

NOORUL ISLAM CENTRE FOR HIGHER EDUCATION

(Deemed to be University Under Section 3 of the UGC Act, 1956)
Kumaracoil, Thuckalay

DEPARTMENT OF MATHEMATICS



M.Sc.MATHEMATICS **CURRICULUM AND SYLLABI**

REGULATION 2023

NOORUL ISLAM CENTRE FOR HIGHER EDUCATION, Kumaracoil

Regulation : 2023

Curriculum and Syllabi

M.Sc. Programme

DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS

Vision of the University

To be recognized by the Government and society at large as an institution able to deliver excellence with relevance in the field of higher education and research focusing on the needs of the nation in tune with the technological revolution to cope with the knowledge explosion and global competence.

Mission of the University

To develop the institution as a Centre of Excellence, keeping pace with the advances in the field, so as to provide quality higher education to the students and instill in them high standards of discipline and ethics so that they become enlightened individuals in the service of humanity and to carry out focused research in the frontier areas of science and technology.

Faculty of Science and Humanities

Department of Mathematics

Vision of the Department

To prepare students to meet the challenges and opportunities facing them as they embark on careers as researchers, educators or members of a variety of fields.

Mission of the Department

- To produce Academic excellence in Mathematics by imparting Ethical motivation through updated curriculum, effective teaching learning process for the growth of science and technology.
- To inculcate Logical & Intuitive reasoning skills, co-curricular & extracurricular competence among students so as to meet societal expectations.

Description of the programme

The **Master of Science (M.Sc.) in Mathematics** is a two-year postgraduate degree program. This course equips students with the mathematical expertise required for both academic research and practical applications in various industries. It also provides an advanced understanding of mathematics, focusing on both theoretical and applied aspects of the subject. The curriculum is designed to enhance problem-solving, analytical reasoning, and research skills, preparing students for academic, research, and professional careers. The curriculum includes advanced-level topics from pure and applied mathematics. Students may choose elective courses or specializations based on their interests and career goals.

M.Sc. Mathematics program includes computational and practical components where students use software like MATLAB, LaTeX for numerical analysis, simulations, and modeling. Research-based projects in the final semesters allow students to explore a particular area of interest in-depth.

Eligibility: Bachelor's Degree: Candidates must hold a B.Sc. in Mathematics, or a related field (such as Statistics or Engineering), with a minimum required percentage from a recognized university.

Course Duration: Two Years (divided into four semesters).

Programme Educational Objectives - PEO	
PEO-01	Provide students with advanced mathematical and computational skills that prepare them to pursue higher studies, research and create a foundation of lifelong learning.
PEO-02	Have significant opportunities in various service domains at National levels like banking, insurance, government jobs, consultancy, teaching, defense and industry.
PEO-03	Achieve peer recognition as an individual or as a team member having specialized knowledge and expertise to investigate, formulate, analyze and implement on the problems of pure, applied and computational mathematics to compete at global level.
PEO-04	Possess strong leadership qualities to effectively navigate diverse circumstances by fostering an interdisciplinary and multidisciplinary learning environment, while maintaining a continuous learning mindset to acquire new skills and techniques for addressing challenges related to emerging technologies.
PEO-05	Inculcate value system while working in a team assigned with a important targets they will contribute through their critical thinking and mathematical competence holding the ethical values

Graduate Attributes-GA	
GA-1	Advanced Scientific Knowledge and Specialization Acquire in-depth knowledge and expertise in specific scientific disciplines, building upon foundational concepts to explore advanced theories, methodologies, and applications in the chosen field of study.
GA-2	Research Methodology and Innovation Demonstrate proficiency in designing, conducting, and interpreting complex research experiments, utilizing advanced research methodologies, tools, and technologies to contribute to scientific innovation and discovery.
GA-3	Data-Driven Decision Making Use sophisticated data analysis techniques, statistical tools, and computational models to solve complex scientific problems, make data-driven decisions, and predict outcomes in research and industry settings.
GA-4	Critical Thinking and Problem-Solving Develop advanced critical thinking and problem-solving skills, enabling the formulation of innovative solutions to theoretical and practical challenges in scientific research and application.
GA-5	Interdisciplinary Collaboration and Leadership Work effectively in interdisciplinary teams, integrating knowledge from various scientific domains to tackle complex, real-world problems, and demonstrate leadership in collaborative research and professional projects.
GA-6	Environmental Stewardship and Sustainable Practices Apply scientific principles to address environmental challenges, promote sustainability, and contribute to the development of environmentally responsible technologies and practices.
GA-7	Ethics and Professional Integrity in Science Uphold the highest standards of ethical conduct and professional integrity in scientific research, ensuring responsible data handling, experimentation, and reporting in accordance with global scientific standards.
GA-8	Advanced Laboratory and Technological Skills Master cutting-edge laboratory techniques, instrumentation, and scientific tools, utilizing them to conduct sophisticated experiments and research that contribute to scientific progress and innovation.
GA-9	Effective Communication of Scientific Ideas Develop strong communication skills, capable of presenting complex scientific concepts, research findings, and technical information clearly and persuasively to both scientific and non-scientific audiences, including through publications and presentations.
GA-10	Lifelong Learning and Professional Development Embrace a commitment to lifelong learning, staying updated with the latest scientific advances, technologies, and best practices, and continuously developing skills to remain at the forefront of the scientific community.

Programme Outcome - PO	
PO-A	Solve intricate mathematical problems using the knowledge of pure and applied Mathematics.
PO-B	Acquaint with the recent advances in applied mathematical sciences such as numerical computations and mathematical modeling.
PO-C	Employ technology in solving and understanding mathematical problems.
PO-D	Capable of formulating and analyzing mathematical models of real life applications.
PO-E	To develop research intensity in the field of pure and applied Mathematics.

Mapping of Graduate Attributes and Programme Educational Objectives(PEO)

GAs PEOs	GA-01	GA-02	GA-03	GA-04	GA-05	GA-06	GA-07	GA-08	GA-09	GA-10
PEO-01	H	H	H	A	H	A	H	A	H	A
PEO-02	H	A	H	H	A	H	H	H	H	A
PEO-03	A	A	H	H	A	H	A	A	H	H
PEO-04	A	H	A	A	H	A	A	A	H	A
PEO-05	H	H	A	H	H	A	H	H	A	H

H- Highly Associated

A- Associated

Not – Not Associated

Mapping of Graduate Attributes and Programme Outcomes (PO)

GA PEOs	GA-01	GA-02	GA-03	GA-04	GA-05	GA-06	GA-07	GA-08	GA-09	GA-10
PO-A	H	A	A	H	A	A	H	A	A	A
PO-B	H	H	H	A	H	A	H	A	H	A
PO-C	H	H	A	H	A	H	H	A	A	A
PO-D	A	A	H	H	H	H	A	H	A	H
PO-E	H	H	H	A	A	A	A	A	H	A

H- Highly Associated

A- Associated

Not – Not Associated

Mapping of Programme Educational Objective(PEOs) and Programme Outcomes (POs)

PEO PO	PEO-01	PEO-02	PEO-03	PEO-04	PEO-05
PO-A	H	H	H	A	A
PO-B	H	H	A	H	H
PO-C	H	H	H	H	H
PO-D	H	A	H	A	H
PO-E	H	H	H	H	H

H- Highly Associated

A- Associated

Not – Not Associated

Duration of the programme: 2 Years/ 4 Semesters

Total credit : 91

CURRICULUM & SYLLABI**SEMESTER I**

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MA4701	Algebraic Structures	3	1	0	4
2.	MA4702	Real Analysis I	3	1	0	4
3.	MA4703	Ordinary Differential Equations	3	1	0	4
4.	MA47XX	From Group A	2	1	0	3
5.	MA47XX	From Group A	2	1	0	3
6.	CS47S5	Office Automation and ICT Tools	2	-	-	2
7.	CS4771	Computer Fundamentals and C Programming Lab	0	-	4	2
TOTAL			15	5	4	22

SEMESTER II

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MA4704	Advanced Algebra	3	1	0	4
2.	MA4705	Real Analysis II	3	1	0	4
3.	MA4706	Partial Differential Equations	3	1	0	4
4.	MA47XX	From Group B	2	1	0	3
5.	MA47XX	From Group B	2	1	0	3
6.	CS47S6	C++ Programming	0	1	2	2
7.	MA47S1	LaTeX	-	-	4	2
TOTAL			13	6	6	22

SEMESTER III

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MA4707	Complex Analysis	3	1	0	4
2.	MA4708	Mathematical Statistics	3	1	0	4
3.	MA4709	Topology	3	1	0	4
4.	MA47XX	From Group C	2	1	0	3
5.	CS47XX	From Group D	3	0	0	3
6.	EG47S1	Soft Skill -I	2	-	-	2
7.	MS47S1	Personality Development	2	-	-	2
8.	MA47P1	Carried out in Summer Vacation at the end of I year – 30 hours	-	-	-	2
TOTAL			18	4	-	24

SEMESTER IV

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MA4710	Functional Analysis	3	1	0	4
2.	MA4711	Operations Research	3	1	0	4
3.	MA4712	Graph Theory	3	1	0	4
4.	MA47XX	From Group C	2	1	0	3
5.	EG47S2	Soft Skill -II	2	-	-	2
6.	MA47S2	NET/SET /Competitive/ coaching	2	-	-	2
PRACTICAL						
7.	MA47P2	Project and Viva – Voce	0	0	8	4
TOTAL			15	4	8	23

Elective List

Semester I : Elective I & Elective II

Electives I & II to be chosen from Group A

Group: A

MA47A2	Algebraic Number Theory	2	1	0	3
MA47A3	Calculus of Variations and Integral Equations	2	1	0	3
MA47A6	Differential Geometry	2	1	0	3
MA47A9	Mathematical Programming	2	1	0	3
MA47B3	Numerical Analysis	2	1	0	3

Semester II : Elective III & Elective IV

Electives III & IV to be chosen from Group B

Group B

MA47A5	Contributions of Indian Mathematicians	2	1	0	3
MA47A8	Fuzzy Mathematics	2	1	0	3
MA47B1	Mechanics	2	1	0	3
MA47B2	Number Theory	2	1	0	3
MA47B4	Stochastic Processes	2	1	0	3

Semester III : Elective V & Elective VI

Electives V to be chosen from Group C and Electives VI to be chosen from Group D

Group C

MA47A1	Advanced Graph theory	2	1	0	3
MA47A4	Coding Theory	2	1	0	3
MA47A7	Discrete Mathematics	2	1	0	3
MA47B5	Wavelets	2	1	0	3

Group D

1.	CS47S1	Modeling and Simulation with Excel	1	0	4	3
2.	CS47S2	PYTHON Programming	3	0	0	3
3.	CS47S3	Statistical Data Analysis using R Programming	1	0	4	3
4.	CS47S4	Web Design	3	0	0	3

Semester IV : Elective VII**Electives V to be chosen from Group C**

SKILL ENHANCEMENT COURSE						
S1	CS47S5	Office Automation and ICT Tools	2	-	-	2
S2	CS47S6	C ⁺⁺ Programming	0	1	2	2
S3	EG47S1	Soft Skill – 1	2	-	-	2
S4	EG47S2	Soft Skill -2	2	-	-	2
ABILITY ENHANCEMENT COURSE						
The courses listed below are only included in the internal component and are not to be included in the question paper for the external examination.						
S1	CS4771	Computer Fundamentals and C Programming Lab	-	-	4	2
S2	MA47S1	LaTeX	-	-	4	2
S3	MS47S1	Personality Development	2	-	-	2
S4	MA47S2	NET/SET /Competitive/ coaching	2	-	-	2
LIST OF SUPPORTIVE COURSES TO OTHER DISCIPLINES						
1	MA47D1	Statistical Methods	2	1	0	3
2	MA47D2	Mathematics for Competitive Examinations	2	0	0	2

Syllabus Format

SEMESTER I

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MA4701	Algebraic Structures	3	1	0	4
2.	MA4702	Real Analysis I	3	1	0	4
3.	MA4703	Ordinary Differential Equations	3	1	0	4
4.	MA47XX	From Group A	2	1	0	3
5.	MA47XX	From Group A	2	1	0	3
6.	CS47S5	Office Automation and ICT Tools	2	-	-	2
7.	CS4771	Computer Fundamentals and C Programming Lab	0	-	4	2
TOTAL			15	5	4	22

MA4701	ALGEBRAIC STRUCTURES	L	T	P	C
		3	1	0	4

OBJECTIVE

To enable the students to comprehend the topics in algebra like groups, group actions. Also to develop computational skills in abstract algebra.

Course Outcome		Cognitive Skill
CO-01	Understand the concepts of Cyclic Groups and Permutation Groups and able to solve the related problems.	R,U,A,An,E,S
CO-02	Able to understand the concepts of isomorphisms and homomorphisms in groups and solve problems regarding them.	R,U,A,An,E,S
CO-03	Understand and apply the concepts of external and internal direct products, normal groups and factor groups in problem solving.	R,U,A,An,E,S
CO-04	Mastering the concepts on fundamental theorem of finitely generated abelian groups and apply them to form a table of groups of small order.	R,U,A,An,E,S
CO-05	Understand the concepts of Sylow's theorem and have increased ability of solving advanced counting problems in group theory.	R,U,A,An,E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	L	M	M	S
CO-02	S	M	M	S	S
CO-03	S	M	M	S	S
CO-04	S	M	M	S	S
CO-05	S	S	M	S	S

S-Strong, M-Medium, L-Low, N-Not relevant

Unit I: Cyclic Groups and Permutation Groups **12**

Cyclic Groups: Properties of Cyclic Groups- Classification of subgroups of cyclic groups.
Permutation Groups: Definition and Notation- Cyclic Notation- Properties of Permutations.

Unit II: Isomorphisms, Cosets and Lagrange's Theorem **12**

Isomorphism: Motivation- Definition and Examples- Cayley's Theorem- Properties of Isomorphism- Automorphisms. Cosets and Lagrange's theorem: Properties of cosets- Lagrange's Theorem: Properties of Cosets- Lagrange's theorem.

Unit III: External Direct Products, Normal Subgroups and Factor Groups **12**

External Direct Products: - Definition and Examples- Properties of External Direct Products.
Normal Subgroups and Factor Groups: Normal Subgroups-Applications of Factor Groups – Initial Direct Products.

Unit IV: Group Homomorphisms and Fundamental Theorem of Finite Abelian Groups **12**

Group Homomorphisms: - Definition and Examples- Properties of Homomorphism's. The first isomorphism Theorem - Fundamental Theorem of Finite Abelian Groups: The fundamental Theorem- The Isomorphism classes of Abelian Groups- The proof of fundamental Theorem.

Unit V: Sylow Theorems **12**

Sylow Theorems: Conjugacy Classes- The class Equation- The Sylow Theorems- Applications of Sylow Theorem.

TOTAL: 60 HOURS

Text Book

Contemporary Abstract Algebra (Seventh Edition) by Joseph A. Gallian, Brooks/Cole Cengage Learning (2010),

Unit 1: Chapter 4: pages 72-81 and Chapter 5 pages 95-106

Unit 2: Chapter 6: pages 122-133 and Chapter 7 pages 138-144

Unit 3: Chapter 8: pages 155-160 and Chapter 9 pages 178-192

Unit 4: Chapter 10: pages 200-203 and Chapter 11 pages 218-225

Unit 5: Chapter 24: pages 403-414

MA4702	ANALYSIS I	L	T	P	C
		3	1	0	4

OBJECTIVE

To provide a strong foundation on the concepts in sequences and series and also enable the students to have a comprehensive idea about the underlying principles of derivatives, continuous functions.

