MOTHER TERESA WOMEN'S UNIVERSITY

KODAIKANAL

DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS

SYLLABUS TO BE IMPLEMENTED FROM THE ACADEMIC YEAR

2021-2022

(CHOICE BASED CREDIT SYSTEM)

Mother Teresa Women's University, Kodaikanal
Department of Mathematics
Choice Based Credit System (CBCS)
(2021-2022 onwards)
M.Sc. Mathematics

1. About the Programme

M.Sc. (Master of Science) Mathematics is a Postgraduate Programme**,** that has a duration of 2-years which is divided into 4 semesters. The main aim of the Programme is intended to provide in-depth knowledge to the students in advanced Pure and Applied mathematics and prepare them for various research activities and career opportunities. The Programme is designed to impart proficiency in Mathematical application in day-to-day in simple and complex situations. The Programme also will enable the learners to shine as collaborators and innovators in addressing social, technical, and business challenges. Programme through its wide range of Courses trains the students as competent citizens with advanced mathematical knowledge and ethically sound humans with its insistence of human ethics. The Programme is intended to promote the culture of interdisciplinary studies and research that is much needed for the current scenario.

2. Programme Educational Objectives (PEOs)

The M.Sc. Mathematics Programme is designed to

PEO1	preparing students for productive careers after the completion of this Programme
PEO2	demonstrate professional acumen through learning new avenues in emerging fields of Pure and Applied Mathematics
PEO3	ensure continuous learning relevant inter–personal skills as an individual, as a member or as a leader throughout the professional career
PEO4	motivate to pursue higher studies and exhibit research skill to meet out academic demands of the country.
PEO5	improvise the women resource that is furnished with the mathematical skills that are necessary in the altering industrial and socio-economic development of the country
PEO6	instil a wide range of mathematical techniques and application of mathematical methods/tools in scientific and engineering domains.
PEO7	develop students' self-confidence in research process independently or within a group and have the ability to pursue multidisciplinary research in universities in India and abroad
PEO8	enhance the awareness of the graduates on public concern and to instill moral and ethical behaviors to shape them as moral humans

3. Eligibility : B.Sc. Mathematics

4. General Guidelines for PG Programme

i. **Duration:** The programme shall extend through a period of 4 consecutive semesters and the duration of a semester shall normally be 90 days or 450 hours. Examinations shall be conducted at the end of each semester for the respective subjects.

ii. **Medium of Instruction:** English

iii. **Evaluation:** Evaluation of the candidates shall be through Internal Assessment and External Examination.

- **Evaluation Pattern**

Evaluation Pattern	Theory		Practical	
	Min	Max	Min	Max
Internal	13	25	13	25
External	38	75	38	75

- **Internal (Theory): Test (15) + Assignment (5) + Seminar/Quiz(5) = 25**
- **External Theory: 75**

- **Question Paper Pattern for External examination for all course papers.**

Max. Marks: 75 **Time: 3 Hrs.**

S.No.	Part	Type	Marks
1	**A**	**10*1 Marks=10** Multiple Choice Questions (MCQs): 2 questions from each Unit	**10**
2	**B**	**5*4=20** Two questions from each Unit with Internal Choice (either / or)	**20**
3	**C**	**3*15=45** Open Choice: Any three questions out of 5 : one question from each unit	**45**
Total Marks			**75**

*** Minimum credits required to pass: 90**

- **Project Report**

A student should select a topic for the Project Work at the end of the third semester itself and submit the Project Report at the end of the fourth semester. The Project Report shall not exceed 75 typed pages in Times New Roman font with 1.5 lines space.

- **Project Evaluation**

There is a Viva Voce Examination for Project Work. The Guide and an External Examiner shall evaluate and conduct the Viva Voce Examination. The Project Work carries 100 marks (Internal: 25 Marks; External (Viva): 75 Marks).

5. Conversion of Marks to Grade Points and Letter Grade (Performance in a Course/Paper)

Range of Marks	Grade Points	Letter Grade	Description
90 – 100	9.0 – 10.0	O	Outstanding
80-89	8.0 – 8.9	D+	Excellent
75-79	7.5 – 7.9	D	Distinction
70-74	7.0 – 7.4	A+	Very Good
60-69	6.0 – 6.9	A	Good
50-59	5.0 – 5.9	B	Average
00-49	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

6. Attendance

Students must have earned 75% of attendance in each course for appearing for the examination. Students with 71% to 74% of attendance must apply for condonation in the Prescribed Form with prescribed fee. Students with 65% to 70% of attendance must apply for condonation in the Prescribed Form with the prescribed fee along with the Medical Certificate. Students with attendance lesser than 65% are not eligible to appear for the examination and they shall re-do the course with the prior permission of the Head of the Department, Principal and the Registrar of the University.

7. Maternity Leave

The student who avails maternity leave may be considered to appear for the examination with the approval of Staff i/c, Head of the Department, Controller of Examination and the Registrar.

8. Any Other Information

In addition to the abovementioned regulations, any other common regulations pertaining to the PG Programmes are also applicable for this Programme.

9. Programme Outcomes (POs)

On completion of the programme, the students will be able to

PO1	to carry out scientific investigation objectively without being biased with preconceived notions.
PO2	analyze problems, formulate a hypothesis, evaluate and validate results, and draw reasonable conclusions thereof.
PO3	pursue research in Mathematical Sciences and allied fields, or careers in industry.
PO4	acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in mathematical Sciences.
PO5	to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges

10. Programme Specific Outcomes (PSOs)

On completion of the programme, the students will be able to

PSO1	understand the fundamental axioms in mathematics and capable of developing ideas based on them.
PSO2	pursue research studies in mathematics and related fields
PSO3	have advanced knowledge on topics in pure mathematics and to pursue higher degrees at reputed academic institutions.
PSO4	acquire skills in problem solving, thinking, creativity through assignments, etc.
PSO5	compete in competitive exams e.g. NET, GATE, etc

M.Sc. MATHEMATICS CURRICULUM

S. NO	Course Code	Course Title	Credits	Hours		CIA	ESE	Total
				L	P			
Semester I								
1	P21MTT11	Core I- Algebra	4	5	-	25	75	100
2	P21MTT12	Core-II- Real Analysis-I	4	5	-	25	75	100
3	P21MTT13	Core-III- Ordinary Differential Equations	4	5	-	25	75	100
4	P21MTT14	Core-IV-Graph Theory	4	5	-	25	75	100
5	P21MTT15	Core – V- Computer Oriented Numerical Methods	4	5	-	25	75	100
6	P21CSS11	**Supportive Course- I(Skill)-** Computer Skills for Web Designing and Video Editing	2	-	4	25	75	100
		Total	**22**	**30**		**-**	**-**	**600**
Semester II								
7	P21MTT21	Core VI-Vector Space and Linear Transformation	4	5	-	25	75	100
8	P21MTT22	Core-VII-Real Analysis –II	4	5	-	25	75	100
9	P21MTT23	Core-VIII-Partial Differential Equations	4	4	-	25	75	100
10	P21MTT24	Core-IX-Topology	4	5	-	25	75	100
11	P21MTT25	Core-X- Optimization Techniques	4	5	-	25	75	100
12		**Non-Major Elective-I**	4	4		25	75	100
13	P21MTS22	**Supportive Course II(Skill)-** MATLAB	2	-	2	25	75	100
		Total	**26**	**30**		**-**	**-**	**700**
Semester III								
14	P21MTT31	Core XI- Complex Analysis	4	5	-	25	75	100
15	P21MTT32	Core-XII- Measure Theory	4	5	-	25	75	100
16	P21MTT33	Core-XIII-Differential Geometry	4	4	-	25	75	100
17	P21MTT34	Core-XIV- Classical Dynamics	4	4	-	25	75	100
18	P21MTT35	Core-XV- Calculus of variations and Integral Equations	4	5	-	25	75	100
19	P21MTT36	Core XVI- Functional Analysis	4	5	-	25	75	100
20	P21WSS33	**Supportive Course III** Women Empowerment	2	2	-	25	75	100
		Total	**26**	**30**				**700**
Semester IV								
21	P21MTE411/ P21MTE412/ P21MTE413/ P21MTE414/	Elective-I* Number Theory/Automata Theory/Probability Theory and Statistics/Astronomy / Any MOOC Course[$]	4	4	-	25	75	100

22	P21MTE421/ P21MTE422/ P21MTE423/ P21MTE424/	Elective –II* Fuzzy sets and their Application/ Stochastic Processes /Fluid Dynamics/Tensor Analysis and Special Theory of Relativity/ Any MOOC Course[$]	4	4	-	25	75	100
23	P21MTR41	Project	8	22	-	25	75	100
		Total	**16**	**30**				**300**
		Grand Total	**90**	**120**				**2300**

Non Major Elective

The candidates who have joined the PG Programme, can also undergo Non Major Elective offered by other Departments.

Non Major Elective (NME) offered by Department of Mathematics

S.No	Course code	Non Major Elective Courses
1	P21MTN211	Numerical Methods
2	P21MTN212	Operation Research
3	P21MTN213	Discrete Mathematics
4	P21MTN214	Differential Equations
5	P21MTN215	Fourier series and Laplace Transforms
6	P21MTN216	Statistics
7	P21MTN217	Mathematical Aptitude

Additional Credit Courses (Mandatory)

1. **Semester –I**

Course Code	Course Name	Category	Credit
P21MTV11	Python Language and Python Lab	Value Added Program- I	2

2. **Semester –II**

Course Code	Course Name	Credit
P21MTI21	Internship/Industrial Training	2

3. **Semester –III**

Course Code	Course Name	Credit
P21MTO31	Online Courses - MOOC Courses	2

4. Semester –IV

Course Code	Course Name	Category	Credit
P21MTV42	Mathematical Modelling	Value Added Program- II	2

*Those who have CGPA 9 and want to do the project in industry/institution during IV semester., these two paper can be opted in III semester

$Students can take one 4 credit course in MOOC as elective or two 2 credit course in MOOC as elective with the approval of Department committee

Outside class hours (Attendance compulsory)

- Health, Yoga and Physical fitness.
- Library information access and utilisation
- Employability Training.
- Students Social Responsibility.

SEMESTER- I

COURSE CODE	P21MTT11	ALGEBRA	L	T	P	C
CORE- I			5	-	-	4

Objectives:

- To provide deep knowledge about various algebraic Structures.
- The learner will be able to recognize some advances of the theory of groups.
- Use Sylow's Theorems in the study of finite groups.
- Formulate some special types of rings and their properties.
- Recognize the interplay between fields and vector spaces.
- Apply the algebraic methods for solving Problems**.**

Unit-I: Counting principle:
Introduction about Counting principle – Product of subgroups and order of product subgroups - Normal subgroups and quotient groups – Homomorphisms of into and onto with kernel function- Automorphisms with the property - Cayley's theorem - Permutation groups for symmetric and alternating group

Unit-II: Another counting principle:
Introduction about Another counting principle – Normalizer and its applications - Sylow's theorems and p-sylow subgroup -Third part of p-Sylow's theorem and examples problems - Direct product – internal direct product of normal subgroups-Finite abelian groups-isomorphic abelian groups and non isomorphic abelian group of order prime theorems

Unit-III: Ring:
Definition and examples -Ring of real quaternion's-Some special Classes of Rings - zero divisor – integral domain-division ring- characteristic - Boolean ring – Homomorphisms of rings with kernel examples-Ideal and Quotient Rings- More Ideals and Quotient Rings- The field of Quotients of an Integral Domain

Unit- IV: Euclidean Rings:
Introduction about Euclidean rings -definition with theorems and lemma's - A Particular Euclidean ring with Gaussian integers theorems-Fermat theorem - Polynomial rings – division algorithm- polynomials over the rational field – Primitive polynomial wit Gauss' lemma-Eisenstein criterion theorem-Polynomial rings over commutative rings-Unique factorization domain-primitive and irreducible polynomial lemma's.

Unit -V: Extension Fields:
Introduction about Extension fields –definition of degree and finite extension of field– definition of algebraic and extension theorems -Roots of polynomials – remainder theorem based on lemmas – Splitting field and irreducible extension theorems-More about roots with lemmas and corollary – Definition of Simple extension and theorems-definition of Finite fields and lemmas and theorems

Text Book:

1.I. N. Herstein, "Topics in Algebra", 2nd edition, John Wiley & Sons, Singapore, 2006.

Unit I: Chapter 2: Sections 2.5, 2.6, 2.7, 2.8, 2.9, 2.10
Unit II: Chapter 2: Sections 2.11, 2.12, 2.13, 2.14
Unit III: Chapter 3: Sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.6
Unit IV: Chapter 3: Sections 3.7, 3.8, 3.9, 3.10, 3.11
Unit V: Chapter 5: Sections 5.1, 5.3, 5.5 & Chapter 7: Section 7.1

Reference Books:

1. **John. B. Fraleigh**, "A First Course in Abstract Algebra", 7th Edition, Addison-Wesley, New Delhi, 2003.
2. **P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul, "**Basic Abstract Algebra", Cambridge University Press, USA, 1986
3. **Charles Lanski,** "Concepts in Abstract Algebra", American Mathematical Society, USA, 2010.
4. **J.J. Rotman**, *"*Advanced Modern Algebra", 2nd Edition, Graduate Studies in Mathematics, Vol. 114, AMS, Providence, Rhode Island, 2010.
5. **G. Strang**, *"*Introduction to Linear Algebra", 2ndEdition, Prentice Hall of India Pvt. Ltd, 2013.

Course Outcomes

Upon the successful completion of the course

CO1: **S**tudents will have a working knowledge of important mathematical concepts in abstract algebra such as definition of a group, order of a finite group and order of an element – K2.

CO2: Students will be introduced to and have knowledge of many mathematical concepts studied in abstract mathematics such as permutation groups, factor groups and abelian groups – K3.

CO3: Students will actively participate in the transition of important concepts such homeomorphisms & isomorphism's from discrete mathematics to advanced abstract mathematics - K4.

CO4: **S**tudents will gain experience and confidence in proving theorems. A blended teaching method will be used requiring the students to prove theorems give the student the experience, knowledge, and confidence to move forward in the study of mathematics – K5.

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	M	S	M	S	M	M	S	S	S
CO4	S	S	S	S	S	S	S	S	M	S

S – Strong: M – Moderate L- Low

COURSE CODE	P21MTT12	REAL ANALYSIS- I	L	T	P	C
CORE- II			5	-	-	4

Objectives:

- To convey concepts of real valued functions in detail.
- To provide the deep knowledge about sequences and series.
- To make a clear difference between differentiability and continuity
- To know some basic theorems**.**

Note: The Question paper may contain problems to a maximum of 20%

Unit -I: Countable and Uncountable sets:

Finite Countable and Uncountable sets – definition of enumerable or denumerable, equivalence relation with theorems and examples- Metric spaces –Euclidean spaces examples- Basic definitions of metric spaces and its examples – Open and closed sets -Compact sets- definition of compact sets with union and intersection theorems and its properties- k- cell is compact-Weierstrass theorem

Unit –II: Perfect sets:

Introduction about Perfect sets – definition of perfect set and cantor set and its theorem- Connected sets-real line is connected property theorem- Convergent and divergence sequences in a metric space theorems –Subsequences - Cauchy sequences and complete - Upper and lower limits - Some special sequences theorems and examples– Series – harmonic series and geometric series examples - The number e - The root and ratio tests and its examples

Unit -III: Power series:

Definition of Power series – radius of convergence with problems - Summation by parts – partial summation formula-Leibnitz theorem-absolute convergence – conditionally convergent - definition and theorems and its examples-addition and multiplication of series with problems – Rearrangements

Unit-IV: Continuity function:

Continuity: Limits of functions - Continuous functions and their properties and theorems- continuity and compactness- uniform continuous-theorems -The derivative of a real function with properties and examples-Mean value theorems and generalized Mean value theorem- The continuity of derivatives - L'Hospital' rule

Unit -V: The Riemann-Stieltjes Integral:

Introduction of Riemann-Stieltjes Integral: Definition and existence of the integral – definition of refinement -upper and lower partition theorems-Properties of the Riemann-Stieltjes Integral and its theorems- definition of unit step function-Integration and differentiation –fundamental theorem of calculus- integration by parts- Integration of vector valued functions.

Text Book:

1.Walter Rudin, "Principles of Mathematical Analysis", 3rd Edition, McGraw – Hill International Book Company, Singapore, (1982).

