SRI SARADA COLLEGE FOR WOMEN (AUTONOMOUS)
SALEM - 16

Reaccredited with 'B++' Grade by NAAC

Affiliated to Periyar University

PG & RESEARCH DEPARTMENT OF MATHEMATICS

(DST-FIST & DBT-STAR SPONSORED)

Outcome Based Syllabus

M.Sc. MATHEMATICS

(For the Academic Year 2024-25 onwards)

M.Sc. MATHEMATICS

PROGRAMME OUTCOMES

PO1 Disciplinary Knowledge: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an Post graduate programme of study.

PO2 Critical Thinking: Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.

PO3 Problem Solving: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's earning to real life situations.

PO4 Analytical & Scientific Reasoning: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples and addressing opposing viewpoints.

PO5 Research related skills: Ability to analyse, interpret and draw conclusions from quantitative / qualitative data; and critically evaluate ideas, evidence, and experiences from an open minded and reasoned research perspective; Sense of inquiry and capability for asking relevant questions / problem arising / synthesizing / articulating / ability to recognize cause and effect relationships / define problems. Formulate hypothesis, Test / analyse / Interpret the results and derive conclusion, formulation and designing mathematical models

PO6 Self-directed & Lifelong Learning: Ability to work independently, identify and manage a project. Ability to acquire knowledge and skills, including "learning how to learn", through self-placed and self-directed learning aimed at personal development, meeting economic, social and cultural objectives.

M.Sc. MATHEMATICS

PROGRAMME SPECIFIC OUTCOMES

PSO1 Acquire good knowledge and understanding, to solve specific theoretical & applied problems in different area of mathematics & statistics.

PSO2 Understand, formulate, develop mathematical arguments, logically and use quantitative models to address issues arising in social sciences, business and other context /fields.

PSO3 To prepare the students who will demonstrate respectful engagement with other's ideas, behaviors, beliefs and apply diverse frames of references to decisions and actions.

To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.

To encourage practices grounded in research that comply with employment laws, leading the organization towards growth and development.

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PG & RESEARCH DEPARTMENT OF MATHEMATICS
(DST-FIST & DBT-STAR SPONSORED)
M.Sc. MATHEMATICS
PROGRAMME STRUCTURE UNDER CBCS
(For the Academic Year 2024-25 onwards)
Total Credits: 91 + Extra Credits (Maximum 16)

I SEMESTER

Course	Course Title	Code	Hours	Credits
Core Course - I	Algebraic Structures	24PMACC1	7	5
Core Course - II	Real Analysis I	24PMACC2	7	5
Core Course - III	Ordinary Differential Equations	24PMACC3	6	4
Elective I	Number Theory and Cryptography / Graph Theory and Applications	24PMADSEC1A/ 24PMADSEC1B	5	3
Elective II	Fuzzy Sets and their Applications / Discrete Mathematics	24PMADSEC2A/ 24PMADSEC2B	5	3
		Total	**30**	**20**
Extra Skills	• *Articulation and Idea Fixation* • *Physical Fitness Practice* • *Life Skills Promotion* • *Productive Preparation for CSIR/SET/JRF- I (24PMASC1)* *(Self – study –1 Extra Credit)*			
Extra Credits are given for extra skills and courses qualified in MOOC/NPTEL				

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(For the Academic Year 2024-25 onwards)
Total Credits: 91 + Extra Credits (Maximum 16)
II SEMESTER

Course	Course Title	Code	Hours	Credits
Core Course - IV	Advanced Algebra	24PMACC4	6	5
Core Course - V	Real Analysis II	24PMACC5	5	5
Core Course - VI	Partial Differential Equations	24PMACC6	5	4
Elective - III	Classical Dynamics / Numerical Analysis	24PMADSEC3A/ 24PMADSEC3B	4	3
Elective - IV	Modeling and Simulation with Excel / Mathematical Modeling	24PMADSEC4A/ 24PMADSEC4B	4	3
Extra Disciplinary Course	Game Theory and Strategy	24PMAEDC1	4	2
Common Subject	Human Rights	24PHRSC	2	1
	Internship*/ Industrial Activity			
Total			**30**	**23**
Extra Skills	• *Articulation and Idea Fixation* • *Physical Fitness Practice* • *Life Skills Promotion* • *Productive Preparation for CSIR/SET/JRF- II (24PMASC2)* *(Self - study -1 Extra Credit)*			
Extra Credits are given for extra skills and courses qualified in MOOC/NPTEL				

***Internship/ Industrial Activity during the Summer Vacation after first year**

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M.Sc. MATHEMATICS
PROGRAMME STRUCTURE UNDER CBCS
(For the Academic Year 2024-25 onwards)
Total Credits: 91 + Extra Credits (Maximum 16)

III SEMESTER

Course	Course Title	Code	Hours	Credits
Core Course – VII	Complex Analysis	24PMACC7	6	5
Core Course – VIII	Probability Theory	24PMACC8	6	5
Core Course - IX	Topology	24PMACC9	6	5
Core Course - X	Machine Learning (Industry Module)	24PMACC10	6	4
Elective - V	Fluid Dynamics / Stochastic Processes	24PMADSEC5A/ 24PMADSEC5B	3	3
Extra Disciplinary Course	Statistics for Life and Social Sciences	24PMAEDC2	3	2
Summer Internship	(Carried out in summer vacation at the end of 1st year-30 hours)	24PMAI	-	2
Total			**30**	**26**
Extra Skills	• *Articulation and Idea Fixation* • *Physical Fitness Practice* • *Life Skills Promotion* • *Productive Preparation for CSIR/SET/JRF- III (24PMASC3)* • *(Self - study -1 Extra Credit)*			
Extra Credits are given for extra skills and courses qualified in MOOC/NPTEL				

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M.Sc. MATHEMATICS
PROGRAMME STRUCTURE UNDER CBCS
(For the Academic Year 2024-25 onwards)
Total Credits: 91 + Extra Credits (Maximum 16)

IV SEMESTER

Course	Course Title	Code	Hours	Credits
Core Course – XI	Functional Analysis	24PMACC11	6	5
Core Course – XII	Differential Geometry	24PMACC12	6	5
Elective - VI	Resource Management Techniques/ Representation Theory	24PMADSEC6A/ 24PMADSEC6B	4	3
Core Course – XIII	Project with Viva - Voce	24PMAPC	10	7
Professional Competency Skill	Advanced Computational Mathematics using Python - Practical	24PMAPCSQ	4	2
	Extension Activity	24PMAEX	-	1
Total			**30**	**23**
Extra Skills	• *Articulation and Idea Fixation* • *Productive Preparation for CSIR/SET/JRF- IV (24PMASC4) (Self - study -1 Extra Credit)*			
Extra Credits are given for extra skills and courses qualified in MOOC/NPTEL				

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">ALGEBRAIC STRUCTURES</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">CORE I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">CORE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">24PMACC1</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>6</td><td colspan="2">1</td><td colspan="2">-</td><td>7</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">UG level Modern Algebra</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">To introduce the concepts and to develop working knowledge on class equation, solvability of groups, finite Abelian groups, linear transformations, real quadratic forms.</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: recall basic counting principle, define class equations to solve problems, explain Sylow’s theorems to find number of Sylow subgroups.
CO2: define direct products, examine the properties of finite abelian groups, define modules, define solvable groups.
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.
CO4: define Jordan, canonical form, Jordan blocks, define rational canonical form, define companion matrix of polynomial, find the elementary divisors of transformation, apply the concepts to find characteristic polynomial of linear transformation.
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 is Hermitian, Unitary and Normal.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">Unit –I (Hours: 21)
Counting Principle - Class equation for finite groups and its applications - Sylow’s Theorem (for theorem 2.12.1, First proof only).
Chapter 2 (Sections 2.11& 2.12) (Omit Lemma 2.12.5)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - II (Hours: 21)
Direct products - Finite Abelian Groups - Modules - Solvable groups
Chapter 2 (Sections 2.13 & 2.14) (Theorem 2.14.1 only)
Chapter 4 (Section 4.5), Chapter 5 (Section 5.7) (Lemma 5.7.1, Lemma 5.7.2 & Theorem, 5.7.1)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - III (Hours: 21)
Linear Transformations: Canonical Forms - Triangular form - Nilpotent Transformations.
Chapter 6 (Sections 6.4 & 6.5)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - IV(Hours:21)
Jordan Form - Rational Canonical Form.
Chapter 6 (Sections 6.6 & 6.7)</td></tr>
</table>

	Unit - V(Hours:21) Trace and Transpose - Hermitian, Unitary and Normal Transformations - Real Quadratic Forms **Chapter 6 (Sections 6.8, 6.10 & 6.11(Omit 6.9)**
Extended Professional Component (is a part of Internal Component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC - CSIR/ GATE/ TNPSC/ others to be solved. (To be discussed during the Tutorial hour)
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	I.N. Herstein. *Topics in Algebra* (II Edition) Wiley Eastern Limited, New Delhi, 1975.
Reference Books	1. M. Artin, *Algebra*, Prentice Hall of India, 1991. 2. P.B. Bhattacharya, S.K. Jain, and S.R. Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition) 3. I.S. Luther and I.B.S. Passi, *Algebra*, Vol. I - Groups (1996); Vol.II Rings, Narosa Publishing House, New Delhi, 1999 4. D.S. Malik, J.N. Mordeson and M.K. Sen, *Fundamental of Abstract Algebra*, McGraw Hill (International Edition), NewYork. 1997. 5. N. Jacobson, *Basic Algebra*, Vol. I & II W.H. Freeman (1980); also published by Hindustan Publishing Company, NewDelhi.
Web resources	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.algebra.com

Mapping of Cos with Pos and PSOs:

	POs						PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">REAL ANALYSIS I</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">CORE II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">CORE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">24PMACC2</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>6</td><td colspan="2">1</td><td colspan="2">-</td><td>7</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">UG level Real Analysis</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">To work comfortably with functions of bounded variation, Riemann-Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence and its inter play between various limiting operations.</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: analyse and evaluate the functions of bounded variation and apply it in infinite series.
CO2: describe the concept of Riemann -Stieltjes integral and its properties .
CO3: demonstrate the theory of Riemann -Stieltjes integral, the mean value theorem, second fundamental theorem of calculus.
CO4: assess the convergence properties of sequence and series and study the related theorems including Bernstein’s theorem, Abel’s limit theorem and Tauber’s theorem.
CO5: understand the concept of sequence of function, series of function and their convergence.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">Unit – I (Hours:21)
Functions of bounded variation - Introduction – Properties of monotonic functions-Functions of bounded variation-Total variation - Additive property of total variation - Total variation on [a,x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions – Continuous functions of bounded variation.
Infinite Series – Absolute and conditional convergence-Dirichlet's test and Abel's test - Rearrangement of series -Riemann's theorem on conditionally convergent series.
Chapter 6 (Sections 6.1 - 6.8)
Chapter 8 (Sections 8.8, 8.15, 8.17&8.18)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit – II (Hours:21)
The Riemann-Stieltjes Integral-Introduction-Notation- The definition of the Riemann -Stieltjes integral - Linear Properties -Integration by parts –Change of variable in a Riemann-Stieltjes integral – Reduction to a Riemann Integral-Euler’s summation formula-monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper, lower integrals -Riemann's condition - Comparison theorems.
Chapter 7 (Sections7.1 - 7.14)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit – III (Hours:21)
The Riemann-Stieltjes Integral - 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 MeanValue Theorem for Riemann integral - Riemann-Stieltjes integrals depending on a parameter - Differentiation under integral sign - Lebesgue criterion for existence of Riemann integrals.
Chapter 7 (Sections 7.15 - 7.26)</td></tr>
</table>

	Unit - IV(Hours:21) Infinite Series and infinite Products - Double sequences –Double series-Rearrangement theorem for double series-A sufficient condition for equality of iterated series - Multiplication of series –Cesarosummability - Infinite products. Power series - Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem -Tauber's theorem **Chapter 8 (Sections 8.20, 8.21 - 8.26)** **Chapter 9 (Sections 9.14, 9.15, 9.19, 9.20, 9.22& 9.23)**
	Unit - V(Hours:21) Sequences of Functions - 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 ConvergenceandTerm-by-termIntegration-Uniformconvergenceanddifferentiation - Sufficient condition for uniform convergence of a series - Mean convergence. **Chapter 9 (Sections 9.1 - 9.6, 9.8,9.9,9.10,9.11& 9.13)**
Extended Professional Component (is a part of Internal Component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC - CSIR/ GATE/ TNPSC/ others to be solved. (To be discussed during the Tutorial hour)
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Tom M**.** Apostol, Mathematical Analysis, 2nd edition, Addison Wesley Publishing Company Inc. New York,1974
Reference Books	1. Bartle, R.G. Real Analysis, John Wiley and Sons Inc.,1976. 2. Rudin, W. Principles of Mathematical Analysis, 3" Edition McGraw Hill Company, New York, 1976. 3. Malik S.C. and Savita Arora Mathematical Analysis, Wiley Eastern Limited New Delhi, 1991. 4. Sanjay Arora and Bansi Lal, Introduction to Real Analysis, SatyaPrakashan, New Delhi, 1991. 5. Gelbaum, B.R. and J. Olmsted, Counter Examples in Analysis, Holden day. San Francisco, 1964. 6. A.L. Gupta and NR. Gupta, Principles of Real Analysis, Pearson Education, (Indian print) 2003
Web resources	1. http://mathforum.org 2. http://ocw.mit.edu/ocwweb/Mathematics 3. http://www.opensource.org, www.mathpages.com