Course Outcomes		Cognitive Skill
At the end of the course students should be able to		
CO-01	Understand terms, definitions and theorems related to topology and limits and limit inferior/superior. Demonstrate knowledge and understanding of concepts such as connectedness and compactness.	R,U,A,An,E
CO-02	Recognize the converging sequence and diverging sequence . Know how to check if a sequence is converging or diverging.	R,U,A,An,E
CO-03	Comprehend the properties of Cauchy and Monotone sequences. Know and be able to apply convergence tests for sequences and series.	R,U,A,An,E
CO-04	Explain the notion of Continuity as related to functions. Students should be able to relate an intuitive notion of continuity to the mathematical definition of continuity and Uniform Continuity.	R,U,A,An,E
CO-05	Apply the Mean Value Theorem and the Fundamental Theorem of Calculus to problems in the context of real analysis and produce rigorous proofs of results that arise in the context of real analysis.	R,U,A,An,E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	S	M	S
CO-02	M	M	S	M	S
CO-03	S	M	M	S	S
CO-04	S	S	S	S	S
CO-05	S	S	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Basic Topology**12**

Finite, Countable and Uncountable sets – Metric Spaces – Compact sets – Perfect sets – Connected sets.

Unit II: Numerical Sequences**12**

Convergent Sequences – Subsequences – Cauchy Sequences – Upper and Lower Limits – Some Special Sequences.

Unit III: Numerical Series**12**

Series of Non-negative Terms – The Number e – The Root and Ratio Tests – Power Series – Summation by Parts – Absolute Convergence – Addition and Multiplication of Series – Rearrangements.

Unit IV: Continuity**12**

Limits of Functions – Continuous Functions – Continuity and Compactness – Continuity and Connectedness - Discontinuities – Monotonic Functions – Infinite Limits and Limits at Infinity.

Unit V: Differentiation**12**

The Derivative of a Real Function – Mean Value Theorems - The Continuity of Derivatives – L’Hospital’s Rule – Derivatives of Higher Order – Taylor’s Theorem – Differentiation of Vector-Valued Functions.

TOTAL: 60 HOURS**Text Book**

Principles of Mathematical Analysis (Third edition) by Walter Rudin,
Chapters 2, 3, 4 and 5.

MA4703	ORDINARY DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

OBJECTIVE

To help the students grasp problem solving techniques in power series solutions of second order ordinary differential equations with variable coefficients and some special functions of mathematical physics. To learn more about linear and non linear differential equations of first and second order in detail.

Course Outcomes		Cognitive Skill
At the end of the course students should be able to		
CO-01	Know about second order homogeneous equations and solve the Initial value problems Understand Wronskian and find the solution of non-homogeneous equation of order two.	R, A ,An,E
CO-02	Understand the power series and special functions. Apply power series method to find the solution of first and second order differential equations. To find the Frobenius series solution of the Hypergeometric equations.	U, A ,An,E
CO-03	Know about Legendre polynomial and Bessel functions and their properties. Derive the Rodrigues formula from the Legendre polynomial and derive the Bessel function from the Bessel equation and to prove some results of the Legendre polynomial and Bessel functions.	R, A ,An,E
CO-04	Evaluate the integrals and derivatives using Laplace transform. Apply the concepts of Convolution theorem to find the solution of differential equations and the integral equations.	U, A ,An,E
CO-05	Apply the Picard's method of successive approximations to find the exact solution of the initial value problems and prove the Picard's theorem. Know the Lipschitz condition and verify the Lipschitz condition for the functions.	U, A ,An,E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	S	M	S
CO-02	S	S	M	M	S
CO-03	S	S	M	M	S
CO-04	S	S	S	M	S
CO-05	S	S	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Linear Equations with Constant Coefficients **12**

Second order homogeneous equations, Initial value problems, Linear dependence and independence, Wronskian and a formula for Wronskian, Non-homogeneous equation of order two.

Unit II: Power Series Solutions and Special Functions **12**

Power Series Solutions : Series Solutions of First and Second Order Linear Equations. Regular Singular Points, Gauss's Hyper-Geometric Equation.

Unit III: Some Special Functions of Mathematical Physics **12**

Some Special Functions of Mathematical Physics: Legendre Polynomial, Bessel Functions. The Gamma Function and their Properties.

Unit IV: Laplace Transforms **12**

Laplace Transforms: Application to Differential Equation, Derivatives and Integrals of Laplace Transforms, Convolution and Integral equation

Unit V: The Existence and Uniqueness of Solutions **12**

The Existence and Uniqueness of Solutions: The Method of Successive Approximations, Picard's Theorem, Systems. The Second order Linear Equation.

TOTAL: 60 HOURS

Text Books

1. Differential Equations with Applications and Historical Notes by George F. Simmons, 2nd Edition. Sections 26 to 31, 44 to 47, 50 to 52, 68 to 70
2. E.A. Coddington, A introduction to differential equations (3rd Printing) Prentice – Hall of India Ltd, New Delhi, 1987. Section Chapter 2: Sections 1 to 6

REFERENCE BOOKS

1. Williams E. Boyce and Richard C. DI Prima, Elementary differential equations and boundary value problems, John Wiley and sons, New York, 1967.
2. B.Rai, D.P.Choudary and H.I. Freedman, A Course in Ordinary Differential Equations, Narosa Publishing House, New Delhi, 2002.
3. W.T. Reid. Ordinary Differential Equations, John Wiley and Sons, New York, 1971.

SEMESTER – II

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MA4704	Advanced Algebra	3	1	0	4
2.	MA4705	Real Analysis II	3	1	0	4
3.	MA4706	Partial Differential Equations	3	1	0	4
4.	MA47XX	From Group B	2	1	0	3
5.	MA47XX	From Group B	2	1	0	3
6.	CS47S6	C ⁺⁺ Programming	0	1	2	2
7.	MA47S1	LaTeX	-	-	4	2
TOTAL			13	6	6	22

MA4704	ADVANCED ALGEBRA	L	T	P	C
		3	1	0	4

OBJECTIVE

To develop a deep theoretical understanding of fields, polynomials, and their roots, as well as the advanced concepts of Galois theory. To gain a comprehensive understanding of finite fields, their structure, and applications in various mathematical and practical contexts.

Course Outcomes At the end of the course students should be able to		Cognitive Skill
CO-01	Prove theorems applying algebraic ways of thinking.	R,U,A,An,E
CO-02	Connect groups with graphs and understanding about Hamiltonian graphs.	R,U,A,An,E
CO-03	Compose clear and accurate proofs using the concepts of Galois Theory.	R,U,A,An,E
CO-04	Bring out insight into Abstract Algebra with focus on axiomatic theories.	R,U,A,An,E
CO-05	Demonstrate knowledge and understanding of fundamental concepts including extension fields, Algebraic extensions, Finite fields, Class equations and Sylow's theorem.	R,U,A,An,E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	M	S	M
CO-02	M	M	M	S	S
CO-03	S	S	M	M	S
CO-04	S	M	M	S	S
CO-05	S	M	S	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Fields	12
Extension fields – Transcendence of e .	
Unit II: Roots of Polynomials	12
Roots of Polynomials.- More about roots	
Unit III: Elements of Galois Theory	12
Elements of Galois theory	
Unit IV: Finite Fields	12
Finite fields -Wedderburn's theorem on finite division rings	
Unit V: Solvability by Radicals	12
Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four - Square theorem.	

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TOTAL: 60 HOURS

Text Book

I.N. Herstein. *Topics in Algebra* (II Edition) Wiley Eastern Limited, New Delhi, 1975.

Chapter 5: Sections 5.1 and 5.2

Chapter 5 : Section 5.3 and 5.5

Chapter 5 : Section 5.6

Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only)

Chapter 5: Section 5.7 (omit Lemma 5.7.1, Lemma 5.7.2 and Theorem 5.7.1)

Chapter 7 : Sections 7.3 and 7.4

REFERENCE BOOKS

1. M.Artin, *Algebra*, Prentice Hall of India, 1991.
2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition)
3. I.S.Luther and I.B.S.Passi, *Algebra*, Vol. I –Groups(1996); Vol. II Rings, Narosa Publishing House , New Delhi, 1999
4. D.S.Malik, J.N. Mordeson and M.K.Sen, *Fundamental of Abstract Algebra*, McGraw Hill (International Edition), New York. 1997.
5. N.Jacobson, *Basic Algebra*, Vol. I & II W.H.Freeman (1980); also published by Hindustan Publishing Company, New Delhi.

MA4705	REAL ANALYSIS II	L	T	P	C
		3	1	0	4

OBJECTIVE

To develop a firm footing in the concepts of Riemann Integrals, Sequences and series of function, Stone-Weierstrass theorem, Inverse function theorem . To handle complex integrals, understand the stages of function sequences and series and apply advanced calculus concepts to theoretical and practical problems in mathematics and related fields.

Course Outcomes		Cognitive Skill
At the end of the course the students would be able to		
CO-01	Describe the concept of Riemann-Stieltjes integral and its properties.	U,A,An,E
CO-02	Understand the concept of existence of Riemann Integrals, Mean Value theorem and Lebesgue criterion for existence of Riemann integrals.	U,A,An,E
CO-03	Capable to understand about Pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weirstrass M-test,. Develop the ability to reflect on problems that are quite significant in the field of real analysis.	U,A,An,E
CO-04	Build-up the ability to estimate the values of the functions of several variables.	U,A,An,E
CO-05	Understand the concept of Contraction Principle, determinants and differentiation of Integrals	U,A,An,E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	M	S	M
CO-02	M	M	M	S	S
CO-03	S	M	M	S	S
CO-04	S	M	M	S	S
CO-05	S	M	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: The Riemann - Stieltjes Integral I**12**

Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral – Euler's summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper, lower integrals - Riemann's condition - Comparison theorems.

Unit II: The Riemann-Stieltjes Integral II**12**

Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of RS integrals- Mean value theorems -integrals as a function of the interval – Second fundamental theorem of integral calculus-Change of variable -Second Mean Value Theorem for Riemann integral- Riemann-Stieltjes integrals depending on a parameter- Differentiation under integral sign-Lebesgue criterion for existence of Riemann integrals.

Unit III: Sequence and Series of Functions**12**

Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions - Uniform convergence and continuity - Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Riemann - Stieltjes integration – Non-uniform Convergence and Term-by-term Integration - Uniform convergence and differentiation - The Stone-Weierstrass Theorem.

Unit IV: Multivariable Differential Calculus**12**

Introduction - The Directional derivative - Directional derivative and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives - Taylor's theorem for functions of $\mathbb{R}^n$ to $\mathbb{R}^1$

Unit V: Implicit Function And Inverse Function**12**

Differentiation-The Contraction Principle –The Inverse Function Theorem..The Implicit Function Theorem- Determinants

TOTAL: 60 HOURS**Text Books**

1. Tom M.Apostol : *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974.
Unit I (Chapter - 7 : Sections 7.1 to 7.14)
Unit II (Chapter - 7 : 7.15 to 7.26)
Unit IV (Chapter 12 : Section 12.1 to 12.14)
2. Principles of Mathematical Analysis (Third Edition) by Walter Rudin.
Unit III Chapters 7
Unit V Chapter 9 (except 9.30, 9.31 and 9.32) .

MA4706	PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

OBJECTIVE

To classify the second order partial differential equations and to study the Cauchy problem, method of separation of variables, boundary value problems and apply the partial differential equations in the physical problems such as wave equations and diffusion equations

Course Outcomes		Cognitive Skill
At the end of the course the students would be able to		
CO-01	Classify Second Order PDE and extract information from partial differential equations to interpret reality.	R, U, A, An, E, S
CO-02	To analyse and solve wave equations in different polar coordinates	R, U, A, An, E, S
CO-03	To solve Vibrating string problem, Heat conduction problem, to identify and solve Laplace and beam equations	R, U, A, An, E, S
CO-04	To apply maximum and minimum principle's and solve Dirichlet, Neumann problems for various boundary conditions	R, U, A, An, E, S
CO-05	Apply the acquired knowledge of wave equation and to select the most appropriate method to solve the particular partial differential equation.	R, U, A, An, E, S

R- Remember, U-Understand, A-Apply, An-Analyse, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	S	M	S
CO-02	S	S	M	S	S
CO-03	S	S	M	M	S
CO-04	S	S	S	M	S
CO-05	S	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Classification of Second Order Equation**12**

Classification of Second Order PDE –Canonical Forms –Linear Partial Differential Equations with Constant Coefficients – Homogeneous Linear PDE with Constant Coefficients.

Unit II: Cauchy Problem**12**

The Cauchy problem – Cauchy-Kowalewsky theorem – Homogeneous wave equation – Initial Boundary value problem- Non-homogeneous boundary conditions – Finite string with fixed ends – Non-homogeneous wave equation – Riemann method – Goursat problem – spherical wave equation – cylindrical wave equation.

Unit III: Method of Separation of Variables**12**

Separation of variable- Vibrating string problem – Existence and uniqueness of the solution of vibrating string problem - Heat conduction problem – Existence and uniqueness of the solution of heat conduction problem – Laplace and beam equations

Unit IV: Boundary Value Problems**12**

Boundary value problems –Maximum and minimum principles – Uniqueness and continuity theorem – Dirichlet Problem for a circle, a circular annulus, a rectangle – Dirichlet problem involving Poisson equation – Neumann problem for a circle and a rectangle.

Unit V: Hyperbolic Differential Equations**12**

Occurrence of the Wave Equation – Derivation of One dimensional Wave Equation - Solution of One dimensional Wave Equation by Canonical Reduction – The Initial Value Problem: D’Alembert’s Solution – Vibrating String – Variable Separable Solution – Forced Vibrations – Solution of Non-homogenous Equation – Boundary and Initial Value Problem for Two-dimensional Wave Equations

TOTAL: 60 HOURS**REFERENCE BOOKS**

1. M.M.Smironov, Second Order Partial Differential Equations, Leningrad, 1964.
2. I.N.Sneddon, Elements of Partial Differential Equations, McGraw Hill, New Delhi, 1983.
3. R. Dennemeyer, Introduction to Partial Differential Equations and Boundary Value Problems, McGraw Hill, New York, 1968.
4. S. Sankar Rao, Introduction to Partial Differential Equations, (Third Edition), Prentice Hall of India, New Delhi. 2011

SEMESTER III

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MA4707	Complex Analysis	3	1	0	4
2.	MA4708	Mathematical Statistics	3	1	0	4
3.	MA4709	Topology	3	1	0	4
4.	MA47XX	From Group C	2	1	0	3
5.	CS47XX	From Group D	3	0	0	3
6.	EG47S1	Soft Skill –I	2	-	-	2
7.	MS47S1	Personality Development	2	-	-	2
8.	MA47P1	Carried out in Summer Vacation at the end of I year – 30 hours	-	-	-	2
TOTAL			18	4	-	24

MA4707	COMPLEX ANALYSIS	L	T	P	C
		3	1	0	4

OBJECTIVE

To train the students to get essential knowledge in the theory of analytic function, complex integration and bilinear transformations in detail.

Course Outcomes		Cognitive Skill
At the end of the course students should be able to		
CO-01	Do problems on Analytic Functions. Compute the Limits of the sequences. Distinguish Convergence and Uniform Convergence of Sequences & Series.	R, , A, An, E, S
CO-02	Do problems on conformal mapping and cross ratio. Compute linear Transformation. Do problems on Complex integration.	R,U, A, An, E, S
CO-03	Compute the Index of a Point with Respect to a closed curve. Identify the problems based on Cauchy's Integral Formula. Distinguish the types of Singularities	R,U, A, An, E, S
CO-04	Compute the Residues. Do problems on Cauchy's Theorem.	R,U, A, An, E, S
CO-05	Solve Problems using Taylor Series and Laurent Series .Understand Harmonic function and Mean - Value Property.	R,U, A, An, E, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	M	M	S
CO-02	S	S	M	M	S
CO-03	S	S	M	M	S
CO-04	S	S	M	M	S
CO-05	S	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Complex Functions**12**

Concept of Analytic Function – Limits and Continuity – Analytic Functions – Polynomials – Rational Functions – Elementary Theory of Power Series - Sequences - Series – Uniform Convergence – Power series – Abel's Limit Theorem.

