M.Sc., MATHEMATICS

Syllabus

Program Code: PMT

2023 - Onwards

MANNAR THIRUMALAI NAICKER COLLEGE

(AUTONOMOUS)

Re-accredited with "A" Grade by NAAC

PASUMALAI, MADURAI – 625 004

GUIDLINESS FOR OUTCOME BASED EDUCATION WITH CHOICE BASED CREDIT SYSTEM

(FOR PG PROGRAM FROM 2023 -2024 ONWARDS)

ELIGIBILITY CONDITION FOR ADMISSION

For admission to Post Graduate Programmers (P.G) a candidate should have passed the 3years degree course (under 10 + 2 + 3 pattern) recognized by the university as equivalent there to.

DURATION

Two years. Each year consists of 2 semesters. The duration of a semester is 90 working days.

ATTENDANCE

75% of the classes in each semester shortage of attendance can be condoned as per existing university rules.

EVALUATION PROCEDURE:

A mark Statement with $$CGPA = \frac{\sum(Marks X credits)}{\sum(Credits)}$$

Where the summations are over all paper appeared up to the current semester.

Examinations: 3 hours duration.

Total marks 100 for all papers

External Internal ratio 75:25 with 2 Internal tests.

Subjects of Study

The courses offered under the PG programs belong to the following categories:

1. Core Subjects
2. Electives
3. Non Major Electives (NME)
4. Skill Enhancement course

CBCS COURSE STRUCTURE - PG COURSES

M.A. (Tamil) - M.A. (English) – M.Com. – M.Com (CA) – M.S.W. M.Sc. (Mathematics) - M.Sc. (CS) - M.Sc. (CS&IT)

Semester–I	Credit	Semester-II	Credit	Semester-III	Credit	Semester–IV	Credit
1.1. Core-I	4	2.1. Core-IV	4	3.1. Core-VII	4	4.1. Core-X	4
1.2 Core-II	4	2.2 Core-V	4	3.2 Core-VII	4	4.2 Core-XI	4
1.3 Core – III	4	2.3 Core – VI	4	3.3 Core – IX	4	4.3 Core – XII	4
1.4 Elective (Generic / Discipline Centric)- I	3	2.4 Elective (Generic / Discipline Centric) – III	3	3.4 Elective (Generic / Discipline Centric) – V	3	4.4 Elective (Generic / Discipline Centric) – VI	3
1.5 Elective (Generic / Discipline Centric)-II	3	2.5 Elective (Generic / Discipline Centric)-IV	3	3.5 Core Industry Module	3	4.5 Project with Viva-Voce	3
1.6Ability Enhancement Course- Soft Skill -1	2	2.6 Ability Enhancement Course - Soft Skill -2	2	3.6 Ability Enhancement Course- Soft Skill -3	2	4.6 Ability Enhancement Course- Soft Skill -4	2
Skill Enhancement Course SEC 1	2	2.7 Skill Enhancement Course SEC 2	2	3.7 Skill Enhancement Course – Term Paper and Seminar Presentation SEC 3	2	4.7 Skill Enhancement Course - Professional Competency Skill	2
				3.8 Internship/ Industrial Activity	2	4.8 Extension Activity	1
	22		**22**		**24**		**23**
						Total Credit Points	**91**

QUESTION PAPER PATTERN FOR THE CONTINUOUS INTERNAL ASSESSMENT

Note: Duration – 1 hour 30 minutes

The components for continuous internal assessment are:

Part –A

Four multiple choice questions (answer all)   4 x01= 04 Marks

Part –B

Two questions ('either …. or 'type)   2 x 05=10 Marks

Part –C

Two questions ('either …. or 'type)   2 x 08=16 Marks

                              Total   40 Marks

The components for continuous internal assessment are:

(40 Marks of two continuous internal assessments will be converted to 15 marks)

Two   tests and their average   --15 marks

Seminar /Group discussion   --5 marks

Assignment   --5 marks

                    Total   25 Marks

OUTCOME BASED EDUCATION

1. Course is defined as a theory, practical or theory cum practical subject studied in a semester. For e.g. Computer Applications Management

2. Course Outcome (CO) Course outcomes are statements that describe significant and essential learning that learners have achieved, and can reliably demonstrate at the end of a course. Outcomes may be specified for each course based on its weightage.

3. Program is defined as the specialization or discipline of a Degree. It is the interconnected arrangement of courses, co-curricular and extracurricular activities to accomplish predetermined objectives leading to the awarding of a degree.

4. Program Outcomes (POs) Program outcomes are narrower statements that describe what students are expected to be able to do by the time of graduation. POs are expected to be Guidelines for Outcome Based Education System 4 aligned closely with Graduate Attributes.

5. Program Educational Objectives (PEOs) of a program are the statements that describe the expected achievements of graduates in their career, and also in particular, what the graduates are expected to perform and achieve during the first few years after graduation.

6. Program Specific Outcomes (PSO) are what the students should be able to do at the time of graduation with reference to a specific discipline. Usually there are two to four PSOs for a Program.

7. Graduate Attributes (GA): The graduation attributes, are exemplars of the attributes expected of a graduate from a Program
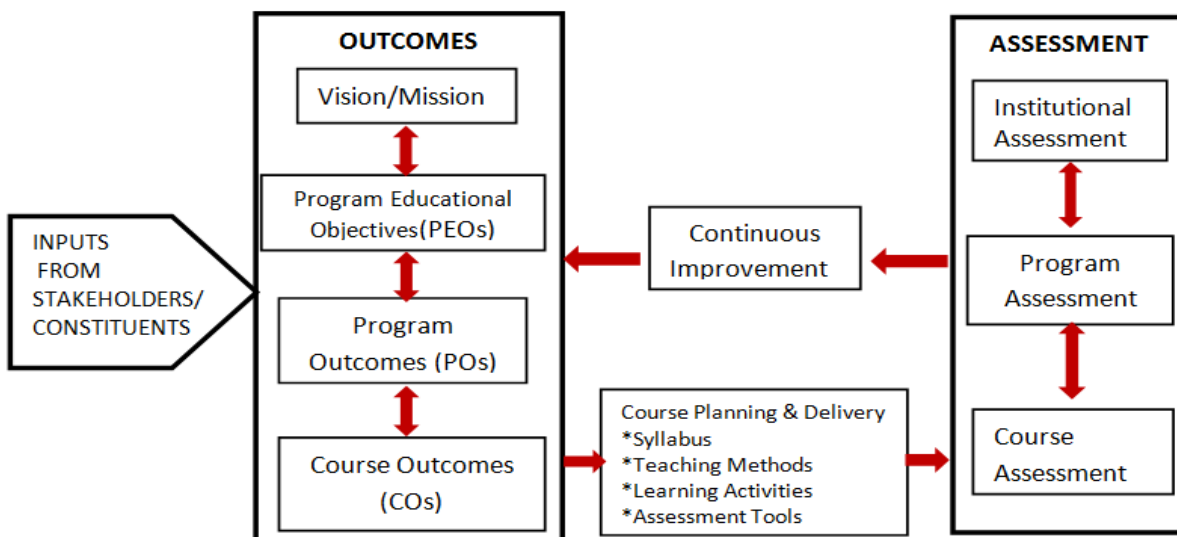
INSTITUTIONAL VISION

To Mould the learners into accomplished individuals by providing them with a stimulus for social change through character, confidence and competence.

INSTITUTIONAL MISSION

1. Enlightening the learners on the ethical and environmental issues.

2. Extending holistic training to shape the learners in to committed and competent citizens.

3. Equipping them with soft skills for facing the competitive world.

4. Enriching their employability through career oriented courses.

5. Ensuring accessibility and opportunity to make education affordable to the underprivileged.

Highlights of the Revamped Curriculum:

➢ Student-centric, meeting the demands of industry & society, incorporating industrial components, hands-on training, skill enhancement modules, industrial project, project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application oriented content wherever required.

➢ The Core subjects include latest developments in the education and scientific front, advanced programming packages allied with the discipline topics, practical training, devising mathematical models and algorithms for providing solutions to industry / real life situations. The curriculum also facilitates peer learning with advanced mathematical topics in the final semester, catering to the needs of stakeholders with research aptitude.

➢ The General Studies and Mathematics based problem solving skills are included as mandatory components in the 'Training for Competitive Examinations' course at the final semester, a first of its kind.

- The curriculum is designed so as to strengthen the Industry-Academia interface and provide more job opportunities for the students.

- The Industrial Statistics course is newly introduced in the fourth semester, to expose the students to real life problems and train the students on designing a mathematical model to provide solutions to the industrial problems.

- The Internship during the second year vacation will help the students gain valuable work experience that connects classroom knowledge to real world experience and to narrow down and focus on the career path.

- Project with viva-voce component in the fifth semester enables the student, application of conceptual knowledge to practical situations. The state of art technologies in conducting a Explain in a scientific and systematic way and arriving at a precise solution is ensured. Such innovative provisions of the industrial training, project and internships will give students an edge over the counterparts in the job market.

- State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature are incorporated as Elective courses, covering conventional topics to the latest - Artificial Intelligence.

MANNAR THIRUMALAI NAICKER COLLEGE (AUTONOMOUS), MADURAI – 625 004
M. SC MATHEMATICS CURRICULUM
(For the student admitted during the academic year 2023-2024 onwards)

Course Code	Title of the Course	Hrs	Credits	Maximum Marks		
				Int	Ext	Total
FIRST SEMESTER						
Part – III	**Core Courses**					
23PMTCC11	ALGEBRAIC STRUCTURES	6	5	25	75	100
23PMTCC12	REAL ANALYSIS - I	6	5	25	75	100
23PMTCC13	ORDINARY DIFFERENTIAL EQUATIONS	6	4	25	75	100
Part – III	**Elective Courses**					
23PMTEC11	GRAPH THEORY AND APPLICATIONS	6	3	25	75	100
23PMTEC12	FUZZY SETS AND THEIR APPLICATIONS	6	3	25	75	100
	Total	**30**	**20**	**125**	**375**	**500**
SECOND SEMESTER						
Part – III	**Core Courses**					
23PMTCC21	ADVANCED ALGEBRA	6	5	25	75	100
23PMTCC22	REAL ANALYSIS - II	6	5	25	75	100
23PMTCC23	PARTIAL DIFFERENTIAL EQUATIONS	6	4	25	75	100
Part – III	**Elective Courses**					
23PMTEC21	NUMERICAL ANALYSIS	6	4	25	75	100
23PMTEC22	RESOURCE MANAGEMENT TECHNIQUES	6	4	25	75	100
	Total	**30**	**22**	**125**	**375**	**500**

FIRST SEMESTER

Course Name	ALGEBRAIC STRUCTURES			
Course Code	23PMTCC11	**L**	**P**	**C**
Category	CORE	6	-	5

COURSE OBJECTIVES:

➢ To introduce the concepts and to develop working knowledge on class equation, solvability of groups, finite abelian groups, linear transformations, real quadratic forms

UNIT – I	18

Counting Principle - Class equation for finite groups and its applications - Sylow's theorems (For theorem 2.12.1, First proof only).

UNIT – II	18

Solvable groups - Direct products - Finite abelian groups- Modules

UNIT - III	18

Linear Transformations: Canonical forms –Triangular form - Nilpotent transformations.

UNIT – IV	18

Jordan form - rational canonical form

UNIT - V	18

Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form.

	Total Lecture Hours	90

BOOKS FOR STUDY:

- I.N. Herstein. *Topics in Algebra* (II Edition) Wiley Eastern Limited, New Delhi, 1975.
  UNIT-I : Chapter 2: Sections 2.11 and 2.12 (Omit Lemma 2.12.5)
  UNIT-II : Chapter 5 : Section 5.7 (Lemma 5.7.1, Lemma 5.7.2, Theorem 5.7.1)

  Chapter 2: Section 2.13 and 2.14 (Theorem 2.14.1 only)

  Chapter 4: Section 4.5
  UNIT-III: Chapter 6: Sections 6.4, 6.5
  UNIT-IV : Chapter 6 : Sections 6.6 and 6.7
  UNIT-V: Chapter 6 : Sections   6.8, 6.10 and 6.11 (Omit 6.9)

BOOKS FOR REFERENCES:

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

WEB RESOURCES:

- ❖ **http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,**
- ❖ **http://www.opensource.org,**
- ❖ **www.algebra.com**

Nature of Course	EMPLOYABILITY		✔	SKILL ORIENTED			ENTREPRENEURSHIP	
Curriculum Relevance	LOCAL		REGIONAL			NATIONAL	✔	GLOBAL
Changes Made in the Course	Percentage of Change		**80**	No Changes Made			New Course	
* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.								

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Recall basic counting principle, define class equations to solve problems, explain Sylow's theorems and apply the theorem to find number of Sylow subgroups	K1 to K5
CO2	Define Solvable groups, define direct products, examine the properties of finite abelian groups, define modules	K1 to K5
CO3	Define similar Transformations, define invariant subspace, explore the properties of triangular matrix, to find the index of nilpotence to decompose a space into invariant subspaces, to find invariants of linear transformation, to explore the properties of nilpotent transformation relating nilpotence with invariants.	K1 to K5
CO4	Define Jordan, canonical form, Jordan blocks, define rational canonical form, define companion matrix of polynomial, find the elementary devices of transformation, and apply the concepts to find characteristic polynomial of linear transformation.	K1 to K5
CO5	Define trace, define transpose of a matrix, explain the properties of trace and transpose, to find trace, to find transpose of matrix, to prove Jacobson lemma using the triangular form, define symmetric matrix, skew symmetric matrix, adjoint, to define Hermitian, unitary, normal transformations and to verify whether the transformation in Hermitian, unitary and normal	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3	2	3	3				
CO2	2	1	3	1	3	3				
CO3	3	2	3	1	3	3				
CO4	1	2	3	2	3	3				
CO5	3	1	2	3	3	3				

S- STRONG   **M – MEDIUM**   **L - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	15	10	5		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	ALGEBRAIC STRUCTURES	HRS	PEDAGOGY
I	Counting Principle - Class equation for finite groups and its applications - Sylow's theorems (For theorem 2.12.1, First proof only).	18	Chalk & Talk
II	Solvable groups - Direct products - Finite abelian groups- Modules	18	Chalk & Talk
III	Linear Transformations: Canonical forms –Triangular form - Nilpotent transformations	18	Chalk & Talk
IV	Jordan form - rational canonical form.	18	Chalk & Talk
V	Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form.	18	Chalk & Talk

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	Cos	K Level	Section A MCQs No. of. Questions	Section A MCQs K - Level	Section B Either or Choice	Section C Either or Choice
CI AI	CO1	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
CI AI	CO2	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
CI AII	CO3	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
CI AII	CO4	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II	No. of Questions to be asked	4		4	4
Question Pattern CIA I & II	No. of Questions to be answered	4		2	2
Question Pattern CIA I & II	Marks for each question	1		5	8
Question Pattern CIA I & II	Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	Cos	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A	Section B	Section C	Total	% of	Consolidated %

	(Multiple Choice Questions)	(Either or Choice	(Either/ or Choice)	Marks	(Marks without choice)	
K1	**5**			**5**	**3.6**	**4**
K2	**5**	**20**		**25**	**17.8**	**18**
K3		**30**	**32**	**62**	**44.3**	**44**
K4			**48**	**48**	**34.3**	**34**
Marks	**10**	**50**	**80**	**140**	**100**	**100**

NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
	Unit - I	CO1	K1		
1.				a)	b)
				c)	d)
	Unit - I	CO1	K2		
2.				a)	b)
				c)	d)
	Unit - II	CO2	K1		
3.				a)	b)
				c)	d)
	Unit - II	CO2	K2		
4.				a)	b)
				c)	d)
	Unit - III	CO3	K1		
5.				a)	b)
				c)	d)
	Unit - III	CO3	K2		
6.				a)	b)
				c)	d)
	Unit - IV	CO4	K1		
7.				a)	b)
				c)	d)
	Unit - IV	CO4	K2		
8.				a)	b)
				c)	d)
	Unit - V	CO5	K1		
9.				a)	b)
				c)	d)
	Unit - V	CO5	K2		
10.				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**			**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**		
		OR			
11. b)	**Unit - I**	**CO1**	**K2**		
12. a)	**Unit - II**	**CO2**	**K3**		
		OR			
12. b)	**Unit - II**	**CO2**	**K3**		
13. a)	**Unit - III**	**CO3**	**K2**		
		OR			
13. b)	**Unit - III**	**CO3**	**K2**		
14. a)	**Unit - IV**	**CO4**	**K3**		
		OR			
14. b)	**Unit - IV**	**CO4**	**K3**		
15. a)	**Unit - V**	**CO5**	**K3**		
		OR			
15. b)	**Unit - V**	**CO5**	**K3**		

Answer **ALL** the questions		**PART – C**			**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**		
		OR			
16. b)	**Unit - I**	**CO1**	**K3**		
17. a)	**Unit - II**	**CO2**	**K4**		
		OR			
17. b)	**Unit - II**	**CO2**	**K4**		
18. a)	**Unit - III**	**CO3**	**K3**		
		OR			
18. b)	**Unit - III**	**CO3**	**K3**		
19. a)	**Unit - IV**	**CO4**	**K4**		
		OR			
19. b)	**Unit - IV**	**CO4**	**K4**		
20. a)	**Unit - V**	**CO5**	**K4**		
		OR			
20. b)	**Unit - V**	**CO5**	**K4**		

Course Name	REAL ANALYSIS - I			
Course Code	23PMTCC12	**L**	**P**	**C**
Category	CORE	6	-	5

COURSE OBJECTIVES:

➢ To work comfortably with functions of bounded variation, Riemann-Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence and its interplay between various limiting operations

UNIT – I Functions of bounded variation & Infinite Series	18

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.

Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series

UNIT – II The Riemann - Stieltjes Integral	18

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

UNIT - III The Riemann-Stieltjes Integral	18

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

UNIT – IV Infinite Series and infinite Products & Power series	18

Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series – Cesaro summability - Infinite products.

Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem

UNIT - V	Sequences of Functions	18

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

	Total Lecture Hours	90

BOOKS FOR STUDY:

➢ Tom M.Apostol : *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974

UNIT I: Chapter – 6 : Sections 6.1 to 6.8
   Chapter 8 : Sections 8.8, 8.15, 8.17, 8.18
UNIT II; Chapter - 7 : Sections 7.1 to 7.14
UNIT-III : Chapter - 7 : 7.15 to 7.26
UNIT-IV : Chapter - 8 Sec, 8.20, 8.21 to 8.26

   Chapter 9 : Sections 9.14 9.15, 9.19, 9.20, 9.22, 9.23
UNIT-V: Chapter -9 Sec 9.1 to 9.6, 9.8,9.9,9.10,9.11, 9.13

BOOKS FOR REFERENCES:

➢ Bartle, R.G. Real Analysis, John Wiley and Sons Inc., 1976.
➢ 2. Rudin,W. Principles of Mathematical Analysis, 3rd Edition. McGraw Hill Company, New York, 1976.
➢ 3. Malik,S.C. and Savita Arora. Mathematical Anslysis, Wiley Eastern Limited.New Delhi, 1991.
➢ 4. Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991.
➢ 5. Gelbaum, B.R. and J. Olmsted, Counter Examples in Analysis, Holden day, San Francisco, 1964.