Mapping of Cos with POs and PSOs:

	POs						**PSOs**		
	1	2	3	4	5	6	1	2	3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">ORDINARY DIFFERENTIAL EQUATIONS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE III</td></tr>
<tr><td>Category</td><td>CORE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2">24PMACC3</td></tr>
<tr><td colspan="2"></td><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per Week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td colspan="2">1</td><td>--</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level Calculus and Differential Equations</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">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</td></tr>
<tr><td colspan="8">Course Outcomes
Students will be able to
CO1: establish the qualitative behavior of solutions of systems of differential equations.
CO2: recognize the physical phenomena modeled by differential equations and dynamical systems.
CO3: analyze solutions using appropriate methods and give examples
CO4: formulate Green’s function for boundary value problems.
CO 5: understand and use various theoretical ideas and results that underlie the mathematics in this course.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">Unit-I (Hours:18)
Linear Equations with Constant Coefficients
The second order homogeneous equation – Initial value problems for second order equations - Linear dependence and independence - A formula for the Wronskian - The non homogeneous equation of order two.
Chapter2 (Sections1 to 6)</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit-II (Hours:18)
Linear Equations with Constant Coefficients
Homogeneous and non-homogeneous equation of order n - Initial value problems-Annihilator method to solve non-homogeneous equation - Algebra of constant coefficient operators.
Chapter 2 (Sections 7 to 12)</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit-III (Hours:18)
Linear Equations with Variable Coefficients
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.
Chapter3(Sections 1 to 8) (Omit section 9)</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit-IV(Hours:18)
Linear Equations with Regular Singular Points
Euler equation - Second order equations with regular singular points -Exceptional cases - Bessel Function.
Chapter 4 (Sections 1 to 4 and 6 to 8)(Omit sections 5 and 9)</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit-V(Hours: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.
Chapter 5 (Sections 1 to 6) (Omit Sections 7 to 9)</td></tr>
</table>

Extended Professional Component(isapartofInternalComponentonly,nottobeincludedintheExternalExamination question paper)	Questions related to the above topics, from various competitive examinations UPSC /TRB/NET/UGC-CSIR/GATE/ TNPSC / others to be solved. (To be discussed during the Tutorial hour)
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	E.A.Coddington-*An Introduction to Ordinary Differential Equations*, Prentice-Hall of India Private Limited New Delhi - 2005. (Units I to V)
Reference Books	1. Williams E. Boyce and Richard C. DI Prima, Elementary differential equations and boundary value problems, John Wiley and sons, New York, 1967. 2. George F Simmons, Differential equations with applications and historical notes, Tata McGraw Hill, New Delhi, 1974. 3. N.N. Lebedev, Special functions and their applications, Prentice Hall of India, New Delhi, 1965. 4. W.T. Reid. Ordinary Differential Equations, John Wiley and Sons, New York, 1971 5. M.D. Raisinghania, Advanced Differential Equations, S. Chand & Company Ltd. New Delhi 2001 6. 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

Mapping of Cos with POs and PSOs:

	POs						**PSOs**		
	1	2	3	4	5	6	1	2	3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">NUMBER THEORY AND CRYPTOGRAPHY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">ECI (DISCIPLINE SPECIFIC)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">24PMADSEC1A</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">-</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">UG Level Abstract and Linear Algebras</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">1. To know about the basic concepts of number theory and cryptography.
2. To get a complete grip of various concepts to present modern Mathematics in elementary terms.
3.To develop the skill of solving problems in number theory and cryptography</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: understand the notion of congruences, and solve congruences
CO2: apply chinese remainder theorem to obtain important properties in number theory
CO3: solve congruences using Quadratic residues
CO4: analyse important functions of number theory
CO5: understand the fundamental algorithms in cryptography and determine the number of keys in Chiper.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">Unit-I (Hours:15)
Divisibility - Primes – Congruences - Solutions of Congruences - Congruences of degree 1.
Chapter1 (Sections 1.2&1.3)
Chapter2 (Sections 2.1-2.3)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit-II (Hours:15)
The function φ(n)-Congruences of higher degree - Prime power moduli-Prime modulus - Congruences of Degree Two, Prime Modulus - Power residues.
Chapter2 (Sections 2.4-2.9)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit –III (Hours:15)
Quadratic residues-Quadratic reciprocity-The Jacobi symbol-Greatest integer function.
Chapter3 (Sections 3.1-3.3)
Chapter4 (Section4.1)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit-IV (Hours:15)
Arithmetic functions-The Moebius Inversion formula-The multiplication of arithmetic functions.
Chapter4: Sections 4.2-4.4</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit -V(Hours:15)
Classical Cryptography: Introduction: Some Simple Cryptosystems - Cryptanalysis.
Chapter1 (Sections 1.1 & 1.2)</td></tr>
<tr><td colspan="2">Extended Professional Component (is a part of Internal Component only,</td><td colspan="7">Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC - CSIR/ GATE/ TNPSC/ others to be solved.</td></tr>
</table>

not to be included in the External Examination question paper)	(To be discussed during the Tutorial hour)
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Ivan Niven and Herbert S Zuckerman, An introduction to the Theory of numbers,3rd edition, Wiley Eastern Limited, New Delhi, 1989, Sixth Wiley Eastern reprint, July1991.(for Unit I to Unit IV) 2. Douglas R. Stinson, Cryptography- Theory and Practice, 3rd edition, Chapman & Hall/CRC, Taylor & Francis Group, Boca Raton, 2006. (for Unit V).
Reference Books	1. D. M. Burton, Elementary Number Theory, Universal Book Stall, New Delhi-2004. 2. Tom Apostol, Analytic Number Theory Springer-Verlag, NewYork,1989. 3. Jonathan Katz and Yehuda Lindell, Introduction to Modern Cryptography, CRC Press, Taylor & Francis Group, Boca Raton, 2021
Web resources	https://nptel.ac.in/

Mapping of COs with POs and PSOs:

	POs						**PSOs**		
	1	2	3	4	5	6			
CO1	3	1	3	-	-	-	3	2	1
CO2	2	1	3	-	-	-	3	2	1
CO3	3	1	3	-	1	-	3	2	1
CO4	3	1	3	2	1	-	3	2	2
CO5	3	1	3	-	-	-	3	2	1

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">GRAPH THEORY AND APPLICATIONS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ECI(DISCIPLINE SPECIFIC)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">24PMADSEC1B</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td>--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level Graph Theory</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">1. To gain knowledge about graph theory
2. To inculcate knowledge about connectedness, trees, matching, coloring and planarity in graphs
3. To apply theoretical knowledge acquired to solve realistic problems</td></tr>
<tr><td colspan="8">Course Outcomes:
Students will be able to
CO1: understand the definition and basics of graphs with types and examples
CO2:interpret the concepts of connectedness in graphs and trees
CO3: apply Eulerian and Hamiltonian graphs to solve related problems
CO4: apply graph coloring concepts to solve Kirkman‘s Schoolgirl problems
CO5: understand the concepts of planar, non-planar graphs, the four color theorem and Heawood five color theorem.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">Unit- I (Hours: 15)
Basic Results: Introduction - Basic Concepts - Subgraphs- Degrees of Vertices - Paths and Connectedness - Automorphism of a Simple Graph.
Directed Graphs: Introduction - Basic Concepts-Tournaments.
Chapter 1 (Sections 1.1 - 1.6)
Chapter 2 (Sections 2.1 - 2.3)</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit- II (Hours: 15)
Connectivity and Trees: Connectivity: Introduction-Vertex cut and Edge Cut-Connectivity and Edge Connectivity.
Trees: Introduction-Definition, Characterization and Simple Properties-Centers and Centroids- Counting the Number of Spanning Trees-Cayley‘s Formula.
Chapter 3 (Sections 3.1- 3.3)
Chapter 4 (Sections 4.1- 4.5)</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit- III (Hours: 15)
Independent Sets and Matchings: Introduction-Vertex-Independent Sets and Vertex Coverings-Edge-Independent sets-Matchings and Factors-Matchings in Bipartite Graphs.
Eulerian and Hamiltonian Graphs: Introduction- Eulerian Graphs-Hamiltonian Graphs.</td></tr>
</table>

	Chapter 5 (Sections 5.1- 5.5) **Chapter 6 (Sections 6.1- 6.3)**
	Unit- IV (Hours: 15) **Graph Colorings:** Introduction-Vertex colorings-Critical Graphs-Edge colorings of Graphs - Kirkman's Schoolgirl- Problem-Chromatic Polynomials. **Chapter 7 (Sections 7.1 ,7.2 ,7.3 (7.3.1 & 7.3.2 only) ,7.6, 7.8 & 7.9)**
	Unit- V (Hours: 15) **Planarity:** Introduction- Planar and Nonplanar Graphs –Euler Formula and its Consequences – K_5 and $K_{3,3}$are Nonplanar Graphs - Dual of a Plane Graph- The Four-Color Theorem and the Heawood Five- Color Theorem-Hamiltonian Plane Graphs-Tait Coloring. **Chapter 8 (Sections 8.1 - 8.6, 8.8 and 8.9)**
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. R. Balakrishnan and K. Ranganathan, Text Book of Graph Theory, (2nd Edition), Springer, New York, 2012.
Reference Books	1. J. A. Bondy and U.S.R. Murty, Graph Theory with Applications, North Holland, New York, 1982. 2. Narasing Deo, Graph Theory with Application to Engineering and Computer Science, Prentice Hall of India, New Delhi. 2003. 3. F. Harary, Graph Theory, Addison – Wesely Pub. Co. The Mass. 1969. 4. L. R. Foulds, Graph Theory Application, Narosa Publ. House, Chennai, 1933.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Mapping of COs with POs and PSOs:

	POs						**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	1	2	1	1	1	3	1	1
CO2	3	2	1	1	1	1	3	1	1
CO3	3	3	3	1	1	1	3	3	1
CO4	3	2	3	2	2	3	3	3	2
CO5	3	2	3	2	2	3	3	3	2

Strong - 3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">FUZZY SETS AND THEIR APPLICATIONS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">EC II (DISCIPLINE SPECIFIC)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">24PMADSEC2A</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">-</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">Basic concepts of Algebra</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">1. To gain knowledge about fuzzy sets and types of operations.
2. To know about fuzzy numbers and fuzzy morphisms.
3. To understand the concept of fuzzy logic with relevant examples</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: gain knowledge about the basic types of fuzzy sets and the difference between crisp sets and fuzzy sets
CO2: understand the concept of operations on fuzzy sets
CO3: Analysethe various operations on fuzzy sets
CO4: acquire knowledge about the concepts of fuzzy arithmetic and gain knowledge to solve the related problems
CO5: create a fuzzy model and solve social, environmental and biological problems</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">Unit - I (Hours:15)
Fuzzy Sets: Basic types - Fuzzy Sets: Basic concepts - Additional properties of α-cuts - Representation of Fuzzy Sets
Chapter 1 (Sections 1.3 and 1.4)
Chapter 2 (Sections 2.1 and 2.2)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - II(Hours:15)
Extension principle for fuzzy sets.
Types of operations - Fuzzy complements
Chapter 2 (Section 2.3)
Chapter 3(Sections 3.1 & 3.2)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - III(Hours:15)
Fuzzy intersections: t-Norms - Fuzzy unions t-conorms - Combinations of operations.
Chapter 3(Sections 3.3 - 3.5)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - IV(Hours:15)
Fuzzy numbers - Arithmetic operations on intervals - Arithmetic operations on Fuzzy numbers.
Chapter 4 (Sections 4.1-4.4)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - V(Hours:15)
Three valued logics - Infinite valued logics - Fuzzy logics - Fuzzy propositions and their interpretations in terms of fuzzy sets - Fuzzy rules and their interpretations in terms of fuzzy relation - Generalized modus ponens - Fuzzy inference mechanism (FIM) - Fuzzy modus tollens - Generalizations of fuzzy logics
Chapter 8 (Sections 8.2, 8.4- 8.8, 8.9.1, 8.10)</td></tr>
</table>