Units I: Chapter- 2: 2.1 to 2.42
Unit II: Chapter- 2: 2.43 to 2.47 and Chapter -3:3.1 to 3.37
Unit III: Chapter- 3: 3.38 to 3.58
Unit IV: Chapter-4: 4.1 to 4.21 and Chapter -5: 5.1 to 5.13
Unit V: Chapter- 6:6.1 to 6.23

Reference Books:

1. **S. Kumaresan**, "Topology of Metric Spaces ", 2nd Edition, Narosa Publishing House, 2011.
2. **S. Ponnusamy**, "Foundations of Mathematical Analysis", Springer Birkhauser, 2012.
3. **S. K. Mappa**, Introduction to Real Analysis, 7th Edition, Sarat Book Distributors, Kolkatta, 2015
4. **Tom Apostol,** "Mathematical Analysis", Addison Wesley Publishing Company, London-1971.
5. **R. G. Bartle & D.R. Sherbert,** "Introduction to Real Analysis", John Wiley & Sons, New York, 1982.
6. **Kenneth A. Ross,** "Elementary Analysis: The theory of Calculus", Springer, New York, 2004.
7. **K. R. Stromberg,** "An Introduction to Classical Real Analysis", Wadsworth, 1981.
8. **G.F.Simmons,** "Introduction to Topology and Modern Analysis", McGraw – Hill, New Delhi, 2004.

Course Outcome:

Upon the successful completion of the course**,**

CO1: Students will be able to demonstrate competence with elementary properties of sets By proving identities involving union and intersection and Cartesian Products of Sets – K2
CO2: Students will be able to demonstrate competence with elementary properties of Functions by proving results involving composite functions and inverse functions – K3
CO3: Students will be able to demonstrate competence with the algebraic and order Properties of real numbers – K4
CO4: Students will be able to demonstrate competence with properties of real numbers by finding supremum and infimum of sets and using the completeness property of real numbers – K5
CO5: Students will be able to demonstrate ability to use Taylor Theorem, the Mean value Theorem, and use L'Hospital's Rule to compute limits of functions – K6

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	S	S	S	M	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	M	S	M	S	M	S	M	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	M	S	S	S	S	S	S	S

S – Strong: M – Moderate L- Low

COURSE CODE	P21MTT13	ORDINARY DIFFERENTIAL EQUATIONS	L	T	P	C
CORE- III			5	-	-	4

Objectives:

- Differential equations arise for many problems in oscillations of mechanical and electrical systems
- It plays a very important role in all modern scientific and engineering studies.
- To give an in-depth knowledge of differential equations and their applications.
- Solve the higher order differential equations in different types with initial and boundary conditions
- Use the method of separation of variables to reduce some partial differential equations to ordinary differential equations of 2^{nd} order.
- To make the students to solve the practical problems used differential equations.

Unit-I: Second Order Linear Equations:

Introduction about Second Order Linear Equations - The General solution of the homogeneous equation– Wronskians - Linearly dependent and independent theorems and lemma's-The use of a known solution to find another –general solution with example- The method of undetermined Coefficients – Problems based on exponentials, sines and cosines, and polynomials. The method of variation of parameters -solving problems

Unit-II: Power Series Solutions:

Power Series definition- A review of power series– definition of power series, converges and diverges – Radius of convergence with examples-Definition analytic function and basic properties-Series solutions of first order equations with initial condition– Second order linear equations - Ordinary point-singular point-Legendre's equation - solving problems.

Unit-III: Special Functions:

Introduction about Special Functions- Regular Points- Singular Points - irregular singular points with examples– Airy equation - Hermite's equation - The generating function - Rodrigues' formula - Bessel equation - Frobenius series - Gauss's hyper geometric equation – The Point at infinity.

Unit-IV: Some Special Functions of Mathematical Physics:

Introduction of Some Special Functions in Mathematical Physics: Legendre Polynomials - generating function and Rodrigues' formula – Properties of Legendre Polynomials – Orthogonality Bessel Functions – The Gamma Function – Properties of Bessel Functions- Bessel function of the first kind and second kind-Proofs of the orthogonality properties.

Unit-V: System of First Order Equations:

System of First Order Equations Introduction - Linear Systems with proof of the homogeneous Linear Systems theorems- Homogeneous Linear Systems with Constant Coefficients -Solving problems– non homogeneous Linear Systems –examples-Nonlinear Systems with examples-Volterra's Prey – Predator Equations.

Text Book:

1. **G.F. Simmons,** "Differential Equations with Applications and Historical Notes", TMH, New Delhi, 1984.
   Unit I - Chapter 3: Sections 15, 16, 18 and 19.
   Unit II -Chapter 5: Sections 26 to 28
   Unit III -Chapter5: Sections 29 to 32
   Unit IV-Chapter8: Sections 44 to 47
   Unit V - Chapter 10: Sections 55 to 57

Reference Books:

1. **Williams E. Boyce and Richard C. Diprima** "Elementary Differential Equations and Boundary Value Problems " 10th edition John Wiley and Sons, New York 2012
2. **M.D. Raisinghania**, " Advanced Differential Equations ", S. Chand & Company Ltd., New Delhi 2012
3. **B. Rai, D.P. Choudhury and H.I. Freedman**, "A Course in Ordinary Differential Equations ", Narosa Publishing House Pvt. Ltd, New Delhi 2012
4. **W.T. Reid,** "Ordinary Differential Equations", John Wiley & Sons, New York, 1971.
5. **E.A. Coddington,** "An Introduction to Ordinary Differential Equation", Prentice Hall of India, New Delhi, 2007.
6. **D.Somasundaram,** "Ordinary Differential Equations", Narosa Publ., House, Chennai - 2002.

Course Outcomes:

Upon the successful completion of the course, students will be able to

CO1: recognize differential equations that can be solved by each of the three methods – direct integration, separation of variables and integrating factor method – and use the appropriate method to solve them – K2

CO2: use an initial condition to find a particular solution of a differential equation, given a general solution – K2

CO3: check a solution of a differential equation in explicit or implicit form, by substituting it into the differential equation – K3

CO4: understand the terms 'exponential growth/decay', proportionate growth rate' and 'doubling/halving time' when applied to population models, and the terms' exponential decay', 'decay constant' and 'half- life' when applied to radioactivity – K5

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	M	S	S	S
CO2	S	M	S	S	S	M	M	M	M	S
CO3	S	S	M	S	S	S	S	S	S	S
CO4	S	S	S	M	S	S	S	S	S	S

S – Strong: M – Moderate L- Low

COURSE CODE	P21MTT14	GRAPH THEORY	L	T	P	C
CORE- IV			5	-	-	4

Objectives:

- To impart the different types of graphs and operations.
- To give a depth knowledge about vertices and edge connectivity.
- To make knowledge in matching and colourings.
- To study related theorems.
- To shipped from digraphs and additional structure in networks.

Unit-I: Graphs and Trees:

Graphs and Sub graphs: Basic definitions of Graphs and simple graphs-Graph isomorphism : complete graph- Bipartite graph- examples of isomorpihic and nonisomorphic graphs-The incidence and adjacency matrices : Eigen values -proof of automorpshism group of G-Subgraphs: Spanning subgraph-induced subgraph - Vertex degrees: Handshaking theorem - minimum and maximum degrees of graph and its relation- Paths and connection: connected and disconnected graph with proof of the theorems- Cycles - Trees -Cut edges and bonds - Cut vertices -Cayley's formula.

Unit-II: Connectivity, Euler Tours and Hamilton Cycles:

Connectivity: vertex connectivity and edge connectivity with examples and theorems- Blocks-proof of the Merger's theorem-Euler Tours and Hamilton Cycles: Euler tours- Hamilton cycles-Eulerian graph and non Eulerian graph with examples and theorems- Hamiltonian graph non Hamiltonian graph with examples and theorems-Dirac theorem- The Chinese postman problem -The travelling salesman problem.

Unit-III: Matchings and Edge Colourings:

Matchings: maximum and perfect matching's in graphs with examples- augmenting path – matchings and coverings in bipartite graphs: Marriage theorem – minimum covering with proof of the theorems and lemmas-Perfect matchings -Halls and Tutte's theorems -Edge chromatic number - Vizing's theorem.

Unit-IV: Independent Set, Cliques and Vertex Colourings:

Independent Set: maximum independent sets - vertex (edge) independence number and covering number with proof of the theorems- Clique- Ramsey's theorems with examples-Turan's theorem - Chromatic number : vertex colourable and edge colourable-critical graph-properties of critical graphs- Brooks theorem – Hajos Conjecture

Unit-V: Directed Graphs and Networks:

Directed graphs: Directed walk, trail, path, cycle - indegrees and outdegrees with examples - reachable - tournament –directed Hamiltonian path- directed Hamiltonian cycle with proof of the theorems- Networks: capacity function-flows- resultant flow -maximum flow- minimum cuts - The Max-flow Min-cut theorem

Text Book:

1. **J. A. Bondy and U. S. R. Murty,** "Graph theory with applications", The MacMillan Press Ltd., 1976.
   Unit I: chapter 1: 1.1 – 1.7 and chapter 2: 2.1 – 2.4
   Unit II: chapter 3: 3.1 – 3.2 and chapter 4: 4.1 – 4.4
   Unit III: chapter 5: 5.1 – 5.3 and chapter 6: 6.1 – 6.2
   Unit IV:chapter 7: 7.1 – 7.3 and chapter 8: 8.1 – 8.3
   Unit V: chapter 10: 10.1 – 10.3 and chapter 11: 11.1 – 11.3

Reference Books

1. **Narsingh Deo,** "Graph Theory with applications to Engineering and Computer Science", PHI learning Pvt Ltd, New Delhi, 2013
2. **L.R. Foulds**, "Graph Theory Applications", Narosa publishing House, 1993.

Course Outcomes

Upon the successful completion of the course, students will be able to

CO1: state all of the technical definitions covered in the course (such as a graph, tree, colouring, cut edges, cut vertices, connectivity's, cycle and tours, digraph, flows and cuts) – K2
CO2: state all of the relevant theorems covered in the course. – K3
CO3: formulate graph theoretic models to solve real world problems (THE MAX-FLOW MIN-CUT) – K4
CO4: analyze combinatorial objects satisfying certain properties and answer questions related to existence (proving the existence or non-existence of such objects), construction (describing how to create such objects in the case they exist), enumeration (computing the number of such objects), and optimization (determining which objects satisfy a certain external property) – K4
CO5: decision/network will take existing/proposed network /social to avoid ambiguity – K6

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate; K6- create

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	M	S
CO3	S	S	S	S	M	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S – Strong: M – Moderate L- Low

COURSE CODE	P21MTT15	COMPUTER ORIENTED NUMERICAL METHODS	L	T	P	C
CORE- V			5	-	-	4

Objectives:

- To develop the mathematical skills of the students in the areas of numerical methods.
- To teach theory and applications of numerical methods in a large number of engineering subjects which require solutions of linear systems, finding Eigen values, Eigen Vectors, Interpolation, and applications, solving ODEs, PDEs and dealing with statistical problems like testing of hypothesis.
- To lay foundation of computational mathematics for specialized studies and research.

Unit – I: Transcendental and Polynomial Equation

Transcendental and Polynomial Equation Introduction- Bisection Method- steps to solve problems in Bisection method - Iteration method based on first degree equation- problems in first degree equation -Iteration method based on second degree equation- problems in second degree equation- Rate of Convergence.

Unit –II: System of Linear Algebraic Equations and Eigen value Problems:

System of Linear Algebraic Equations and Eigen value Problems introduction- Direct Method-Fixed point iteration method-Newton's method- solution of linear system by Gaussian elimination and Gauss –Jordon methods-Iterations Methods- Eigen values and Eigen Vectors-Jacobi method for Symmetric Matrices-Givens Method for Symmetric Matrices-Power Method.

Unit – III: Interpolation and Approximation:

Interpolation and Approximation introduction-Lagrange and Newton Interpolation-Introduction – Formula- Problems in Lagrange and Newton Interpolation -Finite Difference Operators- Interpolating Polynomials Using Finite Differences- Hermit Interpolation-Introduction – Formula- Problems in Hermit Interpolation- Piecewise and Spline Interpolation-Introduction – Formula- Problems in Piecewise and Spline Interpolation

Unit – IV: Differentiation and Integration:

Differentiation and Integration introduction- Numerical Differentiation- - Extrapolation Method- Numerical Integration: trapezoidal and Simpsons 1/3 and 3/8 rules - Formula-Problems in trapezoidal and Simpsons 1/3 and 3/8 rules- Romberg Integration – Double Integration-. Problems in Romberg Integration and Double Integration

Unit –V: Ordinary Differential Equations:

Introduction of Ordinary Differential Equations- Initial Value Problems: Single step Method-Taylor series method-Euler method for first order equation-fourth order Runge-Kutta method for solving first and second order equations-Multi Step Methods : Milne's and Adam's Predictor- Corrector Method

Text Book:

1. **M.K.Jain, S.R.K.Iyengar, R.K.Jain.** "Numerical Methods For Scientific And Engineering Computation "(Fifth Edition). New Age International Publishers. (2007)

Unit-I: Chapter 2: Section: 2.1 – 2.5.
Unit-II: Chapter 3: Section: 3.1, 3.2, 3.4, 3.5, 3.7, 3.8 & 3.10
Unit-III: Chapter 4: Section: 4.1- 4.6
Unit- IV: Chapter 5: Section: 5.1, 5.2, 5.4, 5.6, 5.10 & 5.11
Unit – V: Chapter 6: Section: 6.4, 6.6 & 6.7

Reference Book:

1. **P.Kandasamy, K.Thilagavathi and K. Gunavathi**, "Numerical Methods", S.Chand and Company Ltd , New Delhi 2013.

Course Outcomes

CO	Course Outcomes	Knowledge Level
CO1	Apply numerical methods to find our solution of algebraic equations using different methods under different conditions and numerical solution of system of algebraic equations.	K3
CO2	Apply various interpolation methods and finite difference concepts.	K3
CO3	Workout numerical differentiation and integration whenever and wherever routine methods are not applicable.	K3
CO4	Work numerically on the ordinary differential equations using different methods through the theory of finite differences.	K3
CO5	Work numerically on the partial differential equations using different methods through the theory of finite differences.	K3

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	M	S	S
CO2	S	S	S	S	M	S	S	S	S	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	S	M	S	S	S	S	S	S
CO5	S	S	S	S	M	S	S	S	S	S

S- Strong M-Medium L-Low

SEMESTER- II

COURSE CODE	P21MTT21	VECTOR SPACE AND LINEAR TRANSFORMATION	L	T	P	C
CORE- VI			5	-	-	4

Objectives

- To provide sound foundation in linear Algebra, as well as understanding of the principles underlying in linear Algebra and deep knowledge about various algebraic structures.
- To prepare students to understand principles, concepts necessary to formulate and give a depth knowledge about elementary matrix operations.
- To prepare the students for further courses in higher mathematics and related disciplines and solve linear equation.

Unit-I: Vector Spaces:

Vector introduction – Vector spaces – Subspaces – Linear combinations and systems of linear equations – Exercise problems- Linear dependence and linear independence – Bases and dimensions – Maximal linearly independent subsets- Exercise problems

Unit-II: Linear Transformation:

Introduction of Linear Transformation-The Algebra of Linear transformation - finite dimensional-invertible-range and rank-idempotent - Characteristic Roots and matrices-minimal polynomial-characteristic vector- Exercise problems in Characteristic Roots and matrices- Exercise problems in characteristic vector.

Unit-III: Linear Transformation Cont.:

Types of Linear Transformation -Canonical Forms: Triangular Form- Canonical Forms: Nilpotent transformations- Canonical Forms: A Decomposition of V: Jordan Form-Canonical Forms: rational canonical Form.

Unit-IV: Linear Transformation Cont.

In Linear Transformation Trace and Transpose - characteristic roots based on lemmas- symmetric and skew symmetric matrix- adjoint – determinants - Hermitian, Unitary and normal Transformations-Real Quadratic Forms.

Unit - V: Diagonalization:

Diagonalization Introduction Eigen values and Eigen vectors –Properties of Eigen values and the Cayley Hamilton theorem - Matrix limits and Markov chains – Invariant subspaces - Diagonalizability – similarity transformation and orthogonal transformation of a symmetric matrix to diagonal form- -orthogonal reduction to its canonical form

Text Book:

1. **Stephen H.Friedberg, Arnold J. Insel, Lawrence E. Spence,** "Linear Algebra", Pearson New International Edition, fourth edition , 2014
   Unit I- Chapter 1: Sec1.1- Sec1.7
   Unit V-Chapter 5: Sec 5.1- Sec 5.4
2. **I.N.Herstein**, "Topics In Algebra", Second Edition Published by John Wiley and Sons, Singapore 2006
   Unit II-Chapter 6: Sec 6.1-Sec 6.3
   Unit III- Chapter 6: Sec 6.4- Sec 6.7
   Unit IV – Chapter 6: Sec 6.8- Sec 6.11

Reference Books:

1. **Kenneth M Hoffman and Ray Kunze**, "Linear Algebra", 2nd Edition, Prentice-Hall of India Pvt. Ltd, New Delhi, 2013
2. **John. B. Fraleigh,** "A First Course in Abstract Algebra", 7th Edition, Addison-Wesley,New Delhi, 2003.
3. **S. Kumerason,** "Linear Algebra" Prentoice Hall of India Pvt Ltd New Delhi, 2000.
4. **D.S.Malik, J.N.Mordeson and M.K.Sen**, "Fundamental of Abstract Algebra", McGraw Hill(International Edition),New York. 1997.