➢ 6. A.L.Gupta and N.R.Gupta, Principles of Real Analysis, Pearson Education, (Indian print) 2003.

WEB RESOURCES:

❖ **http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,**
❖ **http://www.opensource.org, www.mathpages.com**

Nature of Course	EMPLOYABILITY		✓	SKILL ORIENTED			ENTREPRENEURSHIP		
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		✓	GLOBAL	
Changes Made in the Course	Percentage of Change		**70**	No Changes Made			New Course		

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Analyze and evaluate functions of bounded variation and Rectifiable Curves.	**K1 to K5**
CO2	Describe the concept of Riemann-Stieltjes integral and its properties.	**K1 to K5**
CO3	Demonstrate the concept of step function, upper function, Lebesgue function and their integrals.	**K1 to K5**
CO4	Construct various mathematical proofs using the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.	**K1 to K5**
CO5	Formulate the concept and properties of inner products, norms and measurable functions.	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3	2	3	3				
CO2	2	1	3	1	3	3				
CO3	3	2	3	1	3	3				
CO4	1	2	3	2	3	3				
CO5	3	1	2	3	3	3				

S- STRONG   M – MEDIUM   L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	**15**	**10**	**5**		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

UNIT	REAL ANALYSIS - I	HRS	PEDAGOGY
LESSON PLAN:			
I	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. Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series.	**18**	**Chalk & Talk**
II	Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral – Euler's summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper, lower integrals - Riemann's condition - Comparison theorems.	**18**	**Chalk & Talk**
III	Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of RS integrals- Mean value theorems -integrals as a function of the interval – Second fundamental theorem of integral calculus-Change of variable -Second Mean Value Theorem for Riemann integral- Riemann-Stieltjes integrals depending on a parameter- Differentiation under integral sign-Lebesgue criteriaon for existence of Riemann integrals.	**18**	**Chalk & Talk**
IV	Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series – Cesaro summability - 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.	**18**	**Chalk & Talk**
V	Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions - Uniform convergence and continuity - Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Riemann - Stieltjes integration – Non-uniform Convergence and Term-by-term Integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence.	**18**	**Chalk & Talk**

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	Cos	K Level	Section A		Section B Either or Choice	Section C Either or Choice
			MCQs			
			No. of. Questions	K - Level		
CI AI	CO1	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
	CO2	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
CI AII	CO3	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
	CO4	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II	No. of Questions to be asked		4		4	4
	No. of Questions to be answered		4		2	2
	Marks for each question		1		5	8
	Total Marks for each section		4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	Cos	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
	Unit - I	CO1	K1		
1.				a)	b)
				c)	d)
	Unit - I	CO1	K2		
2.				a)	b)
				c)	d)
	Unit - II	CO2	K1		
3.				a)	b)
				c)	d)
	Unit - II	CO2	K2		
4.				a)	b)
				c)	d)
	Unit - III	CO3	K1		
5.				a)	b)
				c)	d)
	Unit - III	CO3	K2		
6.				a)	b)
				c)	d)
	Unit - IV	CO4	K1		
7.				a)	b)
				c)	d)
	Unit - IV	CO4	K2		
8.				a)	b)
				c)	d)
	Unit - V	CO5	K1		
9.				a)	b)
				c)	d)
	Unit - V	CO5	K2		
10.				a)	b)
				c)	d)

Answer **ALL** the questions				**PART – B**	**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**		
			OR		
11. b)	**Unit - I**	**CO1**	**K2**		
12. a)	**Unit - II**	**CO2**	**K3**		
			OR		
12. b)	**Unit - II**	**CO2**	**K3**		
13. a)	**Unit - III**	**CO3**	**K2**		
			OR		
13. b)	**Unit - III**	**CO3**	**K2**		
14. a)	**Unit - IV**	**CO4**	**K3**		
			OR		
14. b)	**Unit - IV**	**CO4**	**K3**		
15. a)	**Unit - V**	**CO5**	**K3**		
			OR		
15. b)	**Unit - V**	**CO5**	**K3**		

Answer **ALL** the questions				**PART – C**	**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**		
			OR		
16. b)	**Unit - I**	**CO1**	**K3**		
17. a)	**Unit - II**	**CO2**	**K4**		
			OR		
17. b)	**Unit - II**	**CO2**	**K4**		
18. a)	**Unit - III**	**CO3**	**K3**		
			OR		
18. b)	**Unit - III**	**CO3**	**K3**		
19. a)	**Unit - IV**	**CO4**	**K4**		
			OR		
19. b)	**Unit - IV**	**CO4**	**K4**		
20. a)	**Unit - V**	**CO5**	**K4**		
			OR		
20. b)	**Unit - V**	**CO5**	**K4**		

Course Name	ORDINARY DIFFERENTIAL EQUATIONS			
Course Code	23PMTCC13	**L**	**P**	**C**
Category	CORE	6	-	4

COURSE OBJECTIVES:

➢ To develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points, to study existence and uniqueness of the solutions of first order differential equations

UNIT – I Linear equations with constant coefficients	18

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

UNIT – II Linear equations with constant coefficients	18

Homogeneous and non-homogeneous equation of order n –Initial value problems- Annihilator method to solve non-homogeneous equation- Algebra of constant coefficient operators.

UNIT - III Linear equation with variable coefficients	18

Initial value problems -Existence and uniqueness theorems – Solutions to solve a non-homogeneous equation – Wronskian and linear dependence – reduction of the order of a homogeneous equation – homogeneous equation with analytic coefficients-The Legendre equation

UNIT – IV Linear equation with regular singular point	18

Euler equation – Second order equations with regular singular points –Exceptional cases – Bessel Function.

UNIT - V	18

Existence and uniqueness of solutions to first order equations: Equation with variable separated – Exact equation – method of successive approximations – the Lipschitz condition – convergence of the successive approximations and the existence theorem.

Total Lecture Hours	**90**

BOOKS FOR STUDY:

➢ E.A.Coddington, A introduction to ordinary differential equations (3rd Printing) Prentice-Hall of India Ltd., New Delhi, 1987.

> **Unit I - Chapter 2 : Section 1 to 6**
>
> **Unit II - Chapter 2 : Section 7 to 12**
>
> **Unit III - Chapter 3: Section 1 to 8**
>
> **Unit IV - Chapter 4: Section 1 to 8**
>
> **Unit V   - Chapter 5: Section 1 to 8**

BOOKS FOR REFERENCES:

➢ Williams E. Boyce and Richard C. DI Prima, *Elementary differential equations and boundary value problems*, John Wiley and sons, New York, 1967.

➢ George F Simmons, *Differential equations with applications and historical notes,* Tata McGraw Hill, New Delhi, 1974.

➢ N.N. Lebedev, *Special functions and their applications*, Prentice Hall of India, New Delhi, 1965.

➢ W.T. Reid. *Ordinary Differential Equations*, John Wiley and Sons, New York, 1971

➢ M.D.Raisinghania, *Advanced Differential Equations*, S.Chand & Company Ltd. New Delhi 2001

➢ B.Rai, D.P.Choudary and H.I. Freedman, *A Course in Ordinary Differential Equations,*   Narosa Publishing House, New Delhi, 2002.

WEB RESOURCES:

❖ **http://mathforum.org,**
❖ **http://ocw.mit.edu/ocwweb/Mathematics,**
❖ **http://www.opensource.org,**
❖ **www.mathpages.com**

Nature of Course	EMPLOYABILITY	✔	SKILL ORIENTED		ENTREPRENEURSHIP	
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL	✔	GLOBAL	
Changes Made in the Course	Percentage of Change		No Changes Made	✔	New Course	

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Establish the qualitative behavior of solutions of systems of differential equations.	**K1 to K5**
CO2	Recognize the physical phenomena modeled by differential equations and dynamical systems.	**K1 to K5**
CO3	Analyze solutions using appropriate methods and give examples.	**K1 to K5**
CO4	Formulate Green's function for boundary value problems.	**K1 to K5**
CO5	Understand and use various theoretical ideas and results that underlie the mathematics in this course.	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3	2	3	3				
CO2	2	1	3	1	3	3				
CO3	3	2	3	1	3	3				
CO4	1	2	3	2	3	3				
CO5	3	1	2	3	3	3				

S- STRONG	**M – MEDIUM**	**L - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	**15**	**10**	**5**		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	ORDINARY DIFFERENTIAL EQUATIONS	HRS	PEDAGOGY
I	Second order homogeneous equations-Initial value problems-Linear dependence and independence-Wronskian and a formula for Wronskian-Non-homogeneous equation of order two.	**18**	**Chalk & Talk**
II	Homogeneous and non-homogeneous equation of order n –Initial value problems- Annihilator method to solve non-homogeneous equation-	**18**	**Chalk & Talk**

	Algebra of constant coefficient operators.				
III	Initial value problems -Existence and uniqueness theorems – Solutions to solve a non-homogeneous equation – Wronskian and linear dependence – reduction of the order of a homogeneous equation – homogeneous equation with analytic coefficients-The Legendre equation.	18	Chalk & Talk		
IV	Euler equation – Second order equations with regular singular points – Exceptional cases – Bessel Function.	18	Chalk & Talk		
V	Existence and uniqueness of solutions to first order equations: Equation with variable separated – Exact equation – method of successive approximations – the Lipschitz condition – convergence of the successive approximations and the existence theorem.	18	Chalk & Talk		

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
			Section A		Section B Either or Choice	Section C Either or Choice
			MCQs			
Internal	Cos	K Level	No. of. Questions	K - Level		
CI AI	CO1	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
	CO2	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
CI AII	CO3	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
	CO4	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II	No. of Questions to be asked		4		4	4
	No. of Questions to be answered		4		2	2
	Marks for each question		1		5	8
	Total Marks for each section		4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	Cos	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100

Distribution of Marks with K Level

NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
	Unit - I	CO1	K1		
1.				a)	b)
				c)	d)
	Unit - I	CO1	K2		
2.				a)	b)
				c)	d)
	Unit - II	CO2	K1		
3.				a)	b)
				c)	d)
	Unit - II	CO2	K2		
4.				a)	b)
				c)	d)
	Unit - III	CO3	K1		
5.				a)	b)
				c)	d)
	Unit - III	CO3	K2		
6.				a)	b)
				c)	d)
	Unit - IV	CO4	K1		
7.				a)	b)
				c)	d)
	Unit - IV	CO4	K2		
8.				a)	b)
				c)	d)
	Unit - V	CO5	K1		
9.				a)	b)
				c)	d)
	Unit - V	CO5	K2		
10.				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	GRAPH THEORY AND APPLICATIONS			
Course Code	23PMTEC11	**L**	**P**	**C**
Category	ELECTIVE	6	-	3

COURSE OBJECTIVES:

➢ To understand the fundamental concepts in graph theory.
➢ To apply graph theory in different fields
➢ To improve the different types of proof writing skills.
➢ To learn to model problems using graphs
➢ To solve the problems algorithmically.

UNIT – I	18

The Incidence and Adjacency Matrices, Sub graphs, Vertex degrees, Paths and Connection, Cycles, Sperner's lemma, Trees, Cut edges and Bonds, Cut vertices

UNIT – II	18

Euler tours, Hamiltonian cycles, The travelling salesman problem, Matchings, Matchings and Coverings in Bipartite graphs

UNIT - III	18

 Edge Chromatic Number, Vizing's Theorem, Chromatic number, Brook's theorem.

UNIT – IV	18

Plane and Planar graphs, Dual Graphs ,Euler's formula ,Bridges ,Kuratowski's Theorem, Directed Graphs, Directed Paths, Directed Cycles, Flows, Cuts, The Max-Flow Min –Cut theorem

UNIT - V	18

Algorithms : connectedness and components – spanning tree – cut vertices and separability – directed circuits – shortest path algorithm – planarity testing – isomorphism

	Total Lecture Hours	**90**

BOOKS FOR STUDY:

➢ J.A.Bondy and U.S.R.Murty, Graph Theory with Applications. North Holland Publications, New york, 1976.

       Unit I - Chapter 1 : Section 1.3 to 1.7 and 1.9
              Chapter 2: Section 2.1 to 2.3
       Unit II – Chapter 4: Section 4.1, 4.2 and 4.4
              Chapter 5: Section 5.1 to 5.2
      Unit III - Chapter 6 : Section 6.1, 6.2
              Chapter 8 : Section 8.1, 8.2
      Unit IV - Chapter 9 : Section 9.1 to 9.5
              Chapter 10 : Section 10.1 to 10.3

➢ Narsingh Deo: Graph Theory with Applications to Engineering and Computer Science, Prentice Hall, 1979.

       Unit V - Chapter 11 : Section 11.4 to 11.7

BOOKS FOR REFERENCES:

➢ John Clark and Derek Allan Holton, **A first look at Graph Theory**, World ScientificPublications, Singapore, 1991.

➢ Harary, **Graph Theory**, Narosa Publishing House, New Delhi, 1988.

➢ S.K.Yadav, **Elements of Graph Theory**, Ane Books Pvt. Ltd,New Delhi, 2010

WEB RESOURCES:

❖ **https://nptel.ac.in/courses/111/106/111106102/**
❖ **https://nptel.ac.in/courses/111/106/111106050/**
❖ **https://www.math.kit.edu/iag6/lehre/graphtheo2015w/media/lecture_notes.pdf**

Nature of Course	EMPLOYABILITY		✓	SKILL ORIENTED			ENTREPRENEURSHIP	
Curriculum Relevance	LOCAL		REGIONAL			NATIONAL	✓	GLOBAL
Changes Made in the Course	Percentage of Change			No Changes Made		✓	New Course	
* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.								

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Understand the definition of different types of graphs and Sperner's lemma.	**K1 to K5**
CO2	Make use of graph theory concepts in travelling salesman problem, Matching and covering.	**K1 to K5**
CO3	Categorize chromatic number, edge chromatic number with theorems.	**K1 to K5**
CO4	Develop the different types of proof writing skills for planar graphs and directed graphs	**K1 to K5**
CO5	Apply various types of algorithms in graph.	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	-	-	2				
CO2	2	2	2	1	2	1				
CO3	2	1	1	1	2	-				
CO4	3	2	1	1	1	1				
CO5	3	2	3	2	2	1				

S- STRONG	M – MEDIUM	L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	**15**	**10**	**5**		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	GRAPH THEORY AND APPLICATIONS	HRS	PEDAGOGY
I	The Incidence and Adjacency Matrices, Sub graphs, Vertex degrees, Paths and Connection, Cycles, Sperner's lemma, Trees, Cut edges and Bonds, Cut vertices	18	**PPT, Chalk & Talk, quiz**
II	Euler tours, Hamiltonian cycles, The travelling salesman problem, Matchings, Matchings and Coverings in Bipartite graphs	18	**Chalk & Talk, PPT**

III	Edge Chromatic Number, Vizing's Theorem, Chromatic number, Brook's theorem	18	**Chalk & Talk**		
IV	Plane and Planar graphs, Dual Graphs ,Euler's formula ,Bridges , Kuratowski's Theorem, Directed Graphs, Directed Paths, Directed Cycles, Flows, Cuts, The Max-Flow Min –Cut theorem.	18	**Chalk & Talk, Assignment**		
V	Algorithms : connectedness and components – spanning tree – cut vertices and separability – directed circuits – shortest path algorithm – planarity testing – isomorphism	18	**Chalk & Talk, PPT**		

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	Cos	K Level	Section A		Section B Either or Choice	Section C Either or Choice
			MCQs			
			No. of. Questions	K - Level		
CI AI	CO1	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
	CO2	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
CI AII	CO3	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
	CO4	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II	No. of Questions to be asked		4		4	4
	No. of Questions to be answered		4		2	2
	Marks for each question		1		5	8
	Total Marks for each section		4		10	16

	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
		Distribution of Marks with K Level CIA I & CIA II					
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

S. No	Cos	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
		Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)				
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

	Distribution of Marks with K Level					
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			PART – A		(10 x 1 = 10 Marks)
	Unit - I	CO1	K1		
1.				a)	b)
				c)	d)
	Unit - I	CO1	K2		
2.				a)	b)
				c)	d)
	Unit - II	CO2	K1		
3.				a)	b)
				c)	d)
	Unit - II	CO2	K2		
4.				a)	b)
				c)	d)
	Unit - III	CO3	K1		
5.				a)	b)
				c)	d)
	Unit - III	CO3	K2		
6.				a)	b)
				c)	d)
	Unit - IV	CO4	K1		
7.				a)	b)
				c)	d)
	Unit - IV	CO4	K2		
8.				a)	b)
				c)	d)
	Unit - V	CO5	K1		
9.				a)	b)
				c)	d)
	Unit - V	CO5	K2		
10.				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**			**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**		
			OR		
11. b)	**Unit - I**	**CO1**	**K2**		
12. a)	**Unit - II**	**CO2**	**K3**		
			OR		
12. b)	**Unit - II**	**CO2**	**K3**		
13. a)	**Unit - III**	**CO3**	**K2**		
			OR		
13. b)	**Unit - III**	**CO3**	**K2**		
14. a)	**Unit - IV**	**CO4**	**K3**		
			OR		
14. b)	**Unit - IV**	**CO4**	**K3**		
15. a)	**Unit - V**	**CO5**	**K3**		
			OR		
15. b)	**Unit - V**	**CO5**	**K3**		

Answer **ALL** the questions		**PART – C**			**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**		
			OR		
16. b)	**Unit - I**	**CO1**	**K3**		
17. a)	**Unit - II**	**CO2**	**K4**		
			OR		
17. b)	**Unit - II**	**CO2**	**K4**		
18. a)	**Unit - III**	**CO3**	**K3**		
			OR		
18. b)	**Unit - III**	**CO3**	**K3**		
19. a)	**Unit - IV**	**CO4**	**K4**		
			OR		
19. b)	**Unit - IV**	**CO4**	**K4**		
20. a)	**Unit - V**	**CO5**	**K4**		
			OR		
20. b)	**Unit - V**	**CO5**	**K4**		

COURSE NAME	FUZZY SETS AND THEIR APPLICATIONS			
COURSE CODE	23PMTEC12	**L**	**P**	**C**
CATEGORY	ELECTIVE	6	-	3

COURSE OBJECTIVES:

➢ To familiarize the concept of crisp set and its properties
➢ To learn the basics of fuzzy sets and its operations
➢ To differentiate crisp logic, multi-valued logic and fuzzy logic
➢ To use inference theory in fuzzy logic
➢ To learn the application in real life

UNIT – I	18

Fuzzy sets: Basic types– Basic concepts – Additional properties of α – cuts – Representation of fuzzy sets – Extension principle for fuzzy sets – Types of operations – Fuzzy complements

UNIT – II	18

Fuzzy numbers – Linguistic variables – Arithmetic operation on intervals – Arithmetic operation on fuzzy numbers

UNIT - III	18

Fuzzy relation : Crisp versus Fuzzy relation – projection and cyclinderic extensions- Binary fuzzy relation on a single set – fuzzy equivalence relations – Fuzzy compatibility relation

UNIT – IV	18

Fuzzy logic: Classical logic – An over view – multi valued logic – Fuzzy propositions –Fuzzy quantifiers – Linguistic hedges – Inference from conditional fuzzy propositions – Inference from conditional and quantified propositions – Inference from quantified propositions

UNIT - V	18

Applications: Applications to Civil Engineering –Computer Engineering – Reliability theory – Robotics – Medicine – Economics.