Unit II: Analytic Functions as Mappings**12**

Conformality – Arcs and Closed Curves – Analytic Functions in Regions – Conformal Mapping- Length and Arcs-Linear Transformations – The Linear Group – The Cross Ratio - Symmetry.

Unit III: Complex Integration**12**

Fundamental Theorems : Line Integrals – Rectifiable Arc – Line Integrals as Functions of Arcs – Cauchy's Theorem for a Rectangle – Cauchy's Theorem in a Disk.

Cauchy's Integral Formula : The Index of a Point with Respect to a Closed Curve – The Integral Formula - Higher Derivatives.

Unit IV: Local Properties of Analytical Functions**12**

Removable Singularities – Taylor's Theorem – Zeros and Poles – The Local Mapping – The Maximum Principle.

The General Form of Cauchy's Theorem : Chains and Cycles - Simple Connectivity – Homology - The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem.

The Calculus of Residues : The Residue Theorem – The Argument Principle – Evaluation of Definite Integrals.

Unit V: Harmonic Functions, Series and Product Developments**12**

Harmonic Functions : Definition and Basic Properties – The Mean - Value Property – Poisson's Formula – Schwarz's Theorem – The Reflection Principle.

Series and Product Developments : Power Series Expansions - Weierstrass's Theorem – The Taylor Series – The Laurent Series.

TOTAL: 60 HOURS**Text Book**

L.V. Ahlfors, Complex Analysis (3rd Edition), McGraw Hill ISE, 1981.

Unit I : Chapter 2: sections 1, 2.

Unit II : Chapter 3 : Sections 2, 3 (3.1 to 3.3 only) .

Unit III : Chapter 4: Sections 1, 2.

Unit IV : Chapter 4: Sections 3, 4 (4.1 to 4.5 only) and 5

Unit V : Chapter 4 : Section 6 , Chapter 5: Section 1.

MA4708	MATHEMATICAL STATISTICS	L	T	P	C
		3	1	0	4

OBJECTIVE

To provide students with a comprehensive understanding of the fundamental concepts of probability theory, multivariate distributions, special probability distributions, limiting distributions, and basic statistical inference

Course Outcomes At the end of the course students should be able to		Cognitive Skill
CO-01	Do some simple problems on probability, calculate conditional probabilities using Baye's theorem, identify discrete and continuous random variables, verify pmf and pdf , Transform discrete and continuous random variables, compute expectations and obtain probabilities using on Chebyshev's inequality.	R,U,A,An,E, S
CO-02	Do problems on two dimensional random variables, compute expectations, evaluate correlation coefficient and identify the independent random variables.	R,U,A,An,E, S
CO-03	Know the standard probability distributions, recognise the distribution from their mgf and identify the problems on the special distributions.	R,U,A,An,E, S
CO-04	Understand the limiting distribution of some probability distributions, evaluate the limiting distributions using mgf and apply central limit theorem.	R,U,A,An,E, S
CO-05	Construct confidence interval for unknown parameters, do problems on statistical hypothesis and understand the basic principles of statistical inferences	R,U,A,An,E, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	M	S	S
CO-02	S	S	M	S	S
CO-03	S	S	M	S	S
CO-04	S	M	M	S	S
CO-05	S	M	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Probability and Distributions**12**

Introduction - Set Theory, The Probability Set Functions, Conditional Probability and Independence, Random Variables of the Discrete Type, Random Variables of the Continuous Type, Transformations, Expectation of a Random Variable, Moment Generating function and its Properties- Some Special Expectations, Important Inequalities.

Unit II: Multivariate Distributions**12**

Distributions of Two Random Variables- Expectation – Transformations: Bivariate Random Variables- Conditional Distributions and Expectations, The Correlation Coefficient, Independent Random Variables.

Unit III: Some Special Distributions**12**

The Binomial and Related Distributions, The Poisson Distribution, The Gamma, Chi-Square and Beta Distributions, The Normal Distribution - The t and F Distributions

Unit IV: Limiting Distributions**12**

Expectation - Convergence in Probability, Convergence in Distribution- Limiting Moment Generating Function Technique, The Central Limit Theorem,

Unit V: Some Elementary Statistical Inferences**12**

Sampling and Statistics -More on Confidence Intervals - Confidence Intervals for Differences in Means - Confidence Intervals for Differences in Proportions –Introduction to Hypothesis Testing

TOTAL: 60 HOURS**Text Book**

R.V.Hogg, A.T.Craig and Joseph W.Mckean, Introduction to Mathematical Statistics (6th Edition), Pearson Education, Asia, Reprint 2013.

Chapter 1: Sections : 1.1 to 1.10.

Chapter 2: Sections: 2.1 to 2.5.

Chapter 3: Sections: 3.1 to 3.4 & 3.6

Chapter 4: Sections : 4.1 to 4.4.

Chapter 5: Sections: 5.1, 5.4, 5.5

MA4709	TOPOLOGY	L	T	P	C
		3	1	0	4

OBJECTIVE

To build a solid foundation in various aspects of topology, including different types of topologies, continuous functions, connectedness, compactness, and separation axioms.

Course Outcomes		Cognitive Skill
At the end of the course students should be able to		
CO-01	Distinguish spaces according to their topologies. Construct order topology, product topology and subspace topology from sets and topologies. Identify the closed sets and limit points. Prove various properties and results on limit points and the closed sets.	U, A, An, E, S
CO-02	Distinguish functions which are continuous. Prove various properties and results on continuity, Product and quotient topology.	U, A, An, E, S
CO-03	Determine whether a space is connected. Identify the conditions which imply connectedness and compactness in a topological space. Give logical proofs to results in components and local connectedness.	U, A, An, E, S
CO-04	Understand the local compactness. Distinguish spaces according to the countability axioms. Provide logical proofs for established results in normal spaces	U, A, An, E, S
CO-05	Understand and apply the Urysohn lemma, The Tietze Extension theorem and the Tychonoff theorem	U, A, An, E, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO \ CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	M	M	S
CO-02	S	S	M	M	S
CO-03	S	S	M	M	S
CO-04	S	S	M	M	S
CO-05	S	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Topological Spaces**12**

Topological Spaces and Continuous Functions: Topological Spaces - Basis for a Topology – The Order Topology – The Product Topology on $X \times Y$ – The Subspace Topology - Closed Sets and Limit Points.

Unit II: Continuous Functions**12**

Continuous Functions – The Product Topology – The Quotient Topology.

Unit III: Connected Spaces**12**

Connectedness and Compactness: Connected Spaces, Components and Local Connectedness - Compact Spaces.

Unit IV: Compactness and Countability Axioms**12**

Local Compactness – Countability and Separation Axioms: The Countability Axioms – The Separation Axioms- Normal Spaces.

Unit V: Separation Axioms**12**

The Uryshon Lemma- The Tietze Extension Theorem - The Tychonoff Theorem: Tychonoff Theorem.

TOTAL: 60 HOURS**Text Book**

Topology (2nd Edition) by J. R. Munkres, Pearson Publishers, 2000

Sections 12 to 19, 22, 23, 25, 26, 29 to 33, 35, 37 and 38.

SEMESTER – IV**SEMESTER IV**

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MA4710	Functional Analysis	3	1	0	4
2.	MA4711	Operations Research	3	1	0	4
3.	MA4712	Graph Theory	3	1	0	4
4.	MA47XX	From Group C	2	1	0	3
5.	EG47S2	Soft Skill -II	2	-	-	2
6.	MA47S2	NET/SET /Competitive/ coaching	2	-	-	2
PRACTICAL						
7.	MA47P2	Project and Viva – Voce	0	0	8	4
TOTAL			15	4	8	23

MA4710	FUNCTIONAL ANALYSIS	L	T	P	C
		3	1	0	4

OBJECTIVE

To build a solid foundation in various aspects of topology, including different types of topologies, continuous functions, connectedness, compactness, and separation axioms. Apply important theorems such as the Hahn-Banach theorem, open mapping theorem, and spectral theorem to solve problems in functional analysis

Course Outcomes At the end of the course students should be able to		Cognitive Skill
CO-01	Understand the terminology of Banach spaces. Distinguish which normed spaces are Banach. Evaluate continuity of linear transformations.	U, A, An, E, S
CO-02	Understand the concepts of conjugate space and conjugate operators. Evaluate the conjugate space of given space. Finding conjugate of an operator.	U, A, An, E, S
CO-03	Analyzing which Banach space are Hilbert space. Constructing orthonormal set. Analyse whether the given set is orthonormal.	U, A, An, E, S
CO-04	Understand adjoint and self adjoint sets- Analysing whether an operator is normal or Unit ary.	U, A, An, E, S
CO-05	Applying Finite dimensional spectral theory- Understandings spectrum concepts.	U, A, An, E, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	M	M	S
CO-02	S	S	M	M	S
CO-03	S	S	M	M	S
CO-04	S	S	M	M	S
CO-05	S	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Banach Spaces **12**

Banach spaces-The definition and some examples – Continuous linear transformation – The Hahn- Banach theorem.

Unit II: Operators on Banach Spaces **12**

Conjugate space N^* of normed linear space N – The natural imbedding of N in N^{**} - The open mapping theorem – The conjugate of an operator.

Unit III: Hilbert Spaces **12**

Hilbert spaces – The definition and some simple properties – Orthogonal complements – Orthonormal sets – The conjugate space H^* .

Unit IV: Operators on Hilbert Spaces **12**

Adjoint of an operator – Self-adjoint operators – Normal and Unitary operators – Projections.

Unit V: Spectral Theorem **12**

Finite-dimensional spectral theory – Determinants and the spectrum of an operator – The spectral theorem.

TOTAL:60 HOURS

Text Book

Introduction to Topology and Modern Analysis (2006) by G. F. Simmons, Tata
Mc Graw-Hill Edition, 6th Reprint Sections 46-59, 61 and 62.

MA4711	OPERATIONS RESEARCH	L	T	P	C
		3	1	0	4

OBJECTIVE

To enable the students to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively and also formulating mathematical models in decision theory, PERT, CPM, deterministic inventory systems, queues, replacement and maintenance problems.

Course Outcomes		Cognitive Skills
At the end of the course students should be able to		
CO-01	Apply decision theory techniques to make optimal decisions under different conditions	R,U,A,An,E,S
CO-02	Effectively manage projects using PERT and CPM techniques, including cost analysis	R,U,A,An,E,S
CO-03	Understand inventory management principles and apply appropriate inventory control models to optimize inventory levels.	R,U,A,An,E,S
CO-04	Analyze queueing systems and make informed decisions to minimize waiting times	R,U,A,An,E,S
CO-05	Make informed replacement decisions considering various factors such as maintenance costs, time value of money and system reliability.	R,U,A,An,E,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	M	S	S
CO-02	S	S	M	S	S
CO-03	S	S	M	S	S
CO-04	S	M	M	S	S
CO-05	S	M	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Decision Theory**12**

Steps in Decision Theory Approach - Decision Making Environments - Decision Making Under Conditions of Certainty- Decision Making Under Uncertainty - Decision Making Under Risk – Expected Value Criterion for Continuously Distributed Random Variables- Decision Trees.

Unit II: Project Management : PERT AND CPM**12**

Introduction-Phases of Project Management-Network-Numbering the Events-Measure of Activity-Frequency Distribution Curve for PERT- PERT - Computations-Probability of Meeting the Scheduled Dates-CPM Computations- Critical Path-Float-Cost Analysis-Project Cost-Crashing the Network.

Unit III: Inventory Models**12**

Necessity for Maintaining Inventory- Inventory Costs- Inventory Control Problem-Classification of Fixed Order Quantity Inventory Models- Inventory Models with Deterministic Demand-Model I (a) Demand Rate Uniform and Production Rate Infinite- Model I (b) Demand Rate Non-uniform and Production Rate Infinite- Model I (c) Demand Rate Uniform and Production Rate Finite-Model 2 (a) Demand Rate Uniform and Production Rate Infinite, Shortages Allowed- Model 2 (b) Demand Rate Uniform ,Production Rate Infinite, Shortages Allowed ,Time Interval Fixed- Model 2 (c) Demand Rate Uniform ,Production Rate Finite, Shortages Allowed.

Unit IV: Queueing Models**12**

Characteristic of Queueing Models-Waiting Time and Idle Time Costs-Transient and Steady States of the System-Single Channel Queueing Theory-Models for Arrival and Service times-Model:(M/M/1): (FCFS/ ∞); Model II. (M/M/1): (FCFS/N); Model III. (M/M/C): (FCFS/ ∞) ; Model IV- (M/M/C): (FCFS/N)

Unit V: Replacement Models**12**

Introduction- Replacement of Items Deteriorates with Time- Replacement of Items whose Maintenance and Repair Costs Increase with Time, Ignoring Changes in the Value of Money During the Period- Replacement of Items whose Maintenance Costs Increase with Time and Value of Money also Changes with Time- Replacement of Items that Fail Suddenly-Individual Replacement Policy – Group Replacement Policy- Miscellaneous Replacement Problems.

TOTAL: 60 HOURS**Text Book**

Prem Kumar Gupta, D.S.Hira, Operations Research, Reprint (2001), S.Chand & Company Ltd., New Delhi.

Unit I : Chapter 9 : 9.1 – 9.10

Unit II : Chapter 14.1 - 14.9, 15.1- 15.7, 16.1-16.4, 17.1-17.2

Unit III : Chapter 12 : 12.1 – 12.5 ;

Unit IV : Chapter 10 : 10.1 - 10.7

Unit V : Chapter 11 : 11.1 - 11.5

MA4712	GRAPH THEORY	L	T	P	C
		3	1	0	4

OBJECTIVE

To study and develop the concepts of graphs, sub graphs, trees, connectivity, Euler tours, Hamilton cycles, matching, coloring of graphs, independent sets, cliques, vertex coloring and di graphs.

Course Outcomes		Cognitive Skill
At the end of the course students should be able to		
CO-01	Understand the concept of graph theory, path, vertex degree and trees. To be able to find cut edge and cut vertices.	R,U, A, An, E, S
CO-02	Find Euler path, Euler tour Hamiltonian cycle and connectivity.	R,U, A, An, E, S
CO-03	Understand the concept of Matching and covering in bipartite graph. To able to find perfect matching.	R,U, A, An, E, S
CO-04	Apply the concept of independent sets, cliques etc.	R,U, A, An, E, S
CO-05	Understand the concept of Directed graph, Directed path and cycles. To be able to find Directed path and cycles	R,U, A, An, E, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	M	S	S
CO-02	M	S	M	M	S
CO-03	S	M	S	M	S
CO-04	S	S	M	M	S
CO-05	M	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Graphs, Subgraphs and Trees**12**

Graphs and simple graphs - Graph isomorphism-Incidence and adjacency matrices – Subgraphs - Vertex degrees - Path and Connection cycles – Applications: The shortest path problem – Trees: Trees - Cut edges and bonds - Cut vertices-Cayley’s formula.

Unit II: Euler Tours and Hamilton Cycles**12**

Connectivity – Blocks - Euler tours and Hamilton cycles: Euler tours – Hamilton cycles – Applications: The Chinese Postman Problem.

Unit III: Matchings and Edge colorings**12**

Matchings - Matching and coverings in bipartite graphs - Perfect matchings –. Edge colorings: Edge chromatic number - Vizing’s theorem.

Unit IV: Independent sets and cliques**12**

Independent sets and cliques: Independent sets- Ramsey’s theorem-Turan’s theorem

Unit V: Directed Graphs**12**

Directed Graphs, Directed Paths and Directed Cycles.