Course Outcomes:

Upon successful completion of this course students will be able to

CO1: Determine relationship between coefficient matrix inevertability and solutions to a system of linear equations and the inverse matrices – K2
CO2: Find a basis for the row space, column space and null space of a matrix and find the rank and nullity of a matrix – K3
CO3: Find the matrix representation of a linear transformation given bases of the relevant relevant vector spaces – K4
CO4: Use computational techniques and algebraic skills essential for the study of systems of linear equations, matrix algebra, vector spaces, Eigen values and Eigen vectors, orthogonality and diagonalization. (Computational and Algebraic Skills) – K5
CO5**:** Work collaboratively with peers and instructors to acquire mathematical and understanding and to formulate and solve problems and present solutions – K6
K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

COs/POs	PO1	PO2	*PO3*	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	*S*	S	S	S	S	S	M	S
CO2	S	S	*S*	M	S	S	S	S	S	S
CO3	S	S	*S*	S	S	S	M	S	M	S
CO4	S	S	*M*	S	S	S	S	S	S	S
CO5	S	S	*S*	S	M	S	S	S	S	S

S- Strong = 3, M-Medium = 2, L-Low = 1

COURSE CODE	P21MTT22	REAL ANALYSIS-II	L	T	P	C
CORE- VII			5	-	-	4

Objectives:

- To introduce the concept of integration of real-valued functions.
- To give a deep knowledge about the real valued function.
- To know about linear transformation.
- To solve the problems of differentiation of integrals.

Unit-I: Sequences and Series:

Sequences and Series of Functions: Discussion of Main problem - Uniform Convergence – Uniform convergence and continuity - Uniform convergence and Integration – Uniform convergence and differentiation – Equi continuous families of functions

Unit- II: The Stone-Weierstrass Theorem and some special functions:

The Stone-Weierstrass theorem and some special functions statement and proof - corollary - uniform closure -separate points -Power series - Taylor's series -The exponential and Logarithmic functions - The trigonometric functions- solving problems

Unit- III: The algebraic completeness of the complex field:

Introduction of algebraic completeness of the complex field-Fourier series-Trigonometric polynomial - Fourier coefficient - orthogonal -Bessel inequality - Dirichlet kernel - localization theorem - Parseval's theorem - The Gamma functions - Stirling's formula and Functions of several variables: Linear transformations- linear combination- Linear operators on X.

Unit -IV: Differentiation:

Differentiation introduction- Preliminaries- Differentiable- Partial derivatives -Directional derivative-The contraction principle - The inverse function theorem - The implicit function theorem -The rank theorem -null space, range - projections– Determinants - multiplication of theorem -Jacobians- Derivatives of higher order- second order partial derivatives

Unit -V: Differentiation of Integrals:

Differentiation of Integrals introduction- Mean value theorem and its examples-Integration of Differential forms: Integrations- examples -Primitive mappings-Partitions of unity-Change of variables-Differential forms- Stoke's theorem- examples- elementary properties- product of basic k- forms- differentiation-change of variables

Text Book:

1. **Walter Rudin,** "Principles of Mathematical Analysis", 3rd Edition, McGraw – Hill International Book Company, Singapore, 1982.

   Unit I: Chapter 7: 7.1 to 7.25

   Unit II: Chapter 7: 7.26 to 7.33 and Chapter 8: 8.1 to 8.7

   Unit III: Chapter 8: 8.8 to 8.22 and Chapter 9: 9.1 to 9.09

   Unit IV: Chapter 9: 9.10 to 9.41

   Unit V: Chapter 9: 9.42 to 9.43 and Chapter 10: 10.1 to 10.25

References Books:

1. **S. Kumaresan**, "Topology of Metric Spaces ", 2nd Edition, Narosa Publishing House, 2011.
2. **S. Ponnusamy**, "Foundations of Mathematical Analysis", Springer Birkhauser, 2012.
3. S. K. Mappa, Introduction to Real Analysis, 7th Edition, Sarat Book Distributors, Kolkatta, 2015
4. **Tom Apostol,** "Mathematical Analysis", Addison Wesley Publishing Company, London-1971.
5. **R. G. Bartle & D.R. Sherbert,** "Introduction to Real Analysis", John Wiley & Sons, New York, 1982.
6. **Kenneth A. Ross,** "Elementary Analysis: The theory of Calculus", Springer, New York, 2004.
7. **K. R. Stromberg,** "An Introduction to Classical Real Analysis", Wadsworth, 1981.

Course Outcomes:

Upon the successful completion of the course, students will be able to

CO1: Investigate the ideas of continuity and inverse images of open and closed sets, functions continuous on compact sets – K2

CO2: Differentiate the concepts of connectedness and implement them on various sets – K3

CO3: Examine the derivatives of functions and apply few theorems based on it – K4

CO4: Investigate properties of monotonic functions – K5

CO5: Learn the properties of Riemann- Stieltjes integral – K6

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	M	S	M	S	S	S	S	S
CO4	S	M	S	S	S	S	M	M	S	S
CO5	S	S	M	S	S	S	M	S	S	M

S- Strong = 3, M-Medium = 2, L-Low = 1

COURSE CODE	P21MTT23	PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
CORE- VIII			4	-	-	4

Objectives:

- Differential equations arise for many problems in oscillations of mechanical and electrical systems
- It plays a very important role in all modern scientific and engineering studies.
- To give an in-depth knowledge of differential equations and their applications.
- Solve the higher order differential equations in different types with initial and boundary conditions
- Use the method of separation of variables to reduce some partial differential equations to ordinary differential equations of 2^{nd} order.
- To make the students to solve the practical problems used differential equations.

Unit - I: Partial Differential Equations:

Partial Differential Equations of the First Order: Origins of First order Partial Differential Equations – Linear Equations of First order – Compatible Systems of First order Equations – Char pit's Method - Special types of First order Equations – Solutions satisfying given conditions – Jacobi's Method.

UNIT-II: Second Order Partial Differential Equations:

Partial Differential Equations of the Second order **:** The origin of second order equations – Linear Partial Differential Equations with constant coefficients – Equations with Variable Coefficients – Characteristics Curves of Second order Equations – Separation of variables.

Unit -III: Wave Equation:

Introduction about Wave Equation - Elementary Solutions of the One – dimensional Wave Equation – General Solutions of the Wave Equation - Green's Function for the wave Equation – The Non homogeneous Wave Equation – Riesz's Integrals .problems in this method .

Unit- IV: Laplace and Diffusion Equation:

Laplace and Diffusion Equation introduction - Separation of variables – Elementary Solutions of the Diffusion Equation – Problems in this relevant Exercise. Separation of variables – Use of Green's Functions. Problems in the applications of Green's Functions

Unit -V: Boundary Value Problems:

Introduction of Boundary Value Problems - Eigen values- problems to find Eigen values - Eigen functions Problems using Eigen functions and the vibrating String - The Heat Equation – Sturm Liouville problems. Application in the real time problems.

Text Book:

1. **Ian.N.Sneddon,** "Elements of Partial Differential Equations", Dover Publications, INC, Mineola, Newyork.(2006)
2. **George F.Simmons,** "Differential Equations with Applications and Historical Notes", McGrawhill, Inc, Newyork.(1991)

Unit I: Chapter 2: Section 2.4,9,10,11,12,13 (TB: 1)
Unit II: Chapter 3: Section 3.1,4,5,6,9 (TB: 1)
Unit III: Chapter 5: Section 5.2,6,7,8,9 (TB: 1)
Unit IV: Chapter 4: Section 4.5 and Chapter 6: Section 6.3,4,5,6 (TB: 1)
Unit V: Chapter 7: Section 7.40, 41, 43 (TB: 2)

References Books:

1. **Williams E. Boyce and Richard C. Diprima** "Elementary Differential Equations and Boundary Value Problems " 10th edition John Wiley and Sons, New York 2012
2. **M.D. Raisinghania**, " Advanced Differential Equations ", S. Chand & Company Ltd., New Delhi 2012

Course Outcomes:

Upon the successful completion of the course, students will be able to**;**

CO1: recognize differential equations that can be solved by each of the three methods – direct integration, separation of variables and integrating factor method – and use the appropriate method to solve them – K2

CO2: use an initial condition to find a particular solution of a differential equation, given a general solution – K3

CO3: check a solution of a differential equation in explicit or implicit form, by substituting it into the differential equation – K4

CO4: understand the terms 'exponential growth/decay', proportionate growth rate' and 'doubling/halving time' when applied to population models, and the terms 'exponential decay', 'decay constant' and 'half- life' when applied to radioactivity – K5

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	M	S	S	S
CO2	S	M	S	S	S	M	M	M	M	S
CO3	S	S	M	S	S	S	S	S	S	S
CO4	S	S	S	M	S	S	S	S	S	S

S- Strong = 3, M-Medium = 2, L-Low = 1

COURSE CODE	P21MTT24	TOPOLOGY	L	T	P	C
CORE- IX			5	-	-	4

Objectives:

- Students will learn the fundamental concepts of point-set topology.
- Introduce students to the concepts of open and closed sets abstractly, not necessarily only on the real line approach
- Provide the awareness of tools to students to carrying out advanced research work in pure mathematics Course**.**

Unit- I: Topological Spaces and Continuous Functions:

Topological Spaces and Continuous Functions introduction-Topological spaces- Basis for a Topology- The order Topology- The Product Topology on X×Y- The subspace Topology – Closed sets and Limit points- theorems and examples-relation between interior of A and closure of A -Hausdorff spaces and theorems-Continuous Functions- homeomorphism with examples-The pasting lemma-The product Topology-definition of box and product topology-comparison of the box and product topology

Unit - II: Metric Topology and Connectedness:

Metric Topology definition- The Metric Topology- diameter-standard bounded metric-norm Uniform metric topology- Metrizable-The sequence lemma- Uniform limit theorem-Weierstrass M-test based on problems-Connectedness: Connected Spaces –proof of the theorems- Connected Subspaces of the Real line- Components and Local Connectedness.

Unit- III: Compactness:

Compactness introduction- Compact Spaces- open cover-theorems and examples –The Tube Lemma-finite intersection property with theorem-Compact subspaces of the Real Line-Extreme value theorem-the lebesgue number lemma-Uniform continuity theorem-Limit Point Compactness- sequentially compact-Local Compactness-one point compactification with proof of the theorems.

Unit - IV: Countability and Separation Axioms:

Countability and Separation Axioms introduction - The Separation Axioms- first and second countability axioms and theorems - Lindelof space - Sorgenfrey plane example-Normal Spaces and theorems- The Urysohn Lemma- The Urysohn Metrization Theorem - immbedding theorem

Unit -V: Extension Theorem:

Introduction about Extension Theorem- The Tietze Extension Theorem- The Tychonoff Theorems - The Stone-Cech Compactification- Metrization Theorems: Local finiteness-refinement-The Nagata-Smirov Metrization Theorem- Its relevant Exercise problems.

Text Book:

1. **James. R. Munkres,** "Topology: A first course", 2nd Edition, Prentice Hall of India Pvt Ltd, New Delhi. 2013

Unit I: Chapter 2- Section: 12- Section 19

Unit II: Chapter 2- Section: 20, 21 and Chapter 3-Section: 23- Section: 25

Unit III: Chapter 3- Section: 26- Section 29

Unit IV: Chapter 4- Section: 30- Section 34

Unit V: Chapter 5- Section: 37, 38- Chapter 6: Section 39, 40, 9.1 to9.3

Reference Books:

1. **G.F. Simmons** "Introduction to Topology and modern Analysis", Tata McGraw Hill edition.
   B. Mendelson, "Introduction to Topology", CBS Publishers, Delhi, 1985.
2. **Size- Tsen Hu,** "Introduction to General Topology", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1966.
3. **S. Lipschutz**, "General Topology", Schaum's Series, McGraw-Hill New Delhi, 1965.
4. **K. D. Joshi,** "Introduction to General Topology", New Age International Pvt. Ltd, 1983.
5. **J. L. Kelly**, "General Topology", Springer-Verlag, New York, 1975

Course Outcomes:

Upon the successful completion of the course, students will be able to

CO1: know how the topology on a space is determined by the collection of open sets, by the collection of closed sets, or by a basis of neighbourhoods at each point.–K2.

CO2: know the definition and basic properties of connected spaces, path connected spaces, compact paces, and locally compact spaces – K3

CO3: know what it means for a metric space to be complete, and you can characterize compact metric spaces – K4

CO4: familiar with the Urysohn lemma and the Tietze extension theorem, and you can characterize metrizable spaces – K5

CO5**:** familiar with the construction of the fundamental group of a topological space and applications to covering spaces and homology theory – K5.

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	S	S	S	S	S	S
CO2	S	S	S	S	S	M	S	S	M	S
CO3	S	S	M	S	M	S	S	S	S	S
CO4	S	M	S	S	S	S	S	M	S	S
CO5	S	S	M	S	S	S	S	S	S	S

S- Strong = 3, M-Medium = 2, L-Low = 1

COURSE CODE	P21MTT25	OPTIMIZATION TECHNIQUES	L	T	P	C
CORE- X			5	-	-	4

Objectives:

- Ability to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively;
- Provides a quantitative technique or a scientific approach for making better decisions for operations under the control.
- Use integer programming problem to solve system of linear equations.
- To provide the depth knowledge about inventory control theory and make students to solve the inventory problems.

Unit-I: Integer Programming:

Integer Programming introduction – Gomory's all Integer Programming Problem method - Construction of Gomory's Constraints - Fractional Cut Method - All integer- Fractional Cut Method - Mixed integer-Branch and Bound Method-Applications of Integer programming.

Unit-II: Dynamic Programming:

Dynamic Programming introduction – The Recursive equation approach-Characteristics of Dynamic Programming - Dynamic Programming Algorithm- Solutions of Discrete D.P.P-Some Applications- Solutions of L.P.P by Dynamic Programming.

Unit- III: Queueing Theory:

Queueing Theory introduction – Queueing System –Elements of Queueing System-Operating Characteristics of Queueing System – Probability distribution in Queueing System Classification of Queueing models –Definition of Transient and Steady States-Poisson Queueing System

Unit-IV: Non Linear Programming:

Non Linear Programming introduction - Formulation of Non - Linear Programming Problem(NLPP)- General Non Linear Programming problem- Constraints optimization with equality Constraints- Constraints optimization with inequality Constraints-Saddle point problems-Saddle points and NLPP.

Unit - V: Non Linear Programming Methods:

Non Linear Programming Methods introduction – Graphical Solution- Kuhn-Tucker Conditions with Non-Negative Constraints – Quadratic Programming –Wolfe's Modified Simples Methods-Beal's Method- Separable Convex Programming –Separable Programming Algorithm.

Text Book:

1. **Kanti Swarup, P.K. Gupta, Man Mohan,** "Operations Research", Sultan Chand & Sons, Educational Publishers, New Delhi.2013
   Unit – I: Chapter 7 Section 7.1-7.7
   Unit – II: Chapter 13- Sections 13.1-13.7
   Unit – III: Chapter 20- Sections 20.1-20.8
   Unit – IV: Chapter 24- Sections 24.1-24.7
   Unit – V: Chapter 25- Sections 25.1-25.8

Reference Books:

1. **Panneerselvam.R**, "Operations Research", 2nd Edition, PHI Learning Private Limited, Delhi, 2015
2. **Prem Kumar Gupta.Er, Hira.D.S**. "Operations Research", 7th Edition,S.Chand & Company Pvt.Ltd.2014
3. **Hiller.F.S & Lieberman.J** "Introduction to Operation Research ", 7th Edition, Tata–MCGraw Hill Publishing Company, NewDelhi, 2001.
4. **G. Srinivasan,** "Operations Research principles and applications", Second Edition, PHI Learning Private Limited, New Delhi-110001, 2012.