	Total Lecture Hours	**90**

BOOKS FOR STUDY:

➢ George J Klir and B.Yuan, **Fuzzy sets and Fuzzy logic – Theory and application**, Second edition, Prentice Hall, New Delhi, 1995.

Unit I -	Chapter 1 : Sections 1.2 to 1.4
	Chapter 2 : Sections 2.1 to 2.3
	Chapter 3 : Sections 3.1,3.2
Unit II -	Chapter 4 : Section 4.1 to 4.4
Unit III -	Chapter 5 : Sections 5.1 to 5.6
Unit IV -	Chapter 8 : Sections 8.2 to 8.8
Unit V -	Chapter 16 : Sections 16.1 , 16.2, 16.5 to 16.7,
	Chapter 17 : Sections 17.1 to 17.3.

BOOKS FOR REFERENCES:

➢ H.J.Zimmermann, **Fuzzy Set Theory and its Applications**, Fourth Edition, Springer Publishers, New Delhi, 2006.
➢ Timothy J. Ross, "**Fuzzy Logic with Engineering Applications**", 3rd Edition, Willey, 2010.
➢ Michal Baczynski and Balasubramaniam Jayaram, **Fuzzy Implications**, Springer Verlag, Heidelberg, 2008

WEB RESOURCES:

❖ **https://www.thesisscientist.com/docs/Study%20Notes/66860129-5a91-459d-810f-54e0fc41175d**
❖ **https://ocw.mit.edu/courses/health-sciences-and-technology/hst-951j-medical-decision-support-spring-2003/lecture-notes/lecture4.pdf**
❖ **https://www.iitk.ac.in/eeold/archive/courses/2013/intel-info/d1pdf3.pdf**
❖ **https://nptel.ac.in/courses/106105173/2**
❖ **https://www.cse.iitb.ac.in/~cs621-2011/lectures_2009/cs621-lect38-fuzzy-logic-2009-11-11.ppt**

Nature of Course	EMPLOYABILITY		✓	SKILL ORIENTED			ENTREPRENEURSHIP		
Curriculum Relevance	LOCAL		REGIONAL			NATIONAL	✓	GLOBAL	
Changes Made in the Course	Percentage of Change			No Changes Made		✓	New Course		

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Interpret fuzzy set theory, representation, operation and extension principle	K1 to K5
CO2	Identify fuzzy numbers and its linguistic variables	K1 to K5
CO3	Validate fuzzy relation, projections and its equivalence.	K1 to K5
CO4	Analyse multi valued logic and fuzzy logic with inference theory	K1 to K5
CO5	Apply fuzziness in real valued problems	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	-	1	2	-				
CO2	2	2	-	-	2	-				
CO3	2	1	1	2	2	1				
CO4	2	1	1	2	2	1				
CO5	2	1	1	1	-	2				

S- STRONG   **M – MEDIUM**   **L - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	15	10	5		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	FUZZY SETS AND THEIR APPLICATIONS	HRS	PEDAGOGY
I	Fuzzy sets: Basic types– Basic concepts – Additional properties of α – cuts – Representation of fuzzy sets – Extension principle for fuzzy sets – Types of operations – Fuzzy complements	18	Chalk & Talk
II	Fuzzy numbers – Linguistic variables – Arithmetic operation on intervals – Arithmetic operation on fuzzy numbers	18	Chalk & Talk
III	Fuzzy relation : Crisp versus Fuzzy relation – projection and cyclinderic extensions- Binary fuzzy relation on a single set – fuzzy equivalence relations – Fuzzy compatibility relation	18	Chalk & Talk

IV	Fuzzy logic: Classical logic – An over view – multi valued logic – Fuzzy propositions –Fuzzy quantifiers – Linguistic hedges – Inference from conditional fuzzy propositions – Inference from conditional and quantified propositions – Inference from quantified propositions	18	Chalk & Talk
V	Applications: Applications to Civil Engineering –Computer Engineering – Reliability theory – Robotics – Medicine – Economics.	18	Chalk & Talk

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	Cos	K Level	Section A MCQs		Section B Either or Choice	Section C Either or Choice
			No. of. Questions	K - Level		
CI AI	CO1	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
	CO2	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
CI AII	CO3	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
	CO4	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II	No. of Questions to be asked	4			4	4
	No. of Questions to be answered	4			2	2
	Marks for each question	1			5	8
	Total Marks for each section	4			10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	Cos	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100

NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
1.	Unit - I	CO1	K1		
				a)	b)
				c)	d)
2.	Unit - I	CO1	K2		
				a)	b)
				c)	d)
3.	Unit - II	CO2	K1		
				a)	b)
				c)	d)
4.	Unit - II	CO2	K2		
				a)	b)
				c)	d)
5.	Unit - III	CO3	K1		
				a)	b)
				c)	d)
6.	Unit - III	CO3	K2		
				a)	b)
				c)	d)
7.	Unit - IV	CO4	K1		
				a)	b)
				c)	d)
8.	Unit - IV	CO4	K2		
				a)	b)
				c)	d)
9.	Unit - V	CO5	K1		
				a)	b)
				c)	d)
10.	Unit - V	CO5	K2		
				a)	b)
				c)	d)

				PART – B	
Answer **ALL** the questions					(5 x 5 = 25 Marks)
11. a)	Unit - I	CO1	K2		
			OR		
11. b)	Unit - I	CO1	K2		
12. a)	Unit - II	CO2	K3		
			OR		
12. b)	Unit - II	CO2	K3		
13. a)	Unit - III	CO3	K2		
			OR		
13. b)	Unit - III	CO3	K2		
14. a)	Unit - IV	CO4	K3		
			OR		
14. b)	Unit - IV	CO4	K3		
15. a)	Unit - V	CO5	K3		
			OR		
15. b)	Unit - V	CO5	K3		

				PART – C	
Answer **ALL** the questions					(5 x 8 = 40 Marks)
16. a)	Unit - I	CO1	K3		
			OR		
16. b)	Unit - I	CO1	K3		
17. a)	Unit - II	CO2	K4		
			OR		
17. b)	Unit - II	CO2	K4		
18. a)	Unit - III	CO3	K3		
			OR		
18. b)	Unit - III	CO3	K3		
19. a)	Unit - IV	CO4	K4		
			OR		
19. b)	Unit - IV	CO4	K4		
20. a)	Unit - V	CO5	K4		
			OR		
20. b)	Unit - V	CO5	K4		

SECOND SEMESTER

Course Name	ADVANCED ALGEBRA			
Course Code	23PMTCC21	**L**	**P**	**C**
Category	CORE	6	-	5

COURSE OBJECTIVES:

➢ To study field extension, roots of polynomials, Galois Theory, finite fields, division rings, solvability by radicals and to develop computational skill in abstract algebra.

UNIT – I	18
Extension fields – Transcendence of e	
UNIT – II	**18**
Roots or Polynomials.- More about roots	
UNIT - III	**18**
Elements of Galois theory.	
UNIT – IV	**18**
Finite fields - Wedderburn's theorem on finite division rings.	
UNIT - V	**18**
Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four - Square theorem	
Total Lecture Hours	**90**

BOOKS FOR STUDY:

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

UNIT I: Chapter 5: Section 5.1 and 5.2

UNIT 2: Chapter 5: Sections 5.3 and 5.5

UNIT 3: Chapter 5 : Section 5.6

UNIT 4: Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only)

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

Chapter 7 : Sections 7.3 and 7.4

BOOKS FOR REFERENCES:

➢ M.Artin, *Algebra,* Prentice Hall of India, 1991.

➢ P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition)

➢ I.S.Luther and I.B.S.Passi, *Algebra,* Vol. I –Groups(1996); Vol. II *Rings,*Narosa Publishing House , New Delhi, 1999

➢ D.S.Malik, J.N. Mordeson and M.K.Sen, *Fundamental of Abstract Algebra*, McGraw Hill (International Edition), New York. 1997.

➢ N.Jacobson, *Basic Algebra,* Vol. I & II   Hindustan Publishing Company, New Delhi.

WEB RESOURCES:

❖ **http://mathforum.org**

❖ **http://ocw.mit.edu/ocwweb/Mathematics,**

❖ **http://www.opensource.org,**

❖ **www.algebra.com**

Nature of Course	EMPLOYABILITY		✓	SKILL ORIENTED			ENTREPRENEURSHIP	
Curriculum Relevance	LOCAL		REGIONAL			NATIONAL	✓	GLOBAL	
Changes Made in the Course	Percentage of Change		**100**	No Changes Made			New Course	

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Prove theorems applying algebraic ways of thinking.	**K1 to K5**
CO2	Connect groups with graphs and understanding about Hamiltonian graphs.	**K1 to K5**
CO3	Compose clear and accurate proofs using the concepts of Galois Theory.	**K1 to K5**
CO4	Bring out insight into Abstract Algebra with focus on axiomatic theories.	**K1 to K5**
CO5	Demonstrate knowledge and understanding of fundamental concepts including extension fields, Algebraic extensions, Finite fields, Class equations and Sylow's theorem.	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3	2	3	3				
CO2	2	1	3	1	3	3				
CO3	3	2	3	1	3	3				
CO4	1	2	3	2	3	3				
CO5	3	1	2	3	3	3				
S- STRONG				**M – MEDIUM**				**L - LOW**		

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	**15**	**10**	**5**		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	ADVANCED ALGEBRA	HRS	PEDAGOGY
I	Extension fields – Transcendence of e.	**18**	**Chalk & Talk**
II	Roots or Polynomials.- More about roots	**18**	**Chalk & Talk**
III	Elements of Galois theory.	**18**	**Chalk & Talk**

IV	Finite fields - Wedderburn's theorem on finite division rings.	18	Chalk & Talk
V	Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four - Square theorem.	18	Chalk & Talk

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 – K5**	2	K2	2(K2,K2)	2(K3,K3)
	CO2	**K1 – K5**	2	K2	2(K3,K3)	2(K4,K4)
CI AII	**CO3**	**K1 – K5**	2	K2	2(K2,K2)	2(K3,K3)
	CO4	**K1 – K5**	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	**Section A (Multiple Choice Questions)**	**Section B (Either / Or Choice)**	**Section C (Either / Or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

S. No	Cos	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
Distribution of Marks with K Level						
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	**10**	**50**	**80**	**140**	**100**	**100**

NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
1.	Unit - I	CO1	K1		
				a)	b)
				c)	d)
2.	Unit - I	CO1	K2		
				a)	b)
				c)	d)
3.	Unit - II	CO2	K1		
				a)	b)
				c)	d)
4.	Unit - II	CO2	K2		
				a)	b)
				c)	d)
5.	Unit - III	CO3	K1		
				a)	b)
				c)	d)
6.	Unit - III	CO3	K2		
				a)	b)
				c)	d)
7.	Unit - IV	CO4	K1		
				a)	b)
				c)	d)
8.	Unit - IV	CO4	K2		
				a)	b)
				c)	d)
9.	Unit - V	CO5	K1		
				a)	b)
				c)	d)
10.	Unit - V	CO5	K2		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		(5 x 5 = 25 Marks)
11. a)	Unit - I	CO1	K2	
			OR	
11. b)	Unit - I	CO1	K2	
12. a)	Unit - II	CO2	K3	
			OR	
12. b)	Unit - II	CO2	K3	
13. a)	Unit - III	CO3	K2	
			OR	
13. b)	Unit - III	CO3	K2	
14. a)	Unit - IV	CO4	K3	
			OR	
14. b)	Unit - IV	CO4	K3	
15. a)	Unit - V	CO5	K3	
			OR	
15. b)	Unit - V	CO5	K3	

Answer **ALL** the questions		**PART – C**		(5 x 8 = 40 Marks)
16. a)	Unit - I	CO1	K3	
			OR	
16. b)	Unit - I	CO1	K3	
17. a)	Unit - II	CO2	K4	
			OR	
17. b)	Unit - II	CO2	K4	
18. a)	Unit - III	CO3	K3	
			OR	
18. b)	Unit - III	CO3	K3	
19. a)	Unit - IV	CO4	K4	
			OR	
19. b)	Unit - IV	CO4	K4	
20. a)	Unit - V	CO5	K4	
			OR	
20. b)	Unit - V	CO5	K4	

Course Name	REAL ANALYSIS - II			
Course Code	23PMTCC22	**L**	**P**	**C**
Category	CORE	6	-	5

COURSE OBJECTIVES:

➢ To introduce measure on the real line, Lebesgue measurability and integrability, Fourier Series and Integrals, in-depth study in multivariable calculus.

UNIT – I Measure on the Real line	18

Lebesgue Outer Measure - Measurable sets - Regularity - Measurable Functions - Borel and Lebesgue Measurability.

UNIT – II Integration of Functions of a Real variable	18

Integration of Non- negative functions - The General Integral - Riemann and Lebesgue Integrals

UNIT - III Fourier Series and Fourier Integrals	18

Introduction - Orthogonal system of functions - The theorem on best approximation - The Fourier series of a function relative to an orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Thorem - The convergence and representation problems in for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point – Cesarosummability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem

UNIT – IV Multivariable Differential Calculus	18

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

UNIT - V Implicit Functions and Extremum Problems	18

Functions with non-zero Jacobian determinants – The inverse function theorem-The Implicit function theorem-Extrema of real valued functions of severable variables-Extremum problems with side conditions.

	Total Lecture Hours	90

BOOKS FOR STUDY:

➢ G. de Barra, *Measure Theory and Integration*, Wiley Eastern Ltd., New Delhi, 1981. (for Units I and II)

UNIT I : Chapter - 2 Sec 2.1 to 2.5

UNIT II: Chapter - 3 Sec 3.1,3.2 and 3.4

➢ Tom M.Apostol : *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974. (for Units III, IV and V)

UNIT III: Chapter 11 : Sections 11.1 to 11.15

UNIT IV: Chapter 12 : Section 12.1 to 12.14

UNIT V: Chapter 13 : Sections 13.1 to 13.7

BOOKS FOR REFERENCES:

➢ Burkill,J.C.The Lebesgue Integral, Cambridge University Press, 1951.
➢ Munroe,M.E.Measure and Integration. Addison-Wesley, Mass.1971.
➢ Roydon,H.L.Real Analysis, Macmillan Pub. Company, New York, 1988.
➢ Rudin, W. Principles of Mathematical Analysis, McGraw Hill Company, New York,1979.
➢ Malik,S.C. and Savita Arora. Mathematical Analysis, Wiley Eastern Limited. New Delhi, 1991.
➢ Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991

WEB RESOURCES:

❖ **http://mathforum.org,**
❖ **http://ocw.mit.edu/oc.**
❖ **wweb/Mathematics**
❖ **http://www.opensource.org**

Nature of Course	EMPLOYABILITY		✓	SKILL ORIENTED			ENTREPRENEURSHIP		
Curriculum Relevance	LOCAL		REGIONAL			NATIONAL	✓	GLOBAL	
Changes Made in the Course	Percentage of Change			No Changes Made			New Course		✓
* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.									

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Understand and describe the basic concepts of Fourier series and Fourier integrals with respect to orthogonal system.	**K1 to K5**
CO2	Analyze the representation and convergence problems of Fourier series.	**K1 to K5**
CO3	Analyze and evaluate the difference between transforms of various functions.	**K1 to K5**
CO4	Formulate and evaluate complex contour integrals directly and by the fundamental theorem.	**K1 to K5**
CO5	Apply the Cauchy integral theorem in its various versions to compute contour integration	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3	2	3	3				
CO2	2	1	3	1	3	3				
CO3	3	2	3	1	3	3				
CO4	1	2	3	2	3	3				
CO5	3	1	2	3	3	3				

S- STRONG	M – MEDIUM	L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	**15**	**10**	**5**		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	REAL ANALYSIS II	HRS	PEDAGOGY
I	Lebesgue Outer Measure - Measurable sets - Regularity - Measurable Functions - Borel and Lebesgue Measurability	**18**	**Chalk & Talk**
II	Integration of Non- negative functions - The General Integral - Riemann and Lebesgue Integrals	**18**	**Chalk & Talk**

III	Introduction - Orthogonal system of functions - The theorem on best approximation - The Fourier series of a function relative to an orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Thorem - The convergence and representation problems in for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point – Cesarosummability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem	**18**	**Chalk & Talk**
IV	Introduction - The Directional derivative - Directional derivative and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives - Taylor's theorem for functions of R^n to R^1	**18**	**Chalk & Talk**
V	Functions with non-zero Jacobian determinants – The inverse function theorem-The Implicit function theorem-Extrema of real valued functions of severable variables-Extremum problems with side conditions.	**18**	**Chalk & Talk**

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 – K5**	2	K2	2(K2,K2)	2(K3,K3)
	CO2	**K1 – K5**	2	K2	2(K3,K3)	2(K4,K4)
CI AII	**CO3**	**K1 – K5**	2	K2	2(K2,K2)	2(K3,K3)
	CO4	**K1 – K5**	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II	**No. of Questions to be asked**		4		4	4
	No. of Questions to be answered		4		2	2
	Marks for each question		1		5	8
	Total Marks for each section		4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	Cos	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level

K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100

NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
	Unit - I	CO1	K1		
1.				a)	b)
				c)	d)
	Unit - I	CO1	K2		
2.				a)	b)
				c)	d)
	Unit - II	CO2	K1		
3.				a)	b)
				c)	d)
	Unit - II	CO2	K2		
4.				a)	b)
				c)	d)
	Unit - III	CO3	K1		
5.				a)	b)
				c)	d)
	Unit - III	CO3	K2		
6.				a)	b)
				c)	d)
	Unit - IV	CO4	K1		
7.				a)	b)
				c)	d)
	Unit - IV	CO4	K2		
8.				a)	b)
				c)	d)
	Unit - V	CO5	K1		
9.				a)	b)
				c)	d)
	Unit - V	CO5	K2		
10.				a)	b)
				c)	d)

Answer **ALL** the questions			PART – B	(5 x 5 = 25 Marks)
11. a)	Unit - I	CO1	K2	
			OR	
11. b)	Unit - I	CO1	K2	
12. a)	Unit - II	CO2	K3	
			OR	
12. b)	Unit - II	CO2	K3	
13. a)	Unit - III	CO3	K2	
			OR	
13. b)	Unit - III	CO3	K2	
14. a)	Unit - IV	CO4	K3	
			OR	
14. b)	Unit - IV	CO4	K3	
15. a)	Unit - V	CO5	K3	
			OR	
15. b)	Unit - V	CO5	K3	

Answer **ALL** the questions			PART – C	(5 x 8 = 40 Marks)
16. a)	Unit - I	CO1	K3	
			OR	
16. b)	Unit - I	CO1	K3	
17. a)	Unit - II	CO2	K4	
			OR	
17. b)	Unit - II	CO2	K4	
18. a)	Unit - III	CO3	K3	
			OR	
18. b)	Unit - III	CO3	K3	
19. a)	Unit - IV	CO4	K4	
			OR	
19. b)	Unit - IV	CO4	K4	
20. a)	Unit - V	CO5	K4	
			OR	
20. b)	Unit - V	CO5	K4	

Course Name	PARTIAL DIFFERENTIAL EQUATIONS			
Course Code	23PMTCC23	**L**	**P**	**C**
Category	Core	6	-	4

COURSE OBJECTIVES:

➢ To classify the second order partial differential equations and to study Cauchy problem, method of separation of variables, boundary value problems

UNIT – I Mathematical Models and Classification of second order equation	18

Classical equations-Vibrating string – Vibrating membrane – waves in elastic medium – Conduction of heat in solids – Gravitational potential – Second order equations in two independent variables – canonical forms – equations with constant coefficients – general solution

UNIT – II Cauchy Problem	18

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

UNIT - III Method of separation of variables	18

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

UNIT – IV Boundary Value Problems	18

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

UNIT - V Green's Function	18

The Delta function – Green's function – Method of Green's function – Dirichlet Problem for the Laplace and Helmholtz operators – Method of images and eigen functions – Higher dimensional problem – Neumann Problem.