TOTAL: 60 HOURS**Text Book**

J.A.Bondy and U.S.R.Murty, Graph Theory with Applications (5th Print), Elsevier
Science Publishing Co. Inc., USA, 1982.

Chapters 1 (except 1.9), 2 (except 2.5), 3 (except 3.3), 4 (except 4.4),
5 (except 5.5), 6, 7 (except 7.4 and 7.5) and 8.

Elective List

Semester I : Elective I & Elective II
Electives I & II to be chosen from Group A

Group: A

MA47A2	Algebraic Number Theory	2	1	0	3
MA47A3	Calculus of Variations and Integral Equations	2	1	0	3
MA47A6	Differential Geometry	2	1	0	3
MA47A9	Mathematical Programming	2	1	0	3
MA47B3	Numerical Analysis	2	1	0	3

MA47A2	ALGEBRAIC NUMBER THEORY	L	T	P	C
		2	1	0	3

OBJECTIVE

To enable the students to compute norms and discriminants and to use them to determine the integer rings in algebraic number fields and also to assist the student to factorize ideals into prime ideals in algebraic number fields in straightforward examples.

Course Outcomes		Cognitive Skill
At the end of the course students should be able to		
CO-01	Understand the basic concepts of Rings and fields, Factorization of polynomials, Field extensions, Symmetric polynomials, Free abelian groups.	R, U, A, An, E
CO-02	Recognise the concept of Algebraic numbers, Conjugates and discriminates, Algebraic integers, Integral bases, Norms and traces, Rings of integers.	R, U, A, An, E
CO-03	Describe the concepts and applications of Quadratic fields, Cyclotomic fields, Trivial factorizations, Factorization into irreducible	R, U, A, An, E
CO-04	Understand the concepts of Prime factorization, Euclidean domains, Euclidean quadratic fields, Consequences of unique factorization, The Ramanujan- Nagell theorem.	R, U, A, An, E
CO-05	Describe the concepts and applications of Ideals, Prime factorization of fields, The norm of an ideal, Nonunique factorization in cyclotomic fields.	R, U, A, An, E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO- C	PO-D	PO-E
CO-01	S	S	S	S	S
CO-02	S	M	S	L	M
CO-03	S	S	M	M	M
CO-04	S	S	M	M	L
CO-05	S	S	M	L	S

S - Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Algebraic Background

9

Rings and fields-Factorization of polynomials-Field extensions-Symmetric polynomials-Free abelian groups.

Unit II: Algebraic Numbers

9

Algebraic numbers-Conjugates and discriminates- Algebraic integers-Integral bases-Norms and traces-Rings of integers.

Unit III: Quadratic Cyclotomic Fields

9

Quadratic fields- Cyclotomic fields. Factorization into irreducible: Trivial factorizations – Factorization into irreducible - Examples of non-unique factorization into irreducibles.

Unit IV: Factorization into Irreducibles

9

Prime factorization-Euclidean domains-Euclidean quadratic fields-Consequences of unique factorization-The Ramanujan- Nagell theorem.

Unit V: Ideals

9

Prime factorization of fields-The norm of an ideal – Nonunique factorization in cyclotomic fields.

TOTAL: 45 HOURS

Text Book

N. Stewart and D. O. Tall, Algebraic Number Theory (2nd Edition), Chapman and Hall, 1987.

Chapters 1 to 5.

MA47A3	CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS	L	T	P	C
		2	1	0	3

OBJECTIVE

To introduce the concepts of calculus of variation and its applications and also the various types of integral equations and the methods to solve such equations.

Course Outcomes		Cognitive Skill
At the end of the course the students would be able to:		
CO-01	Understand the concepts of variations and its properties. Use Euler's equation to solve various types of variational problems with fixed boundaries.	U, A,E
CO-02	Modify the Euler's formula for a class of curves with moving boundary points. Identify and solve Sturm-Liouville problems.	R,A,E
CO-03	Able to use and apply periodic boundary and unmixed boundary conditions and apply the green's function and problems.	An,A,E
CO-04	Able to solve Volterra and singular type integral equations and Fredholm first and second kind integral equations, reduce the differential equations to integral equations.	R,A,E ,S
CO-05	Understand the Fredholm theory and identify the Hilbert-Schmidt theorem, and solve the resolvent kernel problems.	U,An,A,E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO \ CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	S	S	S
CO-02	S	S	M	S	S
CO-03	S	M	S	S	S
CO-04	M	S	M	M	S
CO-05	M	M	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction to Calculus of Variations **9**

Maxima and Minima - The Simplest case-Illustrative examples - Natural boundary conditions and transition conditions – The variational notation-The more general case.

Unit II: Applications of Calculus of Variations **9**

Constraints and Lagrange multipliers-Variable end points - Sturm- Liouville problems-Hamilton's principle-Lagrange's equations

Unit III: Integral Equations **9**

Integral Equations: Introduction – Relations between differential and integral equations – The Green's function – Alternative definition of the Green's function.

Unit IV: Linear Integral Equations **9**

Linear equation in cause and effect: The influence function – Fredholm equations with separable kernels – Illustrative example.

Unit V: Integral Equations of Second Kind **9**

Hilbert – Schmidt theory – Iterative methods for solving equations of the second kind – Fredholm theory.

TOTAL: 45 HOURS

Text Book

Francis B. Hildebrand, Methods of Applied Mathematics (2nd Edition), Dover Publications, Inc. New York, 2012.

Sections 2.1 to 2.11, 3.1 to 3.9 and 3.11

MA47A6	DIFFERENTIAL GEOMETRY	L	T	P	C
		2	1	0	3

OBJECTIVE

To introduce space curves and their intrinsic properties of a surface and geodesics and also to explore the non-intrinsic properties of surfaces

Course Outcomes		Cognitive Skill
At the end of the course students should be able to		
CO-01	Understand the definition of space curve Arc length , tangent , normal and binormal. Also curvature and torsion. To contact between curves and surfaces ,Do the problems on tangent of the surface ,involutives and evolutes of the curve. How to find Intrinsic equations , Fundamental Existence Theorem for space curves and Helics.	R,U,A, An,E
CO-02	Remember the definition of a surface and compute the Surface of revolution , Helicoids and Metric. - Direction coefficients , families of curves and Isometric correspondence. Easily study the Intrinsic properties.	R,U,A, An,E
CO-03	Obtain the Geodesics , Canonical geodesic equations . Normal property of geodesics. Know to Prove Existence Theorems and Geodesic parallels	R,U,A, An, E
CO-04	Evaluate the Geodesics curvature , Gauss , Bonnet Theorem and Gaussian curvature. Also evaluate the surface of constant curvature.	R,U,A, An, E
CO-05	Know the second fundamental form , Principal curvature and the Lines of curvature. Also know about Developable and Developable associated with space curves on surface. Also Minimal surfaces and Ruled surfaces.	R,U,A, An, E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	M	M	S
CO-02	S	M	M	S	S
CO-03	S	M	M	L	S
CO-04	S	M	M	S	S
CO-05	S	S	M	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Space Curves**9**

Definition of a space curve - Arc length - tangent - normal and binormal - curvature and torsion - contact between curves and surfaces - tangent surface - involutes and evolutes - Intrinsic equations - Fundamental Existence Theorem for space curves - Helics.

Unit II: Intrinsic Properties of a Surface**9**

Definition of a surface - curves on a surface - Surface of revolution - Helicoids - Metric - Direction coefficients - families of curves - Isometric correspondence - Intrinsic properties.

Unit III: Geodesics I**9**

Geodesics - Canonical geodesic equations - Normal property of geodesics - Existence Theorems - Geodesic parallels

Unit IV: Geodesics II**9**

Geodesics curvature - Gauss - Bonnet Theorem - Gaussian curvature - surface of constant curvature.

Unit V: Non Intrinsic Properties of a Surface**9**

The second fundamental form - Principal curvature - Lines of curvature - Developable - Developable associated with space curves and with curves on surface - Minimal surfaces - Ruled surfaces.

TOTAL: 45 HOURS**Text Book**

An Introduction to Differential Geometry (17th Impression) by T.J.Willmore, Oxford University Press, New Delhi 2002. (Indian Print).

Unit I	: Chapter I : Sections 1 to 9
Unit II	: Chapter II: Sections 1 to 9
Unit III	: Chapter II: Sections 10 to 14
Unit IV	: Chapter II: Sections 15 to 18
Unit V	: Chapter III: Sections 1 to 8

MA47A9	MATHEMATICAL PROGRAMMING	L	T	P	C
		2	1	0	3

OBJECTIVE

To provide fair knowledge of converting real life problems in to Linear Programming Problems. Transportation and Assignment Problems, Integer and Dynamic programming problems and its solutions

Course Outcomes		Cognitive Skill
At the end of the course students should be able to		
CO-01	Understand the real-life problem and formulate it into Mathematical Problems.	R, U, A, An, E
CO-02	Comprehend various techniques and apply them to solve the LPP problems..	R, U, A, An, E
CO-03	Solve Transportation and Assignment Problems	R, U, A, An, E
CO-04	Analyze LPP Problems and searching for integer solutions.	R, U, A, An, E
CO-05	Knowledge of solving Dynamic Problems.	R, U, A, An, E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO- C	PO-D	PO-E
CO-01	S	S	S	L	S
CO-02	S	M	S	M	M
CO-03	S	S	M	L	M
CO-04	S	S	M	M	S
CO-05	S	S	M	S	S

S - Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Linear Programming Problem I**9**

Mathematical formulation - Graphical Solution of Linear Programming Models – Simplex Method

Unit II: Linear Programming Problem II**9**

Artificial variable techniques: Big M method , Two Phase Method, Primal – Maximization Problems - Dual Relationships.

Unit III: Transportation Problem**9**

Transportation Problems – Initial Basic feasible solutions by North West Corner Rule, Least Cost method, Vogel’s approximation methods – Optimal solution by MODI method – Degeneracy, Unbalanced – Maximization Problems -

Unit IV: Assignment Problem**9**

Assignment problem- Hungarian method- Unbalanced – Maximization Problem, Traveling Sales man Problem, Transshipment Problem.

Unit V: Integer Programming Problem**9**

Solution of pure and mixed integer programming problems – Gomorian Cutting plane algorithm.

TOTAL: 45 HOURS**Text Books**

- 1.Gupta P.K., Man Mohan, “Problem in Operations Research” (Methods and Solutions), Sultan Chand and Sons, Ninth Edition, 2003.
- 2.Hamdy A Taha,” Introduction to Operations Research”, Prentice Hall India, Seventh Edition, Third Indian Reprint 2004.
- 3.J.K.Sharma,” Operations Research” (Theory and Applications),Macmillan India Ltd, Second Edition

MA47B3	NUMERICAL ANALYSIS	L	T	P	C
		2	1	0	3

OBJECTIVE

To provide the students an understanding of the basic principles of numerical methods and to apply them in solving algebraic equations and ordinary differential equations numerically. To enable the students for applying various difference operators in interpolation and numerical differentiation and integration.

Course Outcomes		Cognitive Skill
At the end of the course students should be able to		
CO-01	Understand numerical techniques to find the root of transcendental and polynomial equations. Muller's methods to improve the rate of convergence. Also, compute the errors.	R,U, A,An.E
CO-02	Understand Numerical methods to solve a system of linear algebraic equations using Pivotal Strategy.	R,U, A,An.E
CO-03	Analyze the finite difference. Apply minimization results to the interpolation and least squares approximation of data and functions.	R,U, A,An.E
CO-04	To present various methods for doing numerical differentiation and integration. Also, present a general strategy for deriving such methods. Find solution errors and accuracy.	R,U, A,An.E
CO-05	Construct a numerical method to solve ordinary differential equations in a single step and multistep methods.	R,U, A,An.E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	M	M	S
CO-02	S	S	S	S	M
CO-03	S	L	S	M	S
CO-04	S	M	M	S	M
CO-05	S	S	M	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Transcendental and Polynomial Equations **9**

The solution of nonlinear equations: A survey of iterative methods-Fixed point iteration- Muller's Method, Real roots-Complex roots Polynomial Equations using Sturm's sequence.

Unit II: Linear Algebraic Equations **9**

The solution of linear systems by Gauss elimination- The pivoting strategy - Gauss Jordan, The triangular factorization. Gauss Seidel Iteration Method.

Unit III: Interpolation and Approximation **9**

Taylor series interpolations - Gregory Newton forward and backward interpolation, The divided difference, Lagrange's interpolation. Least square approximation.

Unit IV: Differentiation and Integration **9**

Numerical differentiation- Newton forward and backward formula, Stirling's formula, Numerical Integration: Trapezoidal, Romberg's, Simpson's- Double Integration.

Unit V: Ordinary Differential Equations **9**

Single step method: Euler's method, Modified Euler's method-Taylor series method - Runge Kutta method of fourth order. Multi step method: Adams Moulton method type I and II, Milne's predictor and corrector method.

TOTAL: 45 HOURS

Text Book

M.K.Jain, S.R.K.Iyengar and R.K.Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, 2003, Fifth Edition.
Chapters 2 to 6.

Semester II : Elective III & Elective IV**Electives III & IV to be chosen from Group B****Group B**

MA47A5	Contributions of Indian Mathematicians	2	1	0	3
MA47A8	Fuzzy Mathematics	2	1	0	3
MA47B1	Mechanics	2	1	0	3
MA47B2	Number Theory	2	1	0	3
MA47B4	Stochastic Processes	2	1	0	3

MA47A5	CONTRIBUTIONS OF INDIAN MATHEMATICIANS	L	T	P	C
		2	1	0	3

OBJECTIVE

This course explores the significant contributions of Indian mathematicians to various branches of mathematics throughout history. It covers the development of mathematical concepts, techniques, and applications originating from the Indian subcontinent.

Course Outcomes		Cognitive Skill
At the end of the course students should be able to		
CO-01	Understand the historical context and cultural influences on the development of mathematics in ancient India.	R,U,A,An,E,S
CO-02	Examine the contributions of Indian mathematicians to algebra, geometry, number theory, and other branches of mathematics.	R,U,A,An,E,S
CO-03	Analyze the methods and techniques employed by Indian mathematicians in solving mathematical problems.	R,U,A,An,E,S
CO-04	Appreciate the relevance and applications of Indian mathematical concepts in modern mathematics and science.	R,U,A,An,E,S
CO-05	Critically evaluate the legacy and significance of Indian mathematics in the global mathematical community.	R,U,A,An,E,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	M	M	S
CO-02	S	M	M	S	S
CO-03	S	M	M	L	S
CO-04	S	M	M	S	S
CO-05	S	S	M	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction to Indian Mathematics**9**

Overview of ancient Indian mathematical texts and traditions- Cultural and historical influences on the development of Indian mathematics- Notable mathematicians and their contributions- Numerical notation systems: Decimal place value system, concept of zero

Unit II: Algebraic Contributions**9**

Aryabhata's Aryabhatiya and contributions to algebra- Brahmagupta's Brahmasphuta siddhanta and algebraic equations - Solutions of linear and quadratic equations in ancient Indian mathematics - Algebraic Concepts In Bhaskara II's Lilavati And Bijaganita

Unit III: Geometric Contributions**9**

Geometry in Sulba Sutras: Construction of altars and fire sacrifices - Influence of Jyotisha (astronomy) on geometric principles - Development of trigonometric functions and tables- Geometric Constructions And Their Applications

Unit IV: Number Theory and Mathematical Induction**9**

Contributions of Pingala to combinatorics and binary number system - Contributions of Indian mathematicians to number theory - Use of mathematical induction in ancient Indian mathematics - Theorems and proofs in Indian mathematical treatises

Unit V: Applications and Legacy of Indian Mathematics**9**

Transmission of Indian mathematical knowledge to other civilizations - Influence of Indian mathematics on Islamic and European mathematics - Contemporary relevance and applications of Indian mathematical concepts - Debates on the legacy and historiography of Indian mathematics

TOTAL: 45 HOURS**Text Book**

George Gheverghese Joseph ,Indian Mathematics, World Scientific Publishing Company Private Limited, Singapore, Reprint.