Course Outcomes:

Upon the successful completion of the course, students will be able to
CO1: analyze the real-life systems with limited constraints – K2.
CO2: identify the mathematical nature of a given optimization problem – K3
CO3: analyze a range of classes of optimization problems – K4
CO4: identify solution methods for the optimization problems studied – K5
CO5: depict the systems in a mathematical model form – K6

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	M	S
CO2	S	S	S	M	S	S	S	S	M	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	M	S	S	S	S	M	S	S
CO5	S	S	S	S	M	S	S	S	S	S

S- Strong=3, M-Medium=2, L-Low = 1

SEMESTER -III

COURSE CODE	P21MTT31	COMPLEX ANALYSIS	L	T	P	C
CORE- XI			5	-	-	4

Objectives:

- To impart various concepts about the sequence and series, analytic functions in the complex plane.
- Provide deep knowledge about mapping and transformation and the learner will gain knowledge of power series of analytic function
- Learner will be proficient in applications of Cauchy's theorem
- To present students the elements and importance of the Complex analysis.
- To define and recognize the basic properties of the complex numbers.

Unit -I: Functions, Limit, and Continuity:

Functions, Limit, and Continuity introduction- Sequence and series –Concepts of limits and continuity- continuous and discontinuous function- Examples- Stereographic projection – Rieamann's Sphere- limit at infinity-– sequence and series of function- uniform convergence of sequence and series of functions with examples- Weiestrass's M- test Theorem.

Unit -II: Analytic Functions and Power Series:

Analytic Functions and Power Series introduction- Differentiability and Cauchy-Riemann equations – complex differentiable- analytic or holomorphic -Harmonic functions – Finding harmonic conjugates - power series as an Analytic functions –root test and ratio test – Exponential and Trigonometric functions – Periodic function

Unit -III: Complex Integration:

Complex Integration introduction -Plane – properties of complex line integrals – Weak form of Cauchy's Theorem – Cauchy - Goursat Theorem – Cauchy's Theorem for a Disk- Cauchy's integral Theorem and Examples – Consequence of simply connectivity – simply connected – Winding number –Homotopy version of Cauchy's theorem

Unit -IV: Mapping and Transformation:

Mapping And Transformation introduction -Cauchy integral formula and theorems - Gauss Mean value Theorem –Cauchy's inequality and examples - Morera's theorem. Existence of Harmonic Conjugate –Taylor's Theorem and Examples –Zeros of Analytic functions - Identity theorem- Laurent serious –Laurent Theorem –Principle of conformal mapping.

Unit -V: Maximum Principle:

Maximum Principle and Schwarz' Lemma – Liouville's Theorem: Maximum Modulus principle – Hadamard's Three circles/lines theorem – Schwarz' Lemma and its consequence- Liouville's Theorem- Meromorphic Functions - Infinite sums and Meromorphic functions-Infinite products of Complex numbers.

Text Book:

1. **S.Ponnusamy, "**Foundations of Complex Analysis", 2rd Edition, Narosa Publishing House Ltd, Chennai, 2005.
   Unit I - Chapter 1: 1.6 and Chapter 2: 2.2 – 2.4
   Unit II – Chapter 3: 3.1 – 3.4
   Unit III - Chapter 4: 4.1 – 4.6
   Unit IV- Chapter 4: 4.7 –4.12 and Chapter 5: 5.1
   Unit V – Chapter 6: 6.1 – 6.4 and Chapter 11: 11.1-11.2

Reference Books:

1. **John B. Conway —**"Function of one Complex Variable" 2nd Edition, Springers International Students Edition. 2012
2. **Karunakaran,** "Complex Analysis", Narosa Publishing House, New Delhi, 2002.
3. **R.V. Churchill & J. W. Brown,** "Complex Variables & Applications", Mc.Graw Hill,1990.
4. **John. B. Conway,** "Functions of One Complex Variable", Narosa Pub. House, 2002.
5. **Lars V. Ahlfors,** "Complex Analysis", Third Ed. McGraw-Hill Book Company, Tokyo, 1979.

Course Outcomes:

Upon the successful completion of the course, students will be able to

CO1: explain and apply Cauchy's integral formula and some of its consequences – K2

CO2: explain the convergence of power series and develop analytical capabilities in Taylor or Laurent series in a given domain – K3

CO3: define the fundamental concepts of complex numbers and its properties, Exponential, logarithmic, trigonometric and hyperbolic complex functions – K4.

CO4: describe Holomorphic and harmonic complex functions and list different examples – K5

CO5: state Complex integral on a path – Cauchy theorem and Cauchy integral formula name zeros and singularities of a Complex function and the residue theorem – K6

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	M	S	S	M	S	S
CO4	S	M	S	S	S	S	M	S	S	S
CO5	S	S	M	S	S	M	S	S	S	S

S- Strong = 3, M-Medium=2, L-Low = 1

COURSE CODE	P21MTT32	MEASURE THEORY	L	T	P	C
CORE- XII			5	-	-	4

Objectives:

- Understand the concepts of outer measures and integrals
- Provide the relationship between Riemann and Lebesgue integral
- Learner will be derive integration and derivates by using Radon-Nikodym Theorem and Fubini's Theorem
  - Gain understanding of the abstract measure theory and definition and main properties of the integral.
- To construct Lebesgue's measure on the real line and in n-dimensional Euclidean space.
- To explain the basic advanced directions of the theory.

Unit- I: Lebesgue Measure:

Lebesgue Measureintroduction- Lebesgue Outer Measure – Measurable Sets Regularity Measurable Functions – every interval is measurable- Borel set- outer measure of interval equals it's length- regular measure- Borel and Lebesgue Measurability

Unit-II: Borel and Lebesgue Measure:

Borel And Lebesgue Measure introduction– Hausdorff measures on the Real Line – Hausdorff Dimension - Integration of non-negative Functions -Fatou's Lemma-Lebesgue's Monotone Convergence Theorem – General Integral – Lebesgue's Dominated Convergence Theorem - Integration of series – Riemann and Lebesgue Integral

Unit-III: R-S Integral:

R-S Integral introduction- Abstract Measures space – Measures and Outer Measures- Extension of a Measure – Uniqueness of Extension - Completion of a Measure – Measure Spaces – Integration with respect to a Measure – L^p Spaces – Convex Functions –Jensen's Inequality – Completeness.

Unit-IV: Signed Measure:

Signed Measure introduction - Signed Measure and the Hahn Decomposition - Definition of Positive Set, Negative Set, Null Set– the Jordan Decomposition –Definition of Mutually singular– Radon-Nikodym Theorem – Some Application of The Radon-Nikodym Theorem – Randon-Nikodym derivation –Lebesgue Decomposition Theorem

Unit- V: Measurability in a Product Space:

Measurability in a Product Space introduction – Definition of Measurable Rectangle and Elementary Sets- Fubini's Theorem– The Product Measure and Fubini's Theorem -Definition of Monotone Class- Fubini's Theorem – Theorem on Fubini's Theorem

Text Book:

1. **G.De Barra,** "Measure Theory and Integration", 1st edt, New age international (p) Limited, 2003
   Unit – I: Chapter II: Sections 2.1 to 2.5
   Unit – II: Chapter III: Sections 3.1 to 3.4
   Unit – III: Chapter V: Sections 5.1 to 5.6
   Unit – IV: Chapter VII: Sections 7.1 and 7.2, Chapter VIII: Sections 8.1 and 8.2
   Unit – V: Chapter X: Sections 10.1 and 10.2

Reference Books:

1. **P.R. Halmos,** "Measure Theory", D.VanNostrand Company, Inc. Princeton, N.J., 1950
2. **H.L.Royden** "Real Analysis", Prentice Hall of India 2001 edition.
3. **I.K. Rana,** "An Introduction to Measure and Integration", Narosa Publishing House, NewDelhi, 1999
4. **D.L. Cohn,** "Measure Theory", Birkhauser, Switzerland, 1980

Course Outcomes:

CO	CO Statement	Knowledge Level
CO1	Understanding the basic concepts of the definition of general Lebesque integral.	K2
CO2	Derives the concepts of Borel sets, measurable functions, differentiation of monotone functions	K3
CO3	Demonstrate statement of main results in fundamental integral theorems, monotone convergence theorem, and its related proves and results.	K4
CO4	Demonstrate the proof in integration in product spaces and signed measures.	K5
CO5	Apply the theory of this course to solve real problems in difficult situations.	K6

K1- Remember: K2- Understand: K3-Apply, K4 - Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	M	S	S	S	S
CO5	S	S	S	S	S	S	M	S	S	M

S- Strong = 3, M-Medium = 2, L-Low = 1

COURSE CODE	P21MTT33	DIFFERENTIAL GEOMETRY	L	T	P	C
CORE- XIII			4	-	-	4

Objectives:

- To introduce space curves, surfaces and its properties.
- The learner will acquire knowledge in problem solving in curves and surfaces in geometrical approach.
- To make the students to solve the problems in planes, surface in curves, geodesic equations and geodesic curvatures.

Unit - I: Representation and Theory of Space Curves:

Representation and theory of Space Curves introduction-Representation of space curves-Unique parametric representation of a space curve- Arc length - tangent and osculating plane - principal normal and binormal - curvature and torsion - contact between curves and surfaces - osculating circle and osculating sphere - locus of centres of spherical curvature.

Unit- II: Evolutes of a Plane and Space Curve:

Evolutes of a Plane and Space Curveintroduction- Tangent surfaces - Involutes and evolutes Betrand curves - Spherical indicatrix - Intrinsic equations of space curves – Fundamental existence theorem for space curves - Helices.

Unit-III: The First Fundamental Form and Local Intrinsic Properties of a Surface:

The First Fundamental Form and Local Intrinsic Properties of a Surface introduction-Definition of a surface - Nature of points on a surface - Representation of a surface - Curves on surfaces - Tangent plane and surface normal - The general surfaces of revolution – Helicoids - Metric on a surface - The first fundamental form - Direction coefficients on a surface.

Unit- IV: Families of curves:

Families of curves introduction-- Orthogonal trajectories - Double family of curves – Isometric correspondence - Intrinsic properties - Geodesics on a surface: Geodesics and their differential equations - Canonical geodesic equations - Geodesics on surface of revolution - Normal property of geodesics - Differential equations of geodesics using normal property.

Unit-V: Existence Theorems:

Existence theorems proof- Geodesic parallels - Geodesic polar coordinates – Geodesic curvature - Gauss-bonnet theorem-Meusnieu's theorem-Gaussian curvature Euler's theorem-Duplin's indicarix-Surface of revolution conjugate system-Asymptric lines-isometric lines.

Text Book:

1. **D. Somasundaram,** "Differential Geometry: A first course", Narosa Publishing House, New - Delhi, India, 2005.

Unit I: Sections 1.2-1.7, 1.10-1.12
Unit II: Sections 1.13-1.18
Unit III: Sections 2.2-2.10
Unit IV: Sections 2.11-2.15, 3.2-3.6
Unit V: Sections 3.7-3.12

Reference Books:

1. **T.J. Willmore**, "An Introduction to Differential Geometry", Oxford University Press,New Delhi, 2006.
2. **J. N. Sharma & A. R. Vasistha**, "Differential Geormetry", KedarNath Ram Nath, Meerut, 1998.
3. **Dirk J. Struik:** "Lectures on Classical Differential Geometry" (second edition), Addison Wesley Publishing Company.

Course Outcomes:

CO	CO Statement	Knowledge Level
CO1	Understand planes, spaces curves, arc, nature of points, geodesic concepts	K2
CO2	Prove theorems planes, surfaces, Identification of important types of curves in surfaces, including principal curves, asymptotic curves and geodesics using fundamental existence theorem for space curves	K3
CO3	Enumerate some standard examples in geometry, such as surfaces of constant Gaussian curvature, compact and non - compact surfaces, and surfaces of revolution	K4
CO4	Evaluate Gaussian and mean curvatures using variety of methods including patch computations .Differential equations of geodesics using normal property	K5
CO5	Apply/Create real time situation.	K6

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	M
CO2	S	S	S	M	S	S	S	S	M	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	M	S	S	S	S	M	S	S
CO5	M	M	S	L	S	S	M	S	S	S

S- Strong = 3, M-Medium = 2, L-Low = 1

COURSE CODE	P21MTT34	CLASSICAL DYNAMICS	L	T	P	C
CORE- XIV			4	-	-	4

Objectives:

- ❖ To develop familiarity with the physical concepts and facility with the mathematical methods of classical dynamics
- ❖ To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical dynamics

Unit-I: Introductory Concepts:

Introductory Concepts introduction- The mechanical system-Equations of motion-Units - Generalised Coordinates -Degrees of freedom -Generalized Coordinates-Configuration space-Examples- constraints -holonomic constraints - non-holonomic constraints -Unilateral constraints-virtual work-virtual displacement-Principle of virtual work- D'Alembert's principle- Generalized forces-Examples - Energy and momentum-Potential energy-Work and kinetic energy-Conservation of energy-Equilibrium and stability-Kinetic energy of a system-Angular momentum-Generalized momentum-Examples.

Unit-II: Lagrange's Equation:

Lagrange's Equation introduction- Derivation and examples -Kinetic energy-Lagrange's equation-From of the equations of motion-Nonholonomic systems- Integrals of the Motion-Ignorable coordinates-the Kepler problem -Routhian function-Conservative system -Natural systems-Liouville's system-Examples.

Unit-III: Hamilton's Equations:

Hamilton's Equations introduction-Hamilton's principle-Stationary values of a function - Constrained stationary values-Stationary value of a definite integral-The brachistochrone problem-Examples-Geodesic path - Hamilton's equations -Derivation of Hamilton's equation-The form of the Hamiltonian function-Legendre transformation-Examples- Other variational principles -Modified Hamilton's principle-Principle of least action- phase space-Trajectories - Extended phase space -Liouville'theorem.

Unit-IV: Hamilton - Jacobi Theory:

Hamilton - Jacobi Theory introduction- Hamilton's Principal Function-The canonical integral - Pfaffian forms – The Hamilton - Jacobi equation-Jacobi's theorem-Conservative systems and ignorable coordinates-Examples– Separability- Liouville's system-Stackle's theorem - Examples.

Unit-V: Canonical Transformations:

Canonical Transformations introduction -Differential forms and Generating functions-Canonical transformations-Principal forms of generating function-Further comments on the Hamilton-Jacobi method -Examples – Special Transformations -Some simple transformation -Homogeneous canonical transformation-Point transformations-Momentum transformations -Examples– Lagrange and Poisson Brackets-Lagrange brackets-Poisson brackets-The bilinear covariant -Examples.

Text Book:

1. **Donald T. Greenwood**, "Classical Dynamics", PHI Pvt. Ltd., New Delhi, 1985.
   Unit I - Chapter: 1.1-1.5
   Unit II - Chapter: 2.1-2.4
   Unit III - Chapter: 3.1, 3.2 and 3.4 (3.3 Omitted)
   Unit IV - Chapter: 4.1-4.4
   Unit V - Chapter: 5.1-5.3

Reference Books:

1. **H. Goldstein,** "Classical Mechanics", (2^{nd} Edition), Narosa Publishing House, New Delhi, 1998.
2. **John L Synge and Byron A Griffith**, "Priniciples of Mechanics", McGraw-Hill, New York, 1959.
3. **Narayan Chandra Rana &Promod Sharad Chandra Joag,** "Classical Mechanics", Tata McGraw Hill, 1991.

Course Outcomes:

Upon the successful completion of the course, students will be able to

CO1: solve the Lagrange's equations for simple configurations using various Methods – K2

CO2: understand the concept of Hamilton Jacobi Theory – K3

CO3: understand the concept canonical Transformations – K4

CO4: develop skills in formulating and solving physics problems – K5

CO5: get idea of dynamical systems are of relatively recent origin, the concept of motion in phase- space and its geometrical depiction is simple – K6

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	S	S	M	S	S	S	S	S
CO2	S	S	S	M	S	S	S	S	M	S
CO3	S	S	M	S	S	S	M	M	S	S
CO4	S	M	S	S	S	S	S	S	S	S
CO5	S	S	S	S	M	M	S	M	S	S

S- Strong =3, M-Medium = 2, L-Low = 1

COURSE CODE	P21MTT35	CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS	L	T	P	C
CORE- XV			5	-	-	4

Objectives:

- To introduce the concept of maxima, and minima functions al for family of curves of unknown functions.
- To give a knowledge about separable equations, fundamental lemmas of calculations variation, Fredholm integrals, Volterra integral equation and make students to solve the problems.
- To study linear/non integral problems and methods of successive approximations.
- To solve problems in the field of extremals, Jacobi conditions, Legendre condition, transforming equations, conditional/unconditional integral equations.

Unit-I: The Method of Variations in Problems with Fixed Boundaries:
The method of variations in problems with fixed boundaries introduction -Variation and its properties - Euler's equation - Functional of the form $\int F(x,y_1,y_2,\ldots y_n, y_1',y_2',\ldots y_n')\,dx$. Functional dependent on higher order derivatives - Functionals dependent on the functions of several independent variables - Variational problems in parametric form - Some applications.