	Total Lecture Hours	**90**

BOOKS FOR STUDY:

➢ TynMyint-U and Lokenath Debnath, *Partial Differential Equations for Scientists and Engineers* (Third Edition), North Hollan, New York, 1987.

UNIT I : Chapter 2 : Sections 2.1 to 2.6
Chapter 3 : Sections 3.1 to 3.4 (Omit 3.5)
UNIT II: Chapter 4 : Sections 4.1 to 4.11
UNIT III: Chapter 6 : Sections 6.1 to 6.6 (Omit section 6.7)
UNIT IV : Chapter 8 : Sections 8.1 to 8.9
UNIT V: Chapter 10 : Section 10.1 to 10.9

BOOKS FOR REFERENCES:

➢ M.M.Smirnov, Second Order partial Differential Equations, Leningrad, 1964.
➢ I.N.Sneddon, Elements of Partial Differential Equations, McGraw Hill, New Delhi, 1983.
➢ R. Dennemeyer, Introduction to Partial Differential Equations and Boundary Value Problems, McGraw Hill, New York, 1968.
➢ M.D.Raisinghania, Advanced Differential Equations, S.Chand & Company Ltd., New Delhi, 2001.
➢ S, Sankar Rao, Partial Differential Equations, 2nd Edition, Prentice
➢ Hall of India, New Delhi. 2004

WEB RESOURCES:

❖ **http://mathforum.org,**
❖ **http://ocw.mit.edu/ocwweb/Mathematics,**
❖ **http://www.opensource.org, www.mathpages.com**

Nature of Course	EMPLOYABILITY		✓	SKILL ORIENTED			ENTREPRENEURSHIP		
Curriculum Relevance	LOCAL		REGIONAL			NATIONAL	✓	GLOBAL	
Changes Made in the Course	Percentage of Change		**50**	No Changes Made			New Course		
* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.									

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	To understand and classify second order equations and find general solutions	K1 to K5
CO2	To analyse and solve wave equations in different polar coordinates	K1 to K5
CO3	To solve Vibrating string problem, Heat conduction problem, to identify and solve Laplace and beam equations	K1 to K5
CO4	To apply maximum and minimum principle's and solve Dirichlet, Neumann problems for various boundary conditions	K1 to K5
CO5	To apply Green's function and solve Dirichlet, Laplace problems, to apply Helmholtz operation and to solve Higher dimensional problem	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3	2	3	3				
CO2	2	1	3	1	3	3				
CO3	3	2	3	1	3	3				
CO4	1	2	3	2	3	3				
CO5	3	1	2	3	3	3				

S- STRONG	M – MEDIUM	L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	15	10	5		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	PARTIAL DIFFERENTIAL EQUATIONS	HRS	PEDAGOGY
I	Classical equations-Vibrating string – Vibrating membrane – waves in elastic medium – Conduction of heat in solids – Gravitational potential – Second order equations in two independent variables – canonical forms – equations with constant coefficients – general solution	18	Chalk & Talk

II	The Cauchy problem – Cauchy-Kowalewsky theorem – Homogeneous wave equation – Initial Boundary value problem- Non-homogeneous boundary conditions – Finite string with fixed ends – Non-homogeneous wave equation – Riemann method – Goursat problem – spherical wave equation – cylindrical wave equation.	**18**	**Chalk & Talk**
III	Separation of variable- Vibrating string problem – Existence and uniqueness of solution of vibrating string problem - Heat conduction problem – Existence and uniqueness of solution of heat conduction problem – Laplace and beam equations	**18**	**Chalk & Talk**
IV	Boundary value problems – Maximum and minimum principles – Uniqueness and continuity theorem – Dirichlet Problem for a circle , a circular annulus, a rectangle – Dirichlet problem involving Poisson equation – Neumann problem for a circle and a rectangle.	**18**	**Chalk & Talk**
V	The Delta function – Green's function – Method of Green's function – Dirichlet Problem for the Laplace and Helmholtz operators – Method of images and eigen functions – Higher dimensional problem – Neumann Problem	**18**	**Chalk & Talk**

<table>
<tr><td colspan="7" align="center">Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)</td></tr>
<tr><td rowspan="3">Internal</td><td rowspan="3">Cos</td><td rowspan="3">K Level</td><td colspan="2" align="center">Section A</td><td rowspan="2">Section B
Either or Choice</td><td rowspan="2">Section C
Either or Choice</td></tr>
<tr><td colspan="2" align="center">MCQs</td></tr>
<tr><td>No. of. Questions</td><td>K - Level</td></tr>
<tr><td rowspan="2">CI
AI</td><td>CO1</td><td>K1 – K5</td><td>2</td><td>K2</td><td>2(K2,K2)</td><td>2(K3,K3)</td></tr>
<tr><td>CO2</td><td>K1 – K5</td><td>2</td><td>K2</td><td>2(K3,K3)</td><td>2(K4,K4)</td></tr>
<tr><td rowspan="2">CI
AII</td><td>CO3</td><td>K1 – K5</td><td>2</td><td>K2</td><td>2(K2,K2)</td><td>2(K3,K3)</td></tr>
<tr><td>CO4</td><td>K1 – K5</td><td>2</td><td>K2</td><td>2(K3,K3)</td><td>2(K4,K4)</td></tr>
<tr><td rowspan="4">Question Pattern
CIA I & II</td><td colspan="2">No. of Questions to be asked</td><td>4</td><td></td><td>4</td><td>4</td></tr>
<tr><td colspan="2">No. of Questions to be answered</td><td>4</td><td></td><td>2</td><td>2</td></tr>
<tr><td colspan="2">Marks for each question</td><td>1</td><td></td><td>5</td><td>8</td></tr>
<tr><td colspan="2">Total Marks for each section</td><td>4</td><td></td><td>10</td><td>16</td></tr>
</table>

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	Cos	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

			Distribution of Marks with K Level			
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100

NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
	Unit - I	CO1	K1		
1.				a)	b)
				c)	d)
	Unit - I	CO1	K2		
2.				a)	b)
				c)	d)
	Unit - II	CO2	K1		
3.				a)	b)
				c)	d)
	Unit - II	CO2	K2		
4.				a)	b)
				c)	d)
	Unit - III	CO3	K1		
5.				a)	b)
				c)	d)
	Unit - III	CO3	K2		
6.				a)	b)
				c)	d)
	Unit - IV	CO4	K1		
7.				a)	b)
				c)	d)
	Unit - IV	CO4	K2		
8.				a)	b)
				c)	d)
	Unit - V	CO5	K1		
9.				a)	b)
				c)	d)
	Unit - V	CO5	K2		
10.				a)	b)
				c)	d)

Answer **ALL** the questions			**PART – B**	**(5 x 5 = 25 Marks)**
11. a)	Unit - I	CO1	K2	
			OR	
11. b)	Unit - I	CO1	K2	
12. a)	Unit - II	CO2	K3	
			OR	
12. b)	Unit - II	CO2	K3	
13. a)	Unit - III	CO3	K2	
			OR	
13. b)	Unit - III	CO3	K2	
14. a)	Unit - IV	CO4	K3	
			OR	
14. b)	Unit - IV	CO4	K3	
15. a)	Unit - V	CO5	K3	
			OR	
15. b)	Unit - V	CO5	K3	

Answer **ALL** the questions			**PART – C**	**(5 x 8 = 40 Marks)**
16. a)	Unit - I	CO1	K3	
			OR	
16. b)	Unit - I	CO1	K3	
17. a)	Unit - II	CO2	K4	
			OR	
17. b)	Unit - II	CO2	K4	
18. a)	Unit - III	CO3	K3	
			OR	
18. b)	Unit - III	CO3	K3	
19. a)	Unit - IV	CO4	K4	
			OR	
19. b)	Unit - IV	CO4	K4	
20. a)	Unit - V	CO5	K4	
			OR	
20. b)	Unit - V	CO5	K4	

Course Name	NUMERICAL ANALYSIS			
Course Code	23PMTEC21	**L**	**P**	**C**
Category	ELECTIVE	6	-	4

COURSE OBJECTIVES:

➤ To develop Numerical computational skills.
➤ To practice Numerical computational applications.
➤ To introduce difference equations and recurrence equations.
➤ To demonstrate understanding and implementation of numerical solution of algorithms based for employability
➤ To find the errors in the approximation

UNIT – I	18

Bisection method – Iteration method (approximation method) based on first degree equation, second degree equation.

UNIT – II	18

Direct methods: forward substitution method, back substitution method, Cramer rule, Gauss elimination method, Gauss Jordan method – triangulation method – LU decomposition– Cholesky method – Partition method.

UNIT - III	18

Iterative methods - Jacobi iteration methods, Gauss-Seidel iteration methods, Similarity transformation – Eigen values – Eigen vectors –Jacobi method for symmetric matrices.

UNIT – IV	18

Lagrange's and Newton Interpolation, Finite Difference Operators, Interpolating Polynomials using Finite Differences, Hermite Interpolation.

UNIT - V	18

Numerical Differentiation, Partial Differentiation, Numerical Integration, Methods based on Interpolation, Composite Integration methods.

	Total Lecture Hours	**90**

BOOKS FOR STUDY:

➢ M.K.Jain, S.R.K.Iyengar, R.K.Jain, **Numerical Methods for scientific and Engineering computation** – 4th edition, New age international Pvt limited, New Delhi, 2009.

Unit I - Chapter 2 : Section 2.1-2.4 and 2.5
Unit II - Chapter 3 : Section 3.1, 3.2
Unit III - Chapter 3 : Section 3.4, 3.5 and 3.7
Unit IV - Chapter 4 : Section 4.1 – 4.5
Unit V - Chapter 5 : Section 5.1, 5.2, 5.5 - 5.7, 5.9.

BOOKS FOR REFERENCES:

➢ G.Shankar Rao, **Numerical Analysis,** New Age International publishers, New Delhi,1997.
➢ Rainer Kress, **Numerical Analysis**, Springer international Edition, New Delhi, 2010.
➢ S.R.K.Iyengar ,R.K.Jain **,Numerical Methods,** , New age international Pvt limited, New Delhi, 2008.

WEB RESOURCES:

❖ **http://www.ece.mcmaster.ca/~xwu/part6.pdf**
❖ **http://www.cis.upenn.edu/~cis515/cis515-12-sl2.pdf**
❖ **https://wiki.math.ntnu.no/_media/tma4215/2012h/note.pdf**

Nature of Course	EMPLOYABILITY		✔	SKILL ORIENTED			ENTREPRENEURSHIP	
Curriculum Relevance	LOCAL		REGIONAL			NATIONAL	✔	GLOBAL	
Changes Made in the Course	Percentage of Change	**10%**	No Changes Made			New Course		

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

	COURSE OUTCOMES:	K LEVEL
	After studying this course, the students will be able to:	
CO1	Demonstrate the understanding of direct methods and iterative methods for equations	K1 to K5
CO2	Apply proper methods for solving transcendental, algebraic and system of equations	K1 to K5
CO3	Evaluate interpolation and extrapolation using tabular values	K1 to K5
CO4	Associate tabular values with integration and differentiation	K1 to K5
CO5	Use iterative methods for PDE	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	1	1	1				
CO2	3	3	2	2	1	-				
CO3	3	3	3	1	1	1				
CO4	3	3	2	2	1	-				
CO5	3	3	2	2	2	1				

S- STRONG   **M – MEDIUM**   **L - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	15	10	5		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	NUMERICAL ANALYSIS	HRS	PEDAGOGY
I	Bisection method – Iteration method (approximation method) based on first degree equation, second degree equation.	18	Chalk & Talk, PPT
II	Direct methods: forward substitution method, back substitution method, Cramer rule, Gauss elimination method, Gauss Jordan method – triangulation method – LU decomposition– Cholesky method – Partition method.	18	Chalk & Talk

III	Iterative methods - Jacobi iteration methods, Gauss-Seidel iteration methods, Similarity transformation – Eigen values – Eigen vectors – Jacobi method for symmetric matrices.	**18**	**Chalk & Talk**
IV	Lagrange's and Newton Interpolation, Finite Difference Operators, Interpolating Polynomials using Finite Differences, Hermite Interpolation.	**18**	**Chalk & Talk, PPT**
V	Numerical Differentiation, Partial Differentiation, Numerical Integration, Methods based on Interpolation, Composite Integration methods.	**18**	**Chalk & Talk**

<table>
<tr><th colspan="8">Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)</th></tr>
<tr><th rowspan="3">Internal</th><th rowspan="3">Cos</th><th rowspan="3">K Level</th><th colspan="2">Section A</th><th rowspan="3">Section B
Either or
Choice</th><th rowspan="3">Section C
Either or Choice</th></tr>
<tr><th colspan="2">MCQs</th></tr>
<tr><th>No. of.
Questions</th><th>K -
Level</th></tr>
<tr><td>CI
AI</td><td>CO1</td><td>K1 – K5</td><td>2</td><td>K2</td><td>2(K2,K2)</td><td>2(K3,K3)</td></tr>
<tr><td>CO2</td><td>K1 – K5</td><td>2</td><td>K2</td><td>2(K3,K3)</td><td>2(K4,K4)</td></tr>
<tr><td>CI
AII</td><td>CO3</td><td>K1 – K5</td><td>2</td><td>K2</td><td>2(K2,K2)</td><td>2(K3,K3)</td></tr>
<tr><td>CO4</td><td>K1 – K5</td><td>2</td><td>K2</td><td>2(K3,K3)</td><td>2(K4,K4)</td></tr>
<tr><td rowspan="4">Question Pattern
CIA I & II</td><td colspan="2">No. of Questions to be asked</td><td>4</td><td></td><td>4</td><td>4</td></tr>
<tr><td colspan="2">No. of Questions to be answered</td><td>4</td><td></td><td>2</td><td>2</td></tr>
<tr><td colspan="2">Marks for each question</td><td>1</td><td></td><td>5</td><td>8</td></tr>
<tr><td colspan="2">Total Marks for each section</td><td>4</td><td></td><td>10</td><td>16</td></tr>
</table>

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	Cos	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100

NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
	Unit - I	CO1	K1		
1.				a)	b)
				c)	d)
	Unit - I	CO1	K2		
2.				a)	b)
				c)	d)
	Unit - II	CO2	K1		
3.				a)	b)
				c)	d)
	Unit - II	CO2	K2		
4.				a)	b)
				c)	d)
	Unit - III	CO3	K1		
5.				a)	b)
				c)	d)
	Unit - III	CO3	K2		
6.				a)	b)
				c)	d)
	Unit - IV	CO4	K1		
7.				a)	b)
				c)	d)
	Unit - IV	CO4	K2		
8.				a)	b)
				c)	d)
	Unit - V	CO5	K1		
9.				a)	b)
				c)	d)
	Unit - V	CO5	K2		
10.				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**	
11. a)	**Unit - I**	**CO1**	**K2**		
		OR			
11. b)	**Unit - I**	**CO1**	**K2**		
12. a)	**Unit - II**	**CO2**	**K3**		
		OR			
12. b)	**Unit - II**	**CO2**	**K3**		
13. a)	**Unit - III**	**CO3**	**K2**		
		OR			
13. b)	**Unit - III**	**CO3**	**K2**		
14. a)	**Unit - IV**	**CO4**	**K3**		
		OR			
14. b)	**Unit - IV**	**CO4**	**K3**		
15. a)	**Unit - V**	**CO5**	**K3**		
		OR			
15. b)	**Unit - V**	**CO5**	**K3**		

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**	
16. a)	**Unit - I**	**CO1**	**K3**		
		OR			
16. b)	**Unit - I**	**CO1**	**K3**		
17. a)	**Unit - II**	**CO2**	**K4**		
		OR			
17. b)	**Unit - II**	**CO2**	**K4**		
18. a)	**Unit - III**	**CO3**	**K3**		
		OR			
18. b)	**Unit - III**	**CO3**	**K3**		
19. a)	**Unit - IV**	**CO4**	**K4**		
		OR			
19. b)	**Unit - IV**	**CO4**	**K4**		
20. a)	**Unit - V**	**CO5**	**K4**		
		OR			
20. b)	**Unit - V**	**CO5**	**K4**		

Course Name	RESOURCE MANAGEMENT TECHNIQUES			
Course Code	23PMTEC22	**L**	**P**	**C**
Category	ELECTIVE	6	-	4

COURSE OBJECTIVES:

➢ To familiarize various decisions– making tools.
➢ To solve optimization problems.
➢ To introduce the application on inventory control system and etc.
➢ To identify the resources required for a project and generate a plan and work schedule.
➢ To learn about queuing models.

UNIT – I	18

Network definitions- Minimal Spanning Tree Algorithm-Shortest route problem-Maximal Flow Model - CPM and PERT.

UNIT – II	18

Recursive nature of computations in DP - Forward and Backward recursion - Selected DP applications. General inventory models – Static Economic Order Quantity(EOQ) models.

UNIT - III	18

Decision making under certainty-Analytic Hierarchy Process(AHP)-Decision making under risk- Decision under uncertainty-Game theory.

UNIT – IV	18

Queuing systems – Elements of Queuing model – Role of Exponential Distribution – Pure Birth and Death Models – Generalized Poisson Queuing Models – Specialized Poisson Queues.

UNIT - V	18

Unconstrained Problems – Necessary and Sufficient Conditions- Newton – Raphson Method - Constrained Problems – Equality Constraints- Inequality Constraints- Karush-Kuhn-Tucker Conditions.

