CAUVERY COLLEGE FOR WOMEN (AUTONOMOUS)

Nationally Accredited with 'A' Grade by NAAC

ISO 9001:2015 Certified

TIRUCHIRAPPALLI

PG AND RESEARCH DEPARTMENT OF MATHEMATICS

M. Sc. MATHEMATICS

AUTONOMOUS SYLLABUS

2023 – 2024 and onwards

CAUVERY COLLEGE FOR WOMEN (AUTONOMOUS)

PG AND RESEARCH DEPARTMENT OF MATHEMATICS

VISION

To strive for excellence in the mathematical sciences in addition to encourage people to undertake opportunities in transdisciplinary domains.

MISSION

- To enhance analytical and logical problem-solving capabilities.
- To provide excellent mathematical science knowledge for a suitable career and to groom students for national prominence.
- To teach students how to use data analytics.
- To prepare students for transdisciplinary research and applications.
- Value-based education and service-oriented training programmes are used to acquire life skills.

PROGRAMME EDUCATIONAL OBJECTIVES(PEOs)

PEOs	Statements
PEO1	**LEARNING ENVIRONMENT** To facilitate value-based holistic and comprehensive learning by integrating innovative learning practices to match the highest quality standards and train the students to be effective leaders in their chosen fields.
PEO2	**ACADEMIC EXCELLENCE** To provide a conducive environment to unleash their hidden talents and tonurture the spirit of critical thinking and encourage them to achieve their goal.
PEO3	**EMPLOYABILITY** To equip students with the required skills in order to adapt to the changing global scenario and gain access to versatile career opportunities in multidisciplinary domains.
PEO4	**PROFESSIONAL ETHICS AND SOCIAL RESPONSIBILITY** To develop a sense of social responsibility by formulating ethics and equity to transform students into committed professionals with a strong attitude towards the development of the nation.
PEO5	**GREEN SUSTAINABILITY** To understand the impact of professional solutions in societal and environmental contexts and demonstrate the knowledge for an overall sustainable development.

PROGRAMME OUTCOMES FOR M.Sc MATHEMATICS

PO NO.	On completion of M.Sc Mathematics, the students will be able to
PO 1	**Problem Analysis** Provide opportunities to develop innovative design skills, including the ability to formulate problems, to think creatively, to synthesize information, and to communicate effectively.
PO 2	**Scientific Skills** Create and apply advanced techniques and tools to solve the societal environmental issues.
PO 3	**Environment and Sustainability** Ascertain eco-friendly approach for sustainable development and inculcate scientific temper in the society.
PO 4	**Ethics** Imbibe ethical and social values aiming towards holistic development of learners.
PO 5	**Life long learning** Instill critical thinking, communicative knowledge which potentially leads to higher rate of employment and also for higher educational studies.

PROGRAMME SPECIFIC OUTCOMES FOR M.Sc MATHEMATICS

PSO NO.	The Students of M.Sc Mathematics will be able to	POs Addressed
PSO1	Make a significant contribution to society's development through mathematical study	PO1 PO2 PO3
PSO2	Provide an in-depth and extensive functional understanding of mathematical basics.	PO1
PSO3	Develop the experimental abilities in order to solve scientific and technical problems.	PO1 PO5
PSO4	Promote the learners and explore the potential in emerging fields.	PO4 PO5
PSO5	Enhance problem-solving, thinking, and creative skills through assignments and project work.	PO4 PO5

Cauvery College for Women (Autonomous), Trichy-18
PG & Research Department of Mathematics
M.Sc Mathematics
Learning Outcome Based Curriculum Framework (CBCS-LOCF)
For the Candidates admitted from the Academic year
2023-2024onwards

Semester	Course	Course Title	Course Code	Inst. Hrs. / week	Credits	Exam			Total
						Hrs.	Marks		
							Int.	Ext.	
I	Core Course– I (CC)	Algebraic Structures	23PMA1CC1	6	5	3	25	75	100
	Core Course – II (CC)	Real Analysis I	23PMA1CC2	6	5	3	25	75	100
	Core Course –III (CC)	Ordinary Differential Equations	23PMA1CC3	6	5	3	25	75	100
	Core Course - IV (CC)	Probability Theory	23PMA1CC4	6	5	3	25	75	100
	Discipline Specific Elective Course-I (DSE)	A. Number Theory and Cryptography	23PMA1DSE1A	6	3	3	25	75	100
		B. Graph Theory and Applications	23PMA1DSE1B						
		C. Programming in C++ and Numerical Methods	23PMA1DSE1C						
	Total			**30**	**23**	**-**	**-**	**-**	**500**

15 Days INTERNSHIP during Semester Holidays

Semester	Course	Course Title	Course Code	Inst.	Credits	Exam			Total
						Hrs.	Marks		
							Int.	Ext.	
II	Core Course– (CC)	Advanced Algebra	23PMA2CC5	6	5	3	25	75	100
	Core Course – VI (CC)	Real Analysis II	23PMA2CC6	6	5	3	25	75	100
	Core Course - VII (CC)	Linear Algebra	23PMA2CC7	6	5	3	25	75	100
	Core Choice Course– I (CCC)	A. Partial Differential Equations	22PMA2CCC1A	6	4	3	25	75	100
		B. Mathematical Programming	22PMA2CCC1B						
		C. Difference Equations	22PMA2CCC1C						
	Discipline Specific Elective Course-II (DSE)	A. Computational Mathematics Using MATLAB (P)	22PMA2DSE2AP	6	3	3	40	60	100
		B. Advanced Numerical Methods Using MATLAB (P)	23PMA2DSE2BP						
		C. Ordinary Differential Equations and Partial Differential Equations Using MATLAB (P)	22PMA2DSE2CP						
	Internship	Internship	22PMA2INT	-	2	-	-	100	100
	Extra Credit Course	**SWAYAM**	**As per UGC's Recommendation**						
	Total			**30**	**24**	**-**	**-**	**-**	**600**

Semester	Course	Course Title	Course Code	Inst.Hrs. / week	Credits	Exam			Total
						Hrs.	Marks		
							Int.	Ext.	
III	e Course–VIII (CC)	Topology	22PMA3CC8	6	5	3	25	75	100
	Core Course – IX (CC)	Discrete Mathematics	22PMA3CC9	6	5	3	25	75	100
	Core Course - X (CC)	Measure and Integration	22PMA3CC10	6	4	3	25	75	100
	Core Choice Course– II (CCC)	A. Cyber Security	22PGCS3CCC2A	3(T) + 2(P)	4	3	25	75	100
		B. Introduction to Coding Theory	22PMA3CCC2B	5					
		C. Mechanics	22PMA3CCC2C						
	Discipline Specific Elective Course-III (DSE)	A. Analytical Skills for Competitive Examinations	22PMA3DSE3A	4	3	2	-	100	100
		B. Stochastic Processes	22PMA3DSE3B			3	25	75	
		C. Fuzzy Sets and their Applications	22PMA3DSE3C						
	Generic Elective Course -I (GEC)	Foundation for Logical Thinking	22PMA3GEC1	3	2	3	25	75	100
	Extra Credit Course	**SWAYAM**	**As per UGC Recommendation**						
	Total			**30**	**23**	**-**	**-**	**-**	**600**

IV	Core Course–XI(CC)	Complex Analysis	22PMA4CC11	6	5	3	25	75	100
	Core Course - XII(CC)	Functional Analysis	22PMA4CC12	6	5	3	25	75	100
	Core Choice Course–III (CCC)	A. Differential Geometry	22PMA4CCC3A	6	4	3	25	75	100
		B. Formal Language and Automata Theory	22PMA4CCC3B						
		C. Fluid Dynamics	22PMA4CCC3C						
	Generic Elective Course-II (GEC)	Optimization Techniques	22PMA4GEC2	3	2	3	25	75	100
	Project	Project Work	22PMA4PW	9	4	-	-	100	100
	Extension Activity		**23PGEA**	-	1	-	-	-	-
	Total			**30**	**21**	**-**	**-**	**-**	**500**
	Grand Total			**120**	**91**	**-**	**-**	**-**	**2200**

Courses & Credits for PG and Research Department of Mathematics

S. No	Courses	No of Courses	No of Credits	Marks
1.	Core Course– (CC)	12	59	1200
2.	Core Choice Course– (CCC)	3	12	300
3.	Discipline Specific Elective- (DSE)	3	9	300
4.	Generic Elective Course - (GEC)	2	4	200
5.	Project	1	4	100
6.	Internship	1	2	100
7.	Extension Activity	-	1	-
	Total	22	91	2200

Students will go for internship after completing the I Semester exams and the internship willbe calculated in the II Semester and credits for internship is 02.
For each Semester marks will be for 500(600 for II Semester due to internship and 600 for IIISemester also)

The internal and external marks for theory and practical papers are as follows:

Subject	Internal	External
Theory	25	75
Practical	40	60

Separate passing minimum is prescribed for Internal and External

For Theory:

a) The passing minimum for CIA shall be 40% out of 25 marks (i.e. 10 marks).
b) The passing minimum for End Semester Examination shall be 40% out of 75 marks (i.e. 30 marks).
c) The passing minimum not less than 50% in the aggregate.

For Practical:

a) The passing minimum for CIA shall be 40% out of 40 marks (i.e. 16 marks)
b) The passing minimum for End Semester Examinations shall be 40% out of 60 marks (i.e. 24 marks)
c) The passing minimum not less than 50% in the aggregate.