Unit-II: Conditions for an Extremum:
Sufficient conditions for an Extremum: Field of extremals - The function E(x,y,p,y') - Transforming the Euler equations to the canonical form- Extremals with Corners .- One-Sided Variations - Problems - An elementary Problem with Moving Boundaries.

Unit-III: Direct Methods in Variational Problems:
Direct Methods in Variational Problems introduction-Direct methods - Euler's finite difference method - The Ritz method - Kantorovich's method.

Unit -IV: Integral Equations:
Linear Integral Equations: Definition, Regularity conditions – special kind of kernels – Eigen values and Eigen functions – convolution Integral – the inner and scalar product of two functions – Notation – reduction to a system of Algebraic equations – examples – Fredholm alternative - examples – an approximate method

Unit -V: Successive Approximations:
Method of Successive Approximations: Iterative scheme – examples – Volterra Integral equation – examples – some results about the resolvent kernel. Classica l Fredholm Theory: the method of solution of Fredholm – Fredholm's first theorem – Fredholm's second theorem – Fredholm's third theorem.

Text Books:

1. L.**Elsgolts,** "Differential equations and the calculus of variations", MIR publishers, Moscow 1970.

   Unit – I Chapter 6
   Unit – II Chapter 8
   Unit – III Chapter 10

2. **Ram.P.Kanwal**, "Linear Integral Equations Theory and Practice", Academic Press 1971.

   [1] Unit – IV Chapters 1 and 2
   Unit – V Chapters 3 and 4

Reference Books:

1. **S.J. Mikhlin,"** Linear Integral Equations" (translated from Russian), Hindustan Book Agency, 1960.
2. **I.N. Snedden,** "Mixed Boundary Value Problems in Potential Theory", North Holland, 1966.

Course Outcomes:

CO	CO Statement	Knowledge Level
CO1	Demonstrate to understand competence with the basic ideas of The Method of Variations in Problems with fixed Boundaries, and unknown functions are in integral equations	K2
CO2	Develop and solve problems in integral equations , special kind of equation for several independent variables	K3, K4
CO3	Analyse Parametric forms with moving boundaries and other problems and kernel for integral equations	K4
CO4	Apply Euler's finite difference method ,The Ritz method and Kantorovich's method in Vibrational Problems, and in the field of extremely	K6
CO5	Evaluate the extremals of functionals , solving applied problems , Solve differential and integral equations Compose clear and accurate proofs using the concepts of reduction to a system of Algebraic equations	K4,K5, K6

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	M	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	M

S- Strong =3, M-Medium = 2, L-Low = 1

COURSE CODE	P21MTT36	FUNCTIONAL ANALYSIS	L	T	P	C
CORE- XVI			5	-	-	4

Objectives:

- To introduce three structure theorems of Function as Hahn – Banach theorem, open mapping theorem and uniform boundedness principle from Hilbert space.
- To study the finite dimensional spectrum theory.

Unit-I: Banach Spaces

Banach Spaces introduction - The definitions and some examples-Continuous linear transformations-The Hahn-Banach Theorem- The Natural imbedding of N in N^{**}- The Open mapping theorem and closed graph theorem-The conjugate of an operator-properties of conjugate of an operator.

Unit-II: Hilbert Spaces:

Hilbert Spaces introduction- The definitions and some simple properties-orthonormal bases-orthogonal Complements-orthonormal sets-The Conjugate Space H^* - The Adjoint of an operator-Self-adjoint operators-Normal and Unitary operators.

Unit-III: Spectral Theory:

Finite-Dimensional Spectral Theory: Matrices -Basic operations of matrices-determinants and the spectrum of an operator -The spectral theorem for operators on a finite dimensional Hilbert space- - A survey of the situation

Unit -IV: Banach Algebras:

General preliminaries on Banach Algebras: The definition and some examples-Regular and singular elements in Banach algebra-Topological divisors of zero-The Spectrum of an element in a Banach algebra-The formula for the spectrum radius-The radical and semi-simplicity.

Unit-V: The Structure of Commutative Banach Algebras:

The Structure of Commutative Banach Algebras introduction- The Gelfand mapping – Applications of the formula r(x) = lim || xn ||1/n - Involutions in Banach Algebras – The Gelfand-Neumark theorem.

Text Book:

1. **G.F.Simmons** "Introduction to Topology and Modern Analysis" ,Tata McGraw Hill Edn, 2004.

   Unit I: Chapter 9
   Unit II: Chapter 10
   Unit III: Chapter 11
   Unit IV: Chapter 12
   Unit V: Chapter 13

Reference Books:

1. B. V. Limaye, Functional Analysis, Revised Third Edition, New Age International, 2017.
2. M. Thamban Nair, Functional Analysis - A First Course, Prentice Hall of India, 2010.
3. S. Ponnusamy, Foundations of Functional Analysis, Narosa Publishing House, 2002.
4. S. Kesavan, Functional Analysis, TRIM series, Hindustan Book Agency, New Delhi, 2009.
5. Rajendra Bhatia, Lectures on Functional Analysis, TRIM series, Hindustan Book Agency, New Delhi, 2009.

Course Outcomes:

Upon the successful completion of the course, students will be able to

CO	CO Statement	Knowledge Level
CO1	Describe properties of normed linear spaces and construct examples of such spaces	K2
CO2	Apply basic theoretical techniques to analyze linear functionals and operators on Banach and Hilbert spaces.	K3
CO3	Apply Finite-Dimensional Spectral Theory survey of the situation	K4
CO4	Apply theorems to do problems	K5

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	M	S
CO2	S	S	S	M	S	S	S	S	M	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	M	S	S	S	M	S	S	S

S- Strong=3, M-Medium=2, L-Low = 1

SEMESTER –IV

COURSE CODE	P21MTE411	CHOICE -I	L	T	P	C
ELECTIVE -I		NUMBER THEORY	4	-	-	4

Objectives:

- To expose the students to the charm, niceties and nuances in the world of numbers.
- To highlight some of the Applications of the Theory of Numbers.
- The Learner will gain deep knowledge to solve the problems on algebraic number theory.
- The Learner will be know the various type of equations

Unit- I: Arithmetical Functions and Dirichlet Multiplication:

Arithmetical Functions and Dirichlet Multiplication introduction- The Möbius function - Euler totient function - a relation connecting ϕ and μ - a product formula for $\phi(n)$ - the Dirichlet product of arithmetic functions - Dirichlet inverses and the Mobius inversion formula - the Mangoldt function - Multiplicative function - multiplicative functions and Dirichlet Multiplication - The inverse of a completely multiplicative function - Liouville's function - The divisor functions – Generalised convolutions - Formal Power series - The Bell series of an arithmetical function - Bell Series and Dirichlet multiplication - derivatives of arithmetical functions - The Selberg identity.

Unit -II: Averages of Arithmetical Functions:

Averages of Arithmetical Functions introduction- The big oh notation - asymptotic equality of functions - Euler's summation formula-Some elementary asymptotic formulas - average order of d(n) - average order of the divisor functions $\sigma_\alpha(n)$ - average order of $\phi(n)$ - an application to the distribution of lattice points visible from the origin - average order of $\mu(n)$ and of $\Delta(n)$ - the partial sums of a Dirichlet product - applications to $\mu(n)$ and $\Lambda(n)$ - another identity for the partial sums of a Dirichlet product

Unit- III: Congruences:

Introduction about Congruences- Definition and basic properties of Congruences - Residue classes and complete residue system - Linear congruences - reduced residue systems and the Euler - Fermat theorem - polynomial congruences modulo p - Langrange's theorem - applications of Lagrange's theorem - Simultaneous Linear Congruences: The Chinese remainder theorem - applications of the Chinese remainder theorem - Polynomial congruences with prime power moduli - the principle of cross classification - a decomposition property of reduced residue systems.

Unit- IV: Quadratic Residues and Quadratic Reciprocity Law:

Quadratic Residues and Quadratic Reciprocity Law introduction**:** Quadratic residues - Legendre's symbol and its properties - evaluation of (-1/p) and (2/p) - Gauss' Lemma - the quadratic reciprocity Law - applications of the reciprocity law - the Jacobi symbol - Applications to Diophantine equations.

Unit- V: Partition Function:

Partition Function introduction Partitions – Definition- Example -Graphs - Formal power series- Definition- Example - Euler's identity - Definition- Example -Euler's formula- Definition- Example -Jacobi's formula - Definition- Example- a divisibility property- Definition- Example-Exercise problems.

Text Books:

1. **Tom M. Apostol**, "Introduction to Analytic Number Theory", Springer International Student Edition, 1998.
2. **Niven Herbert S. Zuckerman,** "Introduction to the Theory of Numbers", Wiley Eastern University Edition, 1984

Unit I	:	Chapter 2 Section 2.2 - 2.19 (Book 1)
Unit II	:	Chapter 3 Section 3.2 - 3.12 (Book 1)
Unit III	:	Chapter 5 Section 5.1 - 5.11 (Book 1)
Unit IV	:	Chapter 9 Section 9.1- 9. 8 (Book 1)
Unit V	:	Chapter 10 Section 10.1-10.6 (Book 2)

Reference Books:

1. "Elementary Number Theory", **David M Burton,** Seventh edition. https://www.pdfdrive.com/elementary-number-theory-7th-ed-by-david-m-burton-e58704232.html
2. "Basic Number Theory"**, S. B. Malik**, First edition, 1998. https://www.madrasshoppe.com/basic-number-theory-sb-malik-9780706987492-9834.html

Course Outcomes:

Upon the successful completion of the course, students will be able to

CO	CO Statement	Knowledge Level
CO1	Demonstrate factual knowledge including the mathematical notation and terminology of number theory	K2
CO2	Construct mathematical proofs of statements and find counterexamples to false statements in Number Theory.	K3
CO3	Apply theoretical knowledge to problems of computer security	K4
CO4	Analyze the logic and methods behind the major proofs in number theory.	K5

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	**PO4**	**PO5**	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	M	S	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	M	S	S	S	S	M	S	S

S- Strong =3, M-Medium=2, L-Low = 1

COURSE CODE	P21MTE412	CHOICE -II	L	T	P	C
ELECTIVE -I		AUTOMATA THEORY	4	-	-	4

Objectives:

- To make the students to understand the nuances of Automata and Grammar.
- To explain various types of automata and grammar.
- Introduce the fundamental concepts of formal languages, grammars and automata theory.
- Identify different formal language classes and their relationships
- To make them to understand the applications of these techniques in computer science.

Unit-I: Finite Automata and Regular Expressions:

Finite Automata and Regular Expressions introduction- Definitions and examples - Additional forms of Proof – Inductive Proofs- Deterministic and Non deterministic finite Automata - Finite Automata with – moves- Finite Automata with Epsilon Transitions.

Unit-II: Context Free Grammar:

Context Free Grammar introduction- Regular expressions and their relationship with automation - Proving Languages not to be regular – Closure Properties of Regular Languages – Equivalence and Minimization of Automata- Grammar - Ambiguous and unambiguous grammars - Derivation trees – Chomsky Normal form

Unit-III: Pushdown Automaton:

Pushdown Automaton introduction- Parse Trees – Ambiguity in Grammars and Language- Pushdown Automaton - Definition and examples - Relation with Context free languages- Equivalence of Pushdown Automata and CFG, Deterministic Pushdown Automata.

Unit- IV: Finite Automata and Lexical Analysis:

Finite Automata and Lexical Analysis introduction**:** Role of a lexical analyzer - Minimizing the number of states of a DFA - Implementation of a lexical analyzer.

Unit -V: Basic Parsing Techniques:

Basic Parsing Techniques: Parsers introduction - Bottom up Parsers - Shift reduces - operator precedence - Top down Parsers - Recursive descent - Predictive parsers.

Text Books:

1. **John E. Hopcroft and Jeffrey D. Ullman**, "Introduction to Automata theory, Languages and Computations", Narosa Publishing House, Chennai, 2000.
   Unit I: Chapter 2: Sections2.1-2.4,
   Unit II: Chapter 2, Section 2.5, Chapter 4, Sections 4.1-4.3, 4.5, 4.6 and
   Unit III: Chapter 5: Section 5.2, 5.3
2. **A.V. Aho and Jeffrey D. Ullman,** "Principles of Compiler Design", Narosa Publishing House, Chennai, 2002.
   Unit IV: Chapter 3: Section 3.1-3.8 and
   Unit V: Chapter 5: Section 5.1-5.5

Reference Books:

1. **John . E. Hopcraft, Rajeev Motwani and Jeffrey D. Ullman**, "Introduction to Automata Theory, Languages and Computationc", Pearson Education, 2013
2. **Kenneth H. Rosen**, "Discrete Mathematics and it's Applications", 7th Edition/ McGraw Hill Education, New York, 2012
3. **B.S.Vatssa**, "Discrete Mathematics",WISHWA PRAKASHAN,1993.
4. **V.Sundaresan,K.S.Ganapathy Subramanian, K.Ganesan**, "Discrete Mathematics", A.Rd.Publications, 1998.
5. **T.Veerarajan**, "Discrete Mathematics", McGraw Hill Education (India)Pvt.Ltd,New Delhi, 2014.
6. **Harry R. Lewis and Christos H. Papadimitriou**, "Elements of the Theory of Computation", Second Edition, Prentice Hall, 1997.
7. **A.V. Aho, Monica S. Lam, R. Sethi, J.D. Ullman,** "Compilers: Principles, Techniques and Tools", Second Edition, Addison-Wesley, 2007.

Course Outcomes:

Upon the successful completion of the course, students will be able to

CO1: acquire a fundamental understanding of the core concepts in automata theory and formal languages – K2

CO2: design grammars and automata (recognizers) for different language classes – K3

CO3: identify formal language classes and prove language membership properties – K4

CO4: prove and disprove theorems establishing key properties of formal languages and automata – K5

CO5: solve the sums based on automata and grammar – K5

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	M
CO2	S	S	S	M	S	S	M	S	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	M	S	S	S	S	S	S	S
CO5	S	S	S	S	M	S	M	S	S	S

S- Strong =3, M-Medium = 2, L-Low = 1

COURSE CODE	P21MTE413	CHOICE -III	L	T	P	C
ELECTIVE -I		PROBABILITY THEORY AND STATISTICS	4	-	-	4

Objective:

- To learn the advanced theory of possibility and distributions and Estimations.
- To understand the concepts of probability and its properties.
- The learner identifying situations where one-way ANOVA and Latin square

Unit- I: Theory of Probability:

Theory of Probability introduction- Axiomatic approach to axioms of Probability, Conditional probability –Multiplicative law of Probability-Total probability and Baye's theorem – Independent events. Discrete random variable - continuous random variables – Properties of distribution function-Function of random variable- Two-dimension random variable - Marginal Probability Distributions –Conditional Probability Distributions- independent random variables.

Unit-II: Moment Generating Function:

Mathematical Expectations introduction- Expectation, functions of a random variable, properties of expected values – Moment Generating Function: Moments -Moment Generating Function and properties - Characteristic Functions: Probability Generating Function- Correlation: properties of correlation coefficient – Regression: properties of regression co-efficient –Multiple and Partial Correlation: relation between Multiple and partial Correlation Coefficients.

.

Unit-III: Distributions:

Introduction about Distributions: Geometric Distribution - Memoryless property of geometric distribution -The Normal Distribution - Uniform Distribution – Exponential Distribution – Gamma Distributions - Beta Distributions- Sampling distribution - Chi Square, t, F Distribution – Students t Distribution – F-Distribution

Unit-IV: Estimation:

Estimation introduction- Concepts of Point and Interval Estimator –Efficiency - Consistent Estimator –Sufficient Estimator – Properties of Estimator –invariance property of consistent estimator – method of Maximum Likelihood Estimators-Minimum chi square Estimator.

Unit-V: Classifications and types:

Classifications: One way and two way classification -ANOVA- design of Experiments: Experimental Units –basic principles in the design of Experiments- Completely block designs - Completely Randomized Design -Randomized Block design – Latin square designs- analysis of Latin square designs- merits and demerits of Completely Randomized Design - merits and demerits of Random Block design and Latin square design –Factorial Experiments.

Text Book:

1. **P.R.Vital ,** "Mathematical Statistics", Margham publications, Edition 2012.
   Unit I - Chapter 1: 1.4 – 1.48 and Chapter 2 : 2.1 – 2.33
   Unit II- Chapter 3: 3.1 – 3.18, Chapter 5, Chapter 6, Chapter 8, Chapter 9 and Chapter 11
   Unit III- Chapter 15, Chapter 16, Chapter 17, Chapter 18, Chapter 19,Chapter 20, and Chapter 2
   Unit IV- Chapter 23 Unit V -Chapter 26 and Chapter 28.

