINANCE								
MAN626	SEMINAR	MA	NTCC	CORE	0	0	2	2	2
TOTAL (L-P-O/CONTACT HOURS/CREDITS)					**17**	**6**	**2**	**25**	**22**

DETAILED SYLLABUS

MAPN01-SEMESTER III

Course Title/Code	FUNCTIONAL ANALYSIS(MAH618)
Course Type:	Core (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	To provide the student with the concept and the understanding in Banach spaces, Hilbert space and Banach Algebras.
Course outcomes	The student would be able to conceptualize basics of Functional Analysis and applythese concepts in harmonic analysis and stochastic calculus.
Prerequisites (If any) (If any)	NA

Section A

Vector space, Normed linear space, Quotient space, Banach spaces, Bounded linear transformation,B(X,Y) as a normed linear space, Isometric isomorphism, Uniform boundedness principle and its consequences.

Section B

Hahn-Banach Theorem, Application of Hahn-Banach theorem, Conjugate and second conjugate space ofnormed linear space, Weak topology, Strong topology, Open-mapping theorem, Closed graph theorem, Uniform Boundedness theorem.

Section C

Inner Product Spaces, Hilbert spaces, Orthonormal sets, Bessel's Inequality, Complete orthonormalsets and Parseval's identity, Orthonormal bases, Structure of Hilbert space, Projection theorem, Riesz representation theorem, Riesz-Fischer theorem.

Section D

Adjoint of an operator on a Hilbert Space, Strong and weak convergence, Operator theory, Spectral theorem, Polar decomposition, Compact Operator, Fredholm Operators, Closed operators, Symmetric andself-adjoint operators.

Recommended Books:

1. V.S. Sunder, Functional Analysis spectral theory.
2. Walter Rudin, Functional Analysis.
3. S. Ponnusamy, Foundation of Functional Analysis.

Course Title/Code	DIFFERENTIAL GEOMETRY(MAH619)
Course Type:	Core (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	To familiarize students with space curves, geodesics, intrinsic and non-intrinsicproperties of a surface.
Course outcomes	The student would be able to apply the concepts of space curves, geodesics, intrinsicand non-intrinsic properties of a surface.
Prerequisites (If any) (If any)	NA

Section A

Co-ordinate transformation, Covariant, Contravariant and Mixed tensors, Tensors of higher rank, Symmetric and Skew-symmetric tensors, Tensor algebra, Contraction, Inner product, Riemannian metrictensor, Christoffel symbols, Covariant derivatives of tensors.

Section B

Differentible curves in R3 and their parametric representations, Vector fields, Tangent vector, Principal normal, Binormal, Curvature and torsion, Serret-Frenet formula, Frame fields, Covariantdifferentiation, Connection forms, The structural equations.

Section C

Surfaces, Differentiable functions on surfaces, Differential of a differentiable map, Differential forms, Normal vector fields, First fundamental form, Shape operator, Normal curvature, Principal curvatures,Gaussian curvature, Mean curvature, Second fundamental form.

Section D

Gauss equations, Weingarten equation, Codazzi-Mainardi equations, Totally umbilical surfaces, Minimalsurfaces,Variations, First and second variations of arc length, Geodesic, Exponential map, Jacobi vector field, Index form of a geodesic.

Recommended Books:

1. Manfredo P. Do' Carmo, Differential Geometry of Curves and Surfaces, , Prentice Hall Inc.
2. S. Montiel and A. Ros, Curves and Surfaces , American Mathematical Society, 2005.
3. Somasundaram, Differential Geometry, A first course , Narosa Publication.
4. Zafar Ahsan, Tensor Calculus, Anamaya Publications, New Delhi. 19 / 27

5. U. C. De, Tensor Calculus, Narosa Publications, New Delhi.

Course Title/Code	DYNAMICS OF RIGID BODY(MAH620)
Course Type:	Core (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	To familiarize students with the kinematics and dynamics of rigid bodies in generalplanar motion, which is typically encountered in analysis of mechanical systems. .
Course outcomes	To study mechanical systems under generalized coordinate systems,energy and momentum to study mechanics developed by Jacobian, Euler, Legendre, withExtremals and Functionals.
Prerequisites (If any) (If any)	NA

Section A

Moments and products of inertia, The momental ellipsoid , Equimomental systems Principal axes, D'Alembert's principle, The general equation of motion of a rigid body, Motion of Centre of inertia and motion relative to the centre of inertia.

Section B

Motion about the fixed axis, The compound pendulum, Centre of Percussion, Motion of rigid body in two dimensions under finite and impulsive forces.

Section C

Conservation of Momentum and Energy, Initial motions, Lagrange's equation Euler's equations of motion, Hamiltons's principle, Hamilton's equation of motion, Euler's equation for functional containing first order derivative and one independent variable, Extremals.

Section D

Functionals dependent on higher order derivatives Functional s dependent on more than one independent variable, Variational problems in parametric form, Invariance of Euler's equation under coordinate transformation, Jacobian and Legendre conditions, Second variation, Variational principle of least action.

Recommended Books:

1. D. Greenwood, Classical Dynamics, Prentice Hall of India, NewDelhi, 1985.
2. H. Goldstein, Classical Mechanics, (2ndEdition) Narosa Publishing House,New Delhi.
3. A.S Gupta, Calculus of variations with –Applications ,Prentice Hall ofindia,1997
4. S.L. Loney , An elementary Treatise on the dynamics of particle and rigid bodies ,CambridgeUniversity Press.