For Project:

Project : 100 Marks
Dissertation : 80 Marks
Viva Voce : 20 Marks

Semester I	Internal Marks: 25		External Marks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs /Week**	**CREDITS**
23PMA1CC1	**ALGEBRAIC STRUCTURES**	**CORE COURSE**	**6**	**5**

Course Objectives

- **Gain** expertise and confidence in proving theorems to progress in mathematical studies.
- **Acknowledge** the students with experience in axiomatic mathematics while keeping in close touch with the computational aspects of the subject.
- **Enhance** students to understand principles, concepts necessary to formulate, solve and analyze Algebra.

Prerequisite

Basic knowledge of sets, relations and functions.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	COStatement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Apply the Basic Concepts of Counting Principle, Sylow's Theorems, Modules, Linear Transformations and Real Quadratic Forms	K1, K2, K3
CO2	Examine in detail about Direct Products, Canonical Forms Canonical Forms, and Normal Transformations	K3
CO3	Solve problems related to Sylow's theorems, Canonical Forms and Linear Transformations	K4
CO4	Classify the Counting Principle, Linear and Normal Transformation	K4
CO5	Analyze the concepts of Sylow's Theorems, Solvability by Radicals, Canonical Forms, Linear and Normal Transformation.	K5

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3	3	3	2	2	2
CO2	3	2	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	2	3	3	2	2	3
CO5	3	2	3	3	2	3	3	3	3	2

"1" – Slight (Low) Correlation ¬ "2" – Moderate (Medium) Correlation ¬

"3" – Substantial (High) Correlation ¬ "-" indicates there is no correlation.

Syllabus

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	Counting Principle - Sylow's theorems	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	Direct products - Finite abelian groups – Modules – Solvability by Radicals	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	Linear Transformations: Canonical forms : Triangular form - Canonical forms : Nilpotent transformations	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	Canonical forms: A Decomposition of V: Jordan form - Canonical forms : Rational canonical form	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	Trace and Transpose - Hermitian, Unitary and Normal Transformations - Real Quadratic Forms	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
VI	**Self-Study for Enrichment (Not included for End Semester Examinations)** Galois Groups over the Rationals - The Algebra of Linear Transformation – Characteristics Roots- Matrices – Determinants	-	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Book

I.N. Herstein (2016), *Topics in Algebra(II Edition),* Wiley Eastern Limited, New Delhi.

Chapters and Sections

UNIT- I Chapter 2: Sections 2.11 and 2.12

UNIT- II Chapter 2: Section 2.13 and 2.14

Chapter 4: Section 4.5

Chapter 5 : Section 5.7

UNIT- III Chapter 6: Sections 6.4 and 6.5

UNIT- IV Chapter 6 : Sections 6.6 and 6.7

UNIT- V Chapter 6 : Sections 6.8, 6.10 and 6.11

Reference Books

1. David S. Dummit and Richard M. Foote (2004), *Abstract Algebra*, Wiley and Sons, Third Edition.
2. Joseph A. Gallian, (1999), *Contemporary Abstract Algebra*, Narosa Publishing House, Fourth Edition.
3. M. Artin, (1991), *Algebra*, Prentice Hall of India.
4. P. B. Bhattacharya, S. K. Jain, and S. R. Nagpaul (1997), *Basic Abstract Algebra* (II Edition) Cambridge University Press, Indian Edition

Web References

1. https://www.youtube.com/watch?v=g7L_r6zw4-c
2. https://www.youtube.com/watch?v=VSB8jisn9xI
3. https://www.youtube.com/watch?v=WwndchnEDS4
4. http://mathforum.org
5. http://ocw.mit.edu/ocwweb/Mathematics
6. http://www.opensource.org

Pedagogy

Power Point Presentations, Group Discussions, Seminar, Quiz, Assignment.

Course Designer

Dr. K. Kalaiarasi

Semester I	Internal Marks: 25		External Marks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs /Week**	**CREDITS**
23PMA1CC2	**REAL ANALYSIS - I**	**CORE**	**6**	**5**

Course Objectives

- **Define** the notion of functions of bounded variation, Riemann – Stieltjes integration, convergence of infinite series, uniform convergence.
- **Explore** the fundamental concepts of Riemann – Stieltjes integration and infinite series.
- **Apply** the idea of construction of infinite series and power series in various fields.

Prerequisite

UG level real analysis concepts

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Explainthe concepts of functions of bounded variation, Riemann-Stieltjes integral, infinite series, power series, double sequences and sequence of functions.	K2
CO2	Apply the concepts of functions of bounded variation, Riemann-Stieltjes integral, infinite series, power series, double sequences and sequence of functions and its properties in various fields.	K3
CO3	Classify the concepts of functions of bounded variation, Riemann-Stieltjes integral, infinite series, power series, double sequences and sequence of functions.	K4
CO4	Evaluate Riemann-Stieltjes integral, infinite series, power series, double sequences and sequence of functions.	K5
CO5	Construct various mathematical proofs using the properties of Riemann-Stieltjes integral, infinite series, power series, double sequences and sequence of functions.	K6

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3	3	2	3	3	3
CO2	3	3	3	3	3	2	3	3	2	3
CO3	3	3	3	3	3	2	3	2	3	3
CO4	3	3	3	3	3	3	3	2	2	3
CO5	3	3	3	3	3	3	2	3	3	3

"1" – Slight (Low) Correlation ¬ "2" – Moderate (Medium) Correlation ¬

"3" – Substantial (High) Correlation ¬ "-" indicates there is no correlation.

Syllabus

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Functions of bounded variation:** Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation. **Infinite Series:** Infinite Series - Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4, K5, K6
II	**The Riemann - Stieltjes Integral:** Introduction - Notation - The definition of the Riemann-Stieltjes integral - Linear Properties - Integration by parts - Change of variable in a Riemann-Stieltjes integral - Reduction to a Riemann Integral – Step functions as integrators – Reduction to a Riemann – Stieltjes integral to a finite sum - Euler's summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper and lower integrals - Riemann's condition - Comparison theorems.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4, K5, K6
III	**The Riemann-Stieltjes Integral:** Integrators of bounded variation - Sufficient conditions for the existence of Riemann-Stieltjes integrals - Necessary conditions for the existence of Riemann-Stieltjes integrals - Mean value theorems for Riemann-Stieltjes integrals – The integral as a function of the interval – Second fundamental theorem of integral calculus - Change of variable in a Riemann integral - Second Mean-Value Theorem for Riemann integrals - Riemann-Stieltjes integrals depending on a parameter - Differentiation under integral sign – Interchanging the order of integration – Lebesgue's criterion for existence of Riemann integrals.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4, K5, K6
IV	**Infinite Series and infinite Products:** Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series – Cesaro summability - Infinite products. **Power Series:** Power series- Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4, K5, K6
V	**Sequences of Functions:** Pointwise convergence of sequences of functions - Examples of sequences of real-valued functions – Definition of uniform convergence - Uniform convergence and continuity – The Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Uniform convergence and Riemann-Stieltjes integration – Non uniformly convergent sequences that can be integrated term by term - Uniform convergence and differentiation - Sufficient conditions for uniform convergence of a series - Mean convergence.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4, K5, K6
VI	**Self Study for Enrichment:** **(Not included for End Semester Examinations)** Alternating Series – Complex-valued Riemann-Stieltjes integrals – Euler's product for the Riemann zeta function – A space-filling curve – Uniform convergence and double sequences.	-	CO1, CO2, CO3, CO4, CO5	K2, K3, K4, K5, K6

Text Book

Tom M. Apostol. (2002). *Mathematical Analysis (Second Edition)*. Narosa Publishing House.

Chapters and Sections

UNIT-I	Chapter 6:	Sections 6.1 – 6.8
	Chapter 8:	Sections 8.5, 8.8, 8.15, 8.17, 8.18
UNIT-II	Chapter 7:	Sections 7.1 – 7.14
UNIT-III	Chapter 7:	Sections 7.15 – 7.26
UNIT- IV	Chapter 8:	Sections 8.20 – 8.26
	Chapter 9:	Sections 9.14, 9.15, 9.19, 9.20, 9.22, 9.23
UNIT- V	Chapter 9:	Sections 9.1 – 9.6, 9.8 – 9.11, 9.13

Reference Books

1. Robert G. Bartle and Donald R. Sherbert. (2019). *Introduction to Real Analysis (Fourth Edition)*. Wiley India Pvt. Limited.
2. Walter Rudin. (1986). *Principles of Mathematical Analysis (Third Edition)*. McGraw-Hill Book Company.
3. Royden H.L. (2003). *Real Analysis (Third Edition, Nineth Reprint)*. PHI Learning Private Limited, New Delhi.

Web References

1. **https://youtu.be/SMSzqCV91rQ**
2. **https://youtu.be/qVaFEF1NpLY**
3. **https://tinyurl.com/yu8vrpnt**
4. **https://youtu.be/8FhIY5kjDqE**
5. **https://youtu.be/Vx004k9r_YQ**
6. **https://tinyurl.com/236r88xp**
7. **https://tinyurl.com/4y3m4daj**

Pedagogy

Power Point Presentations, Group Discussions, Seminar, Quiz, Assignment.

Course Designer

Dr. S. Vidhya

SEMESTER I	INTERNAL MARKS: 25	EXTERNAL MARKS:75		
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS /WEEK**	**CREDITS**
23PMA1CC3	**ORDINARY DIFFERENTIAL EQUATIONS**	**CORE COURSE**	**6**	**5**

Course Objectives

- **Recognize** certain basic types of second order homogeneous and non-homogeneous ODEsfor which exact solutions maybe obtained and to apply the corresponding methods of solution.
- **Qualitative Analysis** of Solutions of Initial value problems.
- **Analyze** the concepts of existence and uniqueness of solutions.