Reference Books:

1. **Robert V. Hogg & Allen T. Craig,** "Introduction to Mathematical Statistics", 5th Edition, Pearson Education, Singapore, 2002.
2. **Irwin Miller &Marylees Miller, John E. Freund's** "Mathematical Statistics", 6th Edition, Pearson Education, New Delhi, 2002.
3. **John E. Freund**, "Mathematical Statistics", 5 th edition, Prentice Hall India, 1994.
4. **S.M. Ross,** "Introduction to Probability Models", Academic Press, India, 2000.

Course Outcomes:

CO	CO Statement	Knowledge Level
CO1	Demonstrate the basic concepts of statistics, probability and random variables	K2
CO2	Apply the concepts in finding the moments of the distributions.	K3
CO3	Identify the type of the distribution and estimation	K4
CO4	Understand the basics of sampling distribution theory	K5

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping With Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	S	M	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	M	S	S	M	S	S	S	S

S- Strong =3, M-Medium=2, L-Low = 1

COURSE CODE	P21MTE414	CHOICE -IV	L	T	P	C
ELECTIVE -I		ASTRONOMY	4	-	-	4

Objectives:

To acquire the knowledge about the celestial objects and planets.

- ❖ Develop skills to design observing projects with research telescopes and projects drawing
- ❖ upon data in the literature and in archives.
- ❖ To be familiar with the appearance of a range of common astronomical objects, such as asteroids, comets, satellites, planets, stars, and galaxies.

Unit I: Spherical trigonometry:

Spherical trigonometry (only the four formulae) Celestial sphere – Four systems of coordinates Conversion of Coordinates- Diurnal Motion -Sidereal time – West Hour angle of a body expressed in time units and Azimuth at rising – Latitude of a Place –Morning and Evening Stars- Circumpolar star

Unit II: The Earth

The Earth – Zones of the earth – Perpetual Day and Perpetual Night – Terrestrial latitude and Longitude – Date Line – Shape of Earth – Dip of Horizon - Effects of Dip Twilight-, Duration of Twilight, Twilight throughout night, Shortest Twilight, Civil, nautical and astronomical twilights

Unit III: Refraction:

Refraction – Tangent Formula, Constant of Refraction , Refraction on Horizontal and Vertical Arcs – Refraction of any Arc, Cassini's Formula, Horizontal Refraction, Geocentric parallax –Horizontal Parallax - Effect of Geocentric Parallax on Right Ascension and Declination – Angular Diameter – Geocentric Parallax and Refraction

Unit IV : Kepler's Laws of planetary Motion:

Kepler's Laws – Kepler's Laws of planetary Motion – Longitude of Perigee – Forward motion of the apse line – Eccentricity of Earth orbit – Newton's Law of Gravitation – Newton's deductions from Kepler's Law –Mean Anomaly –Geocentric and Heliocentric latitudes and longitudes

Unit V: Eclipses

Eclipses introduction – Umbra and Penumbra -Lunar Eclipse – Solar eclipse – Condition for a Lunar Eclipse – Synodic period of nodes Ecliptic Limits – Maximum and minimum number of eclipses near a node in a year – Saros of Chaldeans – Eclipses Seasons – duration of Lunar and solar eclipses- Importance of total solar eclipses

Text Book:

1. **S,Kumaravelu. & Susheela Kumaravelu** "Astronomy for Degree classes", Rainbow Printers, Nagercoil, 2000.

Reference Books:

1. **V.B.Bhatia** , "Text book for Astronomy and Astrophysics with elements of Cosmology", 2 nd Edition, Narosa Publishing House, New Delhi, 2001.
2. **Subramanian, K., Subramanian, L, V,.Venkatraman,.& Brothers** "A text book of Astronomy," (1st Edition). Educational Publishers (1965)
3. **Daniel Fleish ., Julia Kregenow "**Mathematics of Astronomy ",(1st Edition). Cambridge University Press, New York -.(2013)
4. **Jean Meeus** "More Mathematical Astronomy morsels ",(1st Edition).Willmann Bell Publishing,(2002).

Course Outcomes (CO):

CO	CO Statement	Knowledge Level
CO1	Defining about the observed properties of physical systems that comprise the known universe	K1
CO2	Demonstrate their ability to read, understand, and critically analyze the astronomical/physical concepts.	K2
CO3	Applying their physics and mathematical skills to problems in the areas of planetary science.	K3
CO4	Analyze to draw valid scientific conclusions and communicate those conclusions in a clear and articulate manner	K4

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping With Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	S	M	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	M	S	S	M	S	S	S	S

S- Strong =3, M-Medium=2, L-Low = 1

COURSE CODE	P21MTE421	CHOICE -I	L	T	P	C
ELECTIVE -II		FUZZY SETS AND THEIR APPLICATIONS	4	-	-	4

Objectives:

- To introduce the concept of fuzzy theory and study its application in real problems
- To study the uncertainty environment through the fuzzy sets that incorporates
- Imprecision and subjectivity into the model formulation and solution process.
- To understand the fuzzy relations and fuzzy arithmetic.
- To explain the concept of operations on fuzzy sets**.**

Unit-I: From Classical Sets To Fuzzy Sets

From Classical Sets To Fuzzy Sets: A Grand paradigm shift, Introduction - Fuzzy Sets Verses Crisp Sets : An Overview - Fuzzy Sets : Basic types – Fuzzy sets : Basic Concepts – Characteristics and Significance of the paradigm shift – Additional Properties of α – cuts – Representations of Fuzzy sets First Dcomposition theorem – Second Decomposition theorem– Third Decomposition theorem- Extension Principle for fuzzy sets**.**

Unit-II: Operations on Fuzzy Sets

Operations on Fuzzy Sets:Types of operations – Fuzzy complements – First Characterization Theorem of Fuzzy Complements - Second Characterization Theorem of Fuzzy Complements - Fuzzy Intersections: t-Norms – Some classes of Fuzzy Intersections (t–Norms) - Fuzzy Unions: t-Conorms - Some classes of Fuzzy Unions (t– Conorms) - Combinations of Operations – Aggregation Operations**.**

Unit-III: Fuzzy Arithmetic:

Fuzzy Arithmetic introduction -Fuzzy Numbers – Membership functions of Fuzzy numbers theorem - Linguistic variables -Arithmetic operations on intervals –Arithmetic operations on Fuzzy numbers – Lattice of Fuzzy numbers – Fuzzy Equations – Equation A + X = B and Equation A * X = B.

Unit-IV: Fuzzy Relations:

Fuzzy Relations introduction Crisp and Fuzzy Relations – Projections and Cylindric Extensions – Binary Fuzzy Relations – Binary Relations on a Single Set – Fuzzy Equivalence Relations – Fuzzy Compatibility Relations –Fuzzy Ordering Relations – Fuzzy Morphisms – SUP-i Compositions of Fuzzy Relations – INF-omega Compositions of Fuzzy Relations.

Unit-V: Fuzzy Decision Making

Fuzzy Decision Making introduction -General Discussion - Individual decision making – Multiperson Making – Multicriteria Decision Making – Multistage Decision Making – Fuzzy Ranking methods – Fuzzy Linear programming. ltiperson Decision Making-Ranking methods – Fuzzy Linear programming.

Text Book:

1. **George J. Klir and Bo Yuan**, "Fuzzy sets and Fuzzy Logic Theory and Applications", Prentice Hall of India, (2005).

UnitI- Chapter 1 Sections 1.3, 1.4, Chapter :2 Sections 2.1 and 2.3
Unit II Chapter 3 Sections 3.1, 3.2, 3.3, 3.4, 3.5-
Unit III Chapter 4 Sections 4.1, 4.2, 4.3, 4.4.-
Unit IV- Chapter 5 Sections 5.3, 5.4, 5.5, 5.6, 5.7, 5.8
Unit V- Chapter 15 Sections 15.2,15.3, 15.6, 15.7

Reference Books

1. **H.J. Zimmermann**, "Fuzzy Set Theory and its Applications", Allied Publishers Limited (1991).
2. **M. Ganesh,** "Introduction to Fuzzy sets and Fuzzy logic", Prentice Hall of India, New Delhi (2006).

Course Outcomes:

CO	CO Statement	Knowledge Level
CO1	Demonstrate the basic concepts of fuzzy sets and membership functions , Know various AI search algorithms	K2
CO2	Ability to find examples for crisp equivalence relation.	K3
CO3	Applying the concept in Fuzzy Morphisms.	K4
CO4	Understand the basics of sampling distribution theory	K5

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping With Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	M	S	M	S	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	M	S	S	S	S	S	S	S

S- Strong = 3, M-Medium=2, L-Low=1

COURSE CODE	P21MTE422	CHOICE -II	L	T	P	C
ELECTIVE -II		STOCHASTIC PROCESSES	4	-	-	4

Objectives:

- To give a depth knowledge about Markov chain and Process.
- To understanding the stochastic models for much real life probabilistic situations and expected results.
- To learn the well known models like birth – death and queueing to reorient the knowledge of stochastic analysis.
- The learner understands in depth knowledge about ergording, renewal theory and its application in discrete and continuous process.

Unit-I: Stochastic Processes:
Basic Definitions: Stochastic Processes: An Introduction - Markov Chains : Definition and Examples Higher Transition Probabilities - Generalization of Independent Beronoulli Trials: Sequence of Chain – Dependent Trails - Classification of States and Chains – Determination of Higher Transition Probabilities - Stability of A Markov System – Graph Theoretic Approach.

Unit-II: Sequence of Chains:
Sequence of Chains introduction – definition of Sequence of Chains Poisson Process -Poisson Process and Related Distributions – Generalizations of Poisson Process - Birth and Death Process Introduction – Definition of Birth and Death Process

Unit –III: Classification of States:
Classification of States: Introduction -Brownian Motion – Wiener Process – Differential Equations for AWiener Process -Kolmogorov Equation – First Passage Time Distribution for wiener Process – Ornstein- Uhlenbeck Process.

Unit- IV: Birth and Death Distribution Process:
Introduction about Birth and Death Distribution Process: Renewal Process - Renewal Processes in Continuous Time – Renewal Equation - Stopping Time- Wald's Equation Introduction - Wald's Equation Renewal Theorems

Unit- V: Renewal Theorems:
Introduction of Renewal Theorems- Renewal Theorems -Delayed and Equilibrium Renewal Process introduction – Delayed and Equilibrium Renewal Process- Introduction about Residual and Excess Lifetimes-.Applications of Residual and Excess Lifetimes.

Text Books:

1.J.Medhi "Stochastic process", Second edition- New Age International Publishers.(2008)

Unit I: Chapter 1: 1.5; Chapter 2: 2.1 to 2.7
Unit II: Chapter 3: 3.1 to 3.4
Unit III: Chapter 4: 4.1 to 4.6
Unit IV: Chapter 6: 6.1 to 6.5

Unit V: Chapter 6: 6.6 to 6.11

Reference Books:

1.V.G. Kulkarni, Introduction to Modelling and Analysis of Stochastic Systems, Second Edition, Springer (2011)

2. **Samuel Karlin and Howard M. Taylor,** "A First Course in stochastic process", second edition, Academic Press. 1975

3.**Samuel Karlin and Howard M. Taylor**, "A Second course in stochastic process", Academic Press, 1981.

4.**Narayan Bhat, U,** "Elements of Applied Stochastic Processes", Second Edition John Wiley & Sons,New York.

5.**Feller,** "An Tntroduction to Probability theory and its applications", Volume 1. Third edition, John Wiley & Sons, New York.

Course Outcomes:

CO Number	CO Statement	Knowledge Level
CO1	Demonstrate the basic concepts of Stochastic process, Markov chains	K2
CO2	Apply the concepts in Birth and Death Distribution Process	K K3
CO3	Identify the type of the Differential Equations for A Wiener Process -Kolmogorov Equation	4 K4
CO4	Understand the basics of sampling distribution theory	K5

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	M	S	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	M	S	S	S	M	M	S	M

S- Strong =3, M-Medium = 2, L-Low=1

COURSE CODE	P21MTE423	CHOICE -III	L	T	P	C
ELECTIVE -II		FLUID DYNAMICS	4	-	-	4

Objectives:

- ❖ It is a subject of almost all fields of engineering, astrophysics, biomedicine, and metrology. Basic concepts of fluid dynamics aredelt with in this paper.
- ❖ To understand the concepts of irrotational motion, two dimensional motion and real fluids.
- ❖ To provide clear knowledge about fluid dynamics and apply this concepts on real time problems.
- ❖ To study the concepts of the laminar boundary layer.

Unit I: Fluid

Introductory Notions – Velocity – Stream Lines and path lines – Stream tubes and Filaments – Fluid Body – Density –pressure**.** Differentiation following the fluid – Equation of continuity – Boundary conditions (Kinematical and physical) - Rate of change of linear momentum – Equation of motion of an inviscid fluid.

Unit II: Euler's momentum theorem

Euler's momentum theorem proof - conservative forces - Bernoulli's theorem in steady motion – Energy equation for inviscid fluid – circulation – Kelvin's theorem – vortex motion – Helmholtz equation.

Unit III: Two-dimensional motion

Two-dimensional motion introduction – two-dimensional functions – complex potential -Basic singularities – source, vortex and doublet. Circle theorem - Flow past a circular cylinder with circulation – conformal transformation – Blasius's theorem – lift force.

Unit IV: Viscous flow

Viscous flow Definition-– Navier Stokes Equations – vorticity and circulation in a viscous fluid – steady flow through an arbitrary cylinder under pressure – steady couette flow between cylinders in relative motion – steady flow between parallel planes.

Unit V: Incompressible flow:

The Laminar boundary layer in incompressible flow - Boundary layer concept – Boundary layer equations. Displacement thickness – momentum thickness – kinetic energy thickness – integral equation of boundary layer – flow parallel to semi-infinite flat plate – Blasius's equation and its solution in series.

Text Books

1. L.M.Milne Thomson, Theoretical Hydro dynamics, Macmillan Company, Vedition, 1968.

(For Units I and II)

Unit I	Chapter 1	Sections1.0 – 1.3
	Chapter 3	Sections 3.10 – 3.40 (omit sections 3.32)
Unit II	Chapter 3	Sections 3.41 to 3.53 (omit sections 3.44)

2. N.Curle and H.J.Davies, Modern Fluid Dynamics – Vol. I, D.Van nostrand Company Ltd, London, 1968. (For Units III, IV and V)

Unit III	Chapter 3	Sections 3.1 – 3.7 (omit 3.4 & 3.5.3)
Unit IV	Chapter 5	Sections 5.1 to 5.3 (omit 5.3.4 and 5.3.5)
Unit V	Chapter 6	Sections 6.1 – 6.3 (omit 6.2.2 and 6.3.2 to 6.3.5)

Reference Books

1. F.Chorlton, Text book of Fluid Dynamics , CBS Publishers and distributors, New Delhi-32, 1998.
2. M.D.Raisinghawia, Fluid Dynamics, S.Chand and Company Ltd, New Delhi - 55

Course Outcomes:

CO	CO Statement	Knowledge Level
CO1	Understand the fundamental knowledge of fluids and its properties	K2
CO2	Describe the concepts and equations of fluid dynamics.	K3
CO3	Apply thermodynamic control volume concepts in fluid dynamics for applications that include momentum, mass and energy balances	K4
CO4	Analyze the approximate solutions of the Navier-Stokes equation	K5

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	M	S	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	M	S	M	S	S	S	M	S

S- Strong =3, M-Medium =2, L-Low=1

COURSE CODE	P21MTE424	CHOICE -IV	L	T	P	C
ELECTIVE -II		TENSOR ANALYSIS AND SPECIAL THEORY OF RELATIVITY	4	-	-	4

Objectives:

- To introduce the notion of Tensor and study its properties.
- To study the theory of relativity.
- To understand the concepts of invariance, metric tensor and Einstein tensor.
- To study specific theory of relativity and relativistic dynamics.

Unit- I: Invariance:

Invariance - Transformations of coordinates and its properties - Transformation by invariance - Transformation by covariance and contra variance - Covariance and contra variance - Tensor and Tensor character of their laws - Algebras of tensors - Quotient tensors - Symmetric and skew symmetric tensors – Relative tensors.

Unit-II: Metric Tensor:

Metric Tensor - The fundamental and associated tensors - Christoffel's symbols - Transformations of Chrisffel's symbols- Covariant Differentiation of Tensors - Formulas for covariant Differentiation- Ricci Theorem - Riemann -Christoffel Tensor and their properties.