Extended Professional Component (is a part of Internal Component only, not to be included in the External Examination question paper)	Real life application related to the above topics in various fields. (To be discussed during the Tutorial hour)
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Text	1.G. J. Klir and B. Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, NewDelhi. 2004. (Unit I, II, III and IV only) 2.M. Ganesh, Introduction to fuzzy sets and fuzzy logic, Introduction to fuzzy sets and fuzzy logic, Prentice Hall of India Private Limited, New Delhi (Unit V only)
Reference Books	1. Zimmermann, Hans-Jurgen, Fuzzy Set Theory and its Applications, Springer Publication
Web resources	https://giocher.wordpress.com/chapter-2-par-2-2-fuzzy-relations-and-the-extension- principle/

Mapping of COs with POs and PSOs:

	Pos						**PSOs**		
	1	2	3	4	5	6	1	2	3
CO1	3	1	2	2	1	1	1	1	1
CO2	3	2	2	2	1	1	2	1	1
CO3	3	3	3	2	2	2	3	2	2
CO4	3	3	3	3	3	2	3	2	2
CO5	3	3	3	3	3	3	3	3	3

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">DISCRETE MATHEMATICS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">EC II (DISCIPLINE SPECIFIC)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">24PMADSEC2B</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2"></td><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG Level Discrete Mathematics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">1. To Introduce concepts of mathematical logic for analyzing propositions and proving theorems.
2. Investigate relations, functions and their properties.
3. Acquire skills in designing digital circuits using Boolean functions and logic gates to perform specific tasks or operations.</td></tr>
<tr><td colspan="8">Course Outcomes:
Students will be able to
CO1: analyze logical propositions via truth tables.
CO2: evaluate combinations and permutations on sets.
CO3: determine properties of relations, identify equivalence and partial order relations, sketch relations.
CO4: apply Boolean algebraic laws and theorems to simplify Boolean expressions and optimize digital
circuit designs for efficiency and functionality.
CO5: understand different computational models, including finite-state machines with output, finite-state machines with no output, and Turing machines</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">Unit- I (Hours: 15)
The Foundations: Logic and Proofs: Propositional Logic - Applications of Propositional Logic - Propositional Equivalences - Predicates and Quantifiers.
Algorithms: The Growth of Functions.
Chapter 1 (Sections 1.1 - 1.4)
Chapter 3 (Section 3.2)</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit- II (Hours: 15)
Counting: The Basics of Counting- The Pigeonhole Principle - Permutations and Combinations - Generalized Permutations and Combinations - Generating Permutations and Combinations.
Chapter 6 (Sections 6.1- 6.3, 6.5 and 6.6)</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit- III (Hours: 15)
Advanced Counting Techniques: Applications of Recurrence Relations - Solving Linear Recurrence Relations - Generating Functions.
Chapter 8 (Sections 8.1, 8.2 and 8.4)</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit- IV (Hours: 15)
Boolean Algebra: Boolean Functions- Representing Boolean Functions - Logic Gates - Minimization of Circuits.
Chapter 12 (Sections 12.1 -12.4)</td></tr>
</table>

	Unit- V(Hours: 15) **Modeling Computation:** Finite-State machines with Output- Finite-State machines with No Output-Turing Machines. **Chapter 13(Sections 13.2, 13.3 and 13.5)**
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Kenneth H. Rosen, Discrete Mathematics and it's Applications,7th Edition, WCB / McGraw Hill Education ,New York,2008.
Reference Books	1. J.P. Trembley and R. Manohar, Discrete Mathematical Structures applications to Computer Science, Tata McGraw Hills, New Delhi. 2. T. Veerarajan, Discrete Mathematics with Graph Theory and Combinatorics, Tata McGraw Hills Publishing Company Limited ,7th Reprint,2008.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Mapping of COs with POs and PSOs:

	POs						**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	2	2	1	1	1	3	1	1
CO2	3	2	3	1	1	1	3	2	1
CO3	3	3	2	2	1	1	3	2	1
CO4	3	3	3	2	2	1	3	3	3
CO5	3	3	3	3	2	2	3	3	3

Strong - 3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">ADVANCED ALGEBRA</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">CORE IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">CORE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">24PMACC4</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>5</td><td colspan="2">1</td><td colspan="2">-</td><td>6</td></tr>
<tr><td colspan="2">Pre – requisite</td><td colspan="7">Algebraic Structures</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">To study field extension, roots of polynomials, Galois theory, finite fields, division rings, solvability by radicals and to develop computational skill in abstract algebra.</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: prove theorems applying algebraic ways of thinking.
CO2: connect groups with graphs and understanding about Hamiltonian graphs.
CO3: compose clear and accurate proofs using the concepts of Galois theory.
CO4: bring out insight into abstract algebra with focus on axiomatic theories
CO5: demonstrate knowledge and understanding of fundamental concepts including extension fields, algebraic extensions, finite fields, class equations and Sylow’s theorem.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">Unit -I(Hours: 18)

Extension Fields - Transcendence of e
Chapter 5(Sections5.1&5.2)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - II (Hours: 18)

Roots of polynomials - More about roots
Chapter 5 (Sections 5.3 &5.5)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - III (Hours: 18)

Elements of Galois theory
Chapter 5 (Section 5.6)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - IV(Hours:18)

Finite fields - Wedderburn’s theorem on finite division rings
Chapter 7 (Sections 7.1& 7.2(Theorem 7.2.1 only))</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - V(Hours:18)
Solvability by radicals - A theorem of Frobenius- Integral Quaternions and the four - Square theorem
Chapter 5 (Section 5.7(Omit Lemma 5.7.1, Lemma 5.7.2 and Theorem 5.7.1))
Chapter 7(Sections 7.3 & 7.4)</td></tr>
<tr><td colspan="2">Extended Professional Component
(is a part of Internal Component only, not to be included in the External Examination question paper)</td><td colspan="7">Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC - CSIR/ GATE/ TNPSC/ others to be solved.
(To be discussed during the Tutorial hour)</td></tr>
</table>

Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	I.N. Herstein, *Topics in Algebra* (II Edition) Wiley Eastern Limited, New Delhi, 1975.
Reference Books	1. M. Artin, *Algebra*, Prentice Hall of India, 1991. 2. P.B. Bhattacharya, S.K. Jain, and S.R. Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition) 3. I.S. Luther and I.B.S. Passi, *Algebra*, Vol. I - Groups (1996); Vol.II Rings, Narosa Publishing House, New Delhi, 1999 4. D.S. Malik, J.N. Mordeson and M.K. Sen, *Fundamental of Abstract Algebra*, McGraw Hill (International Edition), New York. 1997. 5. N. Jacobson, *Basic Algebra*, Vol. I & II, Hindustan Publishing Company, New Delhi.
Web resources	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.algebra.com

Mapping of Cos with POs and PSOs

	POs						**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">REAL ANALYSIS II</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">CORE V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">CORE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">24PMACC5</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">-</td><td>5</td></tr>
<tr><td colspan="2">Pre – requisite</td><td colspan="7">Elements of Real Analysis</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">To introduce measure on the real line, Lebesgue measurability and integrability, FourierSeries and Integrals, in-depth study in multivariable calculus.</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: understand the concepts of Lebesgue outer measure, Lebesgue integral, Fourier series, Fourier integrals with respect to orthogonal system, directional derivative and continuity.
CO2: demonstrate the theorems derived from measure theory, integration theory, Fourier integrals and multivariable differential calculus.
CO3: analyze the representation and convergence problems of Fourier series.
CO4: distinguish the role of directional derivatives, total derivative and the partial derivative.
CO5: appraise the requisite of Inverse and Implicit function theorems.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">Unit - I (Hours:15)
Measure on the Real line : Lebesgue outer measure – measurable sets – regularity-measurable functions- borel and Lebesgue measurability
Chapter 2 (Sections 2.1 to 2.5)</td></tr>
<tr><td colspan="7">Unit - II (Hours:15)
Integration of Functions of a Real variable : Integration of non-negative functions - The General Integral - Riemann and Lebesgue Integrals
Chapter 3 (Sections 3.1, 3.2 & 3.4)</td></tr>
<tr><td colspan="7">Unit - III (Hours:15)
Fourier Series and Fourier Integrals : 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 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 – Cesaro summability of Fourier series- Consequences of Fejes's theorem - the Weierstrass approximation theorem
Chapter 11 (Sections 11.1 to 11.15)</td></tr>
<tr><td colspan="7">Unit - IV (Hours:15)
Multivariable Differential Calculus - Introduction - the directional derivative - directional derivative and continuity - the total derivative - the total derivative expressed in terms of partial derivatives - An application to complex- valued functions - 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</td></tr>
</table>

	derivatives - Taylor's theorem for functions of R^n to R^1 **Chapter 12 (Sections 12.1 to 12.14)**
	Unit - V (Hours:15) **Implicit Functions and Extremum Problems:** Functions with non-zero Jacobian determinants - The inverse function theorem - the implicit function theorem-Extrema of real-valued functions of one variable - extrema of real valued-functions of severable variables- extremum problems with side conditions. **Chapter 13 (Sections 13.1 to 13.7)**
Extended Professional Component (is a part of InternalComponent only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC - CSIR/ GATE/ TNPSC/ others to be solved. (To be discussed during the Tutorial hour)
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1.G. de Barra, Measure Theory and Integration, Wiley Eastern Ltd., New Delhi, 1981. (for Units I and II) 2. Tom M. Apostol: Mathematical Analysis, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974. (for Units III, IV and V)
Reference Books	1. Burkill J.C, The Lebesgue Integral, Cambridge University Press, 1951. 2. Munroe M.E, Measure and Integration. Addison-Wesley, Mass.1971. 3. Roydon H.L. Real Analysis, Macmillan Pub. Company, New York, 1988. 4. Rudin W, Principles of Mathematical Analysis, McGraw Hill Company, New York, 1979. 5. Malik S.C. and Savita Arora, Mathematical Analysis, Wiley Eastern Limited, New Delhi, 1991. 6. Sanjay Arora and Bansilal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991
Web resources	1.http://mathforum.org 2.http://ocw.mit.edu/ocwweb/Mathematics 3.http://www.opensource.org, www.mathpages.com

Mapping of Cos with POs and PSOs:

	POs						PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	2	3	1	3	3	3	2	1
CO2	3	2	3	1	3	3	3	2	1
CO3	3	2	3	2	3	3	3	2	1
CO4	3	2	3	2	3	3	3	2	1
CO5	3	2	2	2	3	3	3	2	1

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">PARTIAL DIFFERENTIAL EQUATIONS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">CORE VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">CORE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2">24PMACC6</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td>--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">UG level partial differential equations</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">To classify the second order partial differential equations and to study Cauchy problem, method of separation of variables, boundary value problems.</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: to understand and classify second order equations and find general solutions.
CO2: to analyse and solve wave equations in different polar coordinates
CO3: to solve vibrating string problem, Heat conduction problem, to identify and solve Laplace and beam equations.
CO4: to apply maximum and minimum principle’s and solve Dirichlet, Neumann problems for various boundary conditions.
CO5: to apply Green’s function and solve Dirichlet, Laplace problems, to apply Helmholtz operation and to solve higher dimensional problem.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">UNIT - I (Hours:15)
Mathematical Models and Classification of second order equation: 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
Chapter 3 (Sections 3.1 to 3.6) Chapter 4 (Sections 4.1 to 4.4)</td></tr>
<tr><td colspan="2"></td><td colspan="7">UNIT – II (Hours:15)
Cauchy Problem: 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.
Chapter 5 (Sections 5.1 to 5.11)</td></tr>
<tr><td colspan="2"></td><td colspan="7">UNIT-III (Hours:15)
Method of separation of variables: 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
Chapter 7 (Sections 7.1 to 7.7)</td></tr>
<tr><td colspan="2"></td><td colspan="7">UNIT - IV(Hours:15)
Boundary Value Problems: 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.
Chapter 9 (Sections 9.1 to 9.9)</td></tr>
</table>

	UNIT -V (Hours:15) **Green's Function:** 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. **Chapter 11 (Sections 11.1 to 11.9)**
Extended Professional Component (is a part of internalComponent only, not to be included in the External Examination question paper)	Questions related to the above topics from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	TynMyint-U and Lokenath Debnath, *Partial Differential Equations for Scientists and Engineers* (Fourth Edition), North Hollan, New York, 1987.
Reference Books	1. M. M. Smirnov, *Second Order Partial Differential Equations*, Leningrad, 1964. 2. I. N. Sneddon, *Elements of Partial Differential Equations,* Mc Graw Hill, New Delhi, 1983. 3. R. Denne Meyer, *Introduction to Partial Differential Equations and Boundary Value Problems*, McGraw Hill, New York, 1968. 4. M.D. Rai Singhania, *Advanced Differential Equations,* S. Chand& Company Ltd., New Delhi, 2001. 5. S, Sankar Rao, *Partial Differential Equations*, 2nd Edition, Prentice Hall of India, New Delhi. 2004
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Mapping of COs with POs and PSOs:

	Pos						**PSOs**		
	1	2	3	4	5	6	1	2	3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">CLASSICAL DYNAMICS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">EC III (DISCIPLINE SPECIFIC)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">24PMADSEC3A</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours Per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">-</td><td colspan="2">--</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">UG level Calculus and Differential equations.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">To study mechanical systems under generalized coordinate systems, virtual work, energy and momentum, to study mechanics developed by Newton, Lagrange, Hamilton Jacobi and theory of relativity due to Einstein.</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: demonstrate the knowledge of core principles in mechanics.
CO2: analyze the Derivation of Lagrange’s Equations from Hamilton’s Principle and Extension of Hamilton’s Principle to Non-holonomic Systems.
CO3: apply the variation principle to solve the problems on real physical situations.
CO4: identify the existing symmetries and the corresponding integrals of motion and analyze the qualitative nature of dynamics
CO5: discuss the problem solving skills of classical dynamics in various contexts and distinguish the concept of the Hamilton Equations of Motion and the Principle of Least Action.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">UNIT- I (Hours :12)

Mechanical Systems: The mechanical system - generalized coordinates - constraints - virtual work - energy and momentum

Chapter 1 (Sections 1.1 to 1.5)

UNIT - II (Hours :12)

Lagrange’s Equations: Derivation of Lagrange’s equations - examples - integrals of the motion.