MA47A8	FUZZY MATHEMATICS	L	T	P	C
		2	1	0	3

OBJECTIVE

To make the students to comprehend the fundamentals of Fuzzy set theory, Fuzzy relations, Fuzzy measures and Fuzzy algebra.

Course Outcomes		Cognitive Skill
At the end of the course students should be able to		
CO-01	Learn basic concepts of fuzzy set and understand the membership function crisps set, fuzzy cardinality, and scalar cardinality.	R,U,L,A,
CO-02	Know about fuzzy relations and fuzzy matrices, invertible matrices, similarity of fuzzy relations, and asymptotic forms.	R,U,An
CO-03	Understand the fuzzy inverses, semi inverses and Pseudo similar fuzzy matrices.	R,U,E,S
CO-04	Able to know some elementary properties of union of two fuzzy subgroup, analyse fuzzy normal subgroup, fuzzy conjugate and fuzzy subgroup.	U,E,S
CO-05	Able to find the union of two fuzzy subrings and understand fuzzy homomorphism and fuzzy cosets.	R,U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	S	L	S
CO-02	S	L	M	S	L
CO-03	S	M	M	L	S
CO-04	S	S	L	M	M
CO-05	S	M	L	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Fuzzy Sets **9**

The notion of Fuzzy sets, Basic concepts of Fuzzy sets, Operations on Fuzzy sets, Combinations of operations, fuzzy logic

Unit II: Fuzzy Relations and Matrices **9**

Fuzzy Relations - Fuzzy matrices- Invertible Matrices- Similarity relations-Asymptotic forms determinants- Fuzzy relation equations

Unit III: Inverses **9**

Regular Matrices- Semi-inverses -Minimum Norm g-inverses- Least Square g-inverses -Moore-Penrose inverse-Pseudo-similar Fuzzy matrices.

Unit IV: Fuzzy Subgroups **9**

Some elementary properties, union of two fuzzy subgroups, Fuzzy sub groups generated by a Fuzzy subset, Fuzzy normal subgroups, Fuzzy conjugate subgroups.

Unit V: Fuzzy Subrings **9**

Some elementary properties, union of two fuzzy subrings, Fuzzy subring generated by a fuzzy subset, Fuzzy ideal and homomorphisms, Fuzzy cosets.

TOTAL: 45 HOURS

Text Books

1. George J.Klir and Tina A.Folger, Fuzzy sets – Uncertainty and information, Prentice – Hall of India Pvt. (2006). Chapters: I, II
2. H.J.Zimmermann, Fuzzy set theory and its Applications, Springer – Fourth Edition (2001). Chapter IV.
3. Rajesh Kumar, Fuzzy Algebra, Volume 1, University of Delhi publication Division .Chapter 2 , Section 2.1,2.2,2.3
Chapter 3 and Chapter 4 , Section 4.1,4.2.
4. Dr. A.R. Meenakshi, Fuzzy Matrix Theory and Applications, MJP Publishers, Chennai– 2008. Chapters 1 (1.3) 2 &3.

MA47B1	MECHANICS	L	T	P	C
		2	1	0	3

OBJECTIVE

To study and comprehend mechanical systems under generalized coordinate systems, virtual work, energy and momentum, and mechanics developed by Newton, Langrange, Hamilton Jacobi and also the theory of Relativity.

Course Outcomes At the end of the course students should be able to		Cognitive Skill
CO-01	Have understanding of fundamental concepts of Mechanical system and demonstrate knowledge in the Mechanical system of particles and motion of rigid body. Also learn to represent the Energy and Momentum.	R,U,A,An, E,S
CO-02	Should be able to use advanced concepts of mechanics theory, such as the Lagrange's equations to understand complex mechanical systems. Learn D-Alemberts principle and formulate Lagranges equation of motion.	R,U,A,An, E,S
CO-03	Formulate Hamiltonian equation and understand its physical significance. Explain the applications of Hamilton's equations.	R,U,A,An, E,S
CO-04	Illustrate the Hamilton Jacobi equations and Hamilton Principle function, applications such as linear tri -atomic molecule, two carts connected with three springs, triple pendulum, and double pendulum.	R,U,A,An, E,S
CO-05	Describe and Apply the Canonical transform technique for functions. Explain the applications of, Canonical transformations, Poisson brackets, Invariance of Poisson bracket under canonical transformations – Principle of least action.	R,U,A,An, E,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	M	S	M
CO-02	S	S	S	M	M
CO-03	S	S	S	M	M
CO-04	M	M	S	L	M
CO-05	M	M	M	L	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Mechanical Systems	9
The Mechanical system - Generalised coordinates - Constraints - Virtual work - Energy and Momentum	
Unit II: Lagrange's Equations	9
Derivation of Lagrange's equations- Examples - Integrals of motion.	
Unit III: Hamilton's Equations	9
Hamilton's Principle - Hamilton's Equation - Other variational principle.	
Unit IV: Hamilton - Jacobi Theory	9
Hamilton Principle function - Hamilton-Jacobi Equation - Separability	
Unit V: Canonical Transformation	9
Differential forms and generating functions - Special Transformations - Lagrange and Poisson brackets.	

TOTAL: 45 HOURS

Text Book

D. T. Greenwood , Classical Dynamics , Prentice Hall of India, New Delhi, 1985.

Unit I	Chapter 1 : Sections 1.1 to 1.5
Unit II	Chapter 2 : Sections 2.1 to 2.3 (Omit Section 2.4)
Unit III	Chapter 4 : Sections 4.1 to 4.3 (Omit section 4.4)
Unit IV	Chapter 5 : Sections 5.1 to 5.3
Unit V	Chapter 6 : Sections 6.1, 6.2 and 6.3 (omit sections 6.4, 6.5 and 6.6)

MA47B2	NUMBER THEORY	L	T	P	C
		2	1	0	3

OBJECTIVE

To enable the students to know more about numbers, Bell series, the Mobius function, the Euler totient function and also the application to the distribution of lattice points visible from the origin.

Course Outcomes		Cognitive Skill
At the end of the course the students would be able to:		
CO-01	Understand the basic concepts of numbers, to define and describe different types of functions using theorems on different functions.	R, U, A, An, E, S
CO-02	Describe the concepts and applications of multiplicative functions, Dirichlet multiplicative on different kind of functions, and understand the derivatives of an arithmetical functions.	R, U, A, An, E, S
CO-03	Recognise the concept of big “O” notation and its application in various field of Euler Summation formula.	R, U, A, An, E, S
CO-04	Understand the basic concepts of congruences, residue classes, complete residue systems and linear congruences.	R, U, A, An, E, S
CO-05	Define quadratic residues, Legendre’s symbol, Jacobi symbol and evaluate $(-1 p)$, $(2 p)$, $(-1 P)$ & $(2 P)$	R, U, A, An, E, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	S	M	S
CO-02	S	M	S	M	M
CO-03	S	S	M	M	S
CO-04	S	S	M	L	M
CO-05	S	S	M	L	S

S - Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Fundamental Theorem of Arithmetic and Arithmetical Functions 9

Introduction, Divisibility, Greatest common divisor, Prime numbers, The fundamental theorem of arithmetic, The series of reciprocals of the primes, The Euclidean algorithm, The GCD of more than two numbers, 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 $\wedge(n)$.

Unit II: Dirichlet Multiplication and Generalized Convolution 9

Multiplicative functions and Dirichlet multiplication. The inverse of a completely multiplicative function. Liouville's function $\lambda(n)$, The divisor functions $\sigma_x(n)$, Generalized convolutions Formal power series, The Bell series of an arithmetical function, Bell series and Dirichlet multiplication, Derivatives of arithmetical functions, The Selberg identity.

Unit III: Averages of Arithmetic Functions 9

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 of the divisor functions σ_n , The average order of $\varphi(n)$.

Unit IV: Congruences 9

Definition and basic properties of congruence's, Residue classes and complete residue systems, Linear congruence's, Reduced residue systems and the Euler-Fermat theorem, Polynomial congruence's modulo p , Langrange's theorem. Simultaneous linear congruence's, The Chinese remainder theorem.

Unit V: Quadratic Residues and The Quadratic Reciprocity Law 9

Quadratic residues, Legendre's symbol and its properties, Evaluation of $(-1|p)$ and $(2|p)$, Gauss' lemma, The quadratic reciprocity law, the Jacobi symbol.

TOTAL: 45 HOURS

Text Book

T.M. Apostol, Introduction to Analytic Number Theory(3rd Edition), Narosa Edition, 1991.

Unit I Chapter 1: Sections 1.1 to 1.8 ; Chapter 2: Sections 2.1 to 2.8

Unit II Chapter 2: Sections 2.9 to 2.19

Unit III Chapter 3: Sections 3.1 - 3.7

Unit IV Chapter 5 : Sections 5.1 to 5.5 and 5.7.

Unit V Chapter 9: Sections 9.1 to 9.5 and 9.7

MA47B4	STOCHASTIC PROCESSES	L	T	P	C
		2	1	0	3

OBJECTIVE

To enable the students to comprehend the topics in Stochastic Processes like Discrete-time Markov Chains and Continuous-time Markov Chains.

Course Outcomes		Cognitive Skill
At the end of the course students should be able to		
CO-01	Understand the concepts of classification of Stochastic Processes and able to solve the related problems.	R,U,A,An,E,S
CO-02	Able to understand the concepts of transition probability matrix, Chapman-Kolmogorov equations and calculation of n-step transition probabilities.	R,U,A,An,E,S
CO-03	Understand and apply the concepts of Kolmogorov- Feller differential equations, infinitesimal generator, Poisson process and birth-death process.	R,U,A,An,E,S
CO-04	Mastering the concepts stochastic differential equation, stochastic integral equation.	R,U,A,An,E,S
CO-05	Understand the concepts of Renewal function and its properties, and renewal theorems.	R,U,A,An,E,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	M	M	S
CO-02	S	M	M	S	S
CO-03	S	M	M	L	S
CO-04	S	M	M	S	S
CO-05	S	S	M	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction to Stochastic Processes**9**

Definition and examples of Stochastic Processes, classification of random processes according to state space and parameter space, problems. Weakly stationary and strongly stationary processes,

Unit II: Discrete-Time Markov Chains**9**

Definition and examples of Markov Chain, transition probability matrix, Chapman-Kolmogorov equations; calculation of n-step transition probabilities, limiting probabilities, classification of states, ergodicity, stationary distribution, transient Markov Chain; random walk and gambler's ruin problem.

Unit III: Continuous-Time Markov Chains**9**

Kolmogorov- Feller differential equations, infinitesimal generator, Poisson process, birth-death process, stochastic Petri net, applications to queueing theory and communication networks.

Unit IV: Brownian Motion**9**

Wiener process as a limit of random walk; process derived from Brownian motion, stochastic differential equation, stochastic integral equation.

Unit V: Renewal Processes**9**

Renewal function and its properties, renewal theorems, cost/rewards associated with renewals, Markov renewal and regenerative processes.

TOTAL: 45 HOURS**REFERENCE BOOKS**

1. J. Medhi, Stochastic Processes, 3rd Edition, New Age International, 2009.
2. S.M. Ross, Stochastic Processes, 2nd Edition, Wiley, 1996.
3. S Karlin and H M Taylor, A First Course in Stochastic Processes, 2nd edition, Academic Press, 1975.

Semester III : Elective V & Elective VI**Electives V to be chosen from Group C & Electives VI to be chosen from Group D****Group C**

MA47A1	Advanced Graph theory	2	1	0	3
MA47A4	Coding Theory	2	1	0	3
MA47A7	Discrete Mathematics	2	1	0	3
MA47B5	Wavelets	2	1	0	3

MA47A1	ADVANCED GRAPH THEORY	L	T	P	C
		2	1	0	3

OBJECTIVES

To motivate the students to do research in the field of Graph Theory and to introduce graphs as a powerful modeling tool that can be used to solve practical problems in various fields. To achieve this goal, the course introduces the main concepts such as Ramsey numbers, Perfect graphs and Eigenvalues.

Course Outcomes		Cognitive Skill
At the end of the course students should be able to		
CO-01	Identify whether a graph has Hamiltonian cycles. Find the optimal Hamiltonian circuit for a graph using the brute force algorithm, the nearest neighbor algorithm, and the sorted edges algorithm. Identify a connected graph that is a spanning tree.	R, U, A, An, E, S
CO-02	Understand and create mathematical proof of perfect graph theorem. Able to know the concept of Chromatic number, Connectivity, Directed graphs. Study about imperfect graphs.	R, U, A, An, E, S
CO-03	Learn the concepts of Ramsey numbers and Ramsey theory. To study the partition of large structures and Pigeonhole principle. Able to write the proof of Ramsey's Theorem.	R, U, A, An, E, S
CO-04	To know the properties of Almost All Graphs. Understand the concept of Evaluation and graph Parameters, connectivity and cliques of graphs.	R, U, A, An, E, S
CO-05	Able to find the Characteristic polynomial, Linear algebra of real symmetric Matrices, Eigenvalues and graph parameters, Eigenvalues of regular graphs.	R, U, A, An, E, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	S	S	S
CO-02	S	S	M	S	M
CO-03	S	M	S	S	S
CO-04	M	S	M	M	S
CO-05	M	M	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Hamiltonian Cycles

9

Necessary conditions, sufficient conditions, Cycles in directed graphs

Unit II: Perfect Graphs

9

The perfect graph Theorem, Chordal graphs Revisited, other classes of perfect graphs, Imperfect graphs.

Unit III: Ramsey Theory

9

The Pigeonhole principle revisited, Ramsey's Theorem, Ramsey Numbers, Graph Ramsey theory.

Unit IV: Random Graphs

9

Existence and Expectation, Properties of Almost All Graphs, Threshold Functions, Evaluation and graph Parameters, connectivity, cliques.

Unit V Eigenvalues of Graphs

9

The Characteristic polynomial, Linear algebra of real symmetric Matrices, Eigenvalues and graph parameters, Eigenvalues of regular graphs.

TOTAL: 45 HOURS

Text Book

D.B. West, Introduction to Graph Theory, 2nd edition, Prentice Hall of India, 2005.

Unit I : Section 7.3

Unit II : Section 8.1

Unit III : Section 8.3

Unit IV : Section 8.5

Unit V : Section 8.6

MA47A4	CODING THEORY	L	T	P	C
		2	1	0	3

OBJECTIVE

To make the students to have a thorough understanding of the theory and practice of error control coding techniques for digital data which are widely used in our everyday life. Topics covered in this syllabus include, linear codes, Hadamard codes, the binary Golay code, Bound on codes and the idempotent of a cycle code.

Course Outcomes At the end of the course the students would be able to		Cognitive Skill
CO-01	Understand basic concept of Algebra, Krawtchouk polynomials, Combinatorial theory and Probability theory. Know about Shannon's Theorem and apply it to simple problems.	R,U, A, An, E
CO-02	Understand Block codes, Linear codes, Hamming codes, Majority logic decoding, Weight Enumerators and The Lee metric and apply decoding algorithm to simple problems.	R,U, A, An, E
CO-03	Know about some good codes, hadamard codes and generalizations, The binary Golay code, The ternary Golay code, Reed-Muller code and Kerdock codes. Construct codes from other codes.	R,U, A, An, E
CO-04	Study various bounds on codes like, The Gilbert bound and Upper bounds. Understand Cyclic codes Definitions, Generator matrix and Zeros of a cyclic code.	R,U, A, An, E
CO-05	Understand the idempotent of a cyclic code and study other representations of cyclic codes, BCH codes, Decoding BCH codes and Binary cyclic codes of length $2n$ (n odd).	R,U, A, An, E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	S	M	M
CO-02	S	M	M	M	M
CO-03	S	M	L	M	M
CO-04	S	M	S	M	M
CO-05	S	M	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Mathematical Background and Shannon's Theorem **9**

Algebra – Krawtchouk Polynomials - Combinatorial theory - Introduction - Shannon's Theorem.