Unit -III: Einstein Tensor:

Einstein Tenso rintroduction - Riemannian and Euclidean Spaces (Existence Theorem)- Introduction about The e-systems and the generalized Kronecker deltas - The e-systems and the generalized Kronecker deltas Application of the e-systems.

Unit-IV: Special Theory of Relativity:

Special Theory of Relativity: Galilean Transformation - Maxwell's equations - The ether Theory – The Principle of Relativity Relativistic Kinamatics : Lorentz Transformation equations - Events and simultaneity - Example Einstein Train - Time dilation - Longitudinal Contraction -Invariant Interval - Proper time and Proper distance – World line - Example - twin paradox - addition of velocities - Relativistic Doppler effect.

Unit-V: Relativistic Dynamics :

Relativistic Dynamics : Momentum – energy – Momentum-energy four vector – Force – Conservation of Energy – Mass and energy – Example – inelastic collision – Principle of equivalence – Lagrangian and Hamiltonian formulations . Accelerated Systems: Rocket with constant acceleration – example – Rocket with constant thrust

Text Books:

1. **I.S. Sokolnikoff,** "Tensor Analysis", John Wiley and Sons, New York, 1964
2. **D. Greenwood**, "Classical Dynamics", Prentice Hall of India, New Delhi, 1985

Unit I Chapter 2: Sections 18 to 28 of [1]
Unit II Chapter 2: Sections 29 to 37 of [1]

Unit III Chapter 2: Section 38 to 41 of [1]
Unit IV Chapter 7: Sections 7.1 and 7.2 of [2]
Unit V Chapter 7: Sections 7.3 and 7.4 of [2]

Reference Books:

1. **J.L. Synge and A.Schildt,** "Tensor Calculus", Toronto, 1949.
2. **A.S. Eddington,** "The Mathematical Theory of Relativity", Cambridge University Press, 1930.
3. **P.G. Bergman, "**An Introduction to Theory of Relativity", New york, 1942.
4. **C.E. Weatherburn,** "Riemannian Geometry and Tensor Calculus", Cambridge, 1938.

Course Outcomes:

CO Number	CO Statement	Knowledge Level
CO1	Understand concept of tensor variables and difference from scalar or vector variables.	K2
CO2	Derive base vectors, metric tensors and strain tensors in an arbitrary coordinate system..	K3
CO3	Investigate the Christoffel symbols which provide a concrete representation of the connection of (pseudo-)Riemannian geometry in terms of coordinates on the manifold	K4
CO4	Apply Riemannan-Christoffel tensor to problems of differential geometry, electrodynamics and relativity	K5

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	M	S	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	M	S	S	S	S	S	S	M

S- Strong= 3, M-Medium = 2, L-Low=1

COURSE CODE	P21MTR41	PROJECT	L	T	P	C
PROJECT			-	-	22	8

Rules And Regulation Of The Project:

1. The Project Area/title must be any one of the following
   (i)Pure Mathematics
   (ii)Applied Mathematics
   (iii)Mathematical Application in Real Time Activities.
2. Student allotment Method will be decided by the Department Faculties
   (In October 2nd week)
3. They are Four Project Common Meet(In Front of All Faculty) Power point presentation
   (i). First Meet – November last week. Work done - Topic and Area will be decided (5 marks)
   (ii). Second Meet – January 1st week. Work done-25% work (5 marks)
   (iii). Third Meet –February 1st week, Work done -50% work (5 marks)
   (iv). Fourth Meet – March 1st week, work done -90% work (5 marks)
4. Project Record Submission – Third week of March

NON MAJOR ELECTIVE – MATHEMATICS DEPARTMENT OFFERING COURCES TO OTHER DEPARTMENT

COURSE CODE	P21MTN211	NUMERICAL METHODS	L	T	P	C
SEMESTER -II			4	-	-	4

Objectives:

- To develop efficient algorithms for solving problems in Science, Engineering and Technology.
- The leaner will analyze the different aspects of numerical solution of algebraic and transcendental equations.
- Students will be able to identify the basic concept of numerical differentiation and integration, principle of least squares.
- The learner will become knowledgeable in solving solution to simultaneous linear equations.

Unit- I: Algebraic and Transcendental Equations:

Solution of Algebraic and Transcendental Equations- Bisection Method – Problems in Bisection Method – Iteration Method –Condition for Convergence – Regular Falsi Method-Newton's Method. Problems in Regular Falsi Method and Newton's Method

Unit - II: simultaneous Linear Algebraic Equations:

Solutions of simultaneous Linear Algebraic Equation - Gauss Elimination Method –Gauss Jordan Method –Method of Factorization-Gauss Jacobi – Gauss Siedel Method . Problems in Gauss Elimination, Gauss Jordan , Factorization-Gauss Jacobi and Gauss Siedel Method

Unit - III: Finite Differences:

Finite Differences introduction- First and Higher Order Differences –Forward and Backward Differences – Properties of Operator - Differences of a Polynomial - Factorial Polynomials- Relation between the Operators Δ ,E and D- Summation of the series.

Unit - IV: Interpolation:

Interpolation- Gregory Newton Forward and Backward Formula – Gauss Forward and Backward Formula- Stirling's Formula-Interpolation with Unequal Intervals: Divided differences-Newton's Interpolation Formula-Lagrange's Interpolation Inverse Interpolation.

Unit - V: Numerical Differentiation and Integration:

Numerical Differentiation and Integration introduction - Newton's Forward and Backward Difference Formula – Problems solving using Newton's Forward and Backward Difference Formula- Stirling's Formula to Compute Derivatives-Trapezoidal rule- Simpsons $1/3^{rd}$ and $3/8^{th}$ rule Problems using Trapezoidal rule- Simpsons $1/3^{rd}$ and $3/8^{th}$ rule.

Text Book:

1. **P.Kandasamy , K.Thilagavathi and K. Gunavathi**, "Numerical Methods", S.Chand and Company Ltd New Delhi 2013.

   Unit I – Chapter 3 -3.1 to 3.4
   Unit II – Chapter 4 -4.1 ,4.2,4.4,4.7 to 4.9
   Unit III – Chapter 5- 5.1 to5.4,5.7
   Unit IV –Chapter 6, 7 -7.1 to 7.5 & 8
   Unit V – Chapter 9

Reference Books:

1. **Arumuga, Issac, Somasundaram**,"Numerical Analysis", New Gamma Publishing House, Palayam Kottai 2003.
2. **G. Balaji**, "Numerical Methods", G.Balaji Publishers, Chennai 2007

Course Outcome:

On the successful course completion, students will be able to:		Cognitive Level
CO1	Understand the equations using different methods under differ conditions and numerical solutions of system algebraic equation	K1
CO2	Apply various interpolation methods and finite different concepts	K3
CO3	Analyse differentiation and integration whenever and where ever routine methods are not applicable	K4
CO4	Evaluate the ordinary differential equations using different methods through the theory of finite differences.	K5
CO5	Evaluate the partial differential equations using different methods through the theory of finite differences.	K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create

COURSE CODE	P21MTN212	OPERATION RESEARCH	L	T	P	C
SEMESTER -II			4	-	-	4

Objectives

- To impart the basic concepts and applications of linear programming.
- The leaner will formulate a linear programming problem and solve them graphically and simplex method
- The leaner will be able to understand the concepts of duality programming
- The leaner will analyze the different aspects of transportation problems and also assignment problems
- Students will be able to identify the basic analysis of various inventory models.
- The leaner will develop, organize, evaluate short, long term processes and solve problems

Unit - I: Linear Programming problem:

Introductions- Linear Programming: Mathematical formulation of linear programming problem- Basic Solution - Solving Linear Programming problem using Graphical solution- Unbounded and Infeasible solution in graphical methods -Simplex method - Use of Artificial Variables: – Big M Method – Two Phase Method – Problems using this methods

Unit -II: Transportation Problem:

Transportation Problem introduction- Mathematical formulation of the problem - Finding Initial Basic Feasible Solution using North - West Corner Rule - Row minima methods- Column minima method - Matrix Minima Method - Vogel's Approximation Method - Optimum solution – MODI method .

Unit- III: Assignment Problem:

Assignment Problem: Introduction – Definition of Assignment Problem -Mathematical formulation of Assignment Problem - Assignment Algorithm – Problem solving using Assignment Algorithm- Application of Assignment Problem: Minimization case routing problem

Unit- IV: Replacement Problem:

Replacement Problem: Introduction about Replace problem –Definition Replace problem -and System Reliability – Replacement of Equipment that Deteriorates Gradually- Exercise Problems - Replacement of Equipment the Fails Suddenly-problems in replacement of Equipment the Fails Suddenly

Unit - V: Network Scheduling by Pregame Evaluation and Review Techniques PERT/ Critical Path Method -CPM:

Network Scheduling by PERT/CPM : Introduction network and Basic Components- Rules of Construction –Problems in Network Scheduling using CPM -Critical Path Analysis – Probability Considerations in PERT – Problems in Network Scheduling using PERT Distinction between PERT and CPM.

Text Book:

1. Kanti Swarup, P.K. Gupta, Man Mohan, "Operations Research", Sultan Chand & Sons, Educational Publishers, New Delhi.2013

Reference Books:

1. **Panneerselvam.R**, "Operations Research", 2nd Edition, PHI Learning Private Limited, Delhi, 2015
2. **Prem Kumar Gupta.Er, Hira.D.S**. "Operations Research",7th Edition,S.Chand & Company Pvt.Ltd.2014
3. **Hiller.F.S & Lieberman.J** "Introduction to Operation Research ",7th Edition, Tata–MCGraw Hill Publishing Company, NewDelhi, 2001.
4. **G. Srinivasan,** "Operations Research principles and applications", Second Edition, PHI Learning Private Limited, New Delhi-110001, 2012.
5. **Taha H.A., "**Operations Research An introduction" Prennce Hall of India Private Ltd 1st Edition New Delhi (2008) .

Course Outcome:

On the successful course completion, students will be able to:		Cognitive Level
CO1	understand the application of OR and frame a LP Problem with solution – graphic and through solver add in excel	K1
CO2	analyze and interpret results of transportation and problem using appropriate method Solutions of assignment and problem using appropriate method	K2
CO3	evaluate simple model of L.P.P.	K3
CO4	understand and evaluate of CPM and PERT define basic components of Network and find critical path	K3
CO5	find the replacement period of equipment that failssuddenly/gradually	K4, K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create

COURSE CODE	P21MTN213	DISCRETE MATHEMATICS	L	T	P	C
SEMESTER -II			4	-	-	4

Objectives:

- To study of and, or and not logics by truth tables.
- To study of normal forms.
- Analysis Free and Bound variable formulas.
- Understand Types of Grammar, function of Pushdown automata

Unit- I: Mathematical Logic:

Mathematical Logic Statement and Notation – Connection – Negation Conjunction – Disjunction – Statement Formulas and Truth Tables – Logical Capabilities of Programming Languages – Conditional and Bi Conditional – Well Formed Formula – Tautologies –Equivalence of Formula – Duality Law Tautological Implication.

Unit - II: Normal Forms:

Normal Forms introduction- Disjunctive Normal Forms – Theorem based on Disjunctive Normal Forms - Conversion of given statements into Disjunctive Normal Forms- based on Conjunctive Normal Forms – Theorem based on Conjunctive Normal Forms - Conversion of given statements into Conjunctive Normal Forms -Principal Disjunctive Normal Forms – Principal Conjunctive Norms-Conversion of Disjunctive Normal Forms to Principal Disjunctive Normal Forms-Conversion of Conjunctive Norms to Principal Conjunctive Norms

Unit- III: Theory of Inference:

Theory of inference introduction – Truth Table Technique – Rules of Inference - Inconsistent Premises – Indirect Method of Proof – Predicate calculus- Free and Bound Variables – Valid Formulas and Equivalences – Inference Theory of Predicate Calculus.

Unit - IV: Grammar :

Grammar introduction - alphabet - basic characters- string – Length of string – concatenation of sting -Definition –Types of Grammar – Phrase Structure Grammar – Context Sensitive Grammar – Context Free Grammar – Regular Grammar – Languages Generated by these Grammars. Conversion of one type grammar into other type .

Unit - V: NDFSA to DFSA and Pushdown Automata:

Automata -Definition – Deterministic finite state Automata (DFSA) – Examples for Deterministic finite state Automata - Non-Deterministic finite state Automata NDFSA) – Examples for Non Deterministic finite state Automata Conversion of NDFSA to DFSA- Problem solving in the Conversion of NDFSA to DFSA Pushdown automata- Simple Theorem.

Text Books:

1. **J.P.Tremblay**, **R. Manohar –** "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw – Hill Edition 1997
   Unit I- Chapter :1- 1-1,1-2:1-2.1 to 1-2.11.
   Unit II-Chapter :1-3.1 to 1-3.4
   Unit III- Chapter: 1-4.1to 1- 4.3 .1-5 to1-5.4,1-6:1-6.1 -1-6.4

2. **Dr.Rani Siromoney, "**Formal Languages and Automata, The Chiristian Literature Society"**, Revised Edition 1979.**
   Unit IV-Chapter2 : 2.1 to 2.6
   Unit V-Chapter 5: 5.1 and Chapter 6

Reference Books:

1. **John . E. Hopcraft, Rajeev Motwani and Jeffrey D. Ullman**, "Introduction to Automata Theory, Languages and Computationc", Pearson Education, 2013
2. **Kenneth H. Rosen**, "Discrete Mathematics and it's Applications", 7th Edition/ McGraw Hill Education, New York, 2012
3. **B.S.Vatssa**, "Discrete Mathematics",WISHWA PRAKASHAN,1993.
4. **V.Sundaresan,K.S.Ganapathy Subramanian, K.Ganesan**, "Discrete Mathematics", A.Rd.Publications, 1998.
5. **T.Veerarajan**, "Discrete Mathematics", McGraw Hill Education (India)Pvt.Ltd,New Delhi, 2014.

Course Outcome:

On the successful course completion, students will be able to:		Cognitive Level
CO1	Understanding of some Logic truth tables	K2
CO2	Prove / define basic normal forms	K3
CO3	To analyses the concepts of free and bound variable formulas	K4
CO4	Understanding the concepts of Grammars	K4
CO5	Basic concepts of Languages and basic definitions of Automata	K6

K1- Remember: K2- Understand : K3-Apply, K4- Analyse, K5- Evaluate; K6- create

COURSE CODE	P21MTN214	DIFFERENTIAL EQUATIONS	L	T	P	C
SEMESTER -II			4	-	-	4

Objectives:

- To introduce the basic concepts of differential equations and Laplace Transforms.
- Understand the basic concepts of first order differential equation and it applications.
- Determine solutions to second order linear homogeneous, non-homogeneous differential equations with constant coefficients.
- Understand the elementary theory of partial differential equations, and solve it using various techniques.

Unit- I: **Differential Equations of the first order and first degree:**

Differential Equations of the first order and first degree introduction- Definition – Examples for differential Equations of the first order and first degree - Variable separable method – Homogeneous Linear equation and non – Homogeneous Linear equation- Bernoulli's equations- exact differential equations.

Unit-II: Equation of the first order and higher degree:

Equation of the first order and higher degree introduction- Definition – Examples of Equation of the first order and higher degree- Equations Solvable for dy/dx — Examples in Equations Solvable for dy/dx- Equations solvable for y – Examples in Equations solvable for y-Equations solvable for x – Examples in Equations solvable for x- Clairaut's form.

Unit- III: Linear equations with constant Co- efficient:

Linear equations with constant Co- efficient introduction- Definition – complementary function of a Linear equation with constant Co – efficient – particular Integral – General method of finding P.I – special methods for finding P.I of the functions of the type e^{ax} , cos ax or sin ax , e^{ax} V where V is any function of x , x^m – Linear equations with Variable Co – efficient, Equations reducible to the linear equations.

Unit - IV: Simultaneous Differential Equations:

Simultaneous Differential Equations introduction- Simultaneous equations of the first order and first degree – Simultaneous linear differential equations: Linear equations of the second order: Complete solution given a known integral – Reduction to the normal form – Change of Independent Variables – Variation of Parameters – Methods of operations factors.

Unit - V: Partial Differential Equations(PDE):

Formation of Partial Differential Equations (PDE) – Lagrange method of solving linear Partial Differential Equations – Solution of Partial Differential Equations of type F(p,q)=0- Solution of Partial Differential Equations of type F(z,p,q)=0- Solution of Partial Differential Equations of type F(x,p) = G(y,q) - Clairaut's form and Charpit's method- Solution of Partial Differential Equations using Charpit's method.

Text Book:

1. **S.Narayanan and T.K. Manickavachagam pillai**, "Differential equations and its applications" S. Viswanathan Printers and Publishers Pvt. Ltd., Madras 2014.