Prerequisite

UG level Calculus and Differential Equations

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Define initial value problems, linear dependence and independence, regular singular points, successive approximation of homogeneous and non-homogeneous ordinary differential equations	K1
CO2	Understand the physical phenomena modeled by ordinary differential equations and dynamical systems.	K2
CO3	Examinethe solutions of ordinary differential equations using appropriate methods and give examples.	K3
CO4	Discriminate the Qualitative properties of solutions for Initial value problems, convergence of successive approximations of ordinary differential equations.	K4
CO5	Analyse initial value problems, regular singular points, successive approximations of ordinary differential equations and use various theoretical ideas and results.	K5

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	3	3	3	3	2	3
CO2	3	2	3	3	3	2	3	3	2	3
CO3	3	2	3	3	3	3	3	3	2	3
CO4	3	2	3	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	2	2	3

"1" – Slight (Low) Correlation ¬ "2" – Moderate (Medium) Correlation ¬
"3" – Substantial (High) Correlation ¬ "-" indicates there is no correlation.

Syllabus

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Linear equations with constant coefficients:** Introduction- The Second order homogeneous equations-Initial value problems for second order equations-Linear dependence and independence- A formula for the Wronskian- The Non-homogeneous equation of order two.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Linear equations with constant coefficients:** The Homogeneous equation of order n –Initial value problems for n-th order equations- Equations with real constants- The non-homogeneous equation of order n - A special method for solving the non-homogeneous equation - Algebra of constant coefficient operators.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Linear equation with variable coefficients:** Introduction - Initial value problems for the homogeneous equation - Solutions of the homogeneous equation – The Wronskian and linear independence – Reduction of the order of a homogeneous equation – The non-homogeneous equation – Homogeneous equations with analytic coefficients-The Legendre equation.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Linear equation with Regular singular points:** Introduction – The Euler equation – Second order equations with regular singular points - an example – Second order equations with regular singular points – the general case- The Exceptional cases – The Bessel equation- The Bessel equation(continued).	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Existence and uniqueness of solutions to first order equations:** Introduction - Equation with variables separated – Exact equations – The method of successive approximations – The Lipschitz condition – Convergence of the successive approximations.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
VI	**Self-Study for Enrichment :** **(Not included for End Semester Examinations)** Justification of the power series method- A convergence proof- Regular singular points at infinity- Non-local existence of solutions- Approximations to, and uniqueness of, solutions.	-	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Book

EarlA. Coddington (2005), A introduction to ordinary differential equations, Prentice-Hall of India Private Ltd., New Delhi.

Chapters and Sections

UNIT- I	Chapter 2:	Sections 1 to 6
UNIT- II	Chapter 2:	Sections 7 to 12
UNIT- III	Chapter 3:	Sections 1 to 8
UNIT- IV	Chapter 4:	Sections 1 to 4 and 6 to 8
UNIT- V	Chapter 5:	Sections 1 to 6

Reference Books

1. George F Simmons (1974), Differential equations with applications and historical notes, Tata McGraw Hill, New Delhi.
2. M.D.Raisinghania (2001), Advanced Differential Equations, S.Chand& Company Ltd. New Delhi .
3. B.Rai, D.P.Choudary and H.I. Freedman (2002), A Course in Ordinary Differential Equations, Narosa Publishing House, New Delhi.

Web References

1. https://youtu.be/xZsniBazjfI?list=PLbwJuBHc3YzUIgPk82CIm-doYjZa_SeKe

2. https://youtu.be/CgNVZCog-64?list=PLbwJuBHc3YzUIgPk82CIm-doYjZa_SeKe

3. https://youtu.be/dkpeZHeU1xo

4. https://www.cs.bgu.ac.il/~leonid/ode_bio_files/Ionascu_LectNotes.pdf

5. https://www.math.iitb.ac.in/~siva/afs07.pdf

6. https://www.youtube.com/watch?v=IWm6Coa3_bQ

7.https://www.youtube.com/watch?v=1HUnrokDN0U

Pedagogy

Power Point Presentations, Group Discussions, Seminar, Quiz, Assignment.

Course Designer

Dr. G. Janaki

Semester I	Internal Marks: 25		ExternalMarks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs / Week**	**CREDITS**
23PMA1CC4	**PROBABILITY THEORY**	**CORE**	**6**	**5**

Course Objectives

- **Introduce** axiomatic approach to probability theory.
- **Study** some statistical characteristics, discrete and continuous distribution functions and their properties.
- **Analyze** the characteristic function and basic limit theorems of probability.

Prerequisite

UG level Probability and Statistics.

CourseOutcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Acquire the knowledge of basic probability and probability distributions.	K1
CO2	Understand various theorems on probability and their use in solving problems in various diversified situations.	K2
CO3	Calculate moments, Characteristic functions, distribution function, probability generating functions, to solve problems applying characteristic functions	K3
CO4	Illustrate the theory of probability, random variables, probability distribution with suitable examples	K3
CO5	Find solution of real life problems under the concept of probability and probability distributions.	K4

Mapping of CO with PO and PSO

Cos	PSO1	PSO2	SO3	SO4	SO5	O1	O2	O3	O4	O5
CO1	3	3	3	2	3	3	3	2	2	3
CO2	3	2	3	3	3	3	3	3	2	3
CO3	3	3	2	3	3	3	3	3	3	3
CO4	3	2	3	3	2	3	3	2	2	3
CO5	3	2	3	3	2	3	3	3	3	2

"1" – Slight (Low) Correlation "2" – Moderate (Medium)Correlation
"3" – Substantial (High) Correlation "-" indicates there is no Correlation.

Syllabus

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	Random Events and Random Variables: Preliminary remarks - Random events and operations performed on them –The system of axioms of the theory of probability – Application of Combinatorial formulas for computing probabilities – conditional probability – Bayes Theorem – Independent events – The concept of a random variable – Distribution Function – Random variables of the discrete and continuous type - Functions of random variables – Multidimensional random variables – Marginal Distributions – Conditional Distributions.	18	CO1, CO2, CO3, CO4, CO5	K1 K2, K3, K4, K5
II	Parameters of the Distribution of a random variable: Expected values - Moments – The Chebyshev inequality – Absolute moments – Order parameters – Moments of random vectors – Regression of the first type.	18	CO1, CO2, CO3, CO4, CO5	K1 K2, K3, K4, K5
III	Characteristic Functions: Properties of characteristic functions – The characteristic function and moments – semi-invariants – The characteristic function of the sum of independent random variables – Determination of distribution function by the Characteristic function – The characteristic function of multidimensional random vectors.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	Some Probability Distributions: One-point and two-point distributions – The Bernoulli scheme. The Binomial distribution – The Poisson scheme. The generalized Binomial distribution – The Polya – Hypergeometric distributions – Poisson (discrete) distribution – Uniform – normal – gamma – Beta distributions.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	Limit Theorems : Preliminary remarks – Stochastic convergence – Bernoulli's law of large numbers – The convergence of a sequence of distribution functions – Levy-Cramer Theorem – de Moivre-Laplace Theorem – Lindeberg-Levy Theorem – LapunovTheroem – Poisson's, Chebyshev's and Khintchin's laws of large numbers.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
VI	Self-Study for Enrichment: (Not included for End Semester Examinations) Independent random variables – Functions of multidimensional random variables - Regression of the second type - Probability generating functions – Cauchy and Laplace distributions – The Gnedenko Theorem – The strong law of large numbers.	-	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

M. Fisz(1963), *Probability Theory and Mathematical Statistics,* John Wiley and Sons, NewYork.

Chapters and Sections

UNIT-I Chapter 1: Sections 1.1 to 1.7, Chapter 2 : Sections 2.1 to 2.7.

UNIT-II Chapter 3: Sections 3.1 to 3.7.

UNIT-III Chapter 4: Sections 4.1 to 4.6.

UNIT- IV Chapter 5: Section 5.1 to 5.9.

UNIT- V Chapter 6: Sections 6.1 to 6.4, 6.6 to 6.9, 6.11.

Reference Books

1. K.L.Chung(1974). *A course in Probability*, Academic Press, New York.

2. V.K.Rohatgi(1988). *An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern Ltd., New Delhi, (3rd Print).

3. B.R.Bhat(1999).*Modern Probability Theory* (3rd Edition), New Age International (P)Ltd, New Delhi.

Web References

1. http://mathforum.org
2. http://ocw.mit.edu/ocwweb/Mathematics
3. http://www.opensource.org
4. http://www.probability.net
5. http://onlinecourses.nptel.ac.in/noc22_ma81/preview

Pedagogy

Power Point Presentations, Group Discussions, Seminar, Quiz and Assignment.

Course Designers

1. Dr. S. Premalatha.
2. Dr. E. Litta.

Semester - I	Internal Marks: 25		External Marks:75	
COURSECODE	**COURSE TITLE**	**CATEGORY**	**HOURS / WEEK**	**CREDITS**
23PMA1DSE1A	**NUMBER THEORY AND CRYPTOGRAPHY**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**3**

Course Objectives

- **Explore** fundamental concepts of divisibility, Congruences and primes.
- **Analyze** the quadratic Residues, The Mobius Inversion formula, Diophantine equations and their problems.
- **Apply** the ideas of Pythagorean triangle and The Chinese remainder theorem to solve problems

Prerequisite

- Familiarity in concepts of Theory of Numbers
- Familiarity in concepts of Abstract Algebra.
- Coding, Decoding concepts.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Understand basic concepts of Number theory and Cryptography	**K2**
CO2	Classify algorithms and formulas based on the concepts of Number theory and Cryptography.	**K3**
CO3	Ascertain the notions of Number theory and Cryptography.	**K4**
CO4	Evaluate the concepts of Number theory and Cryptography in problem solving.	**K5**
CO5	Develop mathematical ideas in Divisibility concepts, Quadratic residues, Arithmetic functions, Diophantine Equations and cryptography.	**K6**

Mapping of CO withPO and PSO

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	2	3	3
CO5	3	3	3	3	3	3	3	3	3	3

"1" – Slight (Low) Correlation ¬ "2" – Moderate (Medium) Correlation¬

"3" – Substantial (High) Correlation ¬ "-" indicates there is no correlation.