Unit II: Linear Codes **9**

Block codes – Linear codes – Hamming codes - Majority logic decoding – Weight Enumerators – The Lee metric.

Unit III: Some Good Codes **9**

Hadamard codes and generalizations – The binary Golay code – The ternary Golay code- Constructing codes from other codes - Reed-Muller code – Kerdock codes..

Unit IV: Bound on Codes **9**

The Gilbert bound – Upper bounds – Cyclic codes: Definitions- Generator matrix and check polynomial – Zeros of a cyclic code.

Unit V: The Idempotent of a Cyclic Code **9**

Other Representations of cyclic codes – BCH codes – Decoding BCH codes- Binary cyclic codes of length $2n$ (n odd).

TOTAL: 45 HOURS

Text Book

J. H. Van Lint, Introduction to Coding Theory (3rd Revised and Expanded Edition) by, Springer Verlag New York Inc, 1982.

Chapters 1 (except 1.4)

2 (Sections 2.1 and 2.2 only)

3, 4, 5 (except 5.3), and

Chapter 6 (except 6.8, 6.9 and 6.11).

MA47A7	DISCRETE MATHEMATICS	L	T	P	C
		2	1	0	3

OBJECTIVE

To provide strong foundation on Logic, Mathematical Induction and Counting Principle, gain knowledge on relations and partially ordered sets and the concept of Boolean Algebra.

Course Outcomes		Cognitive Skill
At the end of the course students should be able to		
CO-01	Understand and Analyze the given Mathematical statements	R,U,A,An,E
CO-02	Apply the principle of Mathematical Induction to analysis the validity of various Mathematical statements.	R,U,A,An,E
CO-03	Understand and apply the Counting Principles to count number of elements in the given sets	R,U,A,An,E
CO-04	Introducing and analyzing the notion of order in the given set and creating partially ordered sets	R,U,A,An,E
CO-05	Developing basic properties of Boolean Algebra	R,U,A,An,E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	M	S	M
CO-02	M	M	M	S	S
CO-03	S	M	M	S	S
CO-04	S	M	M	S	S
CO-05	S	M	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: The Foundations: Logics and Proofs**9**

Mathematical Logic, Basic Notation, Truth Tables, Connectives, Normal forms, Predicate logic, Introduction to Proofs.

Unit II: Induction and Recursion**9**

Algorithms, The Growth of Functions, Complexity of Algorithms Induction and Recursion: Mathematical Induction, Strong Induction and Well-Ordering, Recursive Definitions and Structural Induction, Recursive Algorithms.

Unit III: Counting**9**

Advanced Counting Techniques: Recurrence Relations, Generating Functions, Inclusion Exclusion.

Unit IV: Relations**9**

Introduction, Cartesian Product of Sets, Types of Relations

Unit V: Boolean Algebra**9**

Boolean Algebra, Boolean Algebra-properties, Boolean Functions, Homomorphism

TOTAL: 45 HOURS**Text Book**

Kenneth H. Rosen, Discrete Mathematics and Its Applications, McGraw Hill Publication, 2019
Chapter 1,5,6,9,12

REFERENCE BOOKS

1. J.P. Tremblay, R. Manohar, Discrete mathematical structures with applications to computer science, Tata-McGraw Hill Education Pvt.Ltd.
2. T. Sengadir, Discrete Mathematics and Combinatorics, Pearson India.
3. Ralph P. Girmaldi, Discrete and Combinatorial Mathematics, Addison-Wesley, 1993

MA47B5	WAVELETS	L	T	P	C
		2	1	0	3

OBJECTIVE

To provide students with a thorough understanding of both theoretical and practical aspects of Fourier transforms and wavelets, equipping them with the skills necessary to apply these concepts in various scientific and engineering contexts.

Course Outcomes At the end of the course, students will be able to		Cognitive Skill
CO-01	Demonstrate a deep understanding of the fundamental properties of the Discrete Fourier Transform (DFT), including its calculation, symmetry, linearity, and the concepts of circular convolution and correlation.	R,U,A,An E,S
CO-02	Construct wavelets on the finite group, understanding the roles of analysis and synthesis operators in wavelet construction.	R,U,A, An,E,S
CO-03	Gain knowledge of the structure and properties of $l^2(Z)$ and complete orthonormal sets in Hilbert spaces. They will understand the representation of functions using Fourier series in $L^2([-\pi,\pi])$ and analyze the convergence of these series.	R,U,A, An,E S
CO-04	Construct and analyze first-stage wavelets on Z , understanding their properties and applications. They will be able to implement wavelet transforms in practical scenarios, exploring real-world applications and examples.	R,U,A, An,E,S
CO-05	Understand the importance and calculation of the condition number of a matrix, analyzing its implications for numerical stability. They will apply finite difference methods for solving differential equations, utilizing wavelet theory to enhance numerical solutions	R,U,A, An,E,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	S	M	S
CO-02	S	M	S	S	S
CO-03	S	S	S	L	S
CO-04	S	S	S	S	S
CO-05	S	S	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: The Discrete Fourier Transform	9
Basic Properties of the Discrete Fourier Transform – Translation Invariant Linear Transformations.	
Unit II: Wavelets on Z_N	9
Construction of Wavelets on Z_N : Construction of Wavelets on Z_N -The Iteration Step - Examples and Applications.	
Unit III: Wavelets On Z	9
$l^2(Z)$ - Complete orthonormal sets in Hilbert Spaces - $L^2([-\pi, \pi])$ and Fourier Series.	
Unit IV: Wavelets on Fourier Transform	9
The Fourier Transform and Convolution on $l^2(Z)$ - First-Stage wavelets on Z - The Iteration Step for Wavelets on Z - Implementation and Examples.	
Unit V: Wavelets and Differential Equations	9
The Condition Number of a Matrix - Finite Difference Methods for Differential Equations.	

TOTAL: 45 HOURS

Text Book

Frazier M.W. – An Introduction to wavelets through Linear Algebra – Springer (1999)

REFERENCE BOOKS

1. Charles K Chui - An Introduction to Wavelets, Academic, 1992.
2. Daubechies – Ten lectures on Wavelets SIAM, 1992
3. K.R. Unni – Wavelets, Frames and Wavelets Bases in LP lecture Notes (1997, Bhopal)
4. S. Salaivahanan, A.Vallavaraj, C.Gnanapriya- Digital Signal Processing, 12th reprint(2004), Tata McGraw-Hill publishing company Limited, New Delhi,

Group D

1.	CS47S1	Modeling and Simulation with Excel	1	0	4	3
2.	CS47S2	PYTHON Programming	3	0	0	3
3.	CS47S3	Statistical Data Analysis using R Programming	1	0	4	3
4.	CS47S4	Web Design	3	0	0	3

CS47S1	MODELING AND SIMULATION WITH EXCEL	L	T	P	C
		1	0	4	3

OBJECTIVE

To apply basic and advanced functions in Excel and use it to build models for financial and statistical concepts.

Course Outcomes At the end of the course the students would be able to:		Cognitive Skill
CO-01	Know fundamentals of Excel helps Students to learn how to start working with MS EXCEL right from basics to Tables	R
CO-02	Understand the various templates and printing of their work	U
CO-03	Apply the most extensive tool used for many analysis in general and in Business Analytics in Particular, this module will equip students with hands-on skills on excel operations	A
CO-04	Articulate and analyse the financial data	An,S
CO-05	Evaluate formulae used in calculating Banker Discount, Bankers gain, True Discount and Net-Present Value	E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	S	M	S
CO-02	M	S	M	M	M
CO-03	S	S	S	S	M
CO-04	S	M	S	M	S
CO-05	S	M	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction Basics of MS**5**

Windows – Desktop, Icon, creating, saving, and using of different documents and applications, MS- Office: Installing, Customizing, and Using different applications and tools in MS-Office package, Basics of MS-Word, Basics of MS Power Point.

Unit II: Spread Sheets**10**

Basics, Need for Spreadsheets, Work Book, Work –Sheet, Parts of a MS-Excel Work-Sheet- Program area, Work area, Contents of Title-Bar, Manu-Bar, Contents of Manu Ribbons, Meaning of Cell- Cell address, Formula-Bar, Row Numbers, Column-Letters, Quick Access to Tool-Bar, Office Button, Floating Frames, Adding Work- Sheets in Sheet Tab, Status-Bar., and other features of Excel.

Unit III: Selecting Cell and Range of Cells**10**

Merging of Cells, Entering and Saving Data in the Cell, Named Cells, Need of Naming Cells, Entering, Storing, Copying Formula, Using different Arithmetic and logical Operators in Formula, Moving Cell with contents, Copying and Pasting of Cell and Cell Content, Freezing Cells, Editing of Cell Contents, using Cell Formatting Options – Editing Cell Size (increasing Column and Row size of a cell), Text Alignment, using Border, Comments option usage in Cell, Editing and Deleting Comments, Fill, Formatting Fonts, Text Warping, Text Rotate, Using Auto-fit to Adjust Rows and Columns Using of Short Cuts and Short-Cut Manu, Clear Contents in a Cell, Adding, Deleting and Copying Work-Sheet with in a Work-Book, Renaming a File or WorkSheet, Inserting Multiple Work-Sheet at a time, Formatting a Work-Sheet Automatically, Sorting Textual & Numerical DATA, Sort Dates or Times, Sort by Cell Colour, Font Colour, or by icon, Sort by a custom list, Sort Rows, sort by more than column or row and other issues in sorting

Unit IV: Creating a Table**10**

Changing the look of a table, Navigating in a Table, Selecting parts of a Table, Adding, Deleting New Rows/ Columns, Moving a Table, Working with the Total Row, Removing Duplicate rows from a table. Sorting and Filtering a table, Converting Table into Range. Formatting tools on the Home Tab, Mini Toolbar, Fonts, Text Alignment, Wrapping text to fit a cell, Colours and Shading, Borders and Lines, Miming Styles Conditional Formatting and Reporting: Format all Cells by using a Two Colour Scale, Format all Cells by using Data Bars quick formatting, Protecting, Protect a Workbook, Un Protect Work-Book, Protect Work-Sheet Data, Unprotect Work-Sheet data, Spelling and Grammar Check, Referencing – Relative, Absolute, Mixed

Referencing, Basic Functions Viz., SUM, AVERAGE, MAX, MIN, SQRT, TODAY, COUNT, COUNTIF, CHAR, AND, OR, NOT, VALUE, ROUND

Unit V: Using Formulae to Solve the Problems

10

Using Formulae to Find the roots of a Quadratic Equations, Formula of a Straight –line ($Y=MX+C$) to find the Slope of a straight line, Regression Formula, EMI Formula, Formulae used in calculating Banker Discount, Bankers gain, True Discount, Net-Present Value, Sum of AP and GP,) Using IF Condition, and using Multiple IF Condition in University Result Declaration.

TOTAL: 45 HOURS

Text Book

Microsoft Excel Latest Version Inside Out – Mark Doge and Craig Stinson – PHIL earning Private Limited, New Delhi – 110001.

REFERENCE BOOKS

1. Rajkumar S and Nagarajan G and Naveen Kumar M, Fundamentals of MS Excel, Jayvee International Publications, Bangalore.
2. Microsoft Excel Latest Version Inside Out – Mark Doge and Craig Stinson – PHIL earning Private Limited, New Delhi – 110001.
3. John Walkenbach, Excel 2013 Bible ; Wiley
4. Hector Guerreor , Excel Data Analysis – Modeling and Simulation, Springe 6. Microsoft Excel 2013: Data Analysis and Business Modeling:Winston, PHI 7. Excel Functions and Formulas: Bernd Held, BPB Publications.
5. Chandan Sengupta , Financial Analysis and Modeling using Excel and VAB:Wiley

CS47S2	PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To know the basics of algorithmic problem solving.
- To develop Python programs with conditionals and loops.
- To define Python functions and use function calls.
- To use Python data structures – lists, tuples, dictionaries.
- To do input/output with files in Python.

Course Outcomes		Cognitive Skill
CO-01	To get knowledge about the fundamental concepts of the language	R,U
CO-02	Will be able to understand and apply Decision making and branching, Decision making and looping statements	U,A
CO-03	Will gain an idea for using arrays, Character arrays and strings	U,A
CO-04	Will be able to understand and apply user defined functions Structures	U. A
CO-05	Will be able to understand and apply files.	A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	S	M	S
CO-02	S	M	M	S	M
CO-03	S	L	S	M	M
CO-04	S	M	S	M	S
CO-05	S	M	S	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction to Computing and Problem Solving**9**

Fundamentals of Computing – Computing Devices – Identification of Computational Problems – Pseudo Code and Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms – Introduction to Python Programming – Python Interpreter and Interactive Mode– Variables and Identifiers – Arithmetic Operators – Values and Types – Statements.

Unit II: Conditionals and Functions**9**

Operators – Boolean Values – Operator Precedence – Expression – Conditionals: If-Else Constructs – Loop Structures/Iterative Statements – While Loop – For Loop – Break Statement – Function Call and Returning Values – Parameter Passing – Local and Global Scope – Recursive Functions.

Unit III: Simple Data Structures in Python**10**

Introduction to Data Structures – List – Adding Items to a List – Finding and Updating an Item – Nested Lists – Cloning Lists – Looping Through a List – Sorting a List –List Concatenation – List Slices – List Methods – List Loop – Mutability – Aliasing –Tuples: Creation, Accessing, Updating, Deleting Elements in a Tuple, Tuple Assignment, Tuple as Return Value, Nested Tuples, Basic Tuple Operations – Sets.

Unit VI: Strings, Dictionaries, Modules**10**

Strings: Introduction, Indexing, Traversing, Concatenating, Appending, Multiplying, Formatting, Slicing, Comparing, Iterating – Basic Built – In String Functions – Dictionary: Creating, Accessing, Adding Items, Modifying, Deleting, Sorting, Looping, Nested Dictionaries Built – in Dictionary Function – Finding Key And Value in a Dictionary –Modules: Introduction – Module Loading and Execution – Packages – Making Your OwnModule – The Python Standard Libraries.

Unit V: File Handling and Exception Handling**7**

Files: Introduction – File Path – Opening and Closing Files – Reading and Writing Files – File Position – Exception: Errors and Exceptions, Exception Handling, Multiple Exceptions.

TOTAL: 45 HOURS**REFERENCE BOOKS**

1. Reema Thareja, “Python Programming using Problem Solving Approach”, Oxford University Press, 2017.
2. Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, Second Edition, Shroff/O’Reilly Publishers, 2016. (<http://greenteapress.com/wp/thinkpython/>).
3. Guido van Rossum, Fred L. Drake Jr., “An Introduction to Python – Revised and Updated for Python 3.2”, Network Theory Ltd., 2011.
4. John V Guttag, “Introduction to Computation and Programming Using Python”, Revised and Expanded Edition, MIT Press , 2013
5. Charles Dierbach, “Introduction to Computer Science using Python”, Wiley India Edition,2016.