Reference Books:

1. Arumugam and Isaac - "Differential equations and applications", - New gamma publishing house – 1999.

2. P.Kandasamy and K. Thilagavathi "Mathematics for Branch I: Volume III" S. Chand and Company Ltd., New Delhi - 2004.

Course Outcome:

On the successful course completion, students will be able to:		Cognitive Level
CO1	solve linear equations with variable coefficients.	K2
CO2	understand the fundamental properties of the PDE	K1&K2
CO3	apply the Differentation Of Higher Order Methods to solve Practical life problems	K3
CO4	solve partial differential equations using Lagrange's method and Charpit's method	K3&K4
CO5	create real life problems into ordinary differential equations.	K4 &K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create

COURSE CODE	P21MTN215	FOURIER AND LAPLACE TRANSFORMATIONS	L	T	P	C
SEMESTER - II			4	-	-	4

Objectives:

- To enhances basic skills in the areas of Fourier series.
- To acquaint the student with the Fourier transform techniques used in wide variety of situations.
- To study about Fourier series and their applications.
- To introduce the basic concepts of Laplace Transforms.
- First solutions by applying Laplace transform methods.

Unit – I: Fourier series:

Fourier series introduction- Definition –Examples for Fourier series - Dirchlet's conditions Definition -Fourier series of periodicity 2π and 2l –Examples for Fourier series of periodicity 2π and 2l Odd and Even functions – Root mean square value of a function - Problems in this method Parseval's Theorem.

Unit – II: Half range series:

Half range series definition - Half range sine series – Definition -Examples in Half range sine series Half range cosine series – Definition -Examples in Half range cosine series- Harmonic analysis – Definition -Examples of Harmonic analysis -Complex form of Fourier series- problem in Complex form of Fourier series

Unit – III: Fourier Transform:

Fourier Transform introduction – Definition –Examples in Fourier Transform -Properties – Fourier integral theorem – Fourier Sine transforms - Definition –Examples in Sine transforms- Fourier Cosine transforms – Definition –Examples in Fourier Cosine transforms- Convolution Theorem – Parseval's identity**.**

Unit – IV: Laplace Transforms:

Laplace Transforms introduction - Definition – Types of Laplace transform – Examples in each type - Laplace transform of periodic functions – Definition-Examples in Laplace transform of periodic functions- Some general Theorems

.

Unit – V: Inverse Laplace Transforms:

Inverse Laplace Transforms: Definition of Inverse Laplace Transforms – Linearity of Inverse Laplace Transforms- Properties of of Inverse Laplace Transforms-, first shifting Theorem – second shifting Theorem – change of scale- property and examples.

Text Books:

1. **P.Kandasamy and K.Thilagavathy** , "Mathematics, Vol. IV", S.Chand and company Ltd., - 2004. UNIT I: Chapter I UNIT II: Chapter I and UNIT III: Chapter IV

2. **S.Narayanan and T.K Manickavachagam Pillai,** " Differential equations and its applications" S.Viswanathan Printers and Publishers Pvt. Ltd.,Madras 2014.

   UNIT IV and UNIT V: Chapter 9 – Sec. 1 to 7

Reference Books:

1. Laplace Transforms" by **A.R. Vasistha and Dr.R.K. Gupta** Published by Krishna Prakashan Media Pvt, Ltd., Meerut.2012
2. Laplace transform and Fourier transform" by **Dr.J.K Goyal and K.P.Gupta**, Published by Pragathi Prakashan Media Pvt, Ltd., Meerut.2013

Course Outcomes:

CO Number	CO statement	Knowledge level
CO1	Integral equations of Fourier Transforms	K4
CO2	Demonstrate the Fourier Transforms	K3
CO3	Understand the fundamental properties of the Laplace transforms	K1&K2
CO4	Apply the Laplace inverse transforms to solve simultaneous equations	K3

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate, K6 – Create

COURSE CODE	P21MTN216	Statistics	L	T	P	C
SEMESTER - II			4	-	-	4

Objectives:

- To enhances basic skills in the areas of data collection.
- To acquaint the student with the average calculation in various situation.
- To study about deviation of data from the central values.
- To know the testing tools and methods .

Unit – I: Primary and Secondary data:

Collection of Data –Primary data-Secondary data-choice of methods-Direct personal Observation-Indirect oral Interview-Information Through Agencies-Mailed questionnaire Schedules send through Enumerators, Sources of secondary data- Data precautions in the in the use of secondary data- Sample questionnaire

Unit – II: Central Tendency and Variation:

Measure of Central Tendency- Meaning- Definition – Arithmetic Mean - Median- Definition Mode - Definition -Geometric mean- Definition- Harmonic mean – Definition- Individual data- Discrete series and continuous series – Problem in all the three types.

Measure of Variation: Measure of dispersion- range- Quartail deviation- Mean Deviation Standard deviation - Individual data- Discrete series and continuous series – Problem in all the three types.

Unit – III: Correlation and Regression:

Correlation and Regression introduction -Types of correlation graphical representation of Correlation - Karl Pearson's coefficient of correlation – Rank correlation- Coefficient of rank correlation.

Regression: Significance of regression-difference between correlation and regression-RegressionLines - Regression equations

Unit – IV: Theoretical distributions:

Theoretical distributions introduction - Binomial distribution –properties of binomial distribution-simple problems in binomial distribution - Poisson distribution- simple problems in Poisson distribution -Normal distributions – properties of Normal distributions - practical problems in Normal distributions.

Unit – V: Sampling Theory and Testing of Significance:

Sampling Theory and Testing of Significance introduction - Estimation-Hypothesis-Test of significance- Small sample test - Student 't' test –Large sample test for significance of average-Student F-test- Chi –Square test for Goodness of fit-Simple practical problems using - Chi –Square test

Text Books:

1, R.S.N. Pillai and V.Bagavathi,, "Statistics", Sultan Chand, New Delhi, 2008.
2. Gupta S.P, "Statistical Methods", Sultan Chand, New Delhi, 33rd Edition, 2005

Reference Book:

1. **S.C.Gupta and V.K.Kapoor**, "Fundamentals of Mathematical Statisitics", Sultan Chand and Sons, New Delhi -2, 2011

Course Outcomes:

CO Number	CO statement	Knowledge level
CO1	Analyse –Primary data-Secondary data	K4
CO2	Measure of Central Tendency and Measure of Variation	K3
CO3	Understand and apply Correlation and Regression	K1&K2
CO4	Understand Theoretical distributions	K2
CO5	Sampling Theory and Testing of Significance: Estimation-Evaluate	K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate, K6 – Create

COURSE CODE	P21MTN217	MATHEMATICAL APTITUDE	L	T	P	C
Elective - NME			4	-	-	4

Objectives:

- To impart skills in numerical and quantitative techniques.
- Able to critically evaluate various real life situations by resorting to Analysis of key issues and factors.
- Able to demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions.

Unit I :

Numbers – HCF – LCM – Square Roots & Cube Roots- Problems on numbers. (Chapters 1, 2,5, 7)

Unit II :

Decimal Fractions, Simplification, Time & Distance. (Chapter 3,4,17)

Unit III :

Surds and Indices – Percentage – Profit and Loss- Simple Interest. (Chapters 9, 10,11, 21)

Unit IV:

Ratio and Proportion – Partnership – Allegation or Mixture- Probability. (Chapters 12, 13, 20, 31)

Unit V :

Average – Problems on Age- Calender. (Chapters 6,8,27)

Text Book:

Dr.R.S.Aggarwal, "Quantitative Aptitude for Competitive Examinations" , S.Chand & Company Ltd., Ram Nagar, New Delhi -2007.

Link: https://books.shunyafoundation.com/book-quantitative-aptitude-by-r-s-aggarwal-published-by-s-chand-english/dp/ODTRGH2E

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	S	S	S	S	M	M
CO2	S	M	S	M	M	M	M	S	S	M
CO3	S	S	S	S	S	S	M	S	S	S
CO4	M	M	S	M	S	S	S	M	S	S
CO5	M	S	S	S	S	M	S	S	S	M

*S-Strong; M-Medium; L-Low

COURSE CODE	P21MTS22	MATLAB	L	T	P	C
SUPPORTIVE COURSE -II			-	2	-	2

Objectives:

- To impart the programming concepts of Matlab
- Specific outcome of learning the learner will be able to use Matlab for interactive computations Able to draw 2D and 3D graphs.
- Understand richness of Matlab rather than using algebraic Number theory M.S. Word for documentation
- Able to applying programming techniques to solve the programs at advanced level.

Unit -I: MATLAB: Brief Introduction:

MATLAB: Importing and Visualizing Images- Importing and displaying images -Converting between image types -Exporting images- Interactive Exploration of Images- Obtaining pixel intensity values- Extracting a region of interest- Computing pixel statistics –

Introduction To MATLAB**:** Brief Introduction - Installation of MATLAB – History - Use of MATLAB - Key features.

MATLAB Software: Introduction to MATLAB Software – MATLAB window - Command window – Workspace - Command history - Setting directory - working with the MATLAB user interface - Basic commands - Assigning variables - Operations with variables

Unit -II: Data Files and Data Types:

Data Files and Data Types **i**ntroduction **-** Character and string - Arrays and vectors – Column vectors - Row vectors.

Basic Mathematics:

BODMAS Rules - Arithmetic operations - Operators and special characters -Mathematical and logical operators - solving arithmetic equations

Unit -III: Operations on Matrix:

Operations on Matrix introduction -Creating rows and columns Matrix - Matrix operations - Finding transpose, determinant and inverse -Solving matrix

Other Operations**:** Trigonometric functions -Complex numbers- fractions -Real numbers- Complex numbers

Unit-IV: Image processing:

Image processing with Measuring object sizes-Creating a custom interactive tool- Pre-processing Images - Adjusting image contrast -Reducing noise in an image -Using sliding neighbourhood operations -Using block processing operations

Unit -V: Symbolic Math:

Symbolic Math in MATLAB**:** Calculus: Numerical Integration- Linear Algebra- Roots of Polynomials- Algebraic equations Differential Equations (1st & 2nd order) -Transforms (Fourier, Laplace, etc)- Ordinary Differential equations -Examples of few ODEs

Text Books:

1. **Y. Kirani Singh & B. B. Chaudhuri, "**MATLAB Programming", Prentice-Hall of India Pvt. Ltd, New Delhi, 2008.

2. **Desmond. J.Higham &Nicholas J.Hiham**, "MATLAB Guide", 2nd edition SIAM , 2005.

Course Outcomes:

Upon the successful completion of the course, students will be able to

CO1: use MATLAB for interactive computations.
CO2: familiar with memory and file management in MATLAB.
CO3: generate plots and export this for use in reports and presentations.
CO4: cooperating and working with others using subversion
CO5: debugging and optimising their programs

CO	CO Statement	Knowledge Level
CO1	Demonstrate the basic concepts of types of mat lab mathematical operators, Relational, binary and logical operators	K2
CO2	Apply the concepts in expanding and reducing size- reshaping, shifting and sorting matrices.	K3
CO3	Identify different types of Matlab and Matlab file	K4
CO4	Understand the basics of document layout and organization	K5
CO5	Emphasis on estimating a document class and fine tuning text .	K6

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	S	M	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	M	S	S	S	S	M	S	S
CO5	S	S	S	S	M	S	S	S	M	S

S- Strong = 3, M-Medium= 2, L-Low = 1

VALUE ADDED PROGRAM

COURSE CODE	P21MTV11	PYTHON LANGUAGE	L	T	P	C
SEMESTER - I			-	-	-	2

Objectives:

- To understand the fundamentals of Python Programming.
- To get knowledge about the Functions in Python.
- To understand the concepts of List and String methods.
- To gain idea about exception handling and classes.

Unit- I: Introduction to Python:

Introduction to Python: Introduction – Python Overview – Getting Started with Python –Comments – Python Identifiers – Reserved Keywords – Variables – Standard Data types.

Unit- II: Operators:

Types of Operators - Statement and Expressions – String Operations – Boolean Expressions – Control Statements – Iteration While Statement – Input from Keyboard.

Unit- III: Functions:

Functions introduction – Built-in Functions – Composition of Functions – User defined Functions Parameters and Arguments –Function Calls- The return statement – Python Recursive Functions The Anonymous function – Writing Python Scripts.

Unit –IV: Strings and Lists:

Introduction about Strings and Lists: Strings - Lists. Tuples and Dictionaries: Tuples – Dictionaries.

Unit –V: Files and Exceptions:

Files and Exceptions introduction - Text Files – Directories – Exceptions – Exceptions with Arguments- User defined Exceptions- Classes and Objects.

Text Book:

1. **E. Balagurusamy,** "Problem Solving and Python Programming by ", McGraw-Hill first edition (2017)m

Reference Books:

1. **Ashok Namdev Kamthane, , Amit Ashok Kamthane**, "Programming and Problem Solving with Python". (2017),
2. **John B. Schneider Shira Lynn Broschat Jess Dahmen),** "Algorithmic Problem Solving with Python".(2019

Course Outcomes (CO)

CO1	To implement basic concepts of operators and functions.	K1
CO2	To Review various string, list, tuple and dictionaries.	K2
CO3	To evaluate the functionality of an exception handling.	K3
CO4	To analyze the concept of classes and objects.	K4

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	S	M	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	M	S	S	S	S	M	S	S
CO5	S	S	S	S	M	S	S	S	M	S

S- Strong = 3, M-Medium= 2, L-Low = 1

COURSE CODE	P21MTV11	PYTHON LAB	L	T	P	C
Value Added Program- I			-	-	-	2

Objectives:

- To gain knowledge about the fundamentals of python programming.
- To understand the concepts of string, list, tuple.
- To implement the concept of exception handling, classes and objects

List of Practical Programmes:

1. Write a python program to print the prime numbers in given range.
2. Write a python program m to calculate the area of a triangle.
3. Write a python program to find HCF of the given numbers.
4. Write a python program to create a simple calculator.
5. Write a python program to display Fibonacci series sequence using recursion.
6. Write a python program to demonstrate the string methods.
7. Write a python program to demonstrate the built-in list methods.
8. Write a python program to define a function that prints a tuple whose values are the
9. Cube of numbers between 1 1nd 10.
10. Write a python program to demonstrate exception handling.
11. Write a python program to demonstrate classes and their attributes.

Course Outcomes (CO)

CO1	To implement basic operators and function concepts.	K3
CO2	To Review various string and list methods.	K4
CO3	To execute exception handling.	K5

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	S	M	S
CO3	S	S	S	S	S	S	M	S	S	S

S- Strong = 3, M-Medium= 2, L-Low = 1

COURSE CODE	P21MTV42	Mathematical Modelling	L	T	P	C
SEMESTER - IV			-	-	-	2

Objectives :

- ❖ To enrich mathematical application thinking
- ❖ Solve practical problems
- ❖ Develop mathematical Models

Unit- I: Introduction about Simulation and Mathematical Modeling:

Introduction about Simulation and Mathematical Modeling : Basic definitions of Trigonometry - develop mathematical models for trigonometry application

Unit- II: Introduction about the applications of Operation Research:
Introduction about the applications of Operation Research – Develop mathematical models for Cost minimization –Minimum Resource utilization-Time minimization-Queuing model**.**

Unit -III: Introduction to Graph Theory:
Introduction to Graph Theory –Application-Develop Mathematical Modeling for real time application

Unit- IV: Numerical Methods:
Numerical Methods- Introduction –Application – Mathematical models using Numerical Methods for real time problems

Unit- V: Introduction to Ordinary and Partial Differential Equations:
Introduction to Ordinary and Partial Differential Equations- Mathematical Models to solve real time problems**.**

Text Book:

1. **Robert.E.Moyer "** Schaum's outline of Trigonometry" fifth edition . The Mcgraw-Hill Companies New Delhi 2015
2. **S. Narayanan and T.K. Manickavachagam pillai**, "Differential equations and its applications" S. Viswanathan Printers and Publishers Pvt. Ltd., Madras 2014
3. **Kanti Swarup, P.K .Gupta,Man Mohan**"Operations Research", Sultanchand and sons , Edition – 2017.
4. **P.Kandasamy , K.Thilagavathi and K. Gunavathi**, "Numerical Methods", S.Chand and Company Ltd , New Delhi 2013.
5. **S.A.Choudum**, "A first Course in Graph Theory", Macmillan india limited, 1999.

COURSE OUTCOME:

CO1	Develop Mathematical Models For Trigonometry Application	K3
CO2	To Review minimum Resource utilization.	K4
CO3	Develop Mathematical Modeling for real time	K5
CO4	To analyze Mathematical Models to solve real time problems.	K5

K1- Remember: K2- Understand: K3-Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	S	M	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	M	S	S	S	S	M	S	S

S- Strong = 3, M-Medium= 2, L-Low = 1

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