Syllabus

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**DIVISIBILITY AND CONGRUENCES:** Divisibility – Congruences – Solutions of Congruences - Chinese Remainder Theorem, Primitive Roots and Power Residues.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**QUADRATIC RECIPROCITY AND QUADRATIC FORMS:** Quadratic residues – Quadratic reciprocity – The Jacobi symbol - Sum of two squares.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**SOME FUNCTIONS OF NUMBER THEORY:** Greatest Integer function-Arithmetic functions – The Mobius Inversion formula.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**SOME DIOPHANTINE EQUATIONS:** The equation ax + by = c – Simultaneous linear equations – Pythagorean triangles – Assorted Examples- Fermat's Last Theorem.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Classical Encryption Techniques** Symmetric Cipher Model -Cryptography -Cryptanalysis Substitution Techniques- Caesar Cipher – Affine cipher- Monoalphabetic Ciphers -Playfair Cipher -Hill Cipher - Polyalphabetic Ciphers- One-Time Pad -Transposition Techniques **Block Ciphers and the Data Encryption Standard** Block Cipher Principles -Stream Ciphers and Block Ciphers-The Feistel Cipher-Feistel Cipher Structure-Feistel Decryption Algorithm **Public-Key Cryptography and RSA** Principles of Public-Key Cryptosystems- Public-Key Cryptosystems -Applications for Public-Key Cryptosystems -Requirements for Public-Key Cryptography -Public-Key Cryptanalysis **The RSA Algorithm**- Description of the Algorithm-Computational Aspects -The Security of RSA **Key Management; Other Public-Key Cryptosystems** **Key Management**- Distribution of Public Keys - Distribution of Secret Keys Using Public-Key Cryptography **Diffie-Hellman Key Exchange** -The Algorithm- Key Exchange Protocols - Man-in-the-Middle Attack **Elliptic Curve Cryptography**-Analog of Diffie-Hellman Key Exchange- Elliptic Curve Encryption/Decryption - Security of Elliptic Curve Cryptography	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
VI	**Self Study for Enrichment:** **(Not included for End Semester Examinations)** Primes – Binary quadratic forms – Recurrence functions – Ternary quadratic forms – Elliptic Curve Arithmetic	-	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Ivan Niven, Herbert S. Zuckerman & Hugh L. Montgomery (2016) Reprint, An Introduction to the Theory of Numbers, (Fifth Edition, Reprint 2016). Wiley Publishers
2. William Stallings (2009), Cryptography and Network Security - Principles and Practices, (4th edition), Pearson Education Inc.and Dorling Kindersley Publishing Inc.

Chapters and Sections

UNIT-I	Chapter 1[1]:	Sections 1.2
	Chapter 2[1]:	Sections 2.1-2.3, 2.8.
UNIT-II	Chapter 3[1]:	Sections 3.1-3.3, 3.6
UNIT-III	Chapter 4[1]:	Sections 4.1- 4.3
UNIT-IV	Chapter 5[1]:	Sections 5.1 – 5.3
UNIT-V	Chapter 2[2]:	Sections 2.1-2.3
	Chapter 3[2]:	Sections 3.1
	Chapter 9[2]:	Sections 9.1-9.2
	Chapter 10[2]:	Sections 10.1, 10.2 & 10.4

Reference Books

1. David M. Burton (2012), Elementary Number Theory (Sixth Edition), Tata McGraw Hill Education Private Limited, New Delhi.
2. Telang S. G. (2005), Number Theory (Reprint 2001),Tata McGraw Hill Education Private Limited, New Delhi.
3. Neal Koblitz (1994), A Course in Number theory and Cryptography, (2nd edition), Springer – Verlang Newyork Inc.,

Web References

1. https://www.youtube.com/watch?v=ChG_7jeNRHo
2. https://www.youtube.com/watch?v=e8DtzQkjOMQ
3. https://www.youtube.com/watch?v=3W91U-aNclQ
4. https://www.youtube.com/watch?v=bg6CksAkZ-k
5. https://www.youtube.com/watch?v=4dVTlX4bwP0
6. https://www.youtube.com/watch?v=khfIH1H6iUg
7. https://www.youtube.com/watch?v=BC2BdenKsYs
8. https://www.tutorialspoint.com/what-is-discrete-logarithmic-problem-in-information-security
9. https://www.interviewbit.com/blog/0-1-knapsack-problem/

Pedagogy

Power point presentations,Group Discussions, Seminar, Quiz, Assignment.

Course Designer

Dr. P.Saranya

Semester I	Internal Marks: 25	External Marks:75		
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS / WEEK**	**CREDITS**
23PMA1DSE1B	**GRAPH THEORY AND APPLICATIONS**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**3**

Course Objectives

- **Explore** the basic concepts of Graph Theory.
- **Understand** concepts that helps to model real life situation into graphs.
- **Formulate** and prove some theorems about trees, matching, connectivity, colouring and planarity of graphs.

Prerequisite

Basic Knowledge of Graph Theory.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Define the various concepts in Graphs .	K1
CO2	Understand the different terminologies of Graphs.	K2
CO3	Apply the concepts of connectivity, Blocks and Hamilton cycles in the real life.	K3
CO4	Analyze the problems in different aspects and give solutions in their respective streams.	K4
CO5	Assess the concept of both undirected and directed graph which apply in day today life.	K5

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	2	3	2	2	2	3
CO2	2	2	3	2	2	2	2	2	2	3
CO3	3	2	3	2	2	3	2	2	3	3
CO4	3	2	2	2	2	2	2	2	2	2
CO5	2	2	2	3	3	2	3	3	2	2

"1" – Slight (Low) Correlation ¬ "2" – Moderate (Medium) Correlation ¬

"3" – Substantial (High) Correlation ¬ "-" indicates there is no correlation.

Syllabus

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Graphs and Subgraphs:**- Graphs and Simple Graphs- Graph Isomorphism- The Incidence and Adjacency Matrices -Subgraphs- Vertex Degrees–Paths and Connection– Cycles- The Shortest Path Problem	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Trees:** Trees– Cut Edges and Bonds- Cut Vertices – Cayley's Formula- The Connector Problem. **Connectivity:**- Connectivity- Blocks.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Euler Tour and Hamilton Cycles:**- Euler Tours- Hamilton Cycles- The Travelling Salesman Problem. **Matchings:** Matchings- Matchings and Coverings in Bipartite Graphs- Perfect Matchings.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Edge Colourings:** Edge Chromatic Number– Vizing's Theorem. **Independent Sets and Cliques:** Independent Sets. **Vertex Colourings:** Chromatic Number-Brook's Theorem - Chromatic Polynomials.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Planar Graphs:** Plane and Planar Graphs- Euler's Formula- Bridges- Kuratowski's Theorem- Five Colour Theorem and Four -Colour Conjecture. **Directed Graphs:**- Directed Graphs-Directed Paths- Directed Cycles.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
VI	**Self Study for Enrichment: (Not included for End Semester Examination)** Sperner's Lemma- -Construction of Reliable Communication Networks- The Chinese Postman Problem -Hajo's Conjecture -A Storage Problem- Dual Graphs.	-	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Book

Bondy, J. A. and Murthy, U. S. R,(1976)*Graph Theory with Applications*, The Macmillan Press Ltd, London and Basingstoke.

Chapters and Sections

UNIT-I	Chapter 1:	Sections 1.1-1.8
UNIT-II	Chapter 2:	Sections 2.1-2.5
	Chapter 3:	Sections 3.1, 3.2
UNIT-III	Chapter 4:	Sections 4.1- 4.2, 4.4
	Chapter 5:	Sections 5.1- 5.3
UNIT- IV	Chapter 6:	Sections 6.1, 6.2
	Chapter 7:	Section 7.1
	Chapter 8:	Sections 8.1- 8.2, 8.4
UNIT- V	Chapter 9:	Sections 9.1, 9.3 - 9.6
	Chapter 10:	Sections 10.1-10.3

Reference Books

1. Reinhard Diestel (2006). *Graph Theory*, Springer- Verlag, New York.
2. Gary Chartrand, Ping Zhang(2006). *Introduction to Graph Theory*, Tata McGraw- Hill Publishing Company Limited, New Delhi.
3. NarsinghDeo(2022). *Graph Theory With Applications To Engineering & Computer Science*. Prentice Hall of India, New Delhi.

Web References

1. **https://www.youtube.com/results?search_query=graph+theory+definitions+and+examples**
2. **https://www.youtube.com/results?search_query=trees+in+graph+theory**
3. **https://www.whitman.edu/Documents/Academics/Mathematics/stevens.pdf**
4. **https://web.itu.edu.tr/gencata/courses/GT/GTlecture9.pdf**
5. **https://youtu.be/_VzHJXwQCpM**
6. **https://youtu.be/U5f-mxGNTuc**
7. **https://youtu.be/kCaR7WMDf6o**

Pedagogy

Chalk and talk, PPT, Discussion, Assignment, Quiz, Seminar.