CS47S3	ROGRAMMING STATISTICS AND DATA ANALYSIS USING R PROGRAMMING	L	T	P	C
		1	0	4	3

OBJECTIVE

To get an idea to collect, compile and visualize data using simple statistical functions

Course Outcomes At the end of the course the students would be able to:		Cognitive Skill
CO-01	Understand the fundamentals of R.	U
CO-02	Illustrate the loading, retrieval techniques of data.	A
CO-03	understand how data is analyzed using simple functions	U, An
CO-04	Use flow control statements in simple programs	R,U
CO-05	Draw inferences employing statistical packages	E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	S	M	M
CO-02	S	M	M	M	M
CO-03	S	M	L	M	M
CO-04	S	M	S	M	M
CO-05	S	M	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction to R Programming**9**

Installing R and R Studio - R Studio over view working in the console - arithmetic operators - logical operators – functions

Unit II: Data Structures in R**9**

Creating variables - numeric, character and logical data – vectors – data frames – factors - sorting numeric, character, and factor vectors.

Unit III: Control Statements in R**9**

Loop statements- R packages - installing and loading packages - setting up your working directory - working with missing data

Unit VI: Statistical Graphs**9**

Scatter Plots - Box Plots – Histograms – Bar plots – pie chart - ggplot2 package to visualize data – themes for customization

Unit V: Descriptive Statistics in R**9**

Measures of central tendency - measures of variability - skewness and kurtosis - summary functions –correlations

TOTAL : 45 HOURS**Text Book**

Sandip Rakshit, R Programming for Beginners, McGraw Hill Education (India), 2017.

REFERENCE BOOKS

1. Seema Acharya, Data Analytics using R, McGraw Hill Education (India), 2018.
2. Peng, R.D., R Programming for Data Science, Lean publishing, 2020.
3. Hadley Wickham and Garrett Gorlemund., R for Data Science, O'Reilly, 2018.

CS47S4	WEB DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVE

To equip learners with the skills and knowledge needed to design and create web pages using HTML, including advanced concepts such as style sheets, tables, frames, and forms. Through practical exercises and sample projects, students should gain proficiency in HTML coding and web design principles.

Course Outcomes		Cognitive Skill
On completion of the course the students will be able to		
CO-01	Learn the syntax and semantics of HTML.	R,U
CO-02	Understand the basic tags and implement in a web page	U,A
CO-03	Get an idea of designing the web page with table	U,A
CO-04	Learn on the basics of Cascading Style Sheets and frames	U. A
CO-05	Design web page including images, numbering and bullets	A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	S	M	M
CO-02	S	M	M	M	M
CO-03	S	M	L	M	M
CO-04	S	M	S	M	M
CO-05	S	M	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction to HTML**9**

Designing a Home page – History of HTML – HTML generations

– HTML documents – Anchor tag – Hyperlinks – Sample HTML documents. **Head and Body Sections:** Header section – Title – Links – Colorful web page – Comment lines – Some sample HTML documents.

Unit II: Designing the Body section**9**

Heading printing – Aligning the headings – Horizontal Ruler – Paragraph – Tab settings – Images and pictures – Embedding PNG format images. **Ordered and Unordered Lists:** Lists – Unordered lists – Headings in a list – Ordered lists – Nested lists.

Unit III: Table Handling**9**

Tables – Table creation in HTML – Width of the Table and Cells – Cells spanning and multiple rows/Columns – Coloring cells – Column specifications – Some sample tables.

Unit IV: DHTML and Style Sheets**9**

Defining Styles – Elements of Styles – Linking a style sheet to an HTML document – In-line styles – External styles sheets – Internal style sheets – Multiple styles. **Frames:** Frameset definition – Frame definition – Nested framesets.

Unit V: A Web Page Design Project**9**

Frameset Definition - Animals – Birds – Fish. **Forms:** Action attribute – Method attribute – Enctype attribute – Dropdown lists – Sample forms.

TOTAL: 45 HOURS**Text Book**

C. Xavier, (2009), World Wide Web Design with HTML, 21st Reprint, Tata McGrawHill Publishing Company.

REFERENCE BOOKS

1. Ivan Bayross. (2010), Web Enabled Commercial Application Development using HTML, 4th revised edition, BPB Publications.
2. Vikas Gupta. (2003), Comdex Level Series Internet and Web Design, Dreamtech Press.
3. Kris Jamsa, Konrad King, Andy Anderson. (2002), Html & Web Design: Tips & Techniques, Tata McGraw Hill.

SKILL ENHANCEMENT COURSES						
S1	CS47S5	Office Automation and ICT Tools	2	-	-	2
S2	CS47S6	C++ Programming	0	1	2	2
S3	EG47S1	Soft Skill – 1	2	-	-	2
S4	EG47S2	Soft Skill -2	2	-	-	2

CS47S5	OFFICE AUTOMATION AND ICT TOOLS	L	T	P	C
		2	0	0	2

OBJECTIVES

To facilitate students to

- Get good knowledge about different operating systems.
- Develop skills in preparing a document.
- Acquire knowledge in preparing worksheet.
- Analyze the program and follow the presentation style.
- Develop efficient in ICT tools

Course Outcomes At the end of the course the students would be able to:		Cognitive Skill
CO-01	Ability to understand and identify essential computer OS.	U
CO-02	Ability to process and store data effectively in MS-Word	A
CO-03	Ability to process and store data effectively in MS-Excel	R
CO-04	Ability to understand creating presentation style.	U, An
CO-05	Ability to understand and remember in ICT tools.	A, An, E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	S	M	M
CO-02	S	M	M	S	M
CO-03	S	S	L	S	S
CO-04	S	S	S	M	S
CO-05	S	M	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction to Windows and Desktop Operations	6
Using Windows – The Desktop – Point and Click Operations – Starting Up Applications – Windows and Menus – Keyboard Accelerators – Common Controls – Files, Folders and Disks – Online Help – Shutting Down.	
Unit II: Mastering Word: Document Creation and Formatting	6
Getting Comfortable in Word – Editing and Composing Documents – Formatting Documents – Presenting Information – Finalizing Documents.	
Unit III: Excel: Worksheets, Data Manipulation, and Charting	6
Creating and Editing Worksheets – Manipulating Numbers and Text– Manipulating Workbooks and Worksheets – Creating Charts and Graphics.	
Unit IV: PowerPoint: Designing and Delivering Presentations	6
Designing and Creating Presentations – Creating On-Slide Content – Creating Office Graphics – Retrieving Data – Adding Animation and Multimedia – Finalizing and Presenting.	
Unit V: Collaboration Tools: Microsoft Teams and Google Classroom Integration	6
Microsoft Teams – Creating application – office 365 - host meetings, chat, share files – Microsoft Office app Teams. Google Classroom – drive folder – virtual classroom – virtual class room - Integrate educational apps – interactive assignments.	

TOTAL: 30 HOURS

Text Books

1. Preston Gralla – “Windows Vista in a Nutshell – A Desktop Quick Reference” SPD O’Reilly, December 2006.
2. Beth Melton, Mark Dodge, Echo Swinford, Andrew Couch, Eric Legault, Ben M. Schorr&Ciprian Adrian Rusen – “Step by Step – Microsoft Office Professional 2013” PHI, 2014
3. Rajesh Makol and Lalita makol, “Critical understanding of ICT”, Amazon, 2021

CS47S6	C++ PROGRAMMING	L	T	P	C
		0	1	2	2

OBJECTIVE

To Understand Object Oriented Programming Paradigm. To study the Basic concepts of OOP and to Develop Programs Using C++ and understand Code Reuse through Inheritance, manage Console I/O Operations and Files.

Course Outcomes At the end of the course the students would be able to		Cognitive Skill
CO-01	Understand how C++ improves C with object oriented basic features	R
CO-02	Learn how to write Functions, Classes and Objects	A
CO-03	learn how to implement constructors and Destructors	U,An
CO-04	Learn how inheritance and virtual functions implement with polymorphism	E, U, An
CO-05	Learn how to use file handling in C++ programs.	A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	S	M	S
CO-02	S	S	M	M	S
CO-03	S	M	S	S	M
CO-04	S	M	S	M	M
CO-05	S	M	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction to C++ Programming**6**

Beginning With C++ – C++ – Applications of C++ –Simple C++ Program – C++ Statements – Example with Class – Structure of C++ Program – Creating the Source File – Compiling and Linking –Tokens, Expressions and Control Structures.

Unit II: Functions, Overloading, and Classes**6**

The Main Function – Function Prototyping – Call by Reference – Return by Reference – Inline Functions– Function Overloading – Friend and Virtual Functions – Math Library Functions – Classes and Objects.

Unit III: Constructors, Destructors, and Dynamic Object Initialization**6**

Constructors and Destructors – Introduction – Multiple Constructors in a class – Constructors with Default Arguments – Dynamic Initialization of Objects – Copy Constructor – Dynamic Constructors – Constructing Two-dimensional Arrays.

Unit IV: Inheritance, Pointers, and Polymorphism**6**

Inheritance: Extending Classes – Introduction – Derived Class – Single Inheritance – Making a Private Member Inheritable – Multilevel Inheritance – Multiple Inheritance – Hierarchical Inheritance – Hybrid Inheritance –Pointers, Virtual Functions and Polymorphism.

Unit V: File Handling and Console I/O Operations**6**

Managing Console I/O Operations – Working With Files – Introduction – Classes for File Stream Operations – Opening and Closing File – Detecting end-of-file –Updating a File.

TOTAL: 30 HOURS**Text Book**

E. Balagusamy, “Object Oriented Programming with C++”, 6th edition, McGraw Hill Education, 2013.

REFERENCE BOOKS

1. Jeganathan Swaminathan, “Mastering C++ Programming”, Packt Publishing, First Edition, 2017.
2. Herbert Schildt “C++ - The Complete Reference”, McGraw Hill Education, Fourth Edition, 2003.

EG47S1	SOFT SKILLS – 1	L	T	P	C
		2	0	0	2

OBJECTIVES

1. To help learners develop their soft skills.
2. To enhance interpersonal communication skills and develop self-confidence.
3. To overcome communication barriers.

Course Outcomes At the end of the course the students would be able to		Cognitive Skill
CO-01	Identify and demonstrate key soft skills, such as effective communication, teamwork, and problem-solving, essential for personal and professional success.	R,U,A
CO-02	Apply various forms of communication, understand the communication process, and demonstrate effective listening skills, enabling them to communicate clearly and effectively in diverse situations.	R,U,A
CO-03	Interpret and effectively use body language to enhance communication, understanding the difference between positive and negative signals in various social and professional contexts.	R,U,A, An
CO-04	Recognize and effectively utilize different forms of non-verbal communication, enhancing their ability to interpret others' emotions and intentions and to complement verbal interactions in various contexts.	R,U,A
CO-05	Identify common barriers to communication and apply strategies to overcome them, ensuring clearer and more effective communication in personal and professional environments.	R,U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	S	M	S
CO-02	S	S	M	M	S
CO-03	S	M	S	S	M
CO-04	S	M	S	M	M
CO-05	S	M	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction to Soft Skills	6
1. What are Soft Skills?	
2. Importance of soft skill	
3. Types of Soft Skills	
Unit II: Communication skills	6
1. Definitions	
2. Scope and Importance of Communication	
3. Types of Communication	
4. Levels of Communication	
5. Effective Listening	
6. Communication Process	
Unit III: Body language	6
1. Definitions	
2. Important Features of Body Language	
3. Examples of Body Language	
4. Positive and negative body language	
Unit IV: Non-verbal communication	6
1. Facial Expressions	
2. Eye Contact	
3. Posture	
4. Gestures	
5. Paralanguage	
6. Proxemics	
7. Physiological Changes	
Unit V: Barriers in communication	6
1. Barriers to Effective Communication	
2. Overcoming Communication Barriers	

TOTAL : 30 HOURS

REFERENCE BOOKS

1. M. S. Rao ."Soft Skills: Enhancing Employability" , I.K. International Publishing House, 2010
2. Allan Pease and Barbara Pease, "The Definitive Book of Body Language" , Orion, 2004
3. Mary Ellen Guffey and Dana Loewy ,"Business Communication: Process and Product" ,Cengage Learning, 2018 (9th Edition)

EG47S2	SOFT SKILLS – 2	L	T	P	C
		2	0	0	2

OBJECTIVES

1. To know the various skills and techniques of presentation and group discussion.
2. To recognise the importance of time management.
3. To know the importance of Curriculum Vitae/Resume.

Course Outcomes At the end of the course the students would be able to		Cognitive Skill
CO-01	Participate confidently and effectively in group discussions, following appropriate guidelines.	R,U,A
CO-02	Understand and perform well in different types of interviews by applying effective communication and preparation strategies.	R,U,A
CO-03	Deliver engaging and organized presentations using effective techniques and visual aids like PowerPoint slides.	R,U,A, An
CO-04	Apply effective time management strategies to enhance productivity and balance academic and personal responsibilities.	R,U,A
CO-05	Craft a well-structured CV or resume and a tailored cover letter for job applications.	R,U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	S	M	S
CO-02	S	S	M	M	S
CO-03	S	M	S	S	M
CO-04	S	M	S	M	M
CO-05	S	M	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Group Discussion	6
1. Definitions	
2. Purpose of Group Discussion	
3. Types of Group Discussions	
4. Characteristics of Effective Group Discussion	
5. Phases in Group Discussion Process	
6. Do's and Don'ts of participating in Group Discussion	
Unit II: Interview Skills	6
1. Interview Concept and Definition	
2. Purpose/OBJECTIVE of Interview	
3. Types/Classification of Interview	
4. Guidelines for Effective Interview	
Unit III: Presentation Skills	6
1. Definitions	
2. Importance of Presentation	
3. Essentials for making a Presentation Work	
4. Use of power point slides for making a presentation	
Unit IV: Time Management Skills	6
1. Importance of Time Management	
2. Key Factors of Time Management	
3. Effective Time Management	
4. Techniques to Practice To Master Your Own Time	
Unit V: Curriculum Vitae/Resume Writing	6
1. Concept and Definition	
2. Objective/ Purpose of CV/Resume Writing	
3. Importance of CV/Resume Writing	
4. How to write a CV/Resume?	
5. Dos and Don'ts in CV/Resume Writing	
6. How to write a Cover Letter	
TOTAL : 30 HOURS	

REFERENCE BOOKS

1. Alex "Soft Skills: Know Yourself & Know The World", Chand Publishing,: 2013
2. Stephen R. Covey, Simon & Schuster " The 7 Habits of Highly Effective People" by,: 2004
3. Lola Brown "Resume Writing Made Easy" , Vibrant Publishers, 2012

ABILITY ENHANCEMENT COURSES					
CS4771	Computer Fundamentals and C Programming Lab	-	-	4	2
MA47S1	LaTeX	-	-	4	2
MS47S1	Personality Development	2	-	-	2
MA47S2	NET/SET /Competitive/ coaching	2	-	-	2

CS4771	COMPUTER FUNDAMENTALS AND C PROGRAMMING LAB	L	T	P	C
		0	1	2	2

OBJECTIVE

The student should

- Understand the components of the Computer
- Perform system administration tasks
- Understand different Office Automation tools.
- Analyze the program and follow the programming style.
- Develop efficient programs in C

Course Outcomes		Cognitive Skill
At the end of the course the students would be able to		
CO-01	To get a deep knowledge on Starting Up Applications, common controls, Command prompt choices.	U
CO-02	Able to understand comfortable editing and composing on Word documents, formatting Documents.	A
CO-03	Will be able to understand Worksheet creation, Manipulation of worksheets and workbooks.	An
CO-04	Will be able apply and evaluate decision making and branching, Decision making and looping statements in C programming	E
CO-05	Will be able apply and evaluate arrays, Character arrays and strings, functions Structures and Unions in C programming.	E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	S	M	S
CO-02	S	S	M	M	S
CO-03	S	M	S	S	M
CO-04	S	M	S	M	M
CO-05	S	M	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Fundamentals of Computers and Operating Systems. 10

Evolution of computers – Organization of Modern Digital Computers –
Single user Operating System – Multitasking OS – GUI.

Unit II: Office Automation 10

- a. Word Processing
- b. Data Base Management System
- c. Spread Sheet Package
- d. Presentation Software.