Chapter 2 (Sections 2.1 to 2.3)

UNIT - III (Hours :12)

Hamilton's Equation: Hamilton’s Principle – Hamilton’s Equations - other variational principle.

Chapter 4 (Sections 4.1 to 4.3)

UNIT -IV (Hours :12)

Hamilton - Jacobi Theory: Hamilton’s principal function - The Hamilton - Jacobi equation - Separability.

Chapter 5 (Sections 5.1 to 5.3)</td></tr>
</table>

	UNIT- V (Hours :12) **Canonical Transformation:** Differential forms and generating functions - special transformations - Lagrange and Poisson brackets. **Chapter 6 (Sections 6.1 and 6.3)** **Exclude the bilinear covariant.**
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC/TNPSC/others to be solved
Recommended Text	D. Green wood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.
Reference Books	1. H. Goldstein, Classical Mechanics, (2^{nd} Edition) Narosa Publishing House, New Delhi. 2. N. C. Rane and P. S. C. Joag, Classical Mechanics, Tata McGraw Hill, 1991. 3. J. L. Synge and B. A. Griffth, Principles of Mechanics (3^{rd} Edition) McGraw Hill Book Co., New York, 1970
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.physicsforum.com

Mapping with Pos and PSOs

	Pos						**PSOs**		
	1	2	3	4	5	6	1	2	3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">NUMERICAL ANALYSIS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">EC III (DISCIPLINE SPECIFIC)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">24PMADSEC3B</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours Per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">-</td><td colspan="2">--</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level Numerical methods.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">1. To acquire knowledge about the methods of obtaining numerical solutions to various types of equations.
2. To develop problem solving skill applying different numerical methods.</td></tr>
<tr><td colspan="8">Course Outcomes:
Students will be able to
CO1: understand and discuss efficient numerical methods for solving algebraic and transcendental equations, linear systems of equations, ordinary and partial differential equations, boundary and eigen value problems and for interpolating polynomials
CO2: analyse the methods of finding solutions using differentiation and integration methods, Taylor’s series, Euler’s methods, Runge kutta methods
CO3: apply Newton - Raphson method, Romberg integration method, differentiation and integration methods, direct and iterative methods to obtain solutions of linear systems, ordinary and partial differential equations
CO4: determine the solutions of initial and boundary value problems, Laplace equations, parabolic equations and hyperbolic equations
CO5: derive various rules, formulae and interpret their applications</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">UNIT- I (Hours :12)
Solution of algebraic and transcendental equations:
Introduction, Newton - Raphson method, Generalized Newton’s method, The Secant method, Muller’s method, LIN - Bairstow’s method. Numerical differentiation and integration: Numerical differentiation, Errors in Numerical differentiation, Trapezoidal rule, Simpson’s 1/3 rule, Simpson’s 3/8 rule, Romberg integration (Errors in Trapezoidal rule, Simpson’s 1/3 rule, Simpson’s 3/8 rule are included).
Chapter 2 (Sections2.1, 2.5, 2.7, 2.8, 2.10)
Chapter 5 (Sections5.2, 5.2.1, 5.4, 5.4.1, 5.4.2, 5.4.3 and 5.4.6)</td></tr>
<tr><td colspan="2"></td><td colspan="6">UNIT - II (Hours :12)
Solution of linear systems :
Gauss elimination method, Gauss - Jordan method, Lu decomposition, Lu decomposition from Gauss elimination, Iterative methods.
Chapter 6 (Sections6.3.2, 6.3.3, 6.3.6, 6.3.7 and 6.4)
Application of Gauss - Jordan method
Web link : https://youtu.be/Wa6kaCwyYRk</td></tr>
</table>

	UNIT - III (Hours :12) **Numerical solution of ordinary differential equations**: Solution by Taylor's series, Euler's method, Modified Euler's methods, Runge - Kutta methods, Predictor - corrector methods, Adams - Moulton method, Milne's method. **Interpolation**: Interpolating polynomial, Errors in polynomial interpolation, Divided differences and their properties, Newton's General interpolation formula, Interpolation by Iteration. **Chapter 7 (Sections7.2, 7.4 (Omitting 7.4.1 only), 7.5, 7.6).** **Chapter 3 (Sections3.1, 3.2, 3.10, 3.10.1, 3.10.2)**
	UNIT -IV (Hours :12) **Boundary - value problems:** Finite difference method, The shooting method, The cubic spline method. The Eigen value problem: Eigen values of a symmetric tridiagonal matrix, House holder's method. **Chapter 7 (Sections7.10, 7.10.1, 7.10.2 and 7.10.3)** **Chapter 6 (Sections6.5, 6.5.1, 6.5.2)** Application of Eigen value problems Web link : https://youtu.be/juXth3CYKn4
	UNIT- V (Hours :12) **Numerical solution of partial differential equations:** Finite-difference approximation to derivatives, Laplace's equations, Jacobi's method, Gauss-Seidel method, Successive over - relaxation, Parabolic equations, Iterative methods for the solution of equations, Hyperbolic equations. **Chapter 8 (Sections8.2, 8.3, 8.3.1, 8.3.2, 8.3.3, 8.4, 8.5 and 8.6)** Application of Finite difference approximation method Web link: https://youtu.be/_6z_XYpzuG4
Skills acquired from this course	Problem-solving abilities, Algorithmic thinking, critical thinking, and understanding and finding solutions using numerical concepts.
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC/TNPSC/others to be solved
Recommended Text	S. S. Sastry, Introductory methods of Numerical Analysis, Fourth Edition, Prentice - Hall of India, New Delhi
Reference Books	1. Devi Prasad, Introduction to Numerical Analysis, Second Edition, Narosa Publishing House. 2. Rama B. Bhat, S. Chakravarthy, Numerical Analysis in Engineering, Narosa Publishing House.

Website and e-Learning Source	1.http://www.ece.mcmaster.ca/~xwu/part6.pdf 2. http://www.cis.upenn.edu/~cis515/cis515 - 12 - sl2.pdf 3.https://wiki.math.ntnu.no/_media/tma4215/2012h/note.pdf 4.http://www.ehu.eus/aitor/irakas/fin/apuntes/pde.pdf

Mapping with POs and PSOs

	POs						**PSOs**		
	1	2	3	4	5	6	1	2	3
CO1	3	3	3	2	1	2	3	2	2
CO2	3	3	2	3	1	2	3	2	2
CO3	3	3	3	3	2	1	3	2	2
CO4	3	2	3	3	1	1	3	2	2
CO5	3	2	3	3	2	2	3	2	2

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">MODELING AND SIMULATION WITH EXCEL</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">EC IV (DISCIPLINE SPECIFIC)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">24PMADSEC4A</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">-</td><td colspan="2">-</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">Basic Knowledge in Computer and Statistics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">1. To acquire knowledge about model building with excel.
2. To know about modeling and simulation.
3. To build up the capacity of tackling this present reality issues through modeling and simulation via excel.</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: learn the importance of deterministic modeling.
CO2: understand the basic model, sensitivity analysis and scroll bars.
CO3: analyze the types of simulation and uncertainty.
CO4: examine the status of Autohaus model and variation in approaches to poisson arrivals.
CO5: formulate York River Archaeology Budgeting to solve social related problems.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">Unit - I (Hours:12)

Introduction - How do we classify models? - An example of deterministic modeling - understanding the important elements of a model.

Chapter 7 (Sections 7.1 to 7.4)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit – II (Hours:12)

Model Building with excel – Basic Model - sensitivity analysis - Controls from the Forms Control Tools- Scroll Bars.

Chapter 7 (Sections 7.5 to 7.5.3& 7.5.5)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit –III (Hours:12)

Modeling and Simulation - Types of simulation and uncertainty -incorporating uncertain processes in models - the Monte Carlo sampling methodology-Implementing Monte Carlo Simulation Methods-A Word About Probability Distributions -Modeling Arrivals with the Poisson Distribution-VLOOKUP and HLOOKUP Functions.

Chapter 8 (Sections 8.1 to 8.3)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit -IV(Hours:12)

A Financial Example - Income Statement -An Operations Example - autohaus -Status of Autohaus Model -Building the Brain Worksheet - building the Calculation Worksheet- Variation in Approaches to Poisson Arrival - Consideration of Modeling Accuracy</td></tr>
</table>

	Chapter 8 (Sections 8.4 to 8. 5.4)
	Unit -V(Hours:12) Sufficient Sample Size - Building the Data Collection worksheet - solver- constrained optimization – example-York River Archaeology Budgeting –Scenarios. **Chapter 8 (Sections 8.5.5 & 8.5.6)&** **Chapter 9 (Sections 9.1 to 9.4)**
Extended Professional Component (is a part of Internal Component only, not to be included in the External Examination question paper)	Real life application related to the above topics in various fields.
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Text	Hector Guerrero, Excel Data Analysis Modeling and Simulation, Springer Heidelberg Dordrecht London New York.
Reference Books	1. Averill M Law, W David Kelton, Simulation Modelling & Analysis, McGraw Hill Education,2 Penn Plaza, New York, 5th Edition,2015 2. Chandan Sengupta, Financial Modeling Using Excel, John Wiley & Sons, Inc., Hoboken, New Jersey, 2nd Edition, 2004.
Web resources	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Mapping of COs with POs and PSOs:

	POs						**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	3	3

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">MATHEMATICAL MODELING</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">EC IV (DISCIPLINE SPECIFIC)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">24PMADSEC4B</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">-</td><td colspan="2">-</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">UG level differential equations</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">1. To comprehend mathematical modeling ideas
2. To acquire the knowledge of mathematical modeling through ordinary differential equations of first and second order.
3. To build up the capacity of tackling this present reality issues through mathematical modeling.</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: learn the importance of differential equations in solving mathematical models.
CO2: understand the Occurrence, classification and characteristics of Mathematical Models.
CO3: apply problem solving techniques in Mathematical Modeling to bring solutions to various real life situations.
CO4: examine the principles governing the motion of satellites through notions of Mathematical Modeling and interpret the techniques in Mathematical Models to analyse the motion of fluids.
CO5: construct suitable models for population dynamics, medicine and reducing various forms of Pollution.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">Unit - I (Hours:12)
Mathematical Modeling: Need, Techniques, Classifications and Simple Illustrations: Simple Situations Requiring Mathematical Modeling - The Technique of Mathematical Modeling - Classification of Mathematical Models - Some Characteristics of Mathematical Models - Mathematical Modeling Through Ordinary Differential Equations of First Order - Mathematical Modeling Through Differential Equations Linear Growth and Decay Models - Non - Linear Growth and Decay Models - Compartment Models
Chapter 1 (Sections 1.1 - 1.4), Chapter 2 (Sections 2.1 - 2.4)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - II (Hours:12)
Mathematical Modeling Through Systems of Ordinary Differential Equations of First Order: Mathematical Modeling in Population Dynamics - Mathematical Modeling of Epidemics Through Systems of Ordinary Differential Equations of First Order - Compartment Models Through Systems of Ordinary Differential Equations - Mathematical Modeling in Economics Through Systems of Ordinary Differential Equations of First Order
Chapter 3 (Sections 3.1 - 3.4)</td></tr>
</table>