Course Designer

Dr. P. Shalini

Semester: I	Internal Marks: 25		External Marks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS/ WEEK**	**CREDITS**
23PMA1DSE1C	**PROGRAMMING IN C++ AND NUMERICAL METHODS**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**3**

Course Objectives

- **Gain** an appreciation of the concept of error in these methods and need to analyze and predict it.
- **Train** the students to develop analytical thinking and the study of stability analysis.
- **Provide** the keen knowledge of C++ language and enable the students to write object oriented, platform independent and interactive program.

Prerequisite

Basic Knowledge of Numerical Methods and C Language

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the Successful completion of the course, students will be able to	Cognitive Level
CO1	Implement numerical methods in computer programming using C++ language.	**K2,K3**
CO2	Classify the various techniques of interpolation and approximation and design different numerical algorithms with respect to accuracy and efficiency of solution.	**K2, K3**
CO3	Explain and measure errors in numerical computations and outline the basic concepts of Oops, classes, objects and functions.	**K1, K2**
CO4	Compute solutions of interpolation problems and exhibit the knowledge of program execution and debugging ofC++.	**K2, K3**
CO5	Apply various methods to solve transcendental and polynomial equations and Illustrate the components of C++ programming.	**K3, K4**

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**3**	**2**
CO2	**3**	**2**	**3**	**1**	**1**	**3**	**3**	**2**	**3**	**2**
CO3	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**3**	**3**
CO4	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**3**
CO5	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**3**

"1" – Slight (Low) Correlation
"2" – Moderate(Medium)Correlation
"3"–Substantial(High)Correlation
"-"indicates there is no Correlation.

Syllabus

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Transcendental and Polynomial Equations:** Rate of convergence – Polynomial equations: Descartes' Rule of Signs - Iterative Methods: Birge-Vieta method - Bairstow's method.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Interpolation and Approximation:** Hermite Interpolations, Piecewise and Spline Interpolation - Bivariate Interpolation.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Principles of Object-Oriented Programming**: Software Crisis- Software Evolution- A Look at Procedure- Oriented Programming- Object- Oriented Programming Paradigm-Basic concepts of Object-Oriented Programming- Benefits of OOP- Object-Oriented Languages – Application of OOP. **Beginning with C++:** What is C++ - Applications of C++ - A Simple C++ Program – More C++ Statements – An Example with Class – Structure of C++ Program – Creating the Source File – Compiling and Linking.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**FunctionsinC++:** Introduction – The Main Function–Function prototyping – Call by Reference – Return by Reference – Inline functions– Default Arguments – const Arguments – Recursion - Function overloading.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Classes andObjects**: Introduction – C structures Revisited - Specifying a Class– Defining Member Functions – C++ Program with Class – Making an Outside Function Inline – Nesting of Member Functions – Private Member Functions – Arrays within a Class – Memory allocation for Objects- Static Data Members – Static MemberFunctions–Arrays of Objects – Objects as Function Arguments – Friendly Functions – Returning Objects – const Member Functions	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
VI	**Self- Study for Enrichment** **(Not included for End Semester Examinations)** Direct Method: Graeffe's root squaring method - Lagrange Bivariate interpolation - Friend & Virtual Functions – Math Library Functions - Pointers toMembers – Local Classes	-	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain (2022), Numerical Methods for Scientific and Engineering Computation, New Age International (P) Limited Publishers, New Delhi, 8th Edition.
2. E. Balagurusamy (2018), Object-Oriented Programming with C++, TataMcGrawHill,7thEdition.

Chapters and Sections

UNIT- I	Chapter 2: Section 2.5 & 2.9[1]
UNIT- II	Chapter 4: Section 4.5 – 4.7[1]
UNIT- III	Chapter 1: Section 1.1 – 1.8[2]
	Chapter 2: Section 2.1 – 2.8[2]
UNIT- IV	Chapter 4: Section 4.1 – 4.10[2]
UNIT- V	Chapter 5: Section 5.1 – 5.17[2]

Reference Books

1. M.K. Jain (1983), Numerical Solution of Differential Equations, New Age International Pvt Ltd., 2nd Edition,
2. Robert L afore (2019), Object Oriented Programming in C++, Pearson Education, 4th Edition.
3. Rajesh K. Shukla (2009), Object Oriented Programming in C++, Wilsey India Pvt. Ltd, 1st Edition.

Web References

1. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjii6KIktjyAhUq7HMBHdg7C5EQFnoECAMQAQ&url=https%3A%2F%2Fwww.math.ust.hk%2F~machas%2Fnumerical-methods.pdf&usg=AOvVaw2XYqzDmJzupEa79S98dhiS
2. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjT8I2RgtjyAhWC7XMBHZknBY8QFnoECAMQAQ&url=https%3A%2F%2Fwww-personal.acfr.usyd.edu.au%2Ftbailey%2Fctext%2Fctext.pdf&usg=AOvVaw1vmjykV3ynWgE-1Ifz4Th5
3. http://www.nptelvideos.in/2012/11/numerical-methods-and-programing.html
4. http://www.nptelvideos.in/2012/11/numerical-methods-and-computation.html
5. https://nptel.ac.in/courses/122106033/
6. https://nptel.ac.in/courses/122106033/25

Pedagogy

Chalk and Talk, Power Point Presentations, Group discussion, Seminar & Assignment.

Course Designer

Ms. A. Gowri Shankari

Semester II	Internal Marks: 25		External Marks:75	
COURSE CODE	**COURSETITLE**	**CATEGORY**	**Hrs /Week**	**CREDITS**
23PMA2CC5	**ADVANCED ALGEBRA**	**CORE**	**6**	**5**

Course Objective

- **Learn** the fundamentals in Galois theory.
- **Expertise** and confidence in proving theorems to progress in Galois theory.
- **Familiarize** the concepts of Galois group.

Prerequisite

Basic knowledge of Algebra.

Course Outcomes

Course Outcome and Cognitive Level Mapping

COs	CO Statement On the successful completion of the course, students will be ableTo	Cognitive Level
CO1	Analyse the important concepts of Galois theory and identify through various examples.	K1, K2, K3
CO2	Predict the notions and their connections of Galois theory.	K3
CO3	Examine the proof of solvability by Galois theory.	K4
CO4	Evaluate clear cut idea in Galois theory extensions and illustrate through examples.	K5
CO5	Learn and conclude Galois theory correspondence theorem of algebra.	K5

Mapping of CO with PO and PSO

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	2	2	3	2	2	2	2
CO2	3	3	3	2	2	3	3	3	2	2
CO3	3	3	3	3	3	3	3	2	3	3
CO4	2	2	3	3	3	2	2	3	3	3
CO5	2	2	3	3	3	2	3	2	3	3

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation

"3" – Substantial (High) Correlation "-" indicates there is no correlation.

Syllabus

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	Quotient Rings - Polynomial Rings over Fields - Prime Ideals and Maximal Ideals - Irreducible Polynomials.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	Classical Formulas - Splitting Fields.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	The Galois Group - Roots of Unity - Solvability by Radicals.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	Independence of Characters - Galois Extensions.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	The Fundamental Theorem of Galois Theory – Galois's Great Theorem.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
VI	**Self-Study for Enrichment (Not included for End Semester Examinations)** Rings - Domains and Fields - Homomorphism and Ideals - Quotients Rings- Polynomial Rings over Fields- Applications	-	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Book

Joseph Rotman (2010), *Galois Theory*, 2nd Edition, Springer International Edition.

Chapters and Pages

UNIT I Pages 21 - 43

UNIT II Pages 44 - 58

UNIT III Pages 59 - 75

UNIT IV Pages 76 - 82

UNIT V Pages 83, 84, 90 - 95

Reference Books

1. David S. Dummit and Richard M. Foote (2017), *Abstract Algebra (*Third Edition), John Wiley & Sons.
2. John B. Fraleigh (2003), *A First Course in Abstract Algebra* (Seventh Edition), Pearson Education.
3. I. N. Herstein (2016), *Topics in Algebra (*3rd Edition*)*, John Wiley & Sons.

Web References

1. **https://nrich.maths.org/1422**
2. **https://www.math3ma.com/blog/what-is-galois-theory-anyway**
3. **https://people.math.harvard.edu/~elkies/M250.01/galois_topix.html**
4. **https://www.maths.ed.ac.uk/~tl/gt/gt.pdf**
5. **https://mathoverflow.net/questions/34125/is-galois-theory-necessary-in-a-basic-graduate-algebra-course**

Pedagogy

Power point Presentations, Group Discussions, Seminar, Quiz, Assignment.

Course Designer

Dr. K. Kalaiarasi

Semester II	Internal Marks:25		External Marks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs/Week**	**CREDITS**
23PMA2CC6	**REAL ANALYSIS II**	**CORE**	**6**	**5**

Course Objectives

- **Define** the notion of metric space, limits of a function, continuous function and component of a metric space.
- **Explore** the fundamental concepts of derivatives of vector-valued functions.
- **Apply** the idea of matrix representation using linear function.

Prerequisite

Fundamental concepts of Real Analysis

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Explain various mathematical proof of basic results in real analysis.	K2
CO2	Apply the properties of real numbers that lead to the formal development of real analysis.	K3
CO3	Ascertain the concepts of different types of derivatives and partial derivatives.	K4
CO4	Evaluate the concepts of limits, continuity and implicit function that can be applied to important practical problems.	K5
CO5	Develop the important concepts of real analysis.	K6

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3	3	2	3	3	3
CO2	3	3	3	3	3	2	3	3	2	3
CO3	3	3	3	3	3	2	3	2	3	3
CO4	3	3	3	3	3	3	3	2	2	3
CO5	3	3	3	3	3	3	2	3	3	3

"1"–Slight(Low)Correlation "2"–Moderate(Medium) Correlation

"3"–Substantial(High)Correlation "-"indicates there is no correlation.