Course Title/Code	MATHS LAB-III (MAH625)
Course Type:	Core (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	Exposure of students to Maple-Installation, graphs , solution of Mathematicalproblems.
Course Course outcomes	The student would be able to apply the tools of MATLAB software for solving theconcepts of Mathematical problems.
Prerequisites (If any) (If any)	NA

LAB EXERCISE:

1. Introduction to Maple and Methods of entering expressions.
2. An introduction to the point-and-click features in Maple and An introduction to the commands of the Maple Language.
3. Entering and evaluating mathematical expressions in Document mode.
4. Worksheet mode – input prompt and commands.
5. Pallets
6. Introduction to graphs, graphs of Tabular and continuous functions.
7. Graphs of composed functions.
8. To solve standard mathematical problems.
9. To construct and compute with expressions that have units, scientific constants or uncertainty.
10. To evaluate plane curves in rectangular coordinates using Maple.
11. To evaluate curve in polar coordinates using Maple.
12. To calculate asymptotes of curves using Maple.
13. To calculate tangent lines to curve, singular points on curves using Maple.
14. To calculate curvature and torsion of curves using Maple.

MAPN01-SEMESTER IV

SEMESTER - 4									
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**COURSE TYPE (Core/Elective / University Compulsory)**	**L**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MAH635	CALCULUS OF VARIATION & INTEGRAL EQUATIONS	MA	HARD	CORE	4	0	0	4	4
MAH628	FLUID MECHANICS	MA	HARD	CORE	4	0	0	4	4
MAH629	ALGEBRAIC TOPOLOGY	MA	HARD	ELECTIVE	4	0	0	4	4
MAH630	CRYPTOGRAPHY								
MAH627	WAVELET ANALYSIS								
MAH623	ADVANCED OPERATIONS RESEARCH								
MAH636	DIFFERETIABLE MANIFOLDS								
MAH632	THEORY OF ELASTICITY & FRACTURE MECHANICS								
MAH633	MATHS LAB-IV	MA	HARD	CORE	0	4	0	4	2
MAN634	PROJECT	MA	NTCC	CORE	0	0	6	6	6
MAW508	SCILAB	MA	WORKSHOP	ELECTIVE (ANY ONE)	0	3	0	3	2
MAW509	MATHEMATICA								
MAW231	SPSS								
MAW225	LaTeX								
MAW538	ADVANCED STATISTICS USING EXCEL								
	TOTAL (L-P-O/CONTACT HOURS/CREDITS)				**12**	**7**	**6**	**25**	**22**
GRAND TOTAL OF CREDITS									**91**

DETAILED SYLLABUS

MAPN01-SEMESTER IV

Course Title/Code	CALCULUS OF VARIATION & INTEGRAL EQUATIONS **(**MAH601B)
Course Type	Core (Departmental)
L-T-P Structure	4-0-0
Credits	4
Course Objective	The objective of this course is to introduce the fundamental ideas for developing and understanding the concepts of Integral Equations and Calculus of variation.
Course Course outcomess	• Apply and analyze functionals to solve various engineering and science problems. • Use the Euler-Lagrange equation or its first integral to find differential equations for stationary paths and solve, subject to boundary conditions. • Demonstrate the knowledge of different types of Integral equations: Fredholm and Volterra Integral equations. • Obtain an Integral equation from differential equations arising from different engineering and science branches and solve it accordingly using the various methods. • Construct the Green function in solving boundary value problems by converting it to an IE.
Prerequisites (If any) (if any)	NA

Section A

Green function, Use of method of variation of parameters to construct the Green function for a non homogeneous linear second order boundary value problem, Basic four properties of the Green function, Alternate procedure for construction of the Green function by using its basic four properties. Reduction of a boundary value problem to a Fredholm integral equation with kernel as Green function, Hilbert-Schmidt theory for symmetric kernels.

Section B

Introduction to calculus of Variation, Variation of Functionals, Euler's equation, Euler – Lagrange equation, Solutions of Euler's Equation, Necessary and sufficient condition for Extrema. Several dependent variables, Functional involving higher order derivatives, Variational methods for boundary value problems in ordinary and partial differential equations.

Section C

Introduction to Integral equation, Linear Integral equations, Some basic identities, Differentiation of function under an integral sign, Initial value

problems reduced to Volterra integral equations, Methods of successive substitution and successive approximation to solve Volterra integral equations of second kind, Iterated kernels and Neumann series for Volterra equations. Resolvent kernel as a series. Solution of a Volterra integral equation of the first kind.

Section D

Boundary value problems reduced to Fredholm integral equations, Methods of successive approximation and successive substitution to solve Fredholm equations of second kind, Iterated kernels and Neumann series for Fredholm equations. Resolvent kernel as a sum of series. Fredholm resolvent kernel as a ratio of two series. Fredholm equations with separable kernels. Approximation of a kernel by a separable kernel, Fredholm Alternative, Non-homogeneous Fredholm equations with degenerate Kernels.

TEXTBOOKS

1. William Vernon Lovitt, Linear Integral equations, Dover Publications, INC Mineola, New York.
2. Rainer Kress, Linear Integral equations, Springer
3. Ram P. Kanwal, Linear Integral equations, Academic Press, New York and London.

REFERENCE BOOKS

1. Shanti Swarup, Shiv Raj Singh, Linear Integral equations , Krishna Prakashan Media (P) Ltd.
2. D.C Sharma, M.C Goyal, Linear Integral equations, PHI Learning PVT Delhi.
3. A.S.Gupta, Calculus of Variations with Applications, PHI Learning PVT Delhi.
4. I.M Gelfand, S. V Fomin, Calculus of Variations with Applications, Prentice Hall.

Course Title/ Code	FLUID MECHANICS- MAH628-T
Course Type	Core (Departmental)
L-T-P Structure	4-0-0
Credits	4
Objective	To familiarize students with basic concepts of fluid dynamics
Course outcomes	The student would be able to apply the concepts of fluid mechanics for solvingproblems related to fluids.
Prerequisites (If any) (if any)	NA

Section A

Physical Properties of fluids, Concept of fluids, Continuum Hypothesis, Density, Specific weight, Specific volume. Kinematics: Lagrangian and Eulerian methods, Steady and Unsteady flows, Uniform and Non uniform flows, Stream lines, Path lines and streak lines, Equation of continuity (Cartesian, polar& cylindrical coordinates), Equivalence of the two forms of Equation of continuity, velocity potential, Irrotational & Rotational flows, Boundary Surface, Conservation of Momentum: Euler's equation, Equation of motion of inviscid fluids, Bernoullie's equation, Lagrange's equation.