	Unit -III (Hours:12) **Mathematical Modeling Through Systems of Ordinary Differential Equations of First Order:** Mathematical Models in Medicine, Arms Race, Battles and International Trade in Terms of Systems of Ordinary Differential Equations **Mathematical Modeling Through Ordinary Differential Equations of Second Order:** Mathematical Modeling of Planetary Motions - Mathematical Modeling of Circular Motion and motion of Satellites **Chapter 3 (Section 3.5),** **Chapter 4 (Sections 4.1 & 4.2)**
	Unit -IV (Hours:12) **Models for blood flows:** Some Basic Concepts of Fluid Dynamics - Basic Concepts about Blood, Cardiovascular System and Blood Flows - Steady Non - Newtonian Fluid Flows in Circular Tubes - Basic Equations for Fluid Flow - Flow of Power - law Fluid in Circular Tube - Flow of Herschel - Bulkley Fluid in Circular Tube - Flow of Casson Fluid in Circular Tube - Flow of m Immiscible Power - law Fluids in a Circular Tube - Blood Flow through Artery with Mild Stenosis. **Chapter 11 (Sections 11.1, 11.2, 11.3 (11.3.1 - 11.3.5), 11.5)**
	Unit -V (Hours:12) **Models for Optimal Control of Water Pollution:** Water Quality Management Models - Water Quality Management Model 1 - Water Quality Management Model 2 - Water Quality Management Model 3 - Water Quality Management Model 4 - Other Models for Water Quality Management - Other Optimal Pollution Control Models- Optimal Air Pollution Control Models - Control Models for Solid Waste Disposal - Noise Pollution Control Model **Chapter 14 (Sections 14.3: 14.3.1 - 14.3.6) (Sections 14.4: 14.4.1 - 14.4.4)**
Extended Professional Component (is a part of Internal Component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC - CSIR/ GATE/ TNPSC/ others to be solved.
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1.J. N. Kapur, Mathematical modeling, New Age International (P) Limited, Publishers, New Delhi, First Edition (For Unit I - Unit III) 2.J. N. Kapur, Mathematical Models in Biology & Medicine, Affiliated East - West Press Private Limited, New Delhi (For Unit IV and Unit V)
Reference Books	1.D.N. Burghes, Modeling through Differential Equation, Ellis Horwood and John Wiley. 2.C. Dyson and E. Levery, Principle of Mathematical Modeling, Academic Press New York.

	3.Giordano, Weir, Fox, A First Course in Mathematical Modeling 2nd Edition, Brooks/Cole Publishing Company, 1997. 4.B. Barnes, G. R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab, 2nd Ed., Taylor and Francis group, London and New York, 2009.
Web resources	1. https://www.mat.univie.ac.at/~neum/model.html 2. https://nptel.ac.in/courses/111/107/111107113/ 3. https://www.frontiersin.org/articles/10.3389/fgene.2015.00354/full

Mapping of COs with POs and PSOs:

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

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">GAME THEORY AND STRATEGY
(FOR I M.Sc./M.A./M.Com.)</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">EDC</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">EXTRA DISCIPLINARY</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2">24PMAEDC1</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">-</td><td colspan="2">-</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">UG level Linear programming</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">1. It focuses on fundamentals of game theory including basic concepts and techniques, various ways of describing and solving games, and various applications in economics, political sciences, and business.
2. It will help students sharpen their understanding of strategic behavior in different situations involving many individuals.
3. The students will learn how to recognize and model strategic situations, to predict when and how their action will have an influence on others, and to exploit strategic situations for the benefit of their own.</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: distinguish a game situation from a pure individual ‘s decision problem
CO2: explain graphical representation of mixed strategies.
CO3: explain concepts of dominant, dominated, and rationalizable strategies, pure and mixed strategies, and best responses
CO4: analyse economic situations using game theoretic techniques
CO5: Solve simple games using mapping method.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">Unit - I (Hours:12)

Game, Strategy and Saddle Point: Introduction- Description of a game of strategy- Relations among expectations - saddle points- game with perfect information.

Chapter 1(Sections 1.1 to 1.6)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - II (Hours:12)

The Fundamentals: Game without saddle points-mixed strategies - graphical representation of mixed strategies - the minimax theorem - optimal mixed strategies- graphical representation of minimax theorem and proof of minimax theorem.

Chapter 2 (Sections 2.1 to 2.8)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit -III (Hours:12)

Properties of Optimal Strategies: Many optimal strategies - some properties of an optimal strategies - convex set of optimal strategies- operation on games - dominated strategies - all strategies active.

Chapter 3 (Sections 3.1 to 3.6)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - IV (Hours:12)</td></tr>
</table>

	Method of Solving games: Solving for optimal strategies - Guess and verify - Examination of submatrices- Successive approximations - Graphical solutions of 3 x 3 games. **Chapter 5 (Sections 5.1 to 5.5)**
	Unit -V (Hours:12) Mapping method for solving games with constraints - Mapping method for solving games - solution of reconnaissance game by mapping method. **Chapter 5 (Sections 5.6 to 5.8)**
Extended Professional Component (is a part of Internal Component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC - CSIR/ GATE/ TNPSC/ others to be solved.
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Melvin Dresher, Game of Strategy Theory and Application, Prentice Hall-Inc, USA, 1961
Reference Books	1.KantiSwarup, P.K. Gupta and Man Mohan, Operations Research, Eighth Edition‖, Sultan Chand & Sons, New Delhi, 1999. 2. S. Hillier and J. Liebermann, Operations Research, Sixth Edition, McGraw Hill Company, 1995. 3. J. K. Sharma, Operations Research problems and solution, Third edition, Macmillan Publishers India Ltd, India, 2012. 4. Guillermo Owen, Game Theory, 2nd edition, Academic Press, 1982. 5.Philip D. Straffin, Game Theory and Strategy, The Mathematical Association of America, USA, 1993.
Web resources	1. https://nptel.ac.in/courses/110101133 2. https://archive.nptel.ac.in/courses/110/104/110104063/

Mapping of COs with POs and PSOs:

	POs						PSOs		
	1	2	3	4	5	6	1	2	3
CO1	3	2	3	2	3	3	3	2	3
CO2	3	2	3	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	2	2
CO4	3	2	3	2	3	3	3	3	2
CO5	3	2	2	3	3	3	3	3	2

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">COMPLEX ANALYSIS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">CORE VII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">CORE</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2" colspan="2">24PMACC7</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="3">Lab Practice</td><td>Total</td></tr>
<tr><td>5</td><td colspan="2">1</td><td colspan="3">-</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">UG level Complex Analysis</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">To Study Cauchy integral formula, local properties of analytic functions, general form of Cauchy's theorem and evaluation of definite integral and harmonic functions</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: Analyze and evaluate local properties of analytical functions and definite integrals.
CO2: Describe the concept of definite integral and harmonic functions.
CO3: Demonstrate the concept of the general form of Cauchy's theorem.
CO4: Develop Taylor and Laurent series.
CO5: Explain the infinite products, canonical products and Jensen's formula.</td></tr>
<tr><td>Course Outline</td><td colspan="8">UNIT-I (Hours:21)
Cauchy's Integral Formula: The Index of a point with respect to a closed curve – The Integral formula – Higher derivatives. Local Properties of analytical Functions:
Removable Singularities-Taylors's Theorem – Zeros and poles – The local Mapping – The Maximum Principle.
Chapter 4: Section 2: 2.1 to 2.3
Chapter 4: Section 3: 3.1 to 3.4</td></tr>
<tr><td></td><td colspan="8">UNIT-II (Hours:21)
The general form of Cauchy's Theorem: Chains and cycles- Simple Continuity - Homology - The General statement of Cauchy's Theorem - Proof of Cauchy's theorem - Locally exact differentials- Multiply connected regions - Residue theorem - The argument principle.
Chapter 4: Section 4: 4.1 to 4.7
Chapter 4 : Section 5: 5.1 and 5.2</td></tr>
<tr><td></td><td colspan="8">Unit – III (Hours:21)
Evaluation of Definite Integrals and Harmonic Functions: Evaluation of definite integrals - Definition of Harmonic function and basic properties - Mean value property - Poisson formula.
Chapter 4: Section 5: 5.3
Chapter 4: Sections 6: 6.1 to 6.3</td></tr>
<tr><td></td><td colspan="8">Unit – IV (Hours:21)
Harmonic Functions and Power Series Expansions: Schwarz theorem - The reflection principle - Weierstrass theorem – Taylor's Series – Laurent series.
Chapter 4: Sections 6.4 and 6.5
Chapter 5: Sections 1.1 to 1.3</td></tr>
<tr><td></td><td colspan="8">Unit – V (Hours:21)
Partial Fractions and Entire Functions: Partial fractions - Infinite products – Canonical products – Gamma Function- Jensen's formula – Hadamard's Theorem
Chapter 5: Sections 2.1 to 2.4</td></tr>
</table>

	Chapter 5: Sections 3.1 and 3.2
Extended Professional Component (is a part of Internal Component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC - CSIR/ GATE/ TNPSC/ others to be solved. (To be discussed during the Tutorial hour)
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Lars V. Ahlfors, *Complex Analysis*, (3rd edition) McGraw Hill Co., New York, 1979
Reference Books	1. H.A. Presfly, *Introduction to Complex Analysis*, Clarendon Press, oxford, 1990. 2. J.B. Conway, *Functions of one complex variables* Springer - Verlag, International student Edition, Naroser Publishing Co.1978 3. E. Hille, *Analytic function Theory* (2 vols.), Gonm & Co, 1959. 4. M. Heins, *Complex function Theory*, Academic Press, New York,1968.
Web resources	1. http://mathforum.org, 2. http://ocw.mit.edu/ocwweb/Mathematics, 3. http://www.opensource.org ,

Mapping of COs with POs and PSOs:

	POs						**PSOs**		
	1	2	3	4	5	6	1	2	3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1

Strong-3; Medium-2; Low-1

Title of the Course	**PROBABILITY THEORY**						
Paper Number	**CORE VIII**						
Category **CORE**	**Year**	**II**	**Credits**	**5**	**Course Code**	**24PMACC8**	
	Semester	**III**					
Instructional Hours per Week	**Lecture**	**Tutorial**		**Lab Practice**		**Total**	
	5	**1**		**--**		**6**	
Pre-requisite	UG level algebra and calculus						
Objectives of the Course	To introduce axiomatic approach to probability theory, to study some statistical characteristics, discrete and continuous distribution functions and their properties, characteristic function and basic limit theorems of probability.						

Course Outcomes

Students will be able to

CO1: define Random Events, Random Variables, to describe Probability, to apply Bayes, to define Distribution Function, to find Joint Distribution function, to find Marginal Distribution and Conditional Distribution function, to solve functions on random variables

CO2: define Expectation, Moments and Chebyshev Inequality, to solve Regression of the first and second types. .

CO3: define Characteristic functions, to define distribution function, to find probability generating functions, to solve problems applying characteristic functions

CO4: define One point, two-point, Binomial distributions, to solve problems of Hypergeometric and Poisson distributions, to define Uniform, normal, gamma, Beta distributions, to solve problems on Cauchy and Laplace distributions

CO5: discuss Stochastic convergence, Bernoulli law of large numbers, to elaborate Convergence of sequence of distribution functions, to prove Levy-Cramer Theorems and de Moivre-Laplace Theorems, to explain Poisson, Chebyshev, Khintchine Weak law of large numbers, to explain and solve problems on Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.