Unit III: Implementation in C 10

1. Input / output function
2. Control Functions
3. Functions
4. Arrays
5. Pointers
6. Structures and Unions
7. Files

TOTAL: 30 HOURS

MA47S1	LaTeX	L	T	P	C
		0	0	4	2

OBJECTIVE

This course aims to provide a comprehensive theoretical foundation and hands-on practice with LaTeX for preparing documents and tables

Course Outcomes		Cognitive Skill
At the end of the course the students would be able to		
CO-01	Gain proficiency in using LaTeX for typesetting characters, including alphabets, numerals, and mathematical symbols.	U
CO-02	Learn to create and manipulate lists, including enumerate, itemize, and description lists, as well as nesting of lists.	A
CO-03	Understand how to use colors in tables and customize table styles using packages like colorable.	An
CO-04	Understand various types of boxes in LaTeX, including LR boxes, paragraph boxes, nested boxes, and rule boxes.	E
CO-05	Gain proficiency in typesetting mathematical expressions in LaTeX, including fractions, equations, matrices, arrays, and cases.	E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	L	S	S	L	S
CO-02	L	S	S	L	S
CO-03	L	S	S	L	S
CO-04	L	S	S	L	S
CO-05	L	S	S	L	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Fundamentals of Typing in LaTeX.**10**

Characters: Alphabets and Numerals, Mathematical symbols and notations-Latex Input Files: Latex Input file structure, Preamble - The Document: Front matter, Main matter, Back matter- Sectioning commands and its logical relations: Sample body of article, Numbering of heading levels-Lists: Enumerate, Itemize, Description, Nesting of lists, Manipulation of list numbers and labels-Displayed text : Quote and Poetry- Page layout in LaTeX: Page headers and footers, The fancyhdr package, Fun with floats – Items and lists- Footnotes – Marginal notes – Endnotes- Table of Contents – Index – Glossary.

Unit II: Tables, Figures and Boxes.**10**

Table: Construction and table style parameters- long table-The colourable package: The \column color command, The row color command-more colors and tricks-Color tables with \hline-More Examples of color table-Creating Floating Figures-Customizing Float placement-Using Graphics in LaTeX-Rotating and scaling objects- Several Kinds of Boxes: LR Boxes, Paragraph Boxes, Nested boxes and Rule boxes.

Unit III: Bibliography and Mathematical Symbols.**10**

Bibliography Introduction – natbib : Basic commands, multiple citations, numerical mode, Suppressed parantheses, partial citations, citations aliasing, selecting citation style and punctuation – Bibtex style files - Creating a bibliographic database - Cross References in LaTeX – Pointing to a page – Pointing outside – Maths in text – Fraction – Equations, Matrix, Array, Cases- Definitions for Theorems- AMS LaTeX: Allign Envoirment, Split envoirment – Mathematical Symbols-Other letters styles- Accents and Foreign Letters – Typesetting theorems in LaTeX – Designer Theorems : Ready made styles, Custom made theorems.

TOTAL: 30 HOURS**Text Book**

K. S. S. Nambooripad, E. Krishnan, L. A. Ajith and C. V. Radhakrishnan, On-line Tutorial on LATEX, Indian TEX Users Group, 2000.

Sections 2.3, 3.2-3.4,4.1, 4.2, 5.1-5.4, 6.1, 7.1, 8.1-8.4, 9.1-9.5, 10.1, 10.2, 11.2-11.8, 12.2 - 12.4, 13.1, 13.4, 13.5, 14.1-14.3, 15.2, 15.3, 16.1-16.3, 17.1, 17.2

MA47S1	PERSONALITY DEVELOPMENT	L	T	P	C
		2	0	0	2

OBJECTIVE

To equip individuals with a comprehensive understanding of various aspects of personality development, including attitude, motivation, self-esteem, interpersonal skills, and employability skills, to enhance their personal and professional growth and success.

Course Outcomes At the end of the course the students would be able to		Cognitive Skill
CO-01	Understand and articulate the foundational concepts of personality development, recognizing their significance in various life aspects.	U
CO-02	Demonstrate a deep understanding of attitude and motivation, applying motivational theories to set and achieve goals.	R
CO-03	Evaluate and enhance personal self-esteem, understanding its impact on life and relationships	R,U
CO-04	Develop and refine various personality aspects, including emotional intelligence and social skills, for better interpersonal interactions.	R,U
CO-05	Assess and improve their employability quotient through targeted strategies and skill development.	U

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	M	M	S
CO-02	S	S	M	M	S
CO-03	M	M	S	S	M
CO-04	S	M	S	M	S
CO-05	S	M	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction To Personality Development.**8**

Meaning - Definition and Importance of Personality Development - Key Theories of Personality Development (Freud, Erikson, Jung, Maslow) - Factors Influencing Personality (Genetics, environment, Culture, Experiences) - Self-awareness and Self-assessment – Case Studies

Unit II: Self-Management Skills.**6**

Building Self-esteem and Confidence - Managing Emotions and Stress - Goal Setting and Time Management - Developing a Positive Attitude and Growth Mindset - Practical Exercises and Workshops.

Unit III: Communication Skills.**4**

Communication skills -Verbal and Non-verbal Communication - Active Listening and Effective Speaking - Public Speaking and Presentation Skills -Overcoming Stage Fright and Building Confidence Role-plays and Mock Presentations

Unit IV: Interpersonal Skills.**4**

Building and Maintaining Relationships - Conflict Resolution and Negotiation Skills- Teamwork and Collaboration -Empathy and Emotional Intelligence - Group Activities and Discussions.

Unit V: Leadership And Professional Skills.**8**

Understanding Leadership Styles and Traits - Decision Making and Problem-Solving - Professional Etiquette and Workplace Behaviour- Continuous Learning and Self-improvement Case Studies and Leadership Workshops

TOTAL: 30 HOURS**REFERENCE BOOKS**

- 1.Carnegie, D. (2021). How to Win Friends and Influence People (Revised Edition). Gallery Books.
- 2.Covey, S. R. (2021). The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change (30th Anniversary Edition). Simon & Schuster.
- 3.Feist, J., & Feist, G. J. (2020). Theories of Personality (9th ed.). McGraw-Hill Education.
- 4.Maxwell, J. C. (2020). The 21 Irrefutable Laws of Leadership: Follow Them and People Will Follow You (10th Anniversary Edition). HarperCollins Leadership.
- 5.Robbins, S. P., Judge, T. A., & Campbell, T. T. (2022). Organizational Behavior: Concepts, Controversies, and Applications (11th ed.). Pearson.

MA47S2	NET/SET /COMPETITIVE/ COACHING	L	T	P	C
		2	0	0	2

OBJECTIVE

To provide comprehensive coaching and preparation to students aspiring to clear the NET/SET or other competitive examinations in their respective fields.

Course Outcomes At the end of the course the students would be able to		Cognitive Skill
CO-01	Apply fundamental principles of analysis and linear algebra to solve mathematical problems involving continuity, compactness, and vector spaces.	R,U,A,An,E, S
CO-02	Analyze and work with the structures of groups and rings, and apply key theorems like Sylow's and Cayley's in various contexts.	R,U,A,An,E, S
CO-03	Solve both ordinary and partial differential equations using various methods and apply these solutions to practical mathematical models.	R,U,A,An,E, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	M	S	S
CO-02	S	S	M	S	S
CO-03	S	S	S	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Foundations of Analysis and Linear Algebra

10

Analysis : Elementary set theory, finite, countable and uncountable sets, supremum, infimum, limsup, liminf, Bolzano Weierstrass theorem, Continuity, uniform continuity, Metric spaces, compactness, connectedness.

Linear Algebra : Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices.

Unit II: Abstract Algebra: Groups and Rings

10

Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, class equations, Sylow theorems. Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain,.

Unit III: Ordinary and Partial Differential Equations

10

ODE : Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs. General theory of homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm Liouville boundary value problem, Green's function.

PDE : Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs. Classification of second order PDEs, General solution of higher order PDEs with constant coefficient Classification of second order PDEs, General solution of higher order PDEs with constant coefficient.

TOTAL: 30 HOURS

REFERENCE BOOKS

1. Rajendra Dubey, CSIR – NET /JRF Mathematics Vol. I(Pure Mathematics), Dips Pvt. Ltd. 2019
2. Rajendra Dubey, CSIR – NET /JRF Mathematics Vol. II, (Applied Mathematics), Dips Pvt. Ltd. 2019

MA47P1	INTERNSHIP	L	T	P	C
		0	0	0	2

OBJECTIVES

- To foster teamwork skills among students.
- To equip students with the capability and motivation to address societal challenges.
- To cultivate a strong work ethic.
- To enhance communication skills and foster a sense of responsibility among students.
- To provide opportunities to apply academic knowledge in practical settings.

Course Outcomes At the end of the course the students would be able to		Cognitive Skill
CO-01	Strengthen professional capabilities for conducting fieldwork..	R
CO-02	Acquire hands-on experience relevant to their academic studies.	An
CO-03	Facilitate deeper comprehension of subject theories and methodologies..	S
CO-04	Develop practical skills and knowledge.	R,U
CO-05	Enhance students' prospects for employment opportunities	E,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mode of Evaluation

Internal	Certificate from the Organisation	25 Marks
External	Viva Voce Examination based on Internship report	75 Marks
Total Marks		100

MA47P2	PROJECT	L	T	P	C
		0	0	0	4

OBJECTIVES

- To empower students with confidence for their future careers.
- To enhance students' readiness to address real-world problems and encourage them to seek additional information relevant to their topics during teaching.
- To foster the development of students' interpersonal skills.
- To encourage students to adopt a well-rounded, collaborative approach to tackling real societal challenges, both independently and as part of a team.

Course Outcomes At the end of the course the students would be able to		Cognitive Skill
CO-01	Provide students with essential skills such as problem-solving and fosters the development of additional skills crucial for their future, including critical thinking and time management	R
CO-02	Enhance students' knowledge through practical experiences	An
CO-03	Develop interpersonal and decision-making skills	S
CO-04	Offer a platform for students to showcase their abilities	R,U
CO-05	Facilitate the identification of strengths and weaknesses, enabling students to enhance and improve their abilities.	E,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mode of Evaluation

Internal	Dissertation
External	Viva Voce Examination
Total Marks	100

LIST OF SUPPORTIVE COURSES TO OTHER DISCIPLINES						
1	MA47D1	Statistical Methods	2	1	0	3
2	MA47D2	Mathematics for Competitive Examinations	2	0	0	2

MA47D1	STATISTICAL METHODS	L	T	P	C
		2	1	0	3

OBJECTIVE

To equip the students with different statistical techniques to summarize, analyse the data which are essential for decision making. Also to enable the students to solve statistical problems using computer packages like SPSS.

Course Outcomes At the end of the course the students would be able to:		Cognitive Skills
CO-01	Probability: Concept of random experiment- sample space, events, disjoint events- Definition of probability -Addition and Multiplication theorem, Conditional probability - simple problems.	R, U,A
CO-02	Introduction to Statistics – Classification, Frequency distribution: Discrete and Continuous frequency distribution. – Diagrammatic and Graphic representation: Bar diagram, Rectangle diagram and Pie diagram – Histograms- Frequency polygon, Advantages and limitations. Measures of Central Tendency - Dispersion – Standard deviation, Variance, Co-efficient of variation. - Applications of Binomial and Normal distributions.	R, U, A, An
CO-03	Correlation Analysis- Karl Pearson's correlation coefficient- Rank correlation- Regression lines.	R, U, A, An
CO-04	Definition-Type I and Type II errors – Null Hypothesis, Alternative Hypothesis- One tailed and two tailed tests- Large sample tests. Tests for mean and equality of means. Small sample tests: t -test for mean, equality of means, F test.	R, U, A, An
CO-05	Quality Control –Chance causes and Assignable causes - Control charts for variables – Control chart for Mean ($\bar{X}$) and Range (R). Control charts for Attributes, Proportion of defective (p chart), Number of defectives per Unit (c chart).	R, U, A, An

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO- C	PO-D	PO-E
CO-01	S	S	S	M	S
CO-02	M	M	M	S	S
CO-03	M	S	S	S	M
CO-04	S	M	M	S	S
CO-05	S	S	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Probability.

9

Probability: Concept of random experiment- sample space, events, disjoint events- Definition of probability (frequency and axiomatic)-Addition and Multiplication theorem, Conditional probability - simple problems.

Unit II: Descriptive Statistics and Distributions.

9

Introduction to Statistics – Classification, Frequency distribution: Discrete and Continuous frequency distribution. – Diagrammatic and Graphic representation: Bar diagram, Rectangle diagram and Pie diagram – Histograms- Frequency polygon, Advantages and limitations. Measures of Central Tendency - Dispersion – Standard deviation, Variance, Co-efficient of variation. - Applications of Binomial and Normal distributions (Problems only).

Unit III: Correlation and Regression Lines.

9

Correlation Analysis- Karl Pearson's correlation coefficient- Rank correlation- Regression lines.

Unit IV: Testing of Hypothesis.

9

Definition-Type I and Type II errors – Null Hypothesis, Alternative Hypothesis- One tailed and two tailed tests- Large sample tests. Tests for mean and equality of means. Small sample tests: t - test for mean, equality of means, F test.

Unit V: Statistical Quality Control .

9

Quality Control –Chance causes and Assignable causes - Control charts for variables – Control chart for Mean ($\bar{X}$) and Range (R). Control charts for Attributes, Proportion of defective (p chart), Number of defectives per Unit (c chart).

TOTAL: 45 HOURS

REFERENCE BOOKS

1. Gupta.S.P ,Statistical Methods (38th Edition) by, Sultan Chand & Sons, 2004.
2. Srivastava, S.C, Sangya Srivastava, Fundamentals of Statistics by Anmol Publications Private Ltd., New Delhi, 2006.
3. Bruce L. Bowcman, Richard T.O. Connell and Michael L. Hand, Business Statistics in Practice (2nd Edition) by , “McGraw – Hill, 2001.
4. Richard I. Levin and David S, Statistics for Management (7th Edition) by, Prentice Hall of India, 2002.

MA47D2	MATHEMATICS FOR COMPETITIVE EXAMINATIONS	L	T	P	C
		2	1	0	3

OBJECTIVE

To provide comprehensive preparation in mathematics for competitive examinations, equipping students with the knowledge and skills necessary to excel in a wide range of competitive tests.

Course Outcome		Cognitive Skill
At the end of the course the students would be able to		
CO-01	Understand the concepts of Ages, Percentages and can do problems on it.	U,A,An,E
CO-02	Ability to analyze, interpret and solve the problems on Profit , Loss, Ratio and Proportions.	U,A,An,E
CO-03	Understand the concept of simple interest and able to do problems on work and time.	U,A,An,E
CO-04	Understand and calculate compound interest, annuity, discount, true discount.	U,A,An,E
CO-05	Understand the concept of bankers discount and bankers gain. Also apply the knowledge of stock and share in real problems.	U,A,An,E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

PO CO	PO-A	PO-B	PO- C	PO-D	PO-E
CO-01	S	S	S	M	S
CO-02	M	M	M	S	S
CO-03	M	S	S	S	M
CO-04	S	M	M	S	S
CO-05	S	S	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I :	Problems on Ages – Percentage.	15
Unit II:	Profit and Loss – Ratio and Proportion.	15
Unit III:	Time and Work – Simple Interest.	15
Unit IV:	Compound Interest – Calendar.	15
Unit V:	Stocks and Shares – Bankers' Discount.	15

TOTAL: 45 HOURS

Text Book

Quantitative Aptitude by R.S. Agarwal (Reprint 2012), S. Chand and Company Ltd., New Delhi. Chapters 8, 10 to 12, 15, 21, 22, 27, 29 and 31.