M.Sc., MATHEMATICS

Syllabus

Program Code: PMT

2024 - 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 2024-2025 onwards)

Course Code	Title of the Course	Hrs	Credits	Maximum Marks		
				Int	Ext	Total
FIRST SEMESTER						
Part – III	**Core courses**					
24PMTCC11	ALGEBRAIC STRUCTURES	6	5	25	75	100
24PMTCC12	REAL ANALYSIS - I	6	5	25	75	100
24PMTCC13	ORDINARY DIFFERENTIAL EQUATIONS	6	4	25	75	100
Part – III	**Elective courses**					
24PMTEC11	GRAPH THEORY AND APPLICATIONS	6	3	25	75	100
24PMTEC12	FUZZY SETS AND THEIR APPLICATIONS	6	3	25	75	100
	Total	30	20	125	375	500
SECOND SEMESTER						
Part – III	**Core courses**					
24PMTCC21	ADVANCED ALGEBRA	6	5	25	75	100
24PMTCC22	REAL ANALYSIS - II	6	5	25	75	100
24PMTCC23	PARTIAL DIFFERENTIAL EQUATIONS	6	4	25	75	100
Part – III	**Elective courses**					
24PMTEC21	NUMERICAL ANALYSIS	5	3	25	75	100
24PMTEC22	RESOURCE MANAGEMENT TECHNIQUES	5	3	25	75	100
24PMTSP21	MATHEMATICS USING PYTHON	2	2	25	75	100
	Total	30	22	125	375	500


FIRST SEMESTER

Course Name	ALGEBRAIC STRUCTURES			
Course Code	24PMTCC11	**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		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		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)**
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 - I			
Course Code	24PMTCC12	**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		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		

LESSON PLAN:			
UNIT	**REAL ANALYSIS - I**	**HRS**	**PEDAGOGY**
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.						

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	ORDINARY DIFFERENTIAL EQUATIONS			
Course Code	24PMTCC13	**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)

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)**
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	GRAPH THEORY AND APPLICATIONS			
Course Code	24PMTEC11	**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

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	FUZZY SETS AND THEIR APPLICATIONS			
COURSE CODE	24PMTEC12	**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**		**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)**
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**	


SECOND SEMESTER

Course Name	ADVANCED ALGEBRA			
Course Code	24PMTCC21	**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		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 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	REAL ANALYSIS - II			
Course Code	24PMTCC22	**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)**
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	PARTIAL DIFFERENTIAL EQUATIONS			
Course Code	24PMTCC23	**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			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	18	Chalk &

	circular annulus, a rectangle – Dirichlet problem involving Poisson equation – Neumann problem for a circle and a rectangle.		**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**

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)**	
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	NUMERICAL ANALYSIS			
Course Code	24PMTEC21	**L**	**P**	**C**
Category	ELECTIVE	5	-	3

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		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 –	18	Chalk & Talk

	Jacobi method for symmetric matrices.		
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**

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)**
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	RESOURCE MANAGEMENT TECHNIQUES			
Course Code	24PMTEC22	**L**	**P**	**C**
Category	ELECTIVE	5	-	3

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. Genera 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 to6.5
Unit II - Chapter 10: sections 10.1 to10.3
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 to18.2

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**

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.						

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	MATHEMATICS USING PYTHON			
Course Code	24PMTSP21	**L**	**P**	**C**
Category	SKILL	-	2	2

COURSE OBJECTIVES:

- To introduce the concepts and to develop working knowledge on the mathematical methods used to solve the problems using Python programming language.

LIST OF PROGRAMMES

1. Find the factorial of a number n.
2. Find the sum of n terms of a series.
3. Find the nth power of a number x.
4. Divide two numbers and two polynomials.
5. Prepare a Python program to use arithmetic operators
6. Solve a system of two equations
7. Solve an ordinary differential equation using Range-Kutta method.
8. Solve an ordinary differential equation using Euler method

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	**K1 to K5**
CO2	write the Python programs using arithmetic operators	**K1 to K5**
CO3	write the Python programs to solve ordinary differntial equations.	**K1 to K5**
CO4	Write the Python programs to find the factorial of a number	**K1 to K5**
CO5	Write the Python programs to find sum of n terms of a series	**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:	
MATHEMATICS USING PYTHON	
LIST OF PROGRAMMES	**HRS**
1. Find the factorial of a number n. 2. Find the sum of n terms of a series. 3. Find the nth power of a number x. 4. Divide two numbers and two polynomials. 5. Prepare a Python program to use arithmetic operators 6. Solve a system of two equations 7. Solve an ordinary differential equation using Range-Kutta method. 8. Solve an ordinary differential equation using Euler method	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)							

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**	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**