Section B

Viscous fluid flow: Stress analysis, Symmetry of stress tensor, stress in a fluid at rest and in motion, Transformation of stress components, Principal stresses and principal directions, Strain analysis, Rate of strain quadric, Navier stokes equation of motion of viscous fluid, Equation of energy, Dissipation of energy, Vorticity and circulations & viscous fluids, Diffusion of vorticity, the equations of state, Reynolds number.

Section C

Conservation Laws : Equation of conservation of mass, equation of conservation of momentum, Navier Stokes equation, Equation of moments of momentum, Equation of energy, Basic equations in different co-ordinate systems, Boundary conditions.

Section D

Irrotational Motion:- General motion of a fluid element, Vorticity, Flow and Circulation, Stoke's theory, Kelvin's circulation theory Motion in two dimensions:- Stream function & its physical interpretation complex potential and complex velocity, Motion in two dimensions; Stream function, Complex potential, Source, Sink, Doublet, Complex potential and images with respect to straight line and circle, Milne-Circle theorem, Blausius theorem.

Recommended Books:

1. S.W.Yuan, Foundation to Fluid Mechanics.
2. F. Chorltron, Text book of Fluid Dynamics.
3. Bansi Lal, Theoretical Hydro-Dynamics.
4. M. Ray and Sharma, A text book of Fluid –Dynamics.
   R. K. Gupta, Fluid Dyanamics

Course Title/Code	MATHS LAB-IV MAH633-P
CourseType	Core (Departmental)
Course Nature:	Hard
L-P-O Structure	(0-4-0)
Objective	To familiarize student with Discrete Fourier transform using MATLAB
Course outcomes	The student would be able to apply the tools of Matlab software for solving the problemsof Fourier & Wavelet Analysis.
Prerequisites (If any) (If any)	MATH LAB-I(MAH507-P) & MATHS LAB(MAH516)

LAB EXERCISE:

1. To evaluate discrete Fourier transform (DFT) of functions or signals using MATLAB.
2. To evaluate inverse discrete Fourier transform (IDFT) of functions or signals using MATLAB.
3. To evaluate Fast Fourier transform (FFT) of functions or signals using MATLAB.
4. To evaluate Inverse Fourier transform (IFFT) of functions or signals using MATLAB.
5. Evaluation of Fourier basis using MATLAB.
6. To plot discrete and continuous signals.
7. To evaluate translation of a given signals and plot the translated signals.
8. To plot discrete Fourier transform () of a given signal(z) and also plot real & imaginary partof (), phase(angle) and magnitude of ().
9. To find convolution of a given signals using MATLAB.
10. To evaluate first stage Shannon basis using MATLAB and plot the same.
11. To evaluate first stage real Shannon basis using MATLAB and plot the same.
12. To evaluate first-stage Haar basis using MATLAB and plot the same.

Recommended Book:

- MATLAB, An introduction with application-Amos Gilat, Welly India

DEPARTMENTAL ELACTIVE & WORKSHOPS								
SUBJECT CODES	**SUBJECT NAME**	****OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ Workshop/ NTCC)**	**L**	**P**	**O**	**NO. OF CONTACT HOURS PER WEEK**	**NO. OF CREDITS**
MAH504	GRAPH THEORY	MA	HARD	4	0	0	4	4
MAH505	OPERATIONS RESEARCH							
MAH506	MATHEMATICAL MODELING & SIMULATION							
MAH514	MATHEMATICAL STATISTICS							
MAH513	FUZZY SETS & FUZZY LOGICS							
MAH515	TOPOLOGY-II							
MAH621	CODING THEORY							
MAH623	ADVANCED OPERATIONS RESEARCH							
MAH624	FOURIER ANALYSIS							
MAH629	ALGEBRAIC TOPOLOGY							
MAH627	WAVELET ANALYSIS							
MAH630	CRYPTOGRAPHY							
MAH632	THEORY OF ELASTICITY & FRACTURE MECHANICS							
MAH636	DIFFERETIABLE MANIFOLDS							
MAW508	SCILAB		WORKSHOP	0	3	0	3	2
MAW509	MATHEMATICA							
MAW231	SPSS							
MAW225	LaTeX							
MAW538	ADVANCED STATISTICS USING EXCEL							
TOTAL (L-P-O/CONTACT HOURS/CREDITS)				**12**	**7**	**6**	**25**	**22**

Course Title/Code	GRAPH THEORY(MAH504)
Course Type:	ELECTIVE (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	To familiarize students with the main concepts of graph theory, graph representationsand the basic classes of graphs.
Course outcomess	The objective of the course is to introduce students with the fundamental concepts ingraph theory, with a sense of some its modern applications.
Prerequisites (If any) (If any)	NA

Section A

Graphs: Basic concepts in graph theory, walks, paths and circuits in a graph, connected graphs and components, degrees, operations on graphs, special graphs, isomorphic graphs, blocks, cut-points, bridges and blocks, block graphs and cut-point graphs.

Section B

Trees: Elementary properties of trees, minimally connected graph, distance , centers and centroids in a tree , radius and diameter, spanning trees ,rank and nullity, block-cut point trees, independent cycles and co-cycles.

Section C

Connectivity and Traversability: Connectivity and line connectivity, Menger's theorems, Euleriangraph, Hamiltonian graphs, travelling salesman problem, shortest path.

Section D

Planarity and Coloring: Planar graphs, outer planar graphs, Euler's formula,, Kuratowski's theorem,dual graphs, self dual graphs, chromatic number, five color theorem, chromatic polynomial.

Recommended Books:

1. R. Balakrishnan and K. Ranganathan, A Text Book of Graph Theory, Springer,2000.
2. B. Bollobas, Modem Graph Theory, Springer, 2002.
3. G. Chartrand and L. Lesniak, Graphs and Digraphs, 4th Edit., Chapman & Hall(CRC), 2005.
4. F. Iarary, Graph Theory, Narosa Publishing House, New Delhi, 200 l.
5. R.I. Wilson, Introduction to Graph Theory, 4th Edit., Addison Wesley, 1996.