Course Outline

Unit-I (Hours:18)

Random Events and Random Variables

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

Chapter 1 (Sections 1.1 to 1.7)

Chapter 2 (Sections 2.1 to 2.9)

Unit-II (Hours:18)

Parameters of the Distribution

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

Chapter 3 (Sections 3.1 to 3.8)

Unit-III (Hours:18)

Characteristic functions

Properties of characteristic functions – Characteristic functions and moments – semi0invariants – characteristic function of the sum of the independent random variables – Determination of distribution function by the Characteristic function– Characteristic function of

	multidimensional random vectors – Probability generating functions. **Chapter 4 (Sections 4.1 to 4.7)**
	Unit-IV(Hours:18) **Some Probability distributions** One point, two-point, Binomial – Polya – Hypergeometric – Poisson (discrete) distributions – Uniform – normal gamma – Beta – Cauchy and Laplace (continuous) distributions. **Chapter 5 (Section 5.1 to 5.10) (Omit Section 5.11)**
	Unit-V(Hours:18) **Limit Theorems** Stochastic convergence – Bernoulli law of large numbers – Convergence of sequence of distribution functions – Levy-Cramer Theorems – de Moivre Laplace Theorem – Poisson, Chebyshev, Khintchine Weak law of large numbers – Lindberg Theorem – Lapunov Theorem – Borel-Cantelli Lemma – Kolmogorov Inequality and Kolmogorov Strong Law of large numbers. **Chapter 6 (Sections 6.1 to 6.4, 6.6 to 6.9, 6.11 and 6.12) (Omit Sections 6.5, 6.10,6.13 to 6.15)**
Extended Professional Component is a part of Internal Component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC /TRB/NET/UGC-CSIR/GATE/TNPSC / others to be solved. (To be discussed during the Tutorial hour)
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	M. Fisz, Probability Theory and Mathematical Statistics, John Wiley and Sons, New York, 1963.
Reference Books	1. V. K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988(3rdPrint). 2. R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972 3. K. L. Chung, A course in Probability, Academic Press, New York, 1974. 4. R. Durrett, Probability: Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996. 5. S. I. Resnick, A Probability Path, Birhauser, Berlin,1999. 6. B. R. Bhat, Modern Probability Theory (3nd Edition), New Age International (P) Ltd, New Delhi, 1999
Web resources	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, http://www.probability.net

Mapping of COs with POs and PSOs:

	POs						PSOs		
	1	2	3	4	5	6	1	2	3
CO1	3	1	3	1	3	3	3	2	1
CO2	3	1	3	1	3	3	3	2	1
CO3	3	2	3	2	3	3	3	2	1
CO4	3	2	3	2	3	3	3	2	1
CO5	3	2	2	1	3	3	3	2	1

Strong-3; Medium-2; Low-1

Title of the Course		**TOPOLOGY**					
Paper Number		**CORE IX**					
Category	**CORE**	**Year**	**II**	**Credits**	**5**	**Course Code**	**24PMACC9**
		Semester	**III**				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**		**Total**
		5	**1**		**-**		**6**
Pre – requisite		Real Analysis					
Objectives of the Course		To study topological spaces, continuous functions, connectedness, compactness, countability and separation axioms.					

Course Outcomes:

Students will be able to

CO1: Learn the concepts of topological spaces, connected and compact spaces, continuous functions, countability and separation axioms.

CO2: Understand the attributes of continuous functions and inspect their applications in connected and compact spaces, countability and separation axioms.

CO3: Demonstrate understanding of connected spaces, the implications of connected subspaces of the Real line and understand components and local connectedness.

CO4: Apply the concept of compact spaces and the properties of compact subspaces of the Real line and understand limit point compactness and local compactness.

CO5: Explore and analyse the principles of countability axioms, separation axioms, and stnormal spaces and prove Urysohn Lemma, Urysohn Metrization Theorem, and Tietze extension theorem.

Course Outline	**UNIT-I (Hours: 18)** **Topological spaces:** Topological spaces – Basis for a topology – The order topology – The product topology on X Y – The subspace topology – Closed sets and limit points. **Chapter 2 (Sections 12 - 17)**
	UNIT-II (Hours: 18) **Continuous functions:** Continuous functions – the product topology – The metric topology. **Chapter 2 (Sections 18 - 21) (Omit Section 22)**
	UNIT-III (Hours: 18) **Connectedness:** Connected spaces- connected subspaces of the Real line – Components and local connectedness. **Chapter 3 (Sections 23 – 25)**
	UNIT- IV (Hours: 18) **Compactness:** Compact spaces – compact subspaces of the Real line – Limit Point Compactness – Local Compactness. **Chapter 3 (Sections 26 - 29)**
	UNIT-V (Hours: 18) **Countability and Separation Axiom:** The Countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohn metrization Theorem – The Tietz extension theorem. **Chapter 4 (Sections 30 – 35)**
Extended Professional	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC - CSIR/ GATE/ TNPSC/ others to

Component (is a part of Internal Component only, not to be included in the External Examination question paper)	be solved. (To be discussed during the Tutorial hour)
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	James R. Munkres, *Topology* (2nd Edition) Pearson Education Pvt. Ltd., Delhi-2002 (Third Indian Reprint)
Reference Books	1. J. Dugundji, *Topology*, Prentice Hall of India, New Delhi, 1975. 2. George F. Sinmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Book Co., 1963 3. J.L. Kelly, *General Topology*, Van Nostrand, Reinhold Co., New York 4. L. Steen and J. Subhash, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970. 5. S. Willard, *General Topology*, Addison - Wesley, Mass., 1970
Web resources	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org , http://en.wikipedia.org

Mapping of COs with POs and PSOs

	POs						**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">MACHINE LEARNING [Industry Module]</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">CORE X</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">CORE</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2">24PMACC10</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>5</td><td colspan="2">1</td><td colspan="2">-</td><td>6</td></tr>
<tr><td colspan="2">Pre – requisite</td><td colspan="7">Basic Knowledge in Computer Science</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">1. To explore how recent technologies influenced the learning environment.
2. To provide a comprehensive understanding of machine learning principles, practical skills in algorithm implementation and familiarity with tools.</td></tr>
<tr><td colspan="9">Course Outcomes: Students will be able to
CO 1: Understand the fundamentals of machine learning, including types and algorithms and apply them to solve problems
CO 2: Apply machine learning algorithms, such as those for supervised and unsupervised learning to real-world scenarios.
CO 3: Explore diverse applications of machine learning, such as Robotic Process Automation (RPA) and cloud computing, across various industries and domains.
CO 4: Analyze and evaluate the performance of machine learning models using techniques like cross-validation and metrics such as accuracy and precision
CO 5: Demonstrate comprehension of advanced machine learning concepts, including those related to cybersecurity and virtual reality and identify their potential applications and implications.</td></tr>
<tr><td>Course Outline</td><td colspan="8">Unit – I (Hours: 18)
Machine Learning: Introduction - Definition - Types of Machine Learning - Supervised, Unsupervised, Reinforcement Learning - Algorithms for Machine Learning – problems solved by Machine Learning – Tools for Machine Learning – Applications.
Chapter 14</td></tr>
<tr><td></td><td colspan="8">Unit - II (Hours: 18)
Robotic Process Automation (RPA): Introduction to RPA –Need for automation programming constructs in RPA- Robots and Softbots – RPA architecture and process methodologies –Industries best suited for RPA.
Chapter 5 (Sections 5.6)</td></tr>
<tr><td></td><td colspan="8">Unit - III (Hours: 18)
Cloud Computing: Need - Definition - Types of Cloud - Types of services – Saas.
Chapter 7 (Section 7.3)</td></tr>
<tr><td></td><td colspan="8">Unit - IV(Hours:18)
Cyber Security: Cyber Crime and Information security – Classification of Cyber Crime Types.
Chapter 11</td></tr>
<tr><td></td><td colspan="8">Unit - V(Hours:18)
Virtual Reality: Definition- Types of Head Mounted Displays-Tools for Reality
Chapter 8 (Section 8.2)</td></tr>
<tr><td>Extended Professional</td><td colspan="8">Real life application related to the above topics in various fields. (To be discussed during the Tutorial hour)</td></tr>
</table>

Component (is a part of Internal Component only, not to be included in the External Examination question paper)	
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	6. 1. P. Kaliraj, T. Devi, *Artificial Intelligence Theory, Models and Applications*, 2022, ISBN 9781032008097, Boca Raton, CRC Press, Taylor & Francis Group (For Unit I) 2. P. Kaliraj and T. Devi, *Industry 4.0 Technologies for Education Transformation Technologies and Applications*, Boca Raton, CRC Press, Taylor & Francis Group, New York, 2022. (For Units II, III & V) 3. P. Kaliraj, T. Devi, *Securing IoT in Industry 4.0 Applications with Blockchain*, 2022, ISBN 9781032008103, Boca Raton, CRC Press, Taylor & Francis Group (For Unit IV)
Reference Books	1. P. Kaliraj and T. Devi, *Higher Education for Industry 4.0 and Transformation to Education 5.0*, Taylor & Francis Group, New York, 2023. 2. UiPath Inc., www.uipath.com/rpa/robotic-process-automation 3. UiPath Inc., www.uipath.com/rpa/academy 4. Uthayan Elangovan, *Industry 5.0 The Future of the Industrial Economy*, Taylor & Francis Group, New York, 2022. 5. Reiko Yamada, Aki Yamada and Deane E. Neubauer Transformation of Higher Education in the Age of Society 5.0 Trends in International Higher Education, Palgrave Macmillan, USA, 2023.
Web resources	https://www.javatpoint.com/applications-of-machine-learning https://flobotics.io/blog/rpa-use-cases-across-industries/ https://startupstash.com/virtual-reality-tools/ https://www.tutorialspoint.com/fundamentals_of_science_and_technology/cyber_crime_and_cyber_security.htm

Mapping of Cos with POs and PSOs

	POs						**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	1	2	2	1	2	3	2	1
CO2	2	3	3	2	2	3	1	2	3
CO3	2	3	3	2	2	3	1	2	3
CO4	2	3	2	3	2	3	2	2	3
CO5	1	2	3	3	2	3	2	2	3

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">FLUID DYNAMICS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">EC V (DISCIPLINE SPECIFIC)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">24PMADSEC5A</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>3</td><td colspan="2">-</td><td colspan="2">-</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">Vector Analysis</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">1. To know the concepts of real fluids, velocity potential, equations of continuity, Eulers equation of motion and vortex motion with examples.
2. To gain knowledge about sources, sinks, doublets and axi - symmetric flows with examples.
3. To discuss the Milne - Thomson circle theorem, the Theorem of Blasius and the Navier -Stokes's equation of motion of a viscous fluid.
4. To develop flexibility and creativity of the students in applying the Mathematical ideas and techniques to solve unfamiliar problems arising in everyday life</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: understand the fundamental knowledge of fluid and its properties
CO2: apply the equation of continuity, Bernoulli's equation, Weiss's sphere theorem, Milne - Thomson circle theorem and Theorem of Blasius to solve the related problems
CO3: derive different governing equations of the fluid motion including equations of continuity, Eulers equation of motion and Navier Stokes's equations of motion
CO4: examine vortex motion, some special forms of the stream function for Axi – symmetric irrotational motions, two dimensional image system and stress analysis in fluid motion
CO5: formulate a fluid dynamics model to solve the problems in Physics, Biology and Engineering</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">Unit I (Hours:9)
Kinematics of Fluids in Motion: Real fluids and Ideal fluids - Velocity of a fluid at a point - Stream lines and path lines - Steady and Unsteady flows - The Velocity Potential - The Vorticity Vector - Local and Particle Rates of Change - The Equation of Continuity - Worked Examples.
Chapter 2 (Sections 2.1 - 2.8)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit II (Hours:9)
Equations of Motion of a Fluid: Pressure at a point in a fluid at rest - Pressure at a point in a moving fluid - Euler's equations of Motion - Bernoulli's equation -Worked Examples - Discussion of the case of steady motion under Conservative Body Forces - Some flows involving axial symmetry (examples 1 and 2 only).
Chapters 3 (Sections 3.1, 3.2,3.4 - 3.7, 3.9)</td></tr>
<tr><td colspan="2"></td><td colspan="7">Unit - III(Hours:9)
Some Three-Dimensional Flows: Introduction - Sources, Sinks and Doublets-Images in rigid infinite plane - Images in solid spheres – Axis symmetric flows.
Chapter 4 (Sections 4.1 - 4.4)</td></tr>
</table>

	Unit - IV(Hours:9) **Some Two-Dimensional Flows:** The Stream Function - The Complex Velocity Potential for Two Dimensional Irrotational, Incompressible Flow - Complex Velocity Potentials for Standard Two Dimensional Flows - Some Worked Examples - Two Dimensional Image Systems - The Milne-Thomson Circle Theorem. **Chapter 5 (Sections 5.3 - 5.8)**
	Unit - V(Hours:9) **Viscous Fluid:** Stress components in a real fluid - Relation between Cartesian Components of Stress - Translational motion of fluid element – The Coefficient of Viscosity and Laminar flow - The Navier- Stokes equation of a viscous fluid - Some solvable problems in viscous flow - Steady motion between parallel planes only. **Chapter 8 (Sections 8.1 - 8.3, 8.8, 8.9 and 8.10.1)**
Extended Professional Component (is a part of Internal Component only, not to be included in the External Examination question paper)	Real life application related to the above topics in various fields. (To be discussed during the Tutorial hour)
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Frank Chorlton, Textbook of Fluid Dynamics, CBS Publishers & Distributors, 2004.
Reference Books	1. L.M. Milne-Thomson, Theoretical Hydrodynamics, Macmillan, London, 1955. 2. G.K. Batchelor, An Introduction to Fluid Dynamics Cambridge Mathematical Library, 2000.
Web resources	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Mapping with POs and PSOs

	POs						**PSOs**		
	1	2	3	4	5	6	1	2	3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	3	3