Syllabus

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Limits:** Introduction–Convergent sequences in a metric space – Cauchy sequences – Complete metric spaces – Limit of a function – Limits of complex-valued functions. **Continuity:** Continuous functions – Continuity of composite functions –Continuous complex-valued and vector-valued functions – Examples of continuous functions.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4, K5, K6
II	**Continuity:** Continuity and inverse images of open or closed sets – Functions continuous on compact sets – Topological mappings (homeomorphisms) – Bolzano's theorem – Connectedness – Components of a metric space – Arcwise connectedness – Uniform continuity – Uniform Continuity and compact sets – Fixed-point theorem for contractions.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4, K5, K6
III	**Derivatives:** Introduction – Definition of derivative – Derivatives and continuity – Algebra of derivatives – The chain rule – One-sided derivatives and infinite derivatives – Functions with nonzero derivative –Zero derivatives and local extrema – Rolle's theorem – The Mean-Value Theorem for derivatives – Intermediate-value theorem for derivatives – Taylor's formula with remainder – Partial derivatives – Differentation of functions of a complex variable – TheCauchy-Riemann equations.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4, K5, K6
IV	**Multivariable Differential Calculus:** Introduction – The directional derivative – Directional derivatives and continuity – the total derivative – The total derivative expressed in terms of partial derivatives – An application to complex-valued functions – The matrix of a linear function – The Jacobian matrix – The chain rule – Matrix form of the chain rule – The Mean-value Theorem for differentiable functions – A Sufficient condition for differentiability – A sufficient condition for equality of mixed partial derivatives.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4, K5, K6
V	**Implicit Functions and Extremum Problems** Introduction – Functions with nonzero Jacobian determinant – The inverse function theorem – The implicit function theorem – Extrema of real-valued functions of one variable – Extrema of real- valued functions of several variables – Extremum problems with side conditions.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4, K5, K6

VI	**Self Study for Enrichment:** **(Not included for End Semester Examinations)** Limits of vector-valued functions - Discontinuities of real-valued functions - Derivatives of vector-valued functions - Taylor's formula for functions from R^n to R^1	-	CO1, CO2, CO3, CO4, CO5	K2, K3, K4, K5, K6

Text Book

Tom M. Apostol.(2002).*Mathematical Analysis (Second Edition 20th Reprint)*, Narosa Publishing House.

Chapters and Sections

UNIT- I Chapter 4: Section 4.1-4.6,4.8-4.11
UNIT- II Chapter 4: Section 4.12 – 4.21
UNIT- III Chapter 5: Section 5.1 – 5.12,5.14-5.16
UNIT- IV Chapter 12: Section 12.1 – 12.13
UNIT- V Chapter 13: Section 13.1 – 13.7

Reference Books

1. Robert G. Bartle and Donald R. Sherbert. (2019). *Introduction to Real Analysis(Fourth Edition).* Wiley India Pvt. Limited.
2. Royden H. L. (2003). *Real Analysis (Third Edition, Nineth Reprint).* Prentice-Hallof India Private Limited, New Delhi.
3. Walter Rudin. (1986). *Principles of Mathematical Analysis (Third Edition).* McGraw-Hill Book Company.

Web References

1. **https://youtu.be/kjpPaKKMJqQ?si=zRjTO-30wx-B_3Y-**
2. **https://youtu.be/59tydOl49Mw?si=p31co7vxk9rOqOH**
3. **https://youtu.be/ZVUOow92hpo?si=rdKPGg_76Up5ar19**
4. **https://youtu.be/IFtjDDB8fzo?si=rG1C6fypshWxZBfz**
5. **https://youtu.be/EJZMPdoYWwc?si=81OokEBqlkdWRksS**
6. **https://youtu.be/LWk7hvY1Goc?si=u4mGKT7v9OSri15j**
7. **https://youtu.be/mslZz8ydzcM?si=VJrvjcANdq4TqNvf**

Pedagogy

Power Point Presentations, Group Discussions, Seminar, Quiz, Assignment.

Course Designer

Dr. P. Shalini

Semester II	Internal Marks: 25		External Marks: 75	
COURSE CODE	COURSE TITLE	CATEGORY	Hrs /Week	CREDITS
23PMA2CC7	LINEAR ALGEBRA	CORE	6	5

Course Objectives

- **Acquire** knowledge related to basic concepts.
- **Develop** rational thinking patterns in terms of problem-solving in competitive exams.
- **Emphasis** on knowledge of the various aspects of Linear Algebra.

Prerequisite

Basic Knowledge of algebra and vector space.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Remember and recall the basic concepts of vector space.	K1
CO2	Illustrate the various techniques of problem-solving in respective stream.	K2
CO3	Apply different terminologies of linear algebra.	K3
CO4	Classify the various properties in transformation.	K4
CO5	Interpret the problems involved in vector spaces.	K5

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	2	3	2	3	2	3	3
CO2	3	3	3	3	3	3	3	3	3	3
CO3	2	2	3	2	3	3	3	2	2	3
CO4	2	2	2	2	3	2	2	2	2	3
CO5	3	3	3	3	3	3	3	3	2	3

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation □

"3" – Substantial (High) Correlation "-" indicates there is no correlation.

Syllabus

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Linear Equations:** Systems of Linear Equations – Matrices and Elementary Row Operations – Row - Reduced Echelon Matrices – Invertible Matrices – Bases and Dimension.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Linear Transformations:** Linear Transformations - The Algebra of Linear Transformations – Isomorphism – Representation of Transformations by Matrices – Linear Functionals – The Transpose of a Linear Transformation.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Determinants:** Commutative Rings – Determinant Functions - Permutations and the Uniqueness of Determinants – Additional Properties of Determinants.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Elementary Canonical Forms:** Characteristic Values – Annihilating Polynomials - Invariant Subspaces – Direct-Sum Decompositions.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Operators on Inner Product Spaces:** Forms on Inner Product Spaces – Positive Forms – More on Forms – Spectral Theory.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
VI	**Self -Study for Enrichment:** **(Not included for End Semester Examination)** Matrix Multiplication – Vector Spaces - The Double Dual – Inner Product Spaces - Further Properties of Normal Operators.	-	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Book

Kenneth Hoffman and Ray Kunze (1975). *Linear Algebra*, Second Edition, PHI Learning Private Limited, New Delhi.

Chapters and Sections

UNIT-I	Chapter 1: Sections 1.2 – 1.4, 1.6 Chapter 2: Sections 2.3
UNIT-II	Chapter 3: Sections 3.1 – 3.5, 3.7
UNIT-III	Chapter 5: Sections 5.1 – 5.4
UNIT- IV	Chapter 6: Sections 6.2 – 6.4, 6.6.
UNIT- V	Chapter 9: Sections 9.2 - 9.5.

Reference Books

1. Kumaresan S(January 2018). *Linear Algebra: A Geometric Approach*, Prentice – Hall of India Ltd.
2. Keshawa Prasad Gupta(2008). *Linear Algebra*, Pragati Prakashan, Fifteenth Revised Edition.
3. Edgar Goodaire G(2014). *Linear Algebra*, Pure & Applied World Scientific, Cambridge University Press India Ltd.

Web References

1. https://youtu.be/Pc2dWW3aSrk
2. https://youtu.be/shs8lWDOBHO
3. https://youtu.be/nPOooyrM5is
4. https://youtu.be/uJNQPgYjlQc
5. https://youtu.be/6PEKr7vWsrw
6. https://ksuweb.kennesaw.edu
7. https://www.math.hkust.edu.hk/~mabfchen/Math111/Week13-14.pdf

Pedagogy

Power Point Presentations, Group Discussions, Seminar, Quiz, Assignment.

Course Designer

Ms.V.ManiMozhi

Semester II	Internal Marks: 25		External Marks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs /Week**	**CREDITS**
22PMA2CCC1A	**PARTIAL DIFFERENTIAL EQUATIONS**	**CORE CHOICE**	**6**	**4**

Course Objectives

- **Recognize** certain basic types of first and second order PDEs and an in-depth knowledge of solving them by various methods.
- **Analyze** the Characteristics and Compatibility of PDE's.
- **Qualitative Analysis** of the solutions of Boundary value Problems.

Prerequisite

Fundamental knowledge of Partial differential equations in UG.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	**Interpret** the solutions of hyperbolic, linear and second order partial differential equations, Exterior, Interior and boundary value problems using various Methods.	**K2**
CO2	**Develop** the various type of first and second order equations, Interior and Exterior value problems and **Determine** the higher order equations in physics, **C**haracteristics of Equations in Three Variables, Linear Hyperbolic Equations and Elementary Solutions of Laplace's Equation.	**K3**
CO3	**Diagnose** the orthogonally, compatibility and characteristics of the partial differential equations with constant and variable coefficients, method of Integral transforms and Families of Equipotential Surfaces.	**K3**
CO4	**Discriminate** the solutions of first, second order and hyperbolic equations, Integral Surfaces Passing through a Given Curve, Surfaces Orthogonal to a Given System of Surfaces, **C**haracteristics of Equations in Three Variables, The Solution of Linear Hyperbolic Equations, Separation of Variables	**K4**
CO5	**Ascertain** the concepts of Laplace equation to find the solution of boundary value problems, Special Types of First-Order Equations, Linear Partial Differential Equations with Constant Coefficients, Equations with Variable Coefficients,the Method of Integral Transforms, Families of Equipotential Surfaces.	**K4**

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3	3	3	2	2	1
CO2	3	2	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	2	3	3	2	2	3
CO5	3	2	3	3	2	3	3	3	3	2

"1" – Slight (Low) Correlation ¬ "2" – Moderate (Medium) Correlation ¬
"3" – Substantial (High) Correlation ¬ "-" indicates there is no correlation.