Course Title/Code	OPERATIONS RESEARCH(MAH505)
Course Type:	Elective (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	To familiarize students to use quantitative methods and techniques for effective decisions–making; model formulation and applications that is used in solving business decision problems.
Course outcomes	The student would be able to apply the concepts of Operations Research in variousreal time problems.
Prerequisites (If any) (If any)	NA

Section A

Convex set theory: Linear independence and dependence of vectors, Convex sets, Extreme points,Hyper planes and Halfspaces, Directions of a convex set, Convex cones, Polyhedral sets and cones.

Section B

Introduction to Linear Programming: Linear Programming Problem Formulation, Graphicalsolution, Simplex Algorithm, Artificial variables techniques: Two–phase method & Big-M method, Duality theory, Dual-simplex method.

Section C

Transportation problem & Assignment problems: Formulation of Transportation problem,Optimal solution, Unbalanced transportation problem, Degeneracy, Formulation of Assignment problem, Optimal solution, Variants of Assignment Problem- Traveling Salesman problem.

Section D

Game Theory: Introduction, Two person zero sum game, Pure strategies, Maximin & miimax principle, Game with saddle points, Mixed strategies, Game without saddle points, Dominance rule.

Recommended Books:

1. H. A. Taha, Operations Research an introduction, pearson India
2. J. K. Sharma, Operations Research theory & applications:
3. Gupta & Hira, Operations Research.

Course Title/Code	MATHEMATICAL MODELING & SIMULATION(MAH506)
Course Type:	ELECTIVE (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	To familiarize the students with mathematical modeling and simulation with anexplanation of basic concepts and ideas, this includes definitions of terms such as system, model, simulation, mathematical model, reflections.
Course outcomess	The student would be able to apply the concepts of Mathematical Modeling andSimulations in various physical problems.
Prerequisites (If any) (If any)	NA

Section A

Mathematical Model, Types of Mathematical models and properties, Procedure of modeling,Graphical method: Barterning model, Basic optimization.

Section B

Basic probability: Monte-Carlo simulation, Approaches to differential equation: Heun method, Localstability theory: Bernoulli Trials, Classical and continuous models, Case studies in problems of engineering and biological sciences.

Section C

General techniques for simulating continuous random variables, Simulation from Normal and Gammadistributions.

Section D

Simulation from discrete probability distributions, Simulating a non– Homogeneous Poisson Processand Queuing system.

Recommended Books:

1. Edward A. Bender.. An Introduction to Mathematical Modeling.
2. A. C. Fowler.. Mathematical Models in Applied Sciences, Cambridge University Press.
3. J. N. Kapoor.. Mathematical Modeling, Wiley eastern Limited.
4. S.M. Ross ..Simulation, India Elsevier Publication.
5. A.M.Law and W.D.Kelton.. Simulation Modeling and Analysis, T.M.H. Edition.

Course Title/Code	FUZZY SETS & FUZZY LOGIC **(**MAH513**)**
Course Type	Elective (Departmental)
L-T-P Structure	4-0-0
Credits	4
Course Objective	The students would be able to understand the concepts of fuzzy sets and fuzzy logics and model vague quantity of numerical and linguistic character, which cannot be described with classical mathematical models.
Course Outcomes (COs)	
CO1	Understand the concept of fuzziness involved in various systems and fuzzy set theory
CO2	Apply the concepts of fuzzy relation to solve related problem
CO3	Use the concepts of fuzzy measure to understand physical problem related to different classes of fuzzy measures
CO4	Analyze the application of fuzzy logic control to real time systems.
Prerequisites (if any)	N.A

SECTION A

Crisp sets and Fuzzy sets - Introduction, crisp sets an overview, the notion of fuzzy sets basic concepts of fuzzy sets, membership functions, methods of generating membership functions, defuzzification methods- operations on fuzzy sets
- fuzzy complement, fuzzy union, fuzzy intersection, combinations of operations, general aggregation operations.

SECTION B

Fuzzy arithmetic and Fuzzy relations: Fuzzy numbers- arithmetic operations on intervals- arithmetic operations on fuzzy numbers- fuzzy equations, Fuzzy relations: binary relations, binary relations on a single set, equivalence and similarity relations, compatibility or tolerance relations.

SECTION C

Fuzzy measures, belief and plausibility measures, probability measures, possibility and necessity measures, possibility distribution - relationship among classes of fuzzy measures.

SECTION D

Fuzzy Logic and Applications: Classical logic: an overview, fuzzy logic, approximate reasoning- other forms of implication operations - other forms of the composition operations, fuzzy decision making fuzzy logic in database and information systems - fuzzy pattern recognition, fuzzy control systems, fuzzy optimization.

TEXTBOOKS

1. G. J. Klir & T. A. Folger , Fuzzy sets, Uncertainty and Information, Prentice Hall of India, 1988.
2. H.J. Zimmerman, Fuzzy Set theory and its Applications, Kluwer Academic Publishers, 4nd Edn.,2001.

REFERENCE BOOKS

1. G. J. Klir& B. Yuan, Fuzzy sets and Fuzzy logic: Theory and Applications, Prentice Hall ofIndia, 1997.
2. H. T. Nguyen & E. A. Walker, First Course in Fuzzy Logic, Chapman & Hall, 2nd Edn., 1999.

J. M. Mendel, Uncertain Rule, Based Fuzzy Logic Systems; Introduction and New Directions, PH PTR, 2000.

3. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw Hill, 1997.
4. J. J. Buckley, E. Eslami, An Introduction to Fuzzy logic and Fuzzy sets, Springer, 2002.