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">STOCHASTIC PROCESSES</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">EC V (DISCIPLINE SPECIFIC)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE</td><td>Year</td><td>II</td><td>Credits</td><td>3</td><td>Course Code</td><td colspan="2">24PMADSEC5B</td></tr>
<tr><td>Semester</td><td>III</td><td colspan="4"></td></tr>
<tr><td colspan="2">Instructional Hours</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">Per week</td><td colspan="2">3</td><td colspan="2">-</td><td>-</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">Probability Theory and Mathematical Statistics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">1. To study how systems evolve over time in a probabilistic manner, taking into account random inputs or disturbances.
2. To comprehend the behavior of systems or processes that exhibit random or unpredictable behavior
3. To investigate the long-term behavior and limiting properties of stochastic processes, such as convergence to a stationary distribution or steady-state behavior.</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: demonstrate proficiency in understanding and applying Chapman-Kolmogorov equations for analysing Markov chains, including the calculation of 'n' step transition probabilities
CO2: understand the concepts of Poisson processes and birth-death processes, and be able to apply them to real-world scenarios such as queues and storage problems
CO3: analyse and modeling stochastic processes characterized by continuous time and continuous state space
CO4: compute and interpret covariance functions, including the application of Bochner's theorem to characterize stationary processes
CO5: analyse renewal processes and their associated renewal functions and demonstrate proficiency in calculating and interpreting renewal functions and their properties</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">UNIT I (Hours:9)

Introduction to stochastic process (SP) - classification of SP according to state space and time domain – countable state markov chain (MC) - Chapman- Kolmogorov equations- Calculation of 'n' step transition probability.
Chapter 1& 2(Sections 1.5, 2.1- 2.2)</td></tr>
<tr><td colspan="2"></td><td colspan="7">UNIT II (Hours:9)

Discrete state space-continuous time MC Kolmogorov differential equations –Poisson process, birth and death process – Application to queues and storage problem – Random walk.
Chapter 2 & 3 (Sections 2.4,2.11 &3.1,3.4)</td></tr>
<tr><td colspan="2"></td><td colspan="7">UNIT III (Hours:9)

Markov process- continuous time and continuous state space - time homogenous markov process - Kolmogorov's equation -Wiener process as a limit of random walk, first passage time Distribution</td></tr>
</table>

	process with Wiener process. **Chapter 3 & 4 (Sections 3.5, 4.1,4.2 ,4.4&4.5)**
	UNIT IV (Hours:9) Stationary process and time series- wide sense and strict sense stationary process - moving average and auto regressive process. Covariance function- Bochner's function(statement), Khintchine's representation of wide sense stationary process. **Chapter 8 (Sections 8.1- 8.3)**
	UNIT V (Hours:9) Renewal theory-renewal function and its properties- Elementary and key renewal theorems. **Chapter 6(Section 6.5)**
Extended Professional Component (is a part of Internal Component only not to be included in the External Examination question paper)	Questions related to the above topics from various competitive examinations UPSC/TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from the Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Medhi. J.(1982)Stochastic process, New age International publishers
Reference Books	1. Basu.A.K.(2003) Introduction to stochastic processes, New age Publishers. 2. Ross. S.M.(1983)Stochastic Process, Wiley, New York. 3. Karlin and First course in Stochastic Process - Vol. I & II, Academic Press. Taylor. H.M. (1975)
Website and e-Learning Source	http://mathforum.org,http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org,www.mathpages.com

Mapping with POs and PSOs

	POs						**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	3	3

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">STATISTICS FOR LIFE AND SOCIAL SCIENCES (FOR I M.SC / M.A. / M.Com.)</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">EDC</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">EXTRA DISCIPLINARY</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2">24PMAEDC2</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td>Lecture
2</td><td colspan="2">Tutorial
1</td><td colspan="2">Lab Practice
--</td><td>Total
3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">UG level Statistics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">The course focuses on imparting statistical techniques tailored for analyzing data in life and social sciences, emphasizing practical application and critical interpretation to enable informed decision-making in research and real-world scenarios.</td></tr>
<tr><td colspan="9">Course Outcomes:
Students will be able to
CO1: to develop proficiency in defining statistical concepts, understanding diverse data collection methods, mastering set theory, and grasping logical principles.
CO2: to equip skills in diagrammatic presentation, frequency distribution, graphical representation of data, and calculation of measures of central tendency.
CO3: to ensure proficiency in Probability Theory, Permutation Theorem, Combination, and Binomial Distribution.
CO4: to understand the nature and significance of statistical inquiries.
CO5: to understand the nature of science and introduce fundamental concepts in social statistics.</td></tr>
<tr><td>Course Outline</td><td colspan="8">UNIT - I (Hours: 9)
Definitions, and Scope of Statistics -Approach to Data Collection - Introduction to Set Theory I & II -Concepts of Logic
Chapter 1 (Page No. 1 -39)</td></tr>
<tr><td></td><td colspan="8">UNIT – II (Hours: 9)
Diagrammatic Presentation of Data -Frequency Distribution - Graphical Presentation of Data - Measures of Central Tendency
Chapter 2 (Page No. 40 -70)</td></tr>
<tr><td></td><td colspan="8">UNIT - III (Hours: 9)
Probability Theory I&II - Permutation Theorem - Combination - Binominal Distribution
Chapter 3 (Page No. 71 - 90)</td></tr>
<tr><td></td><td colspan="8">UNIT – IV (Hours: 9)
Nature and Importance of Statistical Inquiries - Basic Research Methodology I & II
Chapter 4 (Page No. 91 - 126)</td></tr>
<tr><td></td><td colspan="8">UNIT - V (Hours: 9)
Nature of Science -Some Basic Concepts in Social Statistics
Chapter 4 (Page No. 127 -140)</td></tr>
</table>

Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Basic Statistics for Social Sciences, Dr. Henry Obasogie (Course Reviewer) – Benson Idahosa University Dr. Moses Etila Shaibu (Course Editor) – NOUN
Reference Books	1.Osuala, E.C. (1982). Introduction to Research Methodology. Awka Rd Onitsha, Nigeria: Africana-Fep Publisher Limited. 2.Okoro, E. (2002). Quantitative Techniqes in Urban Analysis. Ibadan: Kraft Books Ltd. Kerlinger, Fred N. (1964). . 3.Foundations of Behavioural Research. New York: Holt, Rinehart and Winton. Whitney, F.L. (1968). 4. The Elements of Research. New York: Prentice- Hall.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Mapping with POs and PSOs

	POs						**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1

Strong-3; Medium-2; Low-1

Title of the Course		FUNCTIONAL ANALYSIS					
Paper Number		CORE XI					
Category	CORE	Year	II	Credits	5	Course Code	24PMACC11
		Semester	IV				
Instructional Hours per week		Lecture	Tutorial		Lab Practice		Total
		5	1		-		6
Pre - requisite		Elements of Real Analysis					
Objectives of the Course		To provide students with a strong foundation in functional analysis, focusing on spaces, operators and fundamental theorems. To develop student's skills and confidence in mathematical analysis and proof techniques					

Course Outcomes: Students will be able to

CO 1: Understand the Banach spaces and Transformations on Banach Spaces.

CO 2: Prove Hahn Banach theorem and open mapping theorem.

CO 3: Describe operators and fundamental theorems.

CO 4: Validate orthogonal and orthonormal sets.

CO 5: Analyze and establish the regular and singular elements.

Course Outline	**Unit - I (Hours: 18)** Banach Spaces: The definition and some examples - Continuous linear transformations - The Hahn-Banach theorem - The natural imbedding of N in N ** - The open mapping theorem - The conjugate of an Operator. **Chapter 9: Sections 46-51**
	Unit - II (Hours: 18) Hilbert Spaces: The definition and some simple properties - Orthogonal complements - Ortho normal sets - The conjugate space H*-The adjoint of an operator - self-adjoint operators-Normal and unitary operators - Projections. **Chapter 10: Sections 52-59**
	Unit - III (Hours: 18) Finite-Dimensional Spectral Theory: Matrices - Determinants and the spectrum of an operator - The spectral theorem. **Chapter 11:Sections 60-62**
	Unit - IV(Hours:18) General Preliminaries on Banach Algebras: The definition and some examples - Regular and singular elements - Topological divisors of zero - The spectrum - The formula for the spectral radius - The radical and semi-simplicity. **Chapter 12: Sections 64-69**
	Unit - V(Hours:18) The Structure of Commutative Banach Algebras: The Gelfand mapping - Application of the formula $r(x)=\lim \left\|x^n\right\|^{1/n}$ - Involutions in Banach algebras - The Gelfand-Neumark theorem. **Chapter 13:Sections 70-73**
Extended Professional Component (is a part of Internal Component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC - CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)

Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 1963.
Reference Books	1. W.Rudin, Functional Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 1973. 2. B.V. Limaye, Functional Analysis, New Age International,1996. 3. C. Goffman and G. Pedrick, First course in Functional Analysis, Prentice Hall of India, NewDelhi,1987. 4. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978. 5. M. Thamban Nair, Functional Analysis, A First course, Prentice Hall of India, New Delhi, 2002.
Web resources	http://www.mathforum.org/ http://ocw.mit.edu/ocwweb/Mathematics http://www.opensource.org/ http://en.wikiepedia.org/

Mapping of COs with POs and PSOs:

	POs						**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1

Strong-3; Medium-2; Low-1

Title of the Course		DIFFERENTIAL GEOMETRY					
Paper Number		CORE XII					
Category	CORE	Year	II	Credits	5	Course Code	24PMACC12
		Semester	IV				
Instructional Hours per week		Lecture	Tutorial		Lab Practice		Total
		5	1		-		6
Pre - requisite		Linear Algebra concepts and Calculus					
Objectives of the Course		1. To analyze the fundamental properties of space curves and surfaces, including curvature, torsion, and intrinsic properties, to establish a solid foundation in differential geometry. 2. To equip students with the ability to apply key theorems, such as the Gauss-Bonnet Theorem and Hilbert's Theorem, to understand and characterize various surface types, focusing on both intrinsic and extrinsic properties.					

Course Outcomes: Students will be able to

CO 1: Understand and differentiate between intrinsic and non-intrinsic surface properties by calculating the second fundamental form and identifying lines of curvature, gaining deeper insights into differential geometry.

CO 2: Analyze and interpret space curves by computing arc length and describing tangent, normal, and binormal vectors, as well as curvature and torsion, demonstrating a practical understanding of curve geometry.

CO 3: Apply geodesic equations by solving canonical forms and demonstrate understanding of the Gauss-Bonnet Theorem and Gaussian curvature, enabling them to explore surfaces of constant curvature in real-world contexts.

CO 4: Evaluate intrinsic properties of surfaces, such as metrics, direction coefficients, and families of curves, particularly focusing on surfaces of revolution and helicoids, assessing their geometric significance and applications.

CO 5: Demonstrate an understanding of compact surfaces with constant curvature by applying Hilbert's Theorem, analyzing and identifying conjugate points on geodesics, and synthesizing advanced concepts of complete surfaces

Course Outline	
	Unit - I (Hours: 18) **Space curves:** Definition of a space curve - Arc length - tangent - normal and binormal - curvature and torsion - contact between curves and surfaces- tangent surface- involutes and evolutes- Intrinsic equations - Fundamental Existence Theorem for space curves- Helices. **Chapter I : Sections 1 to 9.**
	Unit - II (Hours: 18) **Intrinsic properties of a surface:** Definition of a surface - curves on a surface - Surface of revolution - Helicoids - Metric- Direction coefficients - families of curves- Isometric correspondence- Intrinsic properties. **Chapter II: Sections 1 to 9.**
	Unit - III (Hours: 18) **Geodesics:** Geodesics - Canonical geodesic equations - Normal property of geodesics- Existence Theorems - Geodesic parallels - Geodesics curvature- Gauss- Bonnet Theorem - Gaussian curvature- Surfaces of constant curvature. **Chapter II: Sections 10 to 18.**
	Unit - IV(Hours:18) **Non-Intrinsic properties of a surface:** The second fundamental form- Principle curvature - Lines of curvature - Developable - Developable associated with space curves and with curves on surface - Minimal surfaces - Ruled surfaces. **Chapter III: Sections 1 to 8.**