Syllabus

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Partial Differential Equations of The First Order:** Partial Differential Equations - Origins of First-order Partial Differential Equations - Cauchy's Problem for First-order Equations - Linear Equations of the First Order - Integral Surfaces Passing through a Given Curve - Surfaces Orthogonal to a Given System of Surfaces.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4
II	**Partial Differential Equations of The First Order:** Cauchy's Method of Characteristics - Compatible Systems of First-order Equations – Charpit's Method - Special Types of First-Order Equations - Jacobi's Method.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4
III	**Partial Differential Equations of the Second Order:** The Origin of Second-order Equations – Second-order Equations in Physics – Higher-order Equations in Physics - Linear Partial Differential Equations with Constant Coefficients - Equations with Variable Coefficients.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4
IV	**Partial Differential Equations of the Second Order:** **C**haracteristics of Equations in Three Variables - The Solution of Linear Hyperbolic Equations - Separation of Variables - The Method of Integral Transforms.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4
V	**Laplace's Equation:** Elementary Solutions of Laplace's Equation - Families of Equipotential Surfaces - Boundary Value Problems - Separation of Variables.	18	CO1, CO2, CO3, CO4, CO5	K2, K3, K4
VI	**Self Study for Enrichment:** **(Not included for End Semester Examinations)** Nonlinear Partial Differential Equations of the First Order - Solutions Satisfying Given Conditions - Characteristic Curves of Second-Order Equations – Nonlinear Equations of the Second Order– Problems with Axial Symmetry.	-	CO1, CO2, CO3, CO4, CO5	K2, K3, K4

Text Book

Ian N. Sneddon (2006), *Elements of Partial Differential Equations*, Dover Publication – INC. Mineola, Newyork.

Chapters and Sections

UNIT- I	Chapter 2:	Sections 1 to 6
UNIT- II	Chapter 2:	Sections 8 to 11, 13
UNIT- III	Chapter 3:	Sections 1 to 5
UNIT- IV	Chapter 3:	Sections 7 to 10
UNIT- V	Chapter 4:	Sections 2 to 5

Reference Books

1. M.D.Raisinghania (2001), *Advanced Differential Equations*, Eighth Edition, S.Chand and Company Ltd., NewDelhi.
2. T.Amarnath (2003), *Elementary Course in Partial Differential Equations*, Second Edition, Narosa Publishing House, New Delhi.
3. Sauvigny, Friedrich (2006), *A Partial Differential Equations 2: Functional Analytic Methods*, Springer, Arizona.

Web References

1. https://people.bath.ac.uk/mir20/images/odenotes.pdf
2. https://pages.pomona.edu/~ajr04747/Spring2014/Math182/Notes/Math182Spring2014Notes.pdf/
3. https://www.youtube.com/watch?v=VBn1diQCykQ/
4. https://www.youtube.com/watch?v=f0FeWyloHrs/
5. https://nptel.ac.in/courses/111106139/

Pedagogy

Power Point Presentations, Group Discussions, Seminar, Quiz, Assignment.

Course Designer

Dr. G. Janaki

Semester II	Internal Marks: 25		External Marks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs /Week**	**CREDITS**
22PMA2CCC1B	**MATHEMATICAL PROGRAMMING**	**CORE CHOICE**	**6**	**4**

Course Objectives

- Ability to **Understand** and **Analyze** managerial problems in industry so that they are able touse resources (capitals, materials, staffing, and machines) more effectively.
- **Knowledge** of formulating mathematical models for quantitative analysis of managerial problems in industry.
- **Allows** a quantitative technique or a scientific approach for making better decisions for operations under the control.

Prerequisite

Basic Knowledge of Operations Research.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Recognize the importance and value of Operations Research and mathematical modeling in solving practical problems in industry	K1, K2
CO2	Know how to use variables for formulating complex mathematical models in management science, industrial engineering and Transportation science and in real life.	K3
CO3	Analyze a managerial decision problem and formulate into a mathematical model	K4
CO4	To design, improve and operate complex systems in the best possible way	K4, K5
CO5	Determine the solution of Non Linear Programming based on Various Method.	K5

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	3	3	3	3	3	2	3
CO2	3	3	3	3	3	3	3	3	2	3
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3
CO5	3	3	2	3	3	3	2	3	3	3

"1" – Slight (Low) Correlation ¬ "2" – Moderate (Medium) Correlation ¬

"3" – Substantial (High) Correlation ¬ "-" indicates there is no correlation.

Syllabus

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Advanced Linear Programming**: From Extreme Points to Basic Solutions - Generalized Simplex Tableau in Matrix form - Development of the Optimality and Feasibility Conditions - Revised Simplex Algorithm.	17	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Integer Linear Programming**: Integer Programming Algorithms – Cutting Plane Algorithm. **DeterministicDynamic Programming:** Recursive Nature of Dynamic Programming(DP) Computations.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Simulation Modeling :** Monte Carlo Simulation – Types of Simulation – Sampling from ProbabilityDistribution.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Classical Optimization Theory**: Unconstrained Problems – Necessary and Sufficient Conditions – The Newton – Raphson Method – Constrained Problems – Equality Constraints (Jacobi Method).	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Non Linear Programming Algorithms:** Unconstrained Algorithms – Direct Search Method – Gradient Method - Constrained Algorithms – Quadratic Programming.	19	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
VI	**Self -Study for Enrichment:** **(Not included for End Semester Examinations)** Duality – Matrix Definition of the Dual Problem – Optimal Dual Solution – Forward and Backward Recursion – Generation of Random Numbers – Equality Constraints (Lagrangean Method) – Chance-Constrained Programming.		CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Book

Hamdy A.Taha, Nineth Edition, (2014), *Operations Research,* Dorling Kindersley (India) Pvt. Ltd.

Chapters and Sections

UNIT-I	Chapter 7:	Sections 1.1, 1.2, 2.1 - 2.2 (Page No. 299 - 313)
UNIT-II	Chapter 8:	Sections 2, 2.2 (Page No. 355, 364 - 373),
	Chapter 11:	Sections1 (Page No. 461 - 464)
UNIT-III	Chapter 17:	Sections 1, 2, 3.2 (Page No. 681 – 686, 688 - 694)
UNIT- IV	Chapter 18:	Sections 1, 1.1, 1.2, 2, 2.1(Page No. 713 - 726)
UNIT- V	Chapter 19:	Sections 1, 1.1, 1.2, 2, 2.2 (Page No. 737 – 744, 753 – 758)

Reference Books

1. KantiSwarup, P.K. Gupta, ManMohan, Nineteenth Edition (2017), *Operations Research*, Sultan Chand and Sons Publishers.
2. J.K. Sharma, Fourth Edition (2009), *Operations Research Theory and Applications*, Macmillan India Limited.
3. S.S. Rao, Second Edition (1985), *Optimization Theory and Applications*, New Age International Ltd.

Web References

1. https://www.youtube.com/watch?v=ii_oSKROeRI
2. https://www.youtube.com/watch?v=NSrIb7mKtwg
3. https://faculty.ksu.edu.sa/sites/default/files/index.pdf
4. https://www.youtube.com/watch?v=eo2tOPV3AoE
5. https://www.youtube.com/watch?v=9ESUw4azhKE

Pedagogy

Power point presentations, Group Discussions, Seminar, Quiz, Assignment.

Course Designer

Dr. E. Litta.

Semester II	Internal Marks: 25		ExternalMarks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS /WEEK**	**CREDITS**
22PMA2CCC1C	**DIFFERENCE EQUATIONS**	**CORE CHOICE**	**6**	**4**

Course Objectives

- **Analyze** the linear difference equations of higher order.
- **Understand** the implementation of nonlinear difference equations..
- **Summarize** the results of oscillation for linear difference equations with systems of variables..

Prerequisite

Classification of linear difference equations.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Recall and Classify the models through linear difference equations of high-order..	K1, K2
CO2	Interpret the systems of two or more dependent variables for various models.	K2
CO3	Solve the Planetary motions through the study of a linear difference or differential equations to examination of an associated complex function..	K3
CO4	Analyze the basic concepts of Difference equations.	K4
CO5	Determine various types of models through the solutions oscillate around zero or eventually positive or eventually negative and also oscillation theory for self-adjoint equations	K5

Mapping of CO with POs and PSOs

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	3	3	3	2	2	2	3
CO2	2	3	3	2	2	2	3	2	2	3
CO3	2	2	3	3	3	3	3	2	3	3
CO4	3	3	2	2	3	3	3	3	2	2
CO5	2	2	3	3	2	3	2	2	2	3

"1" – Slight (Low) Correlation ¬ "2" – Moderate (Medium) Correlation ¬
"3" – Substantial (High) Correlation ¬ "-" indicates there is no correlation.