Course Title/Code	MATHEMATICAL STATISTICS(MAH514)
Course Type:	Elective(Departmental)
L-T-P Structure	4-0-0
Credits	4
Objective	The student will be introduced to the various statistical tools for computingmathematical problems involving data.
Course outcomes	The student would be able to apply the concepts of statistics for solvingmathematical problems and its applications in data analysis for industrial and agricultural sectors
Prerequisites (If any)	NA

Section A

Probability and Baye's Theorem, Random Variables, Probability Density Functions, Multivariate Distributions, Marginal Distributions, Conditional Distributions, Mathematical Expectation, Moments, Moment Generating Functions, Product Moments, The Binomial Distribution, The Poisson Distribution, The Normal Distribution, Correlation and Regression.

Section B

Special Probability Distributions: The Discrete Uniform Distribution, The Negative Binomial and Geometric Distributions, The Hypergeometric Distribution, The Multinomial Distribution, The Multivariate Hypergeometric Distribution, Special Probability Densities: The Uniform Distribution, The Gamma, Exponential and Chi-Square Distributions, The Beta Distribution, The Normal approximation to the Binomial Distribution, The Bivariate Normal Distribution.

Section C

Sampling Distributions & Decision Theory: Point Estimation, Interval Estimation, The Distribution of the mean – finite Populations, Hypothesis Testing, Tests of Hypothesis involving Mean, Variance and Proportions, The Chi- Square Distribution, The t – Distribution, The F – Distribution, Order Statistics.

Section D

The Theory of Games, Statistical Games, the Minimax Criterion.Design and Analysis of Experiments: Introduction, One – Way Designs, Randomized – Block Designs, Factorial Experiments, Multiple Comparisons and Other Experimental Designs. Non- Parametric Tests: The Sign Test, The Signed – Rank Test, and Rank Sum Tests: The U Test and H Test, Tests Based on Runs.

Recommended Books:

1. Mood, A.M., Graybill, F.A. and Boes, D.C., Mc Graw Hill Book Company.
2. Freund, J.E., Mathematical Statistics, Prentice Hall of India.
3. Gupta S.C. and Kapoor V.K., Fundamentals of Mathematical Statistics, S.Chand Pub., New Delhi.

Course Title/ Code	TOPOLOGY-II(MAH515)
Course Type:	Elective(Departmental)
L-T-P Structure	4-0-0
Credits	4
Objective	To familiarize students with concepts of topological spaces , separation Axioms, netsand filters
Course outcomes	The student would be able to conceptualize and apply the concepts of TopologicalSpaces,
Pre-requisites	Topology-I

Section A

Tychonoff product topology in term of standard sub-base and its characterizations, Projection maps, Separation axioms and product spaces, Connectedness and product spaces, Compactness and product spaces, Countability and product spaces .

Section B

Nets and filters, Topology and convergence of nets, Housdorffness and nets , Compactness, Nets Filter and their Convergence.

Section C

Canonical way of converting nets to filters and vice-versa, ultra filters and compactness. Stone-Cech compactification. Application of Urysohn's Lemma, The Stone–Cech Compactification, The Stone–Weierstrass Theorems.

Section D

Homotopy of paths, Fundamental group, Covering spaces, The fundamental group of the circle and fundamental theorem of algebra. Covering of a space, local finiteness, paracompact spaces, Mchaelltheorem on characterisation of paracompactness in regular space, Paracompactness as normal, Nagata- Smirnov Metrization theorem.

Recommended Books:

1. James R. Munkres, Topology (2ndEdition) Pearson Education Pve. Ltd., Delhi-2002
2. J. Dugundji , Topology , Prentice Hall of India, New Delhi, 1975.
3. George F.Sinmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 1963
4. K. D. Joshi : Introduction to General Topology (Wiley Eastern Limited).

Course Title/Code	CODING THEORY(MAH 621)
Course Type:	Elective (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	The students would be able to apply the concepts of coding theory.
Course outcomes	The students would be able to distinguish between different types error correcting codes based on probability of error, understand various methods of generating and detecting different types of error correcting codes, formulate the basic equations of linear block codes.
Prerequisites (If any) (If any)	Algebra, basics of logic, set theory, number theory, matrices, and probability.

Section A

The communication channel, The coding problem, Types of codes, Block codes, Error-detecting and error-correcting codes, Linear codes, The Hamming metric, Description of linear block codes by matrices, Dual codes, Standard array, Syndrome.

Section B

Step-by-step decoding, Modular representation, Error-correction capabilities of linear codes, Bounds on minimum distance for block codes, Plotkin bound, Hamming sphere packing bound, Varshamov- Gilbert-Sacks bound.

Section C

Bounds for burst-error detecting and correcting codes, Important linear block codes,Hamming codes.

Section D

Golay codes, Perfect codes, Quasi-perfect codes, Reed-Muller codes, Codes derived fromHadamard matrices, Product codes, Concatenated codes.

RecommendedBooks:

1. W.W. Peterson and E.J. Weldon, Jr., Error-Correcting Codes. M.I.T. Press, Cambridge,Massachusetts, 1972.
2. Raymond Hill, A First Course in Coding Theory, Oxford University Press, 1990.
3. Man Young Rhee, Error Correcting Coding Theory, McGraw Hill Inc., 1989.
4. F.J. Macwilliams and N.J. A. Sloane, The Theory of Error Correcting Codes, North- Holland, 2006.

Course Title/Code	ADVANCED OPERATIONS RESEARCH(MAH623)
Course Type:	Elective (Departmental)
L-T-P Structure	4-0-0
Credits	4
Objective	The student would be able to apply the concepts of Operations Research in variousreal time problems.
Course outcomes	Applications of the different methods and techniques of Operations Research in practice. A collection of real-life cases will be discussed during the course, and arange of solution approaches will be highlighted.
Prerequisites (If any)	OPERATION RESEARCH(MAH505)

Section A

Project management-PERT & CPM: Significance, Phases of project management, PERT /CPM network components and precedence relationship, Critical path analysis, Forward and backward pass methods, Slack of an activity and event, Project scheduling with uncertain activity times, Estimation of project completion time, Project time –cost trade off, Updating of the project progress.

Section B

Replacement: Introduction, Replacement of items that deteriorate with time – when money value is notcounted and counted – Replacement of items that fail completely, Group replacement, Staffing problem,Equipment renewal problem.