	Total Lecture Hours	90

BOOKS FOR STUDY:

➢ Hamdy A. Taha, **Operations Research** – An introduction, 8th Edition, PHI, New Delhi.

> Unit I-   Chapter 6: sections 6.1 to 6.5
> Unit II -   Chapter 10: sections 10.1 to 10.3
>   Chapter 11: sections 11.1 to 11.3
> Unit III -   Chapter 13: sections 13.1 to 13.4
> Unit IV -   Chapter 15: sections 15.1 to 15.6
>
> Unit V -   Chapter 18: sections 18.1 to 18.2

BOOKS FOR REFERENCES:

➢ KantiSwarup , P.K. Gupta and Man Mohan, "**Operations Research**" , Sultan Chand & sons Publications, Reprint 2006, NewDelhi.
➢ Harvey M. Wagner, "**Principles of Operations Research**", **Second** Edition, Prentice Hall of Pvt Ltd, 1998, NewDelhi.
➢ Prem Kumar Gupta and D.S.Hira, "**Operations Research**", S.Chand Publications, 2009, New Delhi.

WEB RESOURCES:

❖ **https://nptel.ac.in/courses/111/105/111105100/**
❖ **https://nptel.ac.in/courses/111/104/111104071/**
❖ **http://apmonitor.com/me575/**

Nature of Course	EMPLOYABILITY		✓	SKILL ORIENTED			ENTREPRENEURSHIP		
Curriculum Relevance	LOCAL		REGIONAL			NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change			No Changes Made		✓	New Course		

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Identify various decisions– making tools.	**K1 to K5**
CO2	Analyze various models in inventory system.	**K1 to K5**
CO3	Apply suitable method in game theory.	**K1 to K5**
CO4	Explain Poisson Queuing Models	**K1 to K5**
CO5	Classify the constrained and unconstrained Problems	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3				
CO2	3	2	3	2	2	3				
CO3	3	2	3	2	2	3				
CO4	2	2	2	2	2	3				
CO5	2	2	2	2	2	3				

S- STRONG **M – MEDIUM** **L - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	15	10	5		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	RESOURCE MANAGEMENT TECHNIQUES	HRS	PEDAGOGY
I	Network definitions- minimal spanning tree algorithm-Shortest route problem-maximal flow model - CPM and PERT.	18	Chalk and Board, Virtual Class room, LCD projector
II	Recursive nature of computations in DP - Forward and Backward recursion - Selected DP applications. General inventory models – Static Economic Order Quantity(EOQ) models	18	Guest Lectures.
III	Decision making under certainty-Analytic Hierarchy Process(AHP)-Decision making under risk- decision under uncertainty-Game theory.	18	Chalk & Talk
IV	Queuing systems – Elements of Queuing model – Role of Exponential Distribution – Pure Birth and Death Models – Generalized Poisson Queuing Models – Specialized Poisson Queues.	18	Chalk & Talk
V	Unconstrained Problems – Necessary and Sufficient Conditions-Newton – Raphson Method - Constrained Problems – Equality Constraints- Inequality Constraints- Karush-Kuhn-Tucker Conditions	18	Chalk & Talk

Internal	Cos	K Level	Section A MCQs		Section B Either or Choice	Section C Either or Choice
			No. of. Questions	K - Level		
CI AI	CO1	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
	CO2	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
CI AII	CO3	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
	CO4	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II		No. of Questions to be asked	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	Cos	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
	Unit - I	**CO1**	**K1**		
1.				a)	b)
				c)	d)
	Unit - I	**CO1**	**K2**		
2.				a)	b)
				c)	d)
	Unit - II	**CO2**	**K1**		
3.				a)	b)
				c)	d)
	Unit - II	**CO2**	**K2**		
4.				a)	b)
				c)	d)
	Unit - III	**CO3**	**K1**		
5.				a)	b)
				c)	d)
	Unit - III	**CO3**	**K2**		
6.				a)	b)
				c)	d)
	Unit - IV	**CO4**	**K1**		
7.				a)	b)
				c)	d)
	Unit - IV	**CO4**	**K2**		
8.				a)	b)
				c)	d)
	Unit - V	**CO5**	**K1**		
9.				a)	b)
				c)	d)
	Unit - V	**CO5**	**K2**		
10.				a)	b)
				c)	d)

Answer **ALL** the questions	**PART – B**	**(5 x 5 = 25 Marks)**

11. a)	Unit - I	CO1	K2	
			OR	
11. b)	Unit - I	CO1	K2	
12. a)	Unit - II	CO2	K3	
			OR	
12. b)	Unit - II	CO2	K3	
13. a)	Unit - III	CO3	K2	
			OR	
13. b)	Unit - III	CO3	K2	
14. a)	Unit - IV	CO4	K3	
			OR	
14. b)	Unit - IV	CO4	K3	
15. a)	Unit - V	CO5	K3	
			OR	
15. b)	Unit - V	CO5	K3	

Answer **ALL** the questions			**PART – C**	**(5 x 8 = 40 Marks)**
16. a)	Unit - I	CO1	K3	
			OR	
16. b)	Unit - I	CO1	K3	
17. a)	Unit - II	CO2	K4	
			OR	
17. b)	Unit - II	CO2	K4	
18. a)	Unit - III	CO3	K3	
			OR	
18. b)	Unit - III	CO3	K3	
19. a)	Unit - IV	CO4	K4	
			OR	
19. b)	Unit - IV	CO4	K4	
20. a)	Unit - V	CO5	K4	
			OR	
20. b)	Unit - V	CO5	K4	

M.Sc., MATHEMATICS

Syllabus

Program Code: PMT

2023 - Onwards

MANNAR THIRUMALAI NAICKER COLLEGE

(AUTONOMOUS)

Re-accredited with "A" Grade by NAAC

PASUMALAI, MADURAI – 625 004

MANNAR THIRUMALAI NAICKER COLLEGE (AUTONOMOUS),
MADURAI – 625 004
M. SC MATHEMATICS CURRICULUM
(For the students admitted from the academic year 2023-2024 onwards)

Course Code	Title of the Course	Hrs	Credits	Maximum Marks		
				Int	Ext	Total
FIRST SEMESTER						
Part – III	**Core courses**					
23PMTCC11	ALGEBRAIC STRUCTURES	6	5	25	75	100
23PMTCC12	REAL ANALYSIS - I	6	5	25	75	100
23PMTCC13	ORDINARY DIFFERENTIAL EQUATIONS	6	4	25	75	100
Part – III	**Elective courses**					
23PMTEC11	GRAPH THEORY AND APPLICATIONS	6	3	25	75	100
23PMTEC12	FUZZY SETS AND THEIR APPLICATIONS	6	3	25	75	100
	Total	**30**	**20**	**125**	**375**	**500**
SECOND SEMESTER						
Part – III	**Core courses**					
23PMTCC21	ADVANCED ALGEBRA	6	5	25	75	100
23PMTCC22	REAL ANALYSIS - II	6	5	25	75	100
23PMTCC23	PARTIAL DIFFERENTIAL EQUATIONS	6	4	25	75	100
Part – III	**Elective courses**					
23PMTEC21	NUMERICAL ANALYSIS	6	4	25	75	100
23PMTEC22	RESOURCE MANAGEMENT TECHNIQUES	6	4	25	75	100
	Total	**30**	**22**	**125**	**375**	**500**

Course Code	Title of the Course	Hrs	Credits	Maximum Marks		
				Int	Ext	Total
THIRD SEMESTER						
Part – III	**Core courses**					
23PMTCC31	COMPLEX ANALYSIS	**6**	**5**	**25**	**75**	**100**
23PMTCC32	PROBABILITY THEORY	**6**	**5**	**25**	**75**	**100**
23PMTCC33	TOPOLOGY	**6**	**5**	**25**	**75**	**100**
Part – III	**Elective course**					
23PMTEC31	COMBINATORIAL MATHEMATICS	**4**	**3**	**25**	**75**	**100**
Part - IV	**Skill Enhancement course**					
23PMTSP31	MATHEMATICAL DOCUMENTATION USING LATEX	**2**	**2**	**25**	**75**	**100**
Part - IV	**Non Major Elective course**					
23PMTNM31	MATHEMATICS FOR COMPETITIVE EXAMINATIONS	**6**	**3**	**25**	**75**	**100**
23PMTINT31	INTERNSHIP REPORT	**-**	**2**	**25**	**75**	**100**
	Total	**30**	**25**	**175**	**525**	**700**
FOURTH SEMESTER						
Part – III	**Core courses**					
23PMTCC41	FUNCTIONAL ANALYSIS	**6**	**5**	**25**	**75**	**100**
23PMTCC42	INTEGRAL EQUATIONS	**6**	**5**	**25**	**75**	**100**
23PMTPR41	PROJECT & VIVA-VOCE	**10**	**7**	**25**	**75**	**100**
Part – III	**Elective course**					
23PMTEC41	MATHEMATICS FOR SET/NET & GENERAL STUDIES FOR UPSC/TNPSC	**4**	**3**	**25**	**75**	**100**
Part – IV	**Skill Enhancement course**					
23PMTSP41	NUMERICAL ANALYSIS USING PYTHON	**4**	**2**	**25**	**75**	**100**
Part - V	**Extension Activities**					
23PEXTG41	EXTENSION ACTIVITY	**-**	**1**	**25**	**75**	**100**
	Total	**23**	**30**	**150**	**450**	**600**
	Grand Total	**120**	**90**	**525**	**1725**	**2300**

THIRD SEMESTER

Course Name	COMPLEX ANALYSIS			
Course Code	23PMTCC31	**L**	**P**	**C**
Category	CORE VII	6	-	5

COURSE OBJECTIVES:

➢ To Study Cauchy integral formula, local properties of analytic functions, general form of Cauchy's theorem and evaluation of definite integral and harmonic functions

UNIT – I Cauchy's Integral Formula	18

The Index of a point with respect to a closed curve – The Integral formula – Higher derivatives. Local Properties of analytical Functions:Removable Singularities-Taylors's Theorem – Zeros and poles – The local Mapping – The Maximum Principle.

UNIT – II The general form of Cauchy's Theorem	18

Chains and cycles- Simple Continuity - Homology - The General statement of Cauchy's Theorem - Proof of Cauchy's theorem -   Locally exact differentials- Multiply connected regions - Residue theorem - The argument principle.

UNIT - III Evaluation of Definite Integrals and Harmonic Functions	18

Evaluation of definite integrals - Definition of Harmonic function and basic properties - Mean value property - Poisson formula.

UNIT – IV Harmonic Functions and Power Series Expansions	18

Schwarz theorem - The reflection principle - Weierstrass theorem – Taylor's Series – Laurent series

UNIT - V Partial Fractions and Entire Functions	18

Partial fractions - Infinite products – Canonical products – Gamma Function- Jensen's formula – Hadamard's Theorem

	Total Lecture Hours	**90**

BOOKS FOR STUDY:

➢ Lars V. Ahlfors, *Complex Analysis*, (3rd edition) McGraw Hill Co., New York, 1979

UNIT-I :   Chapter 4 : Section 2 : 2.1 to 2.3
            Chapter 4 : Section 3 : 3.1 to 3.4
UNIT-II: Chapter 4 : Section 4 : 4.1 to 4.7
UNIT-III: Chapter 4 : Section 5: 5.1 and 5.2
            Chapter 4 : Section 5 : 5.3
UNIT-IV :   Chapter 4 : Sections 6 : 6.1 to 6.3
            Chapter 4 : Sections 6.4 and 6.5
            Chapter 5 : Sections 1.1 to 1.3
UNIT-V: Chapter 5 : Sections 2.1 to 2.4
            Chapter 5 : Sections 3.1 and 3.2

BOOKS FOR REFERENCES:

➢ H.A. Presfly, *Introduction to complex Analysis*, Clarendon Press, oxford, 1990.
➢ J.B. Conway, *Functions of one complex variables* Springer - Verlag, International student   Edition, Naroser Publishing Co.1978
➢ E. Hille, *Analytic function Thorey* (2 vols.), Gonm& Co, 1959.
➢ M.Heins, *Complex function Theory*, Academic Press, New York,1968

WEB RESOURCES:

❖ **http://ocw.mit.edu/ocwweb/Mathematics,**
❖ **http://mathforum.org,**
❖ **http://www.opensource.org,**
❖ **http://en.wikipedia.org**

Nature of Course	EMPLOYABILITY		✓	SKILL ORIENTED			ENTREPRENEURSHIP		
Curriculum Relevance	LOCAL		REGIONAL			NATIONAL		✓	GLOBAL
Changes Made in the Course	Percentage of Change		**25**	No Changes Made				New Course	
* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.									

	COURSE OUTCOMES:	K LEVEL
	After studying this course, the students will be able to:	
CO1	Analyze and evaluate local properties of analytical functions and definite integrals.	K1 to K5
CO2	Describe the concept of definite integral and harmonic functions.	K1 to K5
CO3	Demonstrate the concept of the general form of Cauchy's theorem	K1 to K5
CO4	Develop Taylor and Laurent series	K1 to K5
CO5	Explain the infinite products, canonical products and jensen's formula .	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3	2	3	3				
CO2	2	1	3	1	3	3				
CO3	3	2	3	1	3	3				
CO4	1	2	3	2	3	3				
CO5	3	1	2	3	3	3				

S- STRONG   **M – MEDIUM**   **L - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	15	10	5		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	COMPLEX ANALYSIS	HRS	PEDAGOGY
I	The Index of a point with respect to a closed curve – The Integral formula – Higher derivatives. Local Properties of analytical Functions: Removable Singularities-Taylors's Theorem – Zeros and poles – The local Mapping – The Maximum Principle.	18	Chalk & Talk
II	Chains and cycles- Simple Continuity - Homology - The General statement of Cauchy's Theorem - Proof of Cauchy's theorem - Locally exact differentials- Multiply connected regions - Residue theorem - The argument principle.	18	Chalk & Talk

III	Evaluation of definite integrals - Definition of Harmonic function and basic properties - Mean value property - Poisson formula.	**18**	**Chalk & Talk, PPT**
IV	Schwarz theorem - The reflection principle - Weierstrass theorem – Taylor's Series – Laurent series .	**18**	**Chalk & Talk**
V	Partial fractions - Infinite products – Canonical products – Gamma Function- Jensen's formula – Hadamard's Theorem	**18**	**Seminar**

Learning Outcome Based Education & Assessment (LOBE) **Formative Examination - Blue Print** **Articulation Mapping – K Levels with Course Outcomes (COs)**

Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI	**CO1**	**K1 – K5**	2	K2	2(K2,K2)	2(K3,K3)
AI	**CO2**	**K1 – K5**	2	K2	2(K3,K3)	2(K4,K4)
CI	**CO3**	**K1 – K5**	2	K2	2(K2,K2)	2(K3,K3)
AII	**CO4**	**K1 – K5**	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		**Total Marks for each section**	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	Cos	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level

K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice)	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100

NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
	Unit - I	CO1	K1		
1.				a)	b)
				c)	d)
	Unit - I	CO1	K2		
2.				a)	b)
				c)	d)
	Unit - II	CO2	K1		
3.				a)	b)
				c)	d)
	Unit - II	CO2	K2		
4.				a)	b)
				c)	d)
	Unit - III	CO3	K1		
5.				a)	b)
				c)	d)
	Unit - III	CO3	K2		
6.				a)	b)
				c)	d)
	Unit - IV	CO4	K1		
7.				a)	b)
				c)	d)
	Unit - IV	CO4	K2		
8.				a)	b)
				c)	d)
	Unit - V	CO5	K1		
9.				a)	b)
				c)	d)
	Unit - V	CO5	K2		
10.				a)	b)
				c)	d)

Answer **ALL** the questions	**PART – B**	**(5 x 5 = 25 Marks)**

11. a)	Unit - I	CO1	K2	
		OR		
11. b)	Unit - I	CO1	K2	
12. a)	Unit - II	CO2	K3	
		OR		
12. b)	Unit - II	CO2	K3	
13. a)	Unit - III	CO3	K2	
		OR		
13. b)	Unit - III	CO3	K2	
14. a)	Unit - IV	CO4	K3	
		OR		
14. b)	Unit - IV	CO4	K3	
15. a)	Unit - V	CO5	K3	
		OR		
15. b)	Unit - V	CO5	K3	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	Unit - I	CO1	K3	
		OR		
16. b)	Unit - I	CO1	K3	
17. a)	Unit - II	CO2	K4	
		OR		
17. b)	Unit - II	CO2	K4	
18. a)	Unit - III	CO3	K3	
		OR		
18. b)	Unit - III	CO3	K3	
19. a)	Unit - IV	CO4	K4	
		OR		
19. b)	Unit - IV	CO4	K4	
20. a)	Unit - V	CO5	K4	
		OR		
20. b)	Unit - V	CO5	K4	

Course Name	PROBABILITY THEORY			
Course Code	23PMTCC32	**L**	**P**	**C**
Category	CORE	6	-	5

COURSE OBJECTIVES:

➢ To introduce axiomatic approach to probability theory, to study some statistical characteristics, discrete and continuous distribution functions and their properties, characteristic function and basic limit theorems of probability.

UNIT – I Random Events and Random Variables	18

Random events – Probability axioms – Combinatorial formulae – conditional probability – Bayes Theorem – Independent events – Random Variables – Distribution Function – Joint Distribution – Marginal Distribution – Conditional Distribution – Independent random variables – Functions of random variables.

UNIT – II Parameters of the Distribution	18

Expectation- Moments – The Chebyshev Inequality – Absolute moments – Order parameters – Moments of random vectors – Regression of the first and second types.

UNIT - III Characteristic functions	18

Properties of characteristic functions – Characteristic functions and moments – semi invariants – characteristic function of the sum of the independent random variables – Determination of distribution function by the Characteristic function – Characteristic function of multidimensional random vectors – Probability generating functions.

UNIT – IV Some Probability distributions	18

One point , two point , Binomial – Polya – Hypergeometric – Poisson (discrete) distributions – Uniform – normal gamma – Beta – Cauchy and Laplace (continuous) distributions.

UNIT - V Limit Theorems	18

Stochastic convergence – Bernaulli law of large numbers – Convergence of sequence of distribution functions – Levy-Cramer Theorems – de Moivre-Laplace Theorem – Poisson, Chebyshev, Khintchine Weak law of large numbers – Lindberg Theorem – Lapunov Theroem – Borel-Cantelli Lemma - Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.