	Unit - V(Hours:18) **Differential Geometry of Surfaces:** Compact surfaces whose points are umbilics- Hilbert's lemma - Compact surface of constant curvature - Complete surface and their characterization - Hilbert's Theorem - Conjugate points on geodesics. **Chapter IV: Sections 1 to 8**
Extended Professional Component (is a part of Internal Component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC - CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	T.J. Willmore, *An Introduction to Differential Geometry*, Oxford University Press, (17th Impression) New Delhi 2002. (Indian Print)
Reference Books	1. Struik, D.T. *Lectures on Classical Differential Geometry*, Addison - Wesley, Mass. 1950. 2. Kobayashi. S. and Nomizu. K. *Foundations of Differential Geometry*, Inter science Publishers, 1963. 3. Wilhelm Klingenberg: *A course in Differential Geometry*, Graduate Texts in Mathematics, Springer-Verlag 1978. 4. J.A. Thorpe *Elementary topics in Differential Geometry*, Under-I graduate Texts in Mathematics, Springer - Verlag 1979. 5. Dr. C. S. Mittal and D. C. Agarwal, Krishna Prakasham Mandir, Meerut
Web resources	https://www.geeksforgeeks.org/real-life-applications-of-differential-geometry/ https://fiveable.me/riemannian-geometry/unit-9 https://www.caltech.edu/about/news/Geometry_of_Minimal_Surfaces

Mapping of COs with POs and PSOs:

	POs						**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	2	3	2	3	3	3	2	2
CO2	2	2	3	2	3	3	3	2	2
CO3	3	2	3	2	3	3	3	2	2
CO4	2	2	3	2	3	3	3	2	2
CO5	3	2	2	3	3	3	3	2	2

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">RESOURCE MANAGEMENT TECHNIQUES</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">EC VI (DISCIPLINE SPECIFIC)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE</td><td>Year</td><td>II</td><td>Credits</td><td>3</td><td>Course Code</td><td colspan="2">23PMADSEC6A</td></tr>
<tr><td>Semester</td><td>IV</td><td colspan="4"></td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td colspan="2"></td><td>3</td><td colspan="2">1</td><td colspan="2">-</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Basics of Calculus, Probability Theory and Operations Research</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">1.To learn the methods of solving the real - world mathematical programming problems, applying minimal spanning tree, shortest route algorithms.
2.To gain knowledge about the applications of deterministic dynamic programming.
3.To analyse the formulation and solution of different inventory models and queuing systems.
4. Interpret the three categories of decision making process.
5.To familiarize the implementation of the course content in day - to - day life.</td></tr>
<tr><td colspan="10">Course Outcomes: Students will be able to
CO1: learn the notions of network models, deterministic dynamic programming, inventory models, decision analysis and queuing models
CO2: understand minimal spanning tree, shortest - route algorithms, forward and backward recursive approaches and solve real world problems
CO3: analyse the criterions for different decision making environments, pure birth and death models and solve related problems
CO4: determine the minimal spanning tree, most economical cable network, replacement policy, optimal inventory policy, solutions of cargo - loading and LP problems using dynamic programming
CO5: discuss Knapsack model, queuing models and the procedure of determining optimum inventory policy in various EOQ models</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="8">Unit - I (Hours:12)
Network Models: Network definitions, Minimal spanning tree algorithm, Shortest - route problem: Examples of the shortest - route applications, Shortest - route algorithms.
Chapter 6 (Sections: 6.1 - 6.3 (6.3.1, 6.3.2(excluding Floyd’s Algorithm))</td></tr>
<tr><td colspan="2"></td><td colspan="8">Unit - II(Hours:12)
Deterministic Dynamic Programming: Recursive nature of computations in DP, Forward and Backward recursion, Selected DP applications: Knapsack/Flyaway Kit/Cargo - loading model, Workforce size model, Equipment replacement model.
Chapter 10 (Sections: 10.1 - 10.3(10.3.1 - 10.3.3)</td></tr>
<tr><td colspan="2"></td><td colspan="8">Unit - III(Hours:12)
Probabilistic Inventory Models: Continuous review models: “Probabilitized” EOQ model, Probabilistic EOQ model, Single - period models: No setup model, Setup model(s - S policy).
Chapter 16 (Sections: 16.1(16.1.1, 16.1.2), 16.2(16.2.1, 16.2.2)</td></tr>
</table>

	Unit - IV(Hours:12) Decision Analysis: Decision making environments, Decision making under certainty, Decision making under risk: Expected value criterion, Variations of the expected value criterion, Decision under uncertainty. **Chapter 14 (Sections: 14.1, 14.2 (14.2.1, 14.2.2),14.3)**
	Unit - V(Hours:12) Queuing Systems: Elements of a queuing model, Role of exponential distribution, Pure birth and death models (Relationship between the exponential and poisson distributions): Pure birth model, Pure death model. **Chapter 17 (Sections: 17.2 - 17.4(17.4.1, 17.4.2)**
Extended Professional Component (is a part of Internal Component only, not to be included in the External Examination question paper)	Real life application related to the above topics in various fields. (To be discussed during the Tutorial hour)
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Text	Hamdy A. Taha - Operations Research, Seventh Edition, Prentice Hall of India Private limited, New Delhi.
Reference Books	1. Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag, PreetamBasu, Introduction to Operations Research, Nineth Edition, Tata - McGraw Hill Publications Company, New Delhi. 2. Kantiswarup, P.K.Gupta, Man Mohan ,Operations Research, Tenth Edition, Sultan Chand & Sons, New Delhi.
Web resources	1. http://www.pondiuni.edu.in/storage/dde/downloads/mbaii_qt.pdf 2. https://www.netlab.tkk.fi/opetus/s383143/kalvot/E_bdpros.pdf 3.https://www.alameen.ac.in/images/QUESTIONBANK/CSE/IIYEAR/MA6453PQTLecture - Notes.pdf

Mapping of COs with POs and PSOs:

	POs						**PSOs**		
	1	2	3	4	5	6	1	2	3
CO1	3	3	3	3	3	3	3	3	2
CO2	3	3	3	3	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	2	2	3	2	2

Strong-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">REPRESENTATION THEORY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">EC VI (DISCIPLINE SPECIFIC)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE</td><td>Year</td><td>II</td><td>Credits</td><td>3</td><td>Course Code</td><td>23PMADSEC6B</td></tr>
<tr><td>Semester</td><td>IV</td><td colspan="4"></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td colspan="2">-</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG Algebra</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">1. To understand the concepts of Group representations and Group algebra.
2. To gain knowledge about Irreducible characters and Character tables.</td></tr>
<tr><td colspan="8">Course Outcomes:
Students will be able to
CO1:recall the basic properties of groups and learn about group representations, FG modules and reducibility and group algebras
CO2: understand the concepts of FG - homomorphisms, Maschik’s theorem, Schur’s lemma and irreducible modules
CO3: recognize inner product of characters and the number of irreducible characters
CO4: analyse the dimensions and characters of representations of symmetric groups, dihedral groups and conjugacy classes
CO5: create the character tables and orthogonality relations and gain knowledge about some elementary character table</td></tr>
<tr><td colspan="2">COURSE OUTLINE</td><td colspan="6">Unit - I (Hours:15)
Group representations, FG modules, FG submodules and reducibility, Group algebras
Page No: 30 – 60</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit - II(Hours:15)
FG - homomorphisms, Maschike‟s Theorem, Schur‟s Lemma, Irreducible modules and the group algebra.
Page No: 61 – 94</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit - III(Hours:15)
More on the group algebra, Conjugacy classes, Characters.
Page No: 95 – 132</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit - IV(Hours:15)
Inner product of characters, The number of irreducible characters.
Page No: 133 – 158</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit - V(Hours:15)
Character tables and orthogonality relations, Normal subgroups and lifted characters, Some elementary character tables.
Page No: 159 – 187</td></tr>
</table>

Extended Professional Component (is a part of Internal Component only, not to be included in the External Examination question paper)	Real life application related to the above topics in various fields. (To be discussed during the Tutorial hour)
Skills acquired from the Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Text	G. James and M. Liebeck, Representations and Characters of Groups, (Second edition), Cambridge University Press, London, 2001.
Reference Books	C.W. Curtis and I. Reiner, Methods of Representation Theory with applications to Finite Groups and Orders, Volume 1, Wiley Interscience, New York,1981.
Web resources	1. https://people.math.ethz.ch/~wilthoma/docs/grep.pdf 2. http://www.m67aths.gla.ac.uk/~abartel/docs/reptheory.pdf

Mapping of COs with POs and PSOs:

	POs						**PSOs**		
	1	2	3	4	5	6	1	2	3
CO1	2	3	3	2	2	2	2	2	2
CO2	3	3	3	2	3	2	3	2	2
CO3	3	3	3	2	3	2	3	2	2
CO4	3	3	3	2	3	2	3	2	2
CO5	3	3	3	2	3	2	3	2	2

Strong-3; Medium-2; Low-1

Title of the Course		**PROJECT WITH VIVA-VOCE**					
Paper Number		CORE XIII					
Category	**CORE**	**Year**	**II**	**Credits**	**7**	**Course Code**	**24PMAPC**
		Semester	**IV**				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**		**Total**
		-	**-**		**-**		**10**
Pre-requisite		UG Level Mathematics					

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">ADVANCED COMPUTATIONAL MATHEMATICS USING PYTHON - PRACTICAL</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">Professional Competency Skill</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Skill Enhancement course</td><td>Year</td><td>II</td><td>Credits</td><td>2</td><td>Course Code</td><td>24PMAPCSQ</td></tr>
<tr><td>Semester</td><td>IV</td><td colspan="4"></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>-</td><td colspan="2">1</td><td colspan="2">3</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level Modern Algebra, Operation Research, Number theory & Artificial Intelligence</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">1. Equip students with practical skills in Python for optimization, data processing, and algebraic applications.
2. Enable students to apply Python for problem-solving in decision analysis, cryptography, and machine learning models.</td></tr>
<tr><td colspan="8">Course Outcomes: Students will be able to
CO1: Learn foundational Python libraries like Pulp, SciPy, NetworkX for solving linear and nonlinear programming problems in optimization
CO2: Understand the application of SymPy for handling algebraic expressions, modular arithmetic, and transformations in mathematical structures
CO3: Apply data processing, visualization, and machine learning techniques like linear regression, logistic regression, clustering on sample datasets using Pandas, Matplotlib, Seaborn, and scikit-learn.
CO4: Explore cryptographic algorithms like RSA and concepts such as the Chinese remainder theorem using Python programming
CO5: Develop decision-making frameworks with analytical hierarchy process, payoff matrices, and simulations to solve complex decision problems</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">Unit - I (Hours: 12)
Optimization, Modeling & Simulation: Using Python for solving LP problems with the Pulp library, Solving Network Analysis using Python with NetworkX, Solving Queuing Theory and Inventory Optimization in Python using Pulp and SciPy.optimize, creating payoff matrices and calculating optimal strategies, Simulating real world processes using SymPy.</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit - II (Hours: 12)
Algebra and Analysis: Basic Python exercises for Algebraic expressions, equations, and simplifications with SymPy, Coding examples of rings and fields, including modular arithmetic, Mapping and transforming structures in Python, Problems on Data analysis using Python.</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit - III (Hours: 12)
Machine Learning Analysis: Exploring and preprocessing a sample dataset using Pandas, Data visualization using Matplotlib and Seaborn, Implementing linear regression using scikit-learn, Implementing logistic regression, KNN, and decision trees in Python, Implementing k-means clustering on a sample dataset, Applying PCA on high-dimensional data using scikit-learn.</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit - IV (Hours: 12)
Number Theory and Cryptography: Problems on Chinese remainder theorem using python, Writing Python functions to compute the Euler’s Totient function, Coding the RSA algorithm for key generation, encryption, and decryption in Python.</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit - V (Hours: 12)
ODE, PDE and Fluid Dynamics: Analyzing simple decision problems on Ordinary Differential Equations, Partial Differential Equations and Fluid dynamics using Pandas, Implementing AHP to rank decision options, Generating and interpreting simulation results for decision problems.</td></tr>
</table>

Extended Professional Component (is a part of Internal Component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC - CSIR/ GATE/ TNPSC/ others to be solved. (To be discussed during the Tutorial hour)
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Albert G. Holzman, Mathematical Programming for Operations Researchers and Computer Scientists, CRC Press, Boca Raton, 1981. 2. Andreas C. Muller and Sarah Guido, Introduction to Machine Learning with Python, O'Reily Media,Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472, 2016. 3. Wes McKinney, Python for Data Analysis, O'Reily Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472, 2022.
Reference Books	1.Chris Albon, Machine Learning with Python Cookbook, O'Reily Media,Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472, 2018. 2.Jeffrey M. W. Wong and David Fuller J., Python Programming for Operations Research 3. Yves Hilpisch, Python for finance: Analyze, O'Reily Media,Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472, 2018 (Second Edition).
Web resources	https://benalexkeen.com/linear-programming-with-python-and-pulp/ https://realpython.com/ https://towardsdatascience.com/ https://www.geeksforgeeks.org/

Mapping of Cos with POs and PSOs

	POs						**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	3	3	3	1	3	3	2	1
CO2	3	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	1	2	3
CO4	3	2	2	3	3	3	2	2	3
CO5	3	3	3	3	3	3	2	2	3

Strong-3; Medium-2; Low-1