Section C

Queuing Theory: Introduction, Single Channel, Poisson arrivals, Exponential service times – withinfinite population and finite population models, Multichannel, Poisson arrivals, exponential servicetimes with infinite population single channel Poisson arrivals.

Section D

Quadratic Programming: Wolfe's method, Complementary pivot algorithm, Duality in quadraticprogramming.

Recommended Books:

1. H. A. Taha, Operations Research an introduction, pearson India
2. J. K. Sharma, Operations Research theory & applications:
3. Gupta & Hira, Operations Research,

Course Title/Code	FOURIER ANALYSIS (MAH624)
Course Type:	Elective (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	To familiarize students with Fourier series, orthogonality, completeness, FourierTransform, tempered distributions.
Course outcomes	The student would be able to apply the concepts of discrete Fourier series, integralFourier and Inverse - Fourier transforms for solving mathematical problems.
Prerequisites (If any)	Calculus-Integral and differential.

Section A

Basic Properties of Fourier Series: Uniqueness of Fourier Series, Convolutions, Cesaro and Abel Summability, Fejer's theorem, Poisson Kernel and Dirichlet problem in the unit disc, Mean square Convergence, Exampleof Continuous functions with divergent Fourier series.

Section B

L2-theory: Orthogonality, Completeness, ON systems, Applications to partial differential equations, Separation of variables, Something about Sturm-Liouville theory and Eigen function expansions.

Section C

Distributions and Fourier Transforms: Calculus of Distributions, Schwartz class of rapidly decreasing functions, Fourier transforms of rapidly decreasing functions, Riemann Lebesgue lemma, Fourier Inversion Theorem, Fourier transforms of Gaussians.

Section D

Tempered Distributions: Fourier transforms of tempered distributions, Convolutions, Applications toPDEs (Laplace, Heat and Wave Equations), Schrodinger-Equation and Uncertainty principle. Paley- Wienner Theorems, Poisson Summation Formula: Radial Fourier transforms and Bessel's functions, Hermite functions.

Recommended Books:

1. R. Strichartz, A Guide to Distributions and Fourier Transforms, CRC Press.
2. E.M. Stein and R. Shakarchi, Fourier Analysis: An Introduction, Princeton University Press,Princeton 2003.

Course Title/Code	WAVELET ANALYSIS(MAH627)
Course Type:	Elective (Departmental)
L-T-P Structure	4-0-0
Credits	4
Objective	The student would be able to apply the concepts of theory of wavelets for solvingproblems in mathematics and signal processing.
Course outcomes	The student would be able to understand the fundamental concepts which has applications in the development of tools and techniques which may be used in signal theory, communication techniques, graphical algorithms and numerical analysis.
Prerequisites (If any)	FUNCTIONAL ANALYSIS(MAH618)

Section A

Study of Spaces ($\boldsymbol{z_N}$), $\boldsymbol{l(z)}$, $\boldsymbol{l^2[0, 2\pi)}$, $\boldsymbol{L^1(R)}$& $\boldsymbol{L^2(R)}$**,** Discrete Fourier Transform, Properties of DFT,Inverse Discrete Fourier Transform, Convolution, The Fast Fourier Transform.

Section B

Construction of Wavelets on Z_N**:** The first stage wavelets on $\boldsymbol{Z_N}$, Up-sampling operator, Down-samplingoperator, The iteration step wavelets on $\boldsymbol{Z_N}$, P^{t^h} stage wavelet basis, Examples & applications.

Wavelets on Z : $\boldsymbol{l^2(Z)}$**,** Complete orthonormal sets in Hilbert Space, Fourier Series, The Fourier transform andconvolution on $l^2(Z)$, The first stage wavelets on $\boldsymbol{Z}$, The iteration steps for Wavelets on Z, Examples.

Section C

Wavelets on R : $\boldsymbol{L^1(R)}$ & $\boldsymbol{L^2(R)}$**,** Fourier & Inverse Fourier Transform on R, Properties of Fourier transform, Orthonormal Wavelets, Characterization of Orthonormal Wavelets, Some standard Wavelets (Haar Wavelets, Shannon Wavelets, Journe's Wavelets, Meyer Wavelets, Daubechies' family of wavelets in detail), Multiresolution Analysis, Father Wavelets & Mother Wavelets, Construction of Wavelets through MRA, Scaling function.

Section D

Characterization of Scaling function, Low-pass filter & High Pass filter, Characterizations of Low & High pass filter, Band limited Wavelets, Compactly Supported Wavelets, Minimally-Supported Frequency (MSF) Wavelets, Wavelet Sets, Characterization of MSF wavelets & Wavelet Sets, Dimension Functions, Characterization of MRA Wavelets, Wavelet Transform.

Recommended Books:

1. Michael W. Frazier, An Introduction to Wavelets through Linear Algebra, Springer
2. Hernandez & Weiss, A First Course of Wavelets, CRC Press
3. Charles K. Chui, An Introduction to Wavelets
4. George Bachman, Lawrence Narici, Edward Beckenstein , Fourier and Wavelet Analysis

Course Title/Code	ALGEBRAIC TOPOLOGY(MAH629)
Course Type:	Elective (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	To familiarize students with topological groups, Homotopies, Deck transform etc.
Course outcomes	The student would be able to conceptualize and apply the concepts of Algebraictopology
Prerequisites (If any)	TOPOLOGY-I(MAH502) & TOPOLOGY-II(MAH515)

Section A

Introduction, Topological groups, Paths, Homotopies and the fundamental group, Categories and functors, Functorial properties of the fundamental group, Brouwer's theorem and its applications.

Section B

Homotopies of maps, Deformation retracts, Fundamental group of the circle, Covering projections, Lifting of paths and homotopies, Action of $\Pi 1(X, x0)$ on the fibers $p^{-1}(x0)$, The lifting criterion.

Section C

Deck transformations, Orbit spaces, Fundamental groups of SO(3, R) and SO(4, R), Coproducts and push-outs, Adjunction spaces, The Seifert Van Kampen theorem.