	Total Lecture Hours	90

BOOKS FOR STUDY:

➤ M. Fisz, *Probability Theory and Mathematical Statistics,* John Wiley and Sons, New York, 1963

    UNIT I :   Chapter 1: Sections 1.1 to 1.7
        Chapter 2 : Sections 2.1 to 2.9
    UNIT II: Chapter 3 : Sections 3.1 to 3.8
    UNIT-III : Chapter 4 : Sections 4.1 to 4.7
    UNIT-IV : Chapter 5 : Section 5.1 to 5.10 (Omit Section 5.11)
    UNIT-V: Chapter 6 : Sections 6.1 to 6.4, 6.6 to 6.9 , 6.11 and 6.12. (Omit Sections 6.5, 6.10,6.13 to 6.15)

BOOKS FOR REFERENCES:

➤ R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972
➤ K.L.Chung, A course in Probability, Academic Press, New York, 1974
➤ R.Durrett, Probability : Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996
➤ V.K.RohatgiAn Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988(3rd Print).
➤ S.I.Resnick, A Probability Path, Birhauser, Berlin,1999.
➤ B.R.Bhat , Modern Probability Theory (3rd Edition), New Age International (P)Ltd, New Delhi, 1999.

WEB RESOURCES:

❖ **http://ocw.mit.edu/ocwweb/Mathematics,**
❖ **http://www.opensource.org**
❖ **http://www.probability.net**

Nature of Course	EMPLOYABILITY		✔	SKILL ORIENTED			ENTREPRENEURSHIP	
Curriculum Relevance	LOCAL		REGIONAL			NATIONAL	✔	GLOBAL	
Changes Made in the Course	Percentage of Change			No Changes Made			New Course	✔

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	To define Random Events, Random Variables, to describe Probability, to apply Bayes, to define Distribution Function, to find Joint Distribution function, to find Marginal Distribution and Conditional Distribution function, to solve functions on random variables.	**K1 to K5**
CO2	To define Expectation, Moments and Chebyshev Inequality, to solve Regression of the first and second types.	**K1 to K5**
CO3	To define Characteristic functions, to define distribution function, to find probability generating functions, to solve problems applying characteristic functions	**K1 to K5**
CO4	To define One point, two-point, Binomial distributions, to solve problems of Hypergeometric and Poisson distributions, to define Uniform, normal, gamma, Beta distributions, to solve problems on Cauchy and Laplace distributions	**K1 to K5**
CO5	To discuss Stochastic convergence, Bernaulli law of large numbers, to elaborate Convergence of sequence of distribution functions, to prove Levy-Cramer Theorems and de Moivre-Laplace Theorems, to explain Poisson, Chebyshev, Khintchine Weak law of large numbers, to explain and solve problems on Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3	2	3	3				
CO2	2	1	3	1	3	3				
CO3	3	2	3	1	3	3				
CO4	1	2	3	2	3	3				
CO5	3	1	2	3	3	3				

S- STRONG   **M – MEDIUM**   **L - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	15	10	5		
WEIGHTED PERCENTAGE	3	2	1		

OF COURSE CONTRIBUTIO N TO POS					

LESSON PLAN:			

UNIT	PROBABILITY THEORY	HRS	PEDAGOGY
I	Random events – Probability axioms – Combinatorial formulae – conditional probability – Bayes Theorem – Independent events – Random Variables – Distribution Function – Joint Distribution – Marginal Distribution – Conditional Distribution – Independent random variables – Functions of random variables.	18	Chalk & Talk
II	Expectation- Moments – The Chebyshev Inequality – Absolute moments – Order parameters – Moments of random vectors – Regression of the first and second types.	18	Chalk & Talk
III	Properties of characteristic functions – Characteristic functions and moments – semi0invariants – characteristic function of the sum of the independent random variables – Determination of distribution function by the Characteristic function – Characteristic function of multidimensional random vectors – Probability generating functions.	18	Chalk & Talk
IV	One point , two point , Binomial – Polya – Hypergeometric – Poisson (discrete) distributions – Uniform – normal gamma – Beta – Cauchy and Laplace (continuous) distributions.	18	Chalk & Talk
V	Stochastic convergence – Bernaulli law of large numbers – Convergence of sequence of distribution functions – Levy-Cramer Theorems – de Moivre-Laplace Theorem – Poisson, Chebyshev, Khintchine Weak law of large numbers – Lindberg Theorem – Lapunov Theroem – Borel-Cantelli Lemma - Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.	18	Chalk & Talk

<table>
<tr><td colspan="8" align="center">**Learning Outcome Based Education & Assessment (LOBE)**
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)</td></tr>
</table>

| Internal | Cos | K Level | Section A MCQs | | Section B Either or Choice | Section C Either or Choice |
			No. of. Questions	K - Level		
CI AI	**CO1**	**K1 – K5**	2	K2	2(K2,K2)	2(K3,K3)
	CO2	**K1 – K5**	2	K2	2(K3,K3)	2(K4,K4)
CI AII	**CO3**	**K1 – K5**	2	K2	2(K2,K2)	2(K3,K3)
	CO4	**K1 – K5**	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

		Distribution of Marks with K Level CIA I & CIA II					
	K Level	**Section A (Multiple Choice Questions)**	**Section B (Either / Or Choice)**	**Section C (Either / Or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	**K1**	2			2	**3.6**	25
	K2	2	10		12	**21.4**	
	K3		10	16	26	**46.4**	46.4
	K4			16	16	**28.6**	28.6
	K5						
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	**K1**	2			2	**3.6**	7.2
	K2	2			2	**3.6**	
	K3		10	16	26	**46.4**	46.4
	K4		10	16	26	**46.4**	46.4
	K5						
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	Cos	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
1.	Unit - I	CO1	K1		
				a)	b)
				c)	d)
2.	Unit - I	CO1	K2		
				a)	b)
				c)	d)
3.	Unit - II	CO2	K1		
				a)	b)
				c)	d)
4.	Unit - II	CO2	K2		
				a)	b)
				c)	d)
5.	Unit - III	CO3	K1		
				a)	b)
				c)	d)
6.	Unit - III	CO3	K2		
				a)	b)
				c)	d)
7.	Unit - IV	CO4	K1		
				a)	b)
				c)	d)
8.	Unit - IV	CO4	K2		
				a)	b)
				c)	d)
9.	Unit - V	CO5	K1		
				a)	b)
				c)	d)
10.	Unit - V	CO5	K2		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	TOPOLOGY			
Course Code	23PMTCC33	**L**	**P**	**C**
Category	CORE - IX	6	-	5

COURSE OBJECTIVES:

➢ To study topological spaces, continuous functions, connectedness, compactness, countability and separation axioms.

UNIT – I	Topological spaces	18

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

UNIT – II	Continuous functions	18

Continuous functions – the product topology – The metric topology.

UNIT - III	Connectedness	18

Connected spaces- connected subspaces of the Real line – Components and local connectedness.

UNIT – IV	Compactness	18

Compact spaces – compact subspaces of the Real line – Limit Point Compactness – Local Compactness

UNIT - V	Countability and Separation Axiom	18

Countability and Separation Axiom: The Countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohnmetrization Theorem – The Tietz extension theorem.

	Total Lecture Hours	90

BOOKS FOR STUDY:

- James R. Munkres, *Topology* (2nd Edition) Pearson Education Pve. Ltd., Delhi-2002 (Third Indian Reprint)

    Unit I -   Chapter 2 : Sections 12 to 17
    Unit II -   Chapter 2 : Sections 18 to 21 (Omit Section 22)
    Unit III - Chapter 3 : Sections 23 to 25.
    Unit IV - Chapter 3 : Sections 26 to 29.
    Unit V   - Chapter 4 : Sections 30 to 35.

BOOKS FOR REFERENCES:

- J. Dugundji ,*Topology* , Prentice Hall of India, New Delhi, 1975.
- George F.Sinmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Book Co., 1963
- J.L. Kelly, *General Topology*, Van Nostrand, Reinhold Co., New York
- L.Steen and J.Subhash, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970.
- S.Willard, *General Topology*, Addison - Wesley, Mass., 1970.

WEB RESOURCES:

- ❖ **http://mathforum.org,**
- ❖ **http://ocw.mit.edu/ocwweb/Mathematics**
- ❖ **http://www.opensource.org,**
- ❖ **http://en.wikipedia.org**

Nature of Course	EMPLOYABILITY		✓	SKILL ORIENTED			ENTREPRENEURSHIP		
Curriculum Relevance	LOCAL		REGIONAL			NATIONAL		✓	GLOBAL	
Changes Made in the Course	Percentage of Change			No Changes Made		✓		New Course	

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

	COURSE OUTCOMES:	K LEVEL
	After studying this course, the students will be able to:	
CO1	Define and illustrate the concept of topological spaces and the basic definitions of open sets, neighbourhood, interior, exterior, closure and their axioms for defining topological space.	K1 to K5
CO2	Understand continuity, compactness, connectedness, homeomorphism and topological properties.	K1 to K5
CO3	Analyze and apply the topological concepts in Functional Analysis.	K1 to K5
CO4	Ability to determine that a given point in a topological space is either a limit point or not for a given subset of a topological space.	K1 to K5
CO5	Develop qualitative tools to characterize connectedness, compactness, second countable, Hausdorff and develop tools to identify when two are equivalent(homeomorphic).	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3	2	3	3				
CO2	2	1	3	1	3	3				
CO3	3	2	3	1	3	3				
CO4	1	2	3	2	3	3				
CO5	3	1	2	3	3	3				

S- STRONG   M – MEDIUM   L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	15	10	5		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	TOPOLOGY	HRS	PEDAGOGY
I	Topological spaces – Basis for a topology – The order topology – The product topology on X × Y – The subspace topology – Closed sets and limit points	18	Chalk & Talk

II	Continuous functions – the product topology – The metric topology.	**18**	**Chalk & Talk**		
III	Connected spaces- connected subspaces of the Real line – Components and local connectedness.	**18**	**Chalk & Talk**		
IV	Compact spaces – compact subspaces of the Real line – Limit Point Compactness – Local Compactness**.**	**18**	**Chalk & Talk**		
V	The Countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohnmetrization Theorem – The Tietz extension theorem.	**18**	**Chalk & Talk**		

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	Cos	K Level	Section A		Section B Either or Choice	Section C Either or Choice
			MCQs			
			No. of. Questions	K - Level		
CI AI	**CO1**	**K1 – K5**	2	K2	2(K2,K2)	2(K3,K3)
	CO2	**K1 – K5**	2	K2	2(K3,K3)	2(K4,K4)
CI AII	**CO3**	**K1 – K5**	2	K2	2(K2,K2)	2(K3,K3)
	CO4	**K1 – K5**	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II

	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)

S. No	Cos	K - Level	Section A (MCQs) No. of Questions	Section A (MCQs) K – Level	Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level

K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice)	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100

NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
	Unit - I	CO1	K1		
1.				a)	b)
				c)	d)
	Unit - I	CO1	K2		
2.				a)	b)
				c)	d)
	Unit - II	CO2	K1		
3.				a)	b)
				c)	d)
	Unit - II	CO2	K2		
4.				a)	b)
				c)	d)
	Unit - III	CO3	K1		
5.				a)	b)
				c)	d)
	Unit - III	CO3	K2		
6.				a)	b)
				c)	d)
	Unit - IV	CO4	K1		
7.				a)	b)
				c)	d)
	Unit - IV	CO4	K2		
8.				a)	b)
				c)	d)
	Unit - V	CO5	K1		
9.				a)	b)
				c)	d)
	Unit - V	CO5	K2		
10.				a)	b)
				c)	d)
Answer **ALL** the questions				**PART – B**	**(5 x 5 = 25 Marks)**

11. a)	Unit - I	CO1	K2	
OR				
11. b)	Unit - I	CO1	K2	
12. a)	Unit - II	CO2	K3	
OR				
12. b)	Unit - II	CO2	K3	
13. a)	Unit - III	CO3	K2	
OR				
13. b)	Unit - III	CO3	K2	
14. a)	Unit - IV	CO4	K3	
OR				
14. b)	Unit - IV	CO4	K3	
15. a)	Unit - V	CO5	K3	
OR				
15. b)	Unit - V	CO5	K3	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	Unit - I	CO1	K3	
OR				
16. b)	Unit - I	CO1	K3	
17. a)	Unit - II	CO2	K4	
OR				
17. b)	Unit - II	CO2	K4	
18. a)	Unit - III	CO3	K3	
OR				
18. b)	Unit - III	CO3	K3	
19. a)	Unit - IV	CO4	K4	
OR				
19. b)	Unit - IV	CO4	K4	
20. a)	Unit - V	CO5	K4	
OR				
20. b)	Unit - V	CO5	K4	

Course Name	COMBINATORIAL MATHEMATICS			
Course Code	23PMTEC31	**L**	**P**	**C**
Category	ELECTIVE	4	-	3

COURSE OBJECTIVES:

- ➢ To understand the rules of sum and product
- ➢ To study the Generating functions, Partitions of integers.
- ➢ To identify the recurrence relations with constant coefficients, and Recurrence relations with two indices.
- ➢ To familiarize the concept of principle of inclusion and exclusion.
- ➢ To understand fundamental theorem.

UNIT – I	12

The rules of Sum and Product - Permutations - Combinations - Distributions of Distinct Objects - Distributions of Non distinct Objects.

UNIT – II	12

Generating Functions for Combinations - Enumerators for Permutations – Distributions of Distinct Objects into Non distinct Cells - Partitions of Integers.

UNIT - III	12

Linear Recurrence relations with Constant Coefficients - Solution by the technique of Generating Functions

UNIT – IV	12

The Principle of Inclusion and Exclusion - The General Formula - Derangements - Permutations with Restrictions on Relative Positions.

UNIT - V	12

Equivalence Classes under a Permutation Group - Equivalence Classes of Functions -Weights and Inventories of Functions - Polya's Fundamental Theorem.

	Total Lecture Hours	**60**

BOOKS FOR STUDY:

➢ C. L. Liu, **Introduction to Combinatorial Mathematics**, McGraw-Hill Inc., Newyork,1968.

    Unit I: -   Chapter 1: Sections 1.1 to 1.6

    Unit II   -   Chapter 2: Sections 2.1 to 2.5

    Unit III: -   Chapter 3: Sections 3.1 to 3.3

    Unit IV: -   Chapter 4: Sections 4.1 to 4.5

    Unit V: -   Chapter 5: Sections 5.1 to 5.6 (Except 5.2)

BOOKS FOR REFERENCES:

➢ J. H. Van Lint and R. M. Wilson, **A Course in Combinatorics**, Cambridge University Press, 2001.
➢ TituAndreescu and ZumingFeng, **A Path to Combinatorics**, Springer Science & Business Media, 2004.
➢ Douglas West, **Combinatorial Mathematics**, Cambridge University Press, 2020

WEB RESOURCES:

❖ **https://www.isinj.com/mt-usamo/Applied%20Combinatorics%20(6th%20Edition)%20by%20Alan%20Tucker%20Wiley%20(2012).pdf**
❖ **http://cseweb.ucsd.edu/~gill/AlgCombSite/Resources/CCSRefP1.pdf**
❖ **https://en.wikipedia.org/w/index.php?title=Special:WhatLinksHere&target=Algorithm**

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✔	ENTREPRENEURSHIP	
Curriculum Relevance	LOCAL		REGIONAL	✔	NATIONAL		GLOBAL	
Changes Made in the Course	Percentage of Change		No Changes Made	✔	New Course	

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Understand the rules of Sum and Product of Permutations and Combinations.	**K1 to K5**
CO2	Discuss distributions of Distinct Objects into Non-distinct Cells and Partitions of Integers.	**K1 to K5**
CO3	Identify Solutions by the technique of Generating Functions and Recurrence Relations with Two Indices.	**K1 to K5**
CO4	Make use of the concepts of Permutations with Restrictions on Relative Positions and the Rook Polynomials.	**K1 to K5**
CO5	Analyze equivanlence classes of functions in Polya's Theory	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	1	1	1				
CO2	3	3	2	2	1	-				
CO3	3	3	3	1	1	1				
CO4	3	3	2	2	1	-				
CO5	3	3	2	2	2	1				

S- STRONG   **M – MEDIUM**   **L - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	**15**	**10**	**5**		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	COMBINATORIAL MATHEMATICS	HRS	PEDAGOGY
I	Permutations and Combinations Introduction - The rules of Sum and Product - Permutations - Combinations - Distributions of Distinct Objects - Distributions of Non distinct Objects	**12**	**Chalk & Talk**
II	Generating Functions Introduction - Generating Functions for Combinations - Enumerators for Permutations – Distributions of Distinct Objects into Non distinct Cells - Partitions of Integers – Elementary relations	**12**	**Chalk & Talk**

III	Recurrence Relation Introduction - Linear Recurrence relations with Constant Coefficients - Solution by the technique of Generating Functions - Recurrence Relations with Two Indices	**12**	**Chalk & Talk**
IV	The Principle of Inclusion and Exclusion Introduction - The Principle of Inclusion and Exclusion - The General Formula - Derangements - Permutations with Restrictions on Relative Positions - The Rook Polynomials	**12**	**Chalk & Talk**
V	Theory of Counting Introduction - Equivalence Classes under a Permutation Group - Equivalence Classes of Functions -Weights and Inventories of Functions - Polya's Fundamental Theorem - Generalization of Polya's Theorem	**12**	**Chalk & Talk**

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 – K5**	2	K2	2(K2,K2)	2(K3,K3)
	CO2	**K1 – K5**	2	K2	2(K3,K3)	2(K4,K4)
CI AII	**CO3**	**K1 – K5**	2	K2	2(K2,K2)	2(K3,K3)
	CO4	**K1 – K5**	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II

	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	Cos	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level

K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice)	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100

NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
	Unit - I	CO1	K1		
1.				a)	b)
				c)	d)
	Unit - I	CO1	K2		
2.				a)	b)
				c)	d)
	Unit - II	CO2	K1		
3.				a)	b)
				c)	d)
	Unit - II	CO2	K2		
4.				a)	b)
				c)	d)
	Unit - III	CO3	K1		
5.				a)	b)
				c)	d)
	Unit - III	CO3	K2		
6.				a)	b)
				c)	d)
	Unit - IV	CO4	K1		
7.				a)	b)
				c)	d)
	Unit - IV	CO4	K2		
8.				a)	b)
				c)	d)
	Unit - V	CO5	K1		
9.				a)	b)
				c)	d)
	Unit - V	CO5	K2		
10.				a)	b)
				c)	d)

Answer **ALL** the questions			**PART – B**		**(5 x 5 = 25 Marks)**

11. a)	**Unit - I**	**CO1**	**K2**	
				OR
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
				OR
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
				OR
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
				OR
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
				OR
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
				OR
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
				OR
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
				OR
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
				OR
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
				OR
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	MATHEMATICAL DOCUMENTATION USING LATEX			
Course Code	23PMTSP31	**L**	**P**	**C**
Category	SKILL	-	2	2

COURSE OBJECTIVES:

➢ To introduce students with a software that is used for typesetting especially in Mathematics and develop typing skill for students with various documents formats of LaTeX.

List of Programmes

1. Creation of a document with different alignments
2. Typing a Letter for applying a job.
3. Creation of own Bio – Data.
4. Creating a Table Structure.
5. Typing a Mathematical Expression involving Differentiation, Integration and Trigonometry.
6. Typing a Mathematical Expression using all Expressions and Inequalities.
7. Creation of an Article using Latex.
8. Inserting Picture in a Latex.
9. Preparing a question paper in Latex Format.
10. Creation of Powerpoint Presentation in Latex.