Syllabus

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Linear Difference Equations of Higher Order** Difference Calculus: The power Shift, Factorial Polynomials and The Antidifference Operator - General Theory of Linear Difference Equations - Linear Homogeneous Equations with Constant Coefficients **Nonhomogeneous Equations:** Method of Undetermined coefficients : The Method of Variation of Constants (Parameters)	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**System of Linear Difference Equations** Autonomous (Time –Invariant) Systems : The Discrete Analogue of the Putzer Algorithm, The Development of the Algorithm for A^n – the Basic Theory **The Jordan form:** Autonomous (Time –Invariant) Systems Revisited **:** Diagonalizable Matrices, The Jordan Form and Block-Diagonal Matrices.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**The Z-Transform Method and Volterra Difference Equations** Definition and Examples : Properties of the Z-Transform – The Inverse Z-transform and Solutions of Difference Equations : The Power Series Method, The Partial Fractions Method and The Inversion Integral Method **Volterra Difference Equations of convolution types:** The Scalar Case.	20	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Oscillation Theory** Three-Term Difference Equations – Self-Adjoint Second- Order Equations.	17	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Asymptotic Behavior of Difference Equations** Tools and Approximation – Poincare's theorem : Infinite Products and Perron's Example – Asymptotically Diagonal Systems – High- Order Difference Equations	17	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
VI	**Self Study for Enrichment:** **(Not included for End Semester Examination)** Limiting behavior of solutions – Linear Periodic System - Volterra Systems - Nonlinear Difference Equations - Second-Order Difference Equations : A Generalization of the Poincare Perron Theorem.	-	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

Saber N Elaydi, Third Edition, (2004), *An Introduction to Difference Equations*, Springer Verlag, New York.

Chapters and Sections

UNIT-I	Chapter 2	Section 2.1 - 2.4
UNIT-II	Chapter 3	Sections 3.1 - 3.3
UNIT-III	Chapter 6	Sections 6.1 - 6.3
UNIT- IV	Chapter 7	Sections 7.1 & 7.2 (Page No. 313 – 320)
UNIT- V	Chapter 8	Sections 8.1 - 8.4

Reference Books

1. Ravi P.Agarwal and Kanishka Perera, Reprint, (2006), *Proceedings of the Conference on Differential and Difference Equations and Applications*, Hindawi Publishing Corporation.
2. Ravi P.Agarwal, Second Edition, (2000), *Difference Eqations and Inequalites*, Marcel Dekker, Inc., New York.
3. Klaus Neusser, Reprint, (2021), *Difference Equations for Economists* RePEc/ IDEAS.

Web References

1. **https://www.youtube.com/watch?v=zw8xM5GHvZQ**
2. **https://www.youtube.com/watch?v=MtHpbGUIGaA**
3. **https://www.youtube.com/watch?v=ESKx8PEJCB4**
4. **https://www.youtube.com/watch?v=_Xub0zCmlXk**
5. **https://www.youtube.com/watch?v=IKtROKsWVR4**
6. **https://eprints.kfupm.edu.sa/id/eprint/9906/1/9906.pdf**

Pedagogy

Power point Presentations, Group Discussions, Seminar, Quiz, Assignment and Smart Classroom.

Course Designer

Dr R. Buvaneswari.

Semester II	Internal Marks: 40		ExternalMarks:60	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs /Week**	**CREDITS**
22PMA2DSE2AP	**COMPUTATIONAL MATHEMATICS USING MATLAB(P)**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**3**

Course Objectives

- To Provide Software that can be used to explore and experiment with Mathematical Constructions.
- Flexible for users to solve the various system of equations.
- To attain a high level of user support.

Prerequisite

- Basic knowledge of Higher Mathematics

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Remember the concepts of Algebra, Geometry, Numerical Analysis, Calculus, etc.	K1
CO2	Understand the calculation by reading documented source code	K2
CO3	Relate the mathematical thinking that is applicable to daily life	K3
CO4	Associate technological tools for graphical visualization	K4
CO5	Develop skills with core elements of MATLAB and gain an appreciation of social scientific work	K6

Mapping of CO with PO and PSO

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	2	2	3	3	2	2	2
CO2	3	3	3	2	2	2	3	2	2	3
CO3	2	2	2	2	2	2	2	2	2	2
CO4	2	3	2	3	2	3	2	3	2	2
CO5	2	2	2	2	2	2	2	2	2	2

“1” – Slight (Low) Correlation ¬ “2” – Moderate (Medium) Correlation ¬

“3” – Substantial (High) Correlation ¬ “-” indicates there is no correlation.

LIST OF PROGRAMS

1. Mathematical operations
2. Finding GCD and LCM
3. Finding roots and solving the system of equations
4. Matrix Operations
5. Decision Making
6. Loop Types
7. Vector Operations
8. Working with Arrays
9. Plotting 2D Graphs
10. Plotting 3D Graphs
11. Importing and Exporting data in Excel
12. Integration
13. Differentiation and Finding Maxima and Minima
14. Manipulating strings
15. Laplace Transform and Fourier Transform

Web References

1. **https://www.mathworks.com/products/matlab.html**
2. **https://www.mathworks.com/help/matlab/ref/plot.html**
3. **https://www.mathworks.com/help/stateflow/ug/operations-for-vectors-and-matrices.html**
4. **https://www.tutorialspoint.com/matlab/matlab_matrics.htm**
5. **https://www.javatpoint.com/matlab-numerical-integration**

Pedagogy

Power point presentations and Assignment.

Course Designers

1. Dr. S. Sasikala
2. Ms. R. Soundaria.

Semester II	Internal Marks:40		External Marks:60	
COURSECODE	**COURSETITLE**	**CATEGORY**	**Hrs/ Week**	**CREDITS**
23PMA2DSE2BP	**ADVANCED NUMERICAL METHODSUSING MATLAB(P)**	**DISCIPLINE SPECIFIC ELECTIVE COURSE - II**	**6**	**3**

Course Objectives

- To provide software that enables the investigation and testing of mathematical structures.
- It is versatile for users to solve various equation systems.
- To gain powerful user support.

Pre requisite

Basic knowledge of Higher Mathematics

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	**Cognitive Level**
CO1	Remember the concepts of Numerical Analysis	K1
CO2	Compute the numerical integration problems	K3
CO3	Apply the knowledge of various methods to solve numerical integration problems	K3
CO4	Relate the mathematical thinking that is applicable to daily life	K3
CO5	Develop skills with core elements of MATLAB	K6

Mapping of CO with PO and PSO

COs	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	2	3	3	2	2	2
CO2	3	3	3	2	2	2	3	2	2	3
CO3	2	2	2	2	2	2	2	2	2	2
CO4	2	3	2	3	2	3	2	3	2	2
CO5	2	2	2	2	2	2	2	2	2	2

"1"–Slight Low) Correlation "2"–Moderate (Medium) Correlation

"3"–Substantial(High) Correlation "-"indicates there is no correlation.

LIST OF PROGRAMS

1. Birge-Vieta method
2. Bairstow's method.
3. Power Method
4. Horner's Method
5. Singular valued Decomposition
6. QR factorization
7. Characteristic Equation
8. Eigen values and Eigen vectors
9. Adams-Bashforth predictor corrector Method
10. Milne's predictor corrector Method
11. Errors of Newton Raphson Method
12. Lobatto IntegrationMethod

Web References

1. **https://www.mathworks.com/matlabcentral/fileexchange/21013-iterative-adaptive-simpson-and-lobatto-quadrature**
2. **https://www.mathworks.com/matlabcentral/answers/308414-newton-raphson-method-errors**
3. **https://www.mathworks.com/matlabcentral/answers/17931-bairstow-method-to-find-polynomial-roots-matlab-code-**
4. **https://www.mathworks.com/matlabcentral/fileexchange/63034-adams-bashforth-moulton-method**
5. **https://www.mathworks.com/matlabcentral/fileexchange/99604-milne-s-method**

Pedagogy

Power point presentations and Assignment.

Course Designer

Dr.R.Radha

Semester II	Internal Marks:40	External Marks:60		
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HOURS / WEEK**	**CREDITS**
22PMA2DSE2CP	**ORDINARY DIFFERENTIAL EQUATIONS AND PARTIAL DIFFERENTIAL EQUATIONS USING MATLAB (P)**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**3**

Course Objectives

- To identify different ordinary and partial differential equation problems and reformulate them in a way that is appropriate for using MATLAB.
- Use functions from the programming language library for efficient calculations and visualization.
- Solve problems systematically and implement the solution in MATLAB.

Prerequisite

Fundamental knowledge of ordinary and partial differential equations.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course,students will be able to	Cognitive Level
CO1	Describe the use of fundamental data structures	**K3**
CO2	Apply MATLAB effectively to analyze and visualize data	**K4**
CO3	Solve scientific and mathematical problems	**K4**
CO4	Apply basic functions for ordinary and partial differential equations	**K3**
CO5	Compute programs in MATLAB	**K5**

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2	2	3	2	2	3
CO2	3	2	3	2	3	2	3	3	3	3
CO3	3	3	3	2	3	2	3	3	3	2
CO4	3	3	2	3	3	3	2	3	3	3
CO5	3	3	2	3	3	3	2	3	3	3

"1"–Slight (Low)Correlation "2"–Moderate (Medium)Correlation

"3"– Substantial (High)Correlation "-" indicates there is no correlation.

LIST OF PROGRAMS

1. Computing the solutions of First Order Differential Equations.
2. Determine the solutions to Initial Value Problems.
3. Plotting the solutions of First Order Differential Equations.
4. Plotting the solution of the second-order equations.
5. Computing the Solutions of the heat equations.
6. Finding the solutions of the Poisson equations.
7. Determine the solutions of Laplace Equations by Direct Method.
8. Computing the solutions of Laplace Equations by Iterative Method.
9. Solving the nonlinear system of Partial Differential Equations.
10. Plotting for the single Partial Differential Equations with the initial conditions.

Web References

1. **https://in.mathworks.com/help/matlab/math/partial-differential-equations.html**
2. https://www.math.tamu.edu/reu/comp/matode.pdf
3. https://www.math.tamu.edu/~phoward/m401/pdemat.pdf
4. https://www.youtube.com/watch?v=-DmTK868J4A
5. https://www.youtube.com/watch?v=rwC7YU2WUf4

Pedagogy

Power point presentations, Live Demo, Hands on training.

Course Designers

1. Dr. G. Janaki
2. Ms. A. Gowri Shankari.