Section D

Homology theory, Singular complex of a topological space, The homology groups and there functoriality, Homotopy invariance of homology, Small simplicies, The Mayer Vietoris sequence, Abelianization of the fundamental group, The Mayer Vietoris sequence, Maps of spheres, Relative homology, Excision theorem, Inductive limits, Jordan Brouwer separation theorem.

RecommendedBooks:

1. Allen Hatcher, Algebraic Topology. Cambridge, UK: Cambridge University Press
2. William S. Massey, A Basic Course in Algebraic Topology. New York, NY: Springer-Verlag
3. Glen Bredon, Topology and Geometry
4. James R. Munkres, Topology (2ndEdition) Pearson Education Pve. Ltd., Delhi-2002.

Course Title/ Code	CRYPTOGRAPHY(MAH630)
Course Type:	Elective (Departmental)
L-P-O Structure	4-0-0
Credits	4
Objective	The student would be able to conceptualize and apply the concepts of Cryptography.
Course outcomes	The student would be able to analyse basic cryptographic protocols, have a solid understanding of the use of fundamental cryptoprimitivesin security in computing, especially in networking (including the capability to analyse existing solutions).
Prerequisites (If any)	NA

Section A

Secure communications, Shift ciphers, Affine ciphers, Vigenere cipher key, Symmetric key, Public key, Block ciphers, One-time pads, Secure random bit generator, Linear feedback shift registersequences.

Section B

Differential cryptanalysis, Modes of DES, Attack on DES, Advanced encryption standard.

Section C

RSA, Attacks on RSA, Diffie-Hellman key exchange, ElGamal public key cryptosystem, cryptographichash function

Section D

RSA signatures, ElGamal signature, Hashing and signing, Digital signature algorithm.

Recommended Books:

1. Johannes A. Buchmann, Introduction to Cryptography, Springer 2000.
2. Douglas Robert Stinson, Cryptography - Theory and Practice, Chapman Hall / CRC 2006.
a. Wade Trappe and Lawrence C. Washington, Introduction to Cryptography with Coding Theory, Prentice Hall, 2006.

Course Title/Code	THEORY OF ELASTICITY & FRACTURE MECHANICS(MAH632)
Course Type:	Elective (Departmental)
L-T-P Structure	4-0-0
Credits	4
Objective	To familiarize students with theory of Elasticity and Fracture Mechanics.
Course outcomes	The student would be able to apply the concepts of fracture mechanics to avoidfracture in a body.
Prerequisites (If any)	N.A

Section A

Analysis of stress and strain, Equilibrium equations , Compatibility equations, stress strain relationship, Generalized Hooke's law, Stress, Strain &Elasticity, Stiffness, Strength and Toughness, Types of mechanical behavior, Relevance, Measurement, Data, Macroscopic, Continuum behavior, Physical mechanisms controlling behavior, Introduction, Stress, Strain, Compliance and stiffness tensors, Physical origin of elastic modulii, Generalized Hooke's law and its application to crystals, Designing for modulus and Composites.

Section B

Plane stress and plane strain, Simple two dimensional problems in Cartesian and polarco-ordinates.

Section C

Importance of Fracture Mechanics, Griffith Fracture Theory, Crack Driving Force & Energy Release Rate, Modes of fracture, Stress intensity factors, Similitude, Role of Crack-tip Plasticity-Plastic Zone Size& Shape, K-dominance, Fracture Toughness-Microstructural issues. Significance of fracture mechanics, Griffith energy balance approach, Irwin's modification to the Griffith theory, Stress intensity approach, Crack tip plasticity, Fracture toughness, sub- critical crack growth, Influence of material behaviour, I, II & III modes, Mixed mode problems.

Section D

Fatigue Crack Growth: Description of fatigue crack growth using stress intensity factor, Effects of stress ratio and crack tip plasticity – crack closure, Prediction of fatigue crack growth under constant amplitude and variable amplitude loading, Fatigue crack growth from notches – the short crack problem.Practical Problems:- Through cracks emanating from holes, Corner cracks at holes, Cracks approaching holes, fracture toughness of weldments, Service failure analysis, applications in pressure vessels, pipelines and stiffened sheet structures.

Recommended Books:

1. Ewalds, H.L. & Wanhill, R.J.H., Fracture Mechanics – Edward Arnold Edition
2. Timoshenko, S. and Goodier J.N."Theory of Elasticity", McGraw Hill Book Co., Newyork, 1988.
3. Broek, D. Elementary Engineering Fracture Mechanics, Sijthoff & Noordhoff Int. Pub., 1988.
4. Broek, D. The Practical Use of Fracture Mechanics, Kluwer Academic Pub., 1990.
5. Hellan, D. Introduction to Fracture Mechanics, McGraw Hill Book Company, 1985.
6. Kumar, P. Elements of Fracture Mechanics, Wheeler Publishing, 1998.

Course Title/ Code	DIFFERENTIABLE MANIFOLD(MAH636)
Course Type:	Core (Departmental)
L-T-P Structure	4-0-0
Credits	4
Objective	To familiarize students with the concept of manifold theory
Course outcomes	The student would be able to conceptualize and apply the concepts of Differentialmanifold.
Prerequisites (If any)	DIFFERENTIAL GEOMETORY(MAH619)

Section A

Almost Complex Manifolds : Elementary notions, Nijenhuis tensor Eigen values of F, Integrability conditions, Contravariant and covariant analytic vectors, F-connection, QuaternionStructure

Section B

Almost Hermitian Manifolds: Definition, Almost analytic vector fields, Curvature tensor, Linearconnections, Almost quaternion Metric structure.

Section C

Kaehler Manifolds: Definition. Curvature tensor, Affine connection, Properties of projective, Conformal,Concircular and conharmonic curvature tensors, Contravariant almost analytic vector, Quaternion Kaehler manifold.

Section D

Nearly Kaehler Manifolds: Introduction, Curvature identities, Almost analytic vectors.