	Total Lecture Hours	**30**

BOOKS FOR REFERENCES:

➢ David F Griffiths and Desmond J. Higham, Learning LaTex, SIAM Publishers, Phildelphia, 1996
➢ A document preparation system LATEX, Second Edition, Leslie Lamport
➢ LATEX- A Beginner Guide to Professional documentation,S. Swapna Kumar.

WEB RESOURCES:

❖ **https://services.math.duke.edu/computing/tex/online.html,**
❖ **https://www.overleaf.com/learn**

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP	
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL	✓ GLOBAL
Changes Made in the Course	Percentage of Change		No Changes Made		New Course	✓

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Know how to create basic types of LaTex documents (article).	**K1 to K5**
CO2	typeset latex commands	**K1 to K5**
CO3	create a paragraph, symbols, comments and font style.	**K1 to K5**
CO4	change font characteristics.	**K1 to K5**
CO5	know about various environments	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	1	1	1	2				
CO2	3	2	1	1	1	2				
CO3	3	2	1	1	1	1				
CO4	3	1	1	1	1	1				
CO5	3	2	1	1	1	2				

S- STRONG   M – MEDIUM   L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	3	2		
CO 3	3	2	2		
CO 4	3	2	1		
CO 5	3	2	2		
WEIGHTAGE	**15**	**11**	**8**		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

List of Programmes	HRS	PEDAGOGY
1. Creation of a document with different alignments 2. Typing a Letter for applying a job. 3. Creation of own Bio – Data. 4. Creating a Table Structure. 5. Typing a Mathematical Expression involving Differentiation, Integration and Trigonometry. 6. Typing a Mathematical Expression using all Expressions and Inequalities. 7. Creation of an Article using Latex. 8. Inserting Picture in a Latex. 9. Preparing a question paper in Latex Format. 10. Creation of Powerpoint Presentation in Latex.	**30**	

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)							
Internal	**Cos**	**K Level**	**Syntax & Semantics**	**Programming principles**	**Concept Applications**	**Coding & Implementation**	**Debugging & Outpu**
CIA	**CO1**	**K1**	5				
	CO2	**K2**		5			
	CO3	**K3**			5		
	CO4	**K4**				5	
	CO5	**K4**					5
Question Pattern CIA	**No. of Questions to be asked**		2	2	2	2	2
	No. of Questions to be answered		2	2	2	2	2
	Marks for each question		2.5	2.5	2.5	2.5	2.5
	Total Marks for each section		5	5	5	5	5

Distribution of Marks with K Level CIA									
	K Level	Syntax & Semantics	Programming principles	Concept Applications	Coding	Debugging & Output	Total Marks	% of (Marks without choice)	Consolidated %
CIA	K1	5					5	20	20
	K2		5				5	20	20
	K3			5			5	20	20
	K4				5	5	10	40	40
	Marks						25	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)							
S. No	Cos	K - Level	Syntax & Semantics	Programming principles	Concept Applications	Coding& Implementation	Debugging & Output
1	CO1	K1	15				
2	CO2	K2		15			
3	CO3	K3			15		
4	CO4	K4				15	
5	CO5	K4					15
No. of Questions to be Asked			2	2	2	2	2
No. of Questions to be answered			2	2	2	2	2
Marks for each question			7.5	7.5	7.5	7.5	7.5
Total Marks for each section			15	15	15	15	15
(Figures in parenthesis denotes, questions should be asked with the given K level)							

	K Level	Syntax & Semantics	Programming principles	Concept Applications	Coding	Debugging & Output	Total Marks	% of (Marks without choice)	Consolidated %
	Distribution of Marks with K Level CIA								
CIA	**K1**	15					**15**	**20**	**20**
	K2		15				**15**	**20**	**20**
	K3			15			15	20	20
	K4				15	1 5	30	40	40
	Marks						**75**	**100**	**100**

Course Name	MATHEMATICS FOR COMPETITIVE EXAMINATIONS			
Course Code	23PMTNM31	**L**	**P**	**C**
Category	NON MAJOR	6	-	3

COURSE OBJECTIVES:

- To develop knowledge on numbers, data interpretation.
- To familiarize the application through various statistical methods.
- To convert real data into a statistical data interpretation.
- To use these concepts in competitive examinations.
- To develop the computational skills.

UNIT – I	18

Ratio and proportion

UNIT – II	18

Simple Interest – Compound Interest

UNIT - III	18

Proportions – Connectives – Conditional & Biconditional Proportions – Tautology and Contradiction

UNIT – IV	18

Equivalence of Proportions – Duality – Tautological Implications – Truth Table Techniques

UNIT - V	18

Non Verbal Reasoning and Number Series

	Total Lecture Hours	90

BOOKS FOR STUDY:

- Book Material will be provided by the department

BOOKS FOR REFERENCES:

- R.S Agarwal, **Quantitative Aptitude**, 4th Edition, Tata McGraw Hill Publications, 2011, New Delhi.
- T Veerarajan, **Discrete Mathematics**, Mcgraw Hill Publication.

WEB RESOURCES:

- **https://thecompanyboy.com/rs-aggarwal-quantitative-aptitude-pdf-free-download**
- **https://www.toprankers.com/exams/quantitative-aptitude-questions-pdf/**
- **https://www.sawaal.com/aptitude-reasoning/quantitative-aptitude-arithmetic-ability-questions-and-answers.html**

Nature of Course	EMPLOYABILITY	✓	SKILL ORIENTED		ENTREPRENEURSHIP	
Curriculum Relevance	LOCAL		REGIONAL	NATIONAL	✓	GLOBAL
Changes Made in the Course	Percentage of Change	**60**	No Changes Made		New Course	

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Understand the concepts of Mathematics along with analytical ability	**K1 to K5**
CO2	Develop the mathematical problem solving skill	**K1 to K5**
CO3	Evaluate the problems on data interpretation	**K1 to K5**
CO4	Identify the time related problems and solving	**K1 to K5**
CO5	Illustrate appropriate methods for solving Permutation and Combination	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	3	3	2				
CO2	3	2	3	3	3	3				
CO3	3	2	3	3	3	2				
CO4	3	3	2	3	3	2				
CO5	2	3	2	3	3	2				

S- STRONG   M – MEDIUM   L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	15	10	5		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	MATHEMATICS FOR COMPETITIVE EXAMINATIONS	HRS	PEDAGOGY
I	Ratio and proportion.	18	PPT, Chalk & Talk, quiz
II	Simple Interest – Compound Interest	18	Chalk & Talk, PPT
III	Proportions – Connectives – Conditional & Biconditional Proportions – Tautology and Contradiction	18	Chalk & Talk
IV	Equivalence of Proportions – Duality – Tautological Implications – Truth Table Techniques	18	Chalk & Talk, Assignment
V	Non Verbal Reasoning and Number Series	18	Chalk & Talk, PPT

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	Cos	K Level	Section A MCQs No. of. Questions	Section A MCQs K - Level	Section B Either or Choice	Section C Either or Choice
CI AI	CO1	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
CI AI	CO2	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
CI AII	CO3	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
CI AII	CO4	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II	No. of Questions to be asked		4		4	4
Question Pattern CIA I & II	No. of Questions to be answered		4		2	2
Question Pattern CIA I & II	Marks for each question		1		5	8
Question Pattern CIA I & II	Total Marks for each section		4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	Cos	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level

K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice)	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100

NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
	Unit - I	CO1	K1		
1.				a)	b)
				c)	d)
	Unit - I	CO1	K2		
2.				a)	b)
				c)	d)
	Unit - II	CO2	K1		
3.				a)	b)
				c)	d)
	Unit - II	CO2	K2		
4.				a)	b)
				c)	d)
	Unit - III	CO3	K1		
5.				a)	b)
				c)	d)
	Unit - III	CO3	K2		
6.				a)	b)
				c)	d)
	Unit - IV	CO4	K1		
7.				a)	b)
				c)	d)
	Unit - IV	CO4	K2		
8.				a)	b)
				c)	d)
	Unit - V	CO5	K1		
9.				a)	b)
				c)	d)
	Unit - V	CO5	K2		
10.				a)	b)
				c)	d)

Answer **ALL** the questions	**PART – B**	**(5 x 5 = 25 Marks)**

11. a)	**Unit - I**	**CO1**	**K2**	
			OR	
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
			OR	
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
			OR	
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
			OR	
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
			OR	
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
			OR	
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
			OR	
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
			OR	
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
			OR	
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
			OR	
20. b)	**Unit - V**	**CO5**	**K4**	

FOURTH SEMESTER

Course Name	FUNCTIONAL ANALYSIS			
Course Code	23PMTCC41	**L**	**P**	**C**
Category	CORE	6	-	5

COURSE OBJECTIVES:

➢ To provide students with a strong foundation in functional analysis, focusing on spaces, operators and fundamental theorems. To develop student's skills and confidence in mathematical analysis and proof techniques.

UNIT – I Banach Spaces	**18**

The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem – The natural imbedding of N in N^{**}- The open mapping theorem – The conjugate of an Operator.

UNIT – II Hilbert Spaces	**18**

The definition and some simple properties–Orthogonal complements–Ortho normal sets–The conjugate space H^*-The adjoint of an operator–self-adjoint operators-Normal and unitary operators – Projections.

UNIT - III Finite-Dimensional Spectral Theory	**18**

Matrices – Determinants and the spectrum of an operator –The spectral theorem.

UNIT – IV General Preliminaries on Banach Algebras	**18**

The definition and some examples – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius– The radical and semi-simplicity

UNIT - V The Structure of Commutative Banach Algebras	**18**

The Gelfand mapping – Application of the formula$r(x) = \lim \|x^n\|^{1/n}$– Involutions in Banach algebras-The Gelfand-Neumark theorem

	Total Lecture Hours	**90**

BOOKS FOR STUDY:

➢ G.F.Simmons, **Introduction to Topology and Modern Analysis**, McGraw Hill Education (India) Private Limited, New Delhi, 1963

UNIT I: Chapter 9:Sections 46-51
UNIT II: Chapter10:Sections52-59
UNIT III: Chapter 11:Sections 60-62
UNIT IV: Chapter 12:Sections 64-69
UNIT V: Chapter 13:Sections 70-73

BOOKS FOR REFERENCES:

➢ W.Rudin, Functional Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 1973.
➢ B.V. Limaye, Functional Analysis, New Age International,1996.
➢ C. Goffman and G. Pedrick, First course in Functional Analysis, Prentice Hall of India, NewDelhi,1987.
➢ E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.
➢ M. Thamban Nair, Functional Analysis, A First course, Prentice Hall of India, New Delhi, 2002

WEB RESOURCES:

❖ **http://mathforum.org**
❖ **http://ocw.mit.edu/ocwweb/Mathematics,**
❖ **http://www.opensource.org,**
❖ **http://en.wikiepedia.org**

Nature of Course	EMPLOYABILITY	✓	SKILL ORIENTED		ENTREPRENEURSHIP	
Curriculum Relevance	LOCAL		REGIONAL	NATIONAL	✓	GLOBAL
Changes Made in the Course	Percentage of Change	75	No Changes Made		New Course	

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Understand the Banach spaces and Transformations on Banach Spaces.	**K1 to K5**
CO2	Prove Hahn Banach theorem and open mapping theorem.	**K1 to K5**
CO3	Describe operators and fundamental theorems	**K1 to K5**
CO4	Validate orthogonal and orthonormal sets.	**K1 to K5**
CO5	Analyze and establish the regular and singular elements.	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3	2	3	3				
CO2	2	1	3	1	3	3				
CO3	3	2	3	1	3	3				
CO4	1	2	3	2	3	3				
CO5	3	1	2	3	3	3				

S- STRONG   **M – MEDIUM**   **L - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	15	10	5		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	FUNCTIONAL ANALYSIS	HRS	PEDAGOGY
I	The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem – The natural imbedding of N in N^{**}- The open mapping theorem – The conjugate of an Operator.	18	PPT, Chalk & Talk, quiz
II	The definition and some simple properties–Orthogonal complements– Ortho normal sets–The conjugate space H*-The adjoint of an operator– self-adjoint operators-Normal and unitary operators – Projections.	18	Chalk & Talk, PPT
III	Finite-Dimensional Spectral Theory: Matrices – Determinants and the spectrum of an operator –The spectral theorem.	18	Chalk & Talk
IV	The definition and some examples – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius– The radical and semi-simplicity.	18	Chalk & Talk, Assignment
V	The Structure of Commutative Banach Algebras: The Gelfand mapping – Application of the formula $r(x) = \lim \|x^n\|^{1/n}$ – Involutions in Banach algebras-The Gelfand-Neumark theorem.	18	Chalk & Talk, PPT

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	Cos	K Level	Section A MCQs No. of. Questions	Section A MCQs K - Level	Section B Either or Choice	Section C Either or Choice
CI AI	CO1	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
CI AI	CO2	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
CI AII	CO3	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
CI AII	CO4	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II	No. of Questions to be asked		4		4	4
Question Pattern CIA I & II	No. of Questions to be answered		4		2	2
Question Pattern CIA I & II	Marks for each question		1		5	8
Question Pattern CIA I & II	Total Marks for each section		4		10	16

Distribution of Marks with K Level CIA I & CIA II

	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)

S. No	Cos	K - Level	Section A (MCQs) No. of Questions	Section A (MCQs) K – Level	Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level

K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice)	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100

NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
	Unit - I	CO1	K1		
1.				a)	b)
				c)	d)
	Unit - I	CO1	K2		
2.				a)	b)
				c)	d)
	Unit - II	CO2	K1		
3.				a)	b)
				c)	d)
	Unit - II	CO2	K2		
4.				a)	b)
				c)	d)
	Unit - III	CO3	K1		
5.				a)	b)
				c)	d)
	Unit - III	CO3	K2		
6.				a)	b)
				c)	d)
	Unit - IV	CO4	K1		
7.				a)	b)
				c)	d)
	Unit - IV	CO4	K2		
8.				a)	b)
				c)	d)
	Unit - V	CO5	K1		
9.				a)	b)
				c)	d)
	Unit - V	CO5	K2		
10.				a)	b)
				c)	d)

Answer **ALL** the questions	**PART – B**	**(5 x 5 = 25 Marks)**

11. a)	Unit - I	CO1	K2	
		OR		
11. b)	Unit - I	CO1	K2	
12. a)	Unit - II	CO2	K3	
		OR		
12. b)	Unit - II	CO2	K3	
13. a)	Unit - III	CO3	K2	
		OR		
13. b)	Unit - III	CO3	K2	
14. a)	Unit - IV	CO4	K3	
		OR		
14. b)	Unit - IV	CO4	K3	
15. a)	Unit - V	CO5	K3	
		OR		
15. b)	Unit - V	CO5	K3	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	Unit - I	CO1	K3	
		OR		
16. b)	Unit - I	CO1	K3	
17. a)	Unit - II	CO2	K4	
		OR		
17. b)	Unit - II	CO2	K4	
18. a)	Unit - III	CO3	K3	
		OR		
18. b)	Unit - III	CO3	K3	
19. a)	Unit - IV	CO4	K4	
		OR		
19. b)	Unit - IV	CO4	K4	
20. a)	Unit - V	CO5	K4	
		OR		
20. b)	Unit - V	CO5	K4	

Course Name	INTEGRAL EQUATIONS			
Course Code	23PMTCC42	**L**	**P**	**C**
Category	CORE	6	-	5

COURSE OBJECTIVES:

➢ To familiarize the key concept of popular and useful transformations
➢ To understand the relationship between integral and differential equations.
➢ To familiarize Fredholm theory
➢ To apply integral equation in various transformations.

UNIT – I	18
Regularity conditions – Special kinds of Kernels – Eigen values and Eigen functions – Convolution Integral – The Inner or Scalar Product of Two Functions – Reduction to a System of Algebraic Equations – Fredholm Alternatives – An Approximate Method	
UNIT – II	**18**
Integral transformation methods – introduction – Fourier transform – Laplace transform – application to Volterra integral equations with Convolution type kernels – examples.	
UNIT - III	**18**
Relationship between linear differential equations and Volterra integral equations, resolvent kernel of Volterra integral equations, solution of integral equation by resolvent kernel, the method of successive approximations	
UNIT – IV	**18**
Volterra integral equations with limits (x, +∞), Volterra integral equations of the first kind, Euler integrals, Abel's problem, Abel's Integral equations and its generalisations.	
UNIT - V	**18**
Fredholm equations of the second kind, fundamentals, the method of Fredholm determinants, iterated kernals, constructing the resolvent kernel with the aid of iterated kernals	
Total Lecture Hours	**90**

BOOKS FOR STUDY:

Linear Integral Equations: Theory & Technique (Second Ed.) by Ram P. Kanwal, Springer Science& Business Media, 2013.
Unit 1: Chapter 1 full, chapter 2.1 to 2.5
Unit 2: Chapter 9.1 to 9.5.

Problems and exercises in Integral Equations by George Yankovsky , MIR Publishers.

Unit 3: Chapter 1 (2,3,4)
Unit 4: Chapter 1 (7,8,9,10)
Unit 5: Chapter 2 (12,13,14,15)

BOOKS FOR REFERENCES:

➢ "**Differential Equations**" by G.F. Simmons, Tata McGraw-Hill, New Delhi, 1979.
➢ "**Ordinary Differential Equations and Stability Theory**" by D.A. Sanchez, Dover, New York, 1968.
➢ "**Notes on Nonlinear Systems**" by J.K. Aggarwal, Van Nostrand, 1972.