Recommended Books:

1. R.S. Mishra: Structure on differentiable manifold and their application, Chandrama Prakashan,Allahabad, 1984.
2. K. Yano and M. Kon: Structures of Manifolds, World Scientific Publishing Co. Pvt. Ltd., 1984.

Course Title/Code	SCILAB(MAW508)
Course Type:	Elective (Departmental)
L-P-O Structure	0-3-0
Credits	2
Objective	To familiarize student with SCILAB Basics, their use in mathematics and statistics.
Course outcomes	The student would be able to apply the tools of SCILAB for solving variousMathematical Problems.
Prerequisites (If any)	NA

LAB EXERCISE:

1. Introduction to Scilab.
2. Scilab environment
3. Scilab as an interactive calculator
4. Scilab workspace and working directory
5. Creating matrices and some simple matrix operations
6. Sub-matrices
7. Statistics
8. Working with polynomials
9. Plotting graphs-2D & 3D.
10. Scilab programming language
11. Script files and function files
12. Writing Scilab functions
13. File operations

Course Title/Code	MATHEMATICA(MAW509)
Course Type:	Core (Departmental)
L-P-O Structure	0-3-0
Credits	2
Objective	To familiarize the students with the mathematica-installation , use of software and theirapplications in real world.
Course outcomes	The student would be able to apply the tools of Mathematica for solving variousMathematical Problems.
Prerequisites (If any)	Basic software Knowledge

LAB EXERCISE:

1. Introduction to MATHEMATICA and use of some simple MATHEMATICA commands.
2. Introduction to some of the fundamentals of MATHEMATICA: Symbols & Variables, Dynamic Data typing, Assignments & Equality Checks, Logical operators, loops and fourtypes of brackets in MATHEMATICA.
3. To study the working with lists in MATHEMATICA.
4. To study rules, patterns and functions.
5. To study functions on lists and functional programming.
6. Writing efficient programs: some techniques and applications.

Course Title/ Code	SPSS WORKSHOP(MAW231)
Course Type:	Core (Departmental)
L-P-O Structure	0-3-0
Credits	2
Objectives	To familiarize the students with SPSS software, and further use the statistical tools for dataanalysis using SPSS
Course outcomes	The students will be able to perform data analysis with SPSS that finds extreme usage asdata analyists in MNC's
Prerequisites (If any)	Basic knowledge of working on Excel

LAB EXERCISE;

1. Introduction SPSS software, open and save an SPSS data file, define codes for categoricalvariables in SPSS, print a copy of an SPSS data file.
2. Categorize a quantitative variable, create a bar chart, create a pie chart.
3. Create a modified box plot of one quantitative variable, create modified box plots of one quantitative variable to compare groups, create modified box plots to compare quantitativevariables.
4. Enter a contingency table into an SPSS data file, create a pie chart from a contingencytable, create a stacked bar chart from a contingency table.
5. Create a contingency table from raw data entered into an SPSS data file, create a stacked bar chartfrom a contingency table.
6. Obtain the equation of the least squares line for predicting one quantitative variable from another quantitative variable create a graph of the least squares line on a scatter plot createa modified box plot of the residuals.
7. Enter data into an SPSS data file perform two sample t tests and create appropriate graphicaldisplays.
8. Perform a one sample paired t test and create an appropriate graphical display.
9. Enter data into an SPSS data file, perform a one-way analysis of variance and createand an appropriate graphical display.
10. Perform a chi-square goodness-of-fit test and create and appropriate graphical displaycreate a stacked bar chart from a contingency table.

Course Title/Code	LaTeX(MAW225)
Course Type:	Core (Departmental)
L-P-O Structure	0-3-0
Credits	2
Objective	The students would be able to apply the concepts of LaTeX to create a document ofScientific Writing.
Course outcomes	The students would be able to successfully install LaTeX and its related components on a home/personal computer, use LaTeX and various templates acquired from the course to compose Mathematical documents, presentation's, reports and access various resources, such as http://ctan.org, to obtain additional LaTeX packages.
Prerequisites (If any)	NIL

LAB EXERCISE:

1. Introduction and basics of LaTeX.
2. Document structure and text formatting in LaTeX.
3. Mechanics of error and warning, lengths, Counters and Boxes.
4. Fundamentals for creating Technical Texts.
5. To Create Special Pages: Indexing ,Glossary, Bibliography
6. To Create Special Documents: Letters, Presentations, Curriculum Vitae.
7. Creating Graphics in LaTeX.
8. Programming: Macros, Plain text, Creating Packages, Themes.
9. Miscellaneous: Modular Documents, Collaborative Writing of LaTeX Documents, Export to otherFormats.
10. Math – Type in Microsoft Word.

Recommended Books:

- LaTeX in 24 hrs by Dillip Dutta, Springer

Course Title/Code	ADVANCED STATISTICS USING EXCEL(MAW538)
Course Type:	Core (Departmental)
L-P-O Structure	0-3-0
Credits	2
Objective	The student would be able to apply the concepts of statistics for solving mathematical problems using Excel.
Course outcomes	The students would be able to utilize the data to obtain the best information and analyse using statistical methods on Excel which finds scope in primary, secondary as well as tertiary sector.
Prerequisites (If any)	NA

LAB EXERCISE

1. To present the data by tables and by diagrams. To study the frequency distributions byhistogram and frequency polygon.
2. To find mean, median, mode, quartiles, deciles and percentiles for the data.
3. To find mean deviation, standard deviation, coefficient of mean deviation and coefficient ofvariation. Comparison of various measures of dispersion.
4. To find moments, coefficient of skewness and measures of kurtosis.
5. Bivariate data scatter diagram, principle of least squares and fitting of polynomials and exponentialcurves.
6. To find coefficient of correlation and rank correlation. Multiple correlation analysis.
7. To find regression coefficients and lines of regression.
8. To construct the index numbers by different methods. Time reversal, factor reversal and circulartests.
9. Analysis of time series by using different methods (graphical method, method of semiaverages, method of fitting curves).
10. To study Sampling distributions. Tests of significance based on t and F distributions.
11. Test of significance based on Chi- square distribution.