WEB RESOURCES:

❖ **http://mathforum.org,**
❖ **http://ocw.mit.edu/oc**
❖ **www.web/Mathematics,**
❖ **www.physicsforum.com**

Nature of Course	EMPLOYABILITY		✓	SKILL ORIENTED			ENTREPRENEURSHIP		
Curriculum Relevance	LOCAL		REGIONAL			NATIONAL	✓	GLOBAL	
Changes Made in the Course	Percentage of Change	**60**	No Changes Made			New Course			

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Explain various types of kernels	**K1 to K5**
CO2	Determine a wide range of differential and integral equations by Fourier transforms	**K1 to K5**
CO3	Solve linear Volterra integral equations using appropriate methods	**K1 to K5**
CO4	Solve Euler equations and Abel's problem	**K1 to K5**
CO5	Solve linear Fredholm integral equations using appropriate methods	**K1 to K5**
MAPPING WITH PROGRAM OUTCOMES:		

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3	2	3	3				
CO2	2	1	3	1	3	3				

CO3	3	2	3	1	3	3				
CO4	1	2	3	2	3	3				
CO5	3	1	2	3	3	3				

S- STRONG	M – MEDIUM	L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	15	10	5		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	INTEGRAL EQUATIONS	HRS	PEDAGOGY
I	Regularity conditions – Special kinds of Kernels – Eigen values and Eigen functions – Convolution Integral – The Inner or Scalar Product of Two Functions – Reduction to a System of Algebraic Equations – Fredholm Alternatives – An Approximate Method	18	PPT, Chalk & Talk, quiz
II	Integral transformation methods – introduction – Fourier transform – Laplace transform – application to Volterra integral equations with Convolution type kernels – examples.	18	Chalk & Talk, PPT
III	Relationship between linear differential equations and Volterra integral equations, resolvent kernel of Volterra integral equations, solution of integral equation by resolvent kernel, the method of successive approximations	18	Chalk & Talk
IV	Volterra integral equations with limits (x, $+\infty$), Volterra integral equations of the first kind, Euler integrals, Abel's problem, Abel's Integral equations and its generalisations.	18	Chalk & Talk, Assignment
V	Fredholm equations of the second kind, fundamentals, the method of Fredholm determinants, iterated kernals, constructing the resolvent kernel with the aid of iterated kernals	18	Chalk & Talk, PPT

<table>
<tr><td colspan="9" align="center">**Learning Outcome Based Education & Assessment (LOBE)**
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)</td></tr>
</table>

Internal	Cos	K Level	Section A MCQs		Section B Either or Choice	Section C Either or Choice
			No. of. Questions	K - Level		
CI AI	CO1	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
	CO2	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
CI AII	CO3	K1 – K5	2	K2	2(K2,K2)	2(K3,K3)
	CO4	K1 – K5	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II		No. of Questions to be asked	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

		Distribution of Marks with K Level CIA I & CIA II					
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

S. No	Cos	K - Level	Section A (MCQs) No. of Questions	Section A (MCQs) K – Level	Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
Distribution of Marks with K Level						
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	**10**	**50**	**80**	**140**	**100**	**100**
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level			
Answer **ALL** the questions				**PART – A**		**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**			
				a)	b)	
				c)	d)	
2.	**Unit - I**	**CO1**	**K2**			
				a)	b)	
				c)	d)	
3.	**Unit - II**	**CO2**	**K1**			
				a)	b)	
				c)	d)	
4.	**Unit - II**	**CO2**	**K2**			
				a)	b)	
				c)	d)	
5.	**Unit - III**	**CO3**	**K1**			
				a)	b)	
				c)	d)	
6.	**Unit - III**	**CO3**	**K2**			
				a)	b)	
				c)	d)	
7.	**Unit - IV**	**CO4**	**K1**			
				a)	b)	
				c)	d)	
8.	**Unit - IV**	**CO4**	**K2**			
				a)	b)	
				c)	d)	
9.	**Unit - V**	**CO5**	**K1**			
				a)	b)	
				c)	d)	
10.	**Unit - V**	**CO5**	**K2**			
				a)	b)	
				c)	d)	

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	PROJECT & VIVA - VOCE			
Course Code	23PMTPR41	**L**	**P**	**C**
Category	CORE PROJECT	-	10	7

COURSE OBJECTIVES:

➢ To apply and adapt a variety of problem – solving strategies to solve problems

➢ To improve thinking skills

➢ To promote effective mathematical communication.

➢ To provide learning environment that simulates and enhances effective learning

➢ To develop positive attitude towards mathematics

Course Description

The Project is conducted by the following Course Pattern.

Internal

  Presentation ⎫
  Submission ⎬ **25**

External

  Project Report ⎫
  Viva Voce   ⎬ **75**
  _____

  Total   - 100

Nature of Course	EMPLOYABILITY		✔	SKILL ORIENTED			ENTREPRENEURSHIP		
Curriculum Relevance	LOCAL		REGIONAL			NATIONAL		✔	GLOBAL
Changes Made in the Course	Percentage of Change			No Changes Made		✔		New Course	

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Apply the skill of presentation and communication techniques	**K1 to K5**
CO2	Motive as an individual or in a team in development of projects.	**K1 to K5**
CO3	Analyze the available resources and to select most appropriate one	**K1 to K5**
CO4	Make use of the fundamentals of Mathematics to search the related literature survey	**K1 to K5**
CO5	Evaluate the real life problems by using Mathematics and its Application.	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	3	3	1	3				
CO2	1	2	2	1	2	1				
CO3	2	2	3	3	2	1				
CO4	3	2	3	2	1	2				
CO5	3	3	3	3	3	3				

S- STRONG　　　　**M – MEDIUM**　　　　**L - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	**15**	**10**	**5**		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

Distribution of Marks with COs & K Level for Correction of CIA

	COs	K - Level	Distribution of the work of the experiment	K - Level	MARKS
CIA	CO1	K1 to K5	Preliminary Research Problem - Introduction	K1	4.0
	CO2	K1 to K5	Literature Survey	K2	5.0
	CO3	K1 to K5	Understanding and Observation of the Data	K3	8.0
	CO4	K1 to K5	Results and Discussion	K4	4.0
	CO5	K1 to K5	Interpretation of result and Conclusion	K5	4.0
	Total Marks				25

Distribution of Marks with K Level CIA

	K Level	Distribution of the work of the experiment	Total Marks	% of (Marks without choice)	Consolidate of %
CIA	K1	Preliminary Research Problem - Introduction	4	16.0	-
	K2	Literature Survey	5	20.0	
	K3	Understanding and Observation of the Data	8	32.0	36.0
	K4	Results and Discussion	4	16.0	68.0
	K5	Interpretation of result and Conclusion	4	16.0	84.0
	Marks		25	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

K5 – Evaluating, interpreting and concluding the results with accurate measurements.

Distribution of Marks with COs &K Level for Correction of the Summative Exam

COs	K - Level	Distribution of the work of the experiment	K - Level	MARKS
CO1	K1 to K5	Preliminary Research Problem - Introduction	K1	10
CO2	K1 to K5	Literature Survey and scope of the problem	K2	10
CO3	K1 to K5	Understanding and Observation of the Data	K3	20
CO4	K1 to K5	Results and Discussion	K4	15
CO5	K1 to K5	Viva Voce	K5	20
Total Marks				75

Distribution of Marks with K Level

K Level	Parameters for K-Level	Total Marks	% of (Marks without choice)	Consolidated %
K1	Preliminary Research Problem - Introduction	10	13.33	13.3
K2	Literature Survey	10	13.33	13.3
K3	Understanding and Observation of the Data	20	26.67	26.7
K4	Results and Discussion	15	20.0	20
K5	Viva Voce	20	26.67	26.7
Marks		75	100	100

Course Name	MATHEMATICS FOR SET/ NET & GENERAL STUDIES FOR UPSC/ TNPSC			
Course Code	23PMTEC41	**L**	**P**	**C**
Category	ELECTIVE	4	-	3

COURSE OBJECTIVES:

➢ The course provides various mathematical aptitude techniques of solving problems

UNIT – I Algebra	**12**
Groups–Sub Groups-Quotients groups –Homomorphisms-Cyclic groups-Permutations-Combinations-Matrices-Rank and Determinant of matrices-Linear equations-Eigen values and Eigen vectors.	
UNIT – II Analysis	**12**
Elementary set theory-Countable and Uncountable sets-Sequences and Series-Convergence-Continuity and Differentiability-Uniform Convergence-Algebra of complex Numbers: Polynomials-Power Series-Analytic functions-Cauchy Riemann Equations-Calculus of Residues-Singular points.	
UNIT - III Differential Equations	**12**
Existence and Uniqueness of solutions of IVP-General Theory of Homogeneous and non-homogeneous linear ODE's-Lagrange and Charpit Methods for solving first order PDE's-Method of Separation of variables for Laplace, Heat and Wave Equations.	
UNIT – IV	**12**
Percentage – profit and loss - proportion	
UNIT - V	**12**
Simple Interest and Compound interest, Time and work	
Total Lecture Hours	**60**

BOOKS FOR STUDY:

➢ Material will be provided by the department

BOOKS FOR REFERENCES:

➢ Upkar's CSIR-UGC NET/JRF/SET Mathematical Science by Dr. Alok Kumar.
➢ Agarwal R.S, Publishers: S.Chand and Co " Quantitative Aptitude" 1990

WEB RESOURCES:

❖ **https://www.classcentral.com/course/swayam-operations-research-14219**
❖ **https://developers.google.com/optimization/support/resources**

Nature of Course	EMPLOYABILITY		✓	SKILL ORIENTED			ENTREPRENEURSHIP		
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL		✓
Changes Made in the Course	Percentage of Change			No Changes Made			New Course		✓

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Understand the basic concepts of Algebra and linear Algebra.	K1 to K5
CO2	Enhance their ability in Real and Complex Analysis	K1 to K5
CO3	Utilize the knowledge to solve the problems in Differential Equations.	K1 to K5
CO4	Apply for competitive examinations with more confidence	K1 to K5
CO5	Solve mathematical problems within a limited time frame.	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	1	1	2	2				
CO2	1	2	3	2	3	1				
CO3	3	2	2	1	3	1				
CO4	1	2	2	3	2	2				
CO5	3	1	2	2	3	1				

S- STRONG   **M – MEDIUM**   **L - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1		
CO 2	3	2	1		
CO 3	3	2	1		
CO 4	3	2	1		
CO 5	3	2	1		
WEIGHTAGE	15	10	5		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	1		

LESSON PLAN:

UNIT	Mathematics for SET/ NET & General Studies for UPSC/ TNPSC	HRS	PEDAGOGY
I	Groups–Sub Groups-Quotients groups –Homomorphisms-Cyclic groups-Permutations-Combinations-Matrices-Rank and Determinant of matrices-Linear equations-Eigen values and Eigen vectors.	**12**	**Chalk and Board, Virtual Class room, LCD projector**
II	Elementary set theory-Countable and Uncountable sets-Sequences and Series-Convergence-Continuity and Differentiability-Uniform Convergence-Algebra of complex Numbers: Polynomials-Power Series-Analytic functions-Cauchy Riemann Equations-Calculus of Residues-Singular points.	**12**	**Guest Lectures.**
III	Existence and Uniqueness of solutions of IVP-General Theory of Homogeneous and non-homogeneous linear ODE's-Lagrange and Charpit Methods for solving first order PDE's-Method of Separation of variables for Laplace, Heat and Wave Equations.	**12**	**Chalk & Talk**
IV	Percentage – profit and loss - proportion	**12**	**Chalk & Talk**
V	Simple Interest and Compound interest, Time and Work	**12**	**Chalk & Talk**

			Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)			

Internal	Cos	K Level	Section A		Section B Either or Choice	Section C Either or Choice
			MCQs			
			No. of. Questions	K - Level		
CI AI	**CO1**	**K1 – K5**	2	K2	2(K2,K2)	2(K3,K3)
	CO2	**K1 – K5**	2	K2	2(K3,K3)	2(K4,K4)
CI AII	**CO3**	**K1 – K5**	2	K2	2(K2,K2)	2(K3,K3)
	CO4	**K1 – K5**	2	K2	2(K3,K3)	2(K4,K4)
Question Pattern CIA I & II	**No. of Questions to be asked**		4		4	4
	No. of Questions to be answered		4		2	2
	Marks for each question		1		5	8
	Total Marks for each section		4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	**Section A (Multiple Choice Questions)**	**Section B (Either / Or Choice)**	**Section C (Either / Or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	K5						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2			2	3.6	
	K3		10	16	26	46.4	46.4
	K4		10	16	26	46.4	46.4
	K5						
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
			Section A (MCQs)		**Section B (Either / or Choice) With K - LEVEL**	**Section C (Either / or Choice) With K - LEVEL**
S. No	**Cos**	**K - Level**	**No. of Questions**	**K – Level**		
1	CO1	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
2	CO2	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
3	CO3	K1 – K5	2	K1,K2	2(K2,K2)	2(K3,K3)
4	CO4	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
5	CO5	K1 – K5	2	K1,K2	2(K3,K3)	2(K4,K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		10	5
Marks for each question			1		1	8
Total Marks for each section			10		10	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level

K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice)	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100

NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions			**PART – A**		**(10 x 1 = 10 Marks)**
	Unit - I	CO1	K1		
1.				a)	b)
				c)	d)
	Unit - I	CO1	K2		
2.				a)	b)
				c)	d)
	Unit - II	CO2	K1		
3.				a)	b)
				c)	d)
	Unit - II	CO2	K2		
4.				a)	b)
				c)	d)
	Unit - III	CO3	K1		
5.				a)	b)
				c)	d)
	Unit - III	CO3	K2		
6.				a)	b)
				c)	d)
	Unit - IV	CO4	K1		
7.				a)	b)
				c)	d)
	Unit - IV	CO4	K2		
8.				a)	b)
				c)	d)
	Unit - V	CO5	K1		
9.				a)	b)
				c)	d)
	Unit - V	CO5	K2		
10.				a)	b)
				c)	d)

Answer **ALL** the questions	**PART – B**	**(5 x 5 = 25 Marks)**

11. a)	**Unit - I**	**CO1**	**K2**	
			OR	
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
			OR	
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
			OR	
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
			OR	
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
			OR	
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
			OR	
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
			OR	
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
			OR	
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
			OR	
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
			OR	
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	NUMERICAL ANALYSIS USING PYTHON			
Course Code	23PMTSP41	**L**	**P**	**C**
Category	SKILL	-	4	2

COURSE OBJECTIVES:

➢ To introduce the concepts and to develop working knowledge on the numerical methods for Mathematical concepts such as differentiation, integration etc to solve these problems using Python programming language

LIST OF PROGRAMMES

1. Find the polynomial for the given data using Newton's Forward Difference formula.

2. Find the polynomial for the given data using Newton's Backward Difference formula.

3. Find the polynomial for the given data using Central Difference formula.

4. Find the polynomial for the given data using Modified Newton's formula.

5. Solve a system of linear equations using Gauss Elimination method.

6. Solve a system of linear equations using Gauss- Jordan method.

7. Solve a system of linear equations using Gauss-Jacobi method.

8. Solve a system of linear equations using Gauss Seidal method.

9. Find a root of a quadratic equation using Newton-Raphson method.

10. Find a root of a cubic equation using Newton-Raphson method.

11. Compute the value of f(x) using Trapezoidal rule.

12. Compute the value of f(x) using Simpson's rule.

Total Lecture Hours	**30**

BOOKS FOR REFERENCES:

➢ P.R. Turner, T. Arildsen, K. Kavanagh, Applied Scientific Computing With Python, Springer International Publishing AG, part of Springer Nature, 2018

➢ J. M. STEWART, Python for Scientists, Cambridge University Press, 2014

➢ 2. C. Hill, Learning Scientific Programming with Python, Second Edition, Cambridge University Press, 2020, 2004.

WEB RESOURCES:

❖ **https://www.w3schools.com/python/python_math.asp**

Nature of Course	EMPLOYABILITY	✓	SKILL ORIENTED		ENTREPRENEURSHIP	
Curriculum Relevance	LOCAL		REGIONAL	NATIONAL	GLOBAL	✓
Changes Made in the Course	Percentage of Change		No Changes Made		New Course	✓

* Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Learn foundations of Python and numerical calculus of Python.	K1 to K5
CO2	Study the different elimination and iterative methods and write the Python programs to solve this linear equations	K1 to K5
CO3	Obtain the solutions of linear equation using different iterative methods and write the Python programs to solve this linear equations.	K1 to K5
CO4	Write the Python programs to find the interpolation	K1 to K5
CO5	Write the Python programs to solve quadratic and cubic equatiions	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3				
CO2	3	2	3	2	3	3				
CO3	3	2	3	2	3	3				
CO4	3	2	3	2	3	3				
CO5	3	3	3	2	3	3				

S- STRONG   M – MEDIUM   L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	2		
CO 2	3	2	2		
CO 3	3	2	2		
CO 4	3	2	2		
CO 5	3	2	2		
WEIGHTAGE	15	10	10		
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	3	2	2		

LESSON PLAN:

LIST OF PROGRAMMES	HRS	PEDAGOGY
1. Find the polynomial for the given data using Newton's Forward Difference formula. 2. Find the polynomial for the given data using Newton's Backward Difference formula. 3. Find the polynomial for the given data using Central Difference formula. 4. Find the polynomial for the given data using Modified Newton's formula. 5. Solve a system of linear equations using Gauss Elimination method. 6. Solve a system of linear equations using Gauss- Jordan method. 7. Solve a system of linear equations using Gauss-Jacobi method. 8. Solve a system of linear equations using Gauss Seidal method. 9. Find a root of a quadratic equation using Newton-Raphson method. 10. Find a root of a cubic equation using Newton-Raphson method. 11. Compute the value of f(x) using Trapezoidal rule. 12. Compute the value of f(x) using Simpson's rule.	30	

<table>
<tr><td colspan="8" align="center">Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)</td></tr>
<tr><td>Internal</td><td>Cos</td><td>K Level</td><td>Syntax & Semantics</td><td>Progra mming principl es</td><td>Concept Applications</td><td>Codin g & Imple mentat ion</td><td>Debug ging & Outpu</td></tr>
<tr><td rowspan="5">CIA</td><td>CO1</td><td>K1</td><td>5</td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td>K2</td><td></td><td>5</td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td>K3</td><td></td><td></td><td>5</td><td></td><td></td></tr>
<tr><td>CO4</td><td>K4</td><td></td><td></td><td></td><td>5</td><td></td></tr>
<tr><td>CO5</td><td>K4</td><td></td><td></td><td></td><td></td><td>5</td></tr>
<tr><td rowspan="4">Question Pattern CIA</td><td colspan="2">No. of Questions to be asked</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td colspan="2">No. of Questions to be answered</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td colspan="2">Marks for each question</td><td>2.5</td><td>2.5</td><td>2.5</td><td>2.5</td><td>2.5</td></tr>
<tr><td colspan="2">Total Marks for each section</td><td>5</td><td>5</td><td>5</td><td>5</td><td>5</td></tr>
</table>

Distribution of Marks with K Level CIA

	K Level	Syntax & Semantics	Programming principles	Concept Applications	Coding	Debugging & Output	Total Marks	% of (Marks without choice)	Consolidated %
CIA	K1	5					5	20	20
	K2		5				5	20	20
	K3			5			5	20	20
	K4				5	5	10	40	40
	Marks						25	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)

S. No	Cos	K - Level	Syntax & Semantics	Programming principles	Concept Applications	Coding & Implementation	Debugging & Output
1	CO1	K1	15				
2	CO2	K2		15			
3	CO3	K3			15		
4	CO4	K4				15	
5	CO5	K4					15
No. of Questions to be Asked			2	2	2	2	2
No. of Questions to be answered			2	2	2	2	2
Marks for each question			7.5	7.5	7.5	7.5	7.5
Total Marks for each section			15	15	15	15	15
(Figures in parenthesis denotes, questions should be asked with the given K level)							

	K Level	Syntax & Semantics	Programming principles	Concept Applications	Coding	Debugging & Output	Total Marks	% of (Marks without choice)	Consolidated %
				Distribution of Marks with K Level CIA					
CIA	**K1**	15					**15**	**20**	**20**
	K2		15				**15**	**20**	**20**
	K3			15			15	20	20
	K4				15	1 5	30	40	40
	Marks						**75**	**100**	**100**