Title of the Course	**:**	**Algebraic Structures**			
Category of the Course	**:**	**CORE COURSE**	**Semester**	**:**	**I**
Course Code	**:**	**P1R3MACC1**	**Nature of the Course**	**:**	**Skill Development**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**7**
Credits	**:**	**5**	**Total Inst. Hrs.**	**:**	**105**

Objectives:

1. To educate the advanced level of Groups
2. To understand the sequential development of Abelian group concepts and skills by using materials for making the transition from the arithmetic to the symbolic
3. To understand the concepts of Jordan form
4. To have a brief study of Linear transformation
5. To study the algebraic structure of finite fields

UnitI: Sylow's Theorem (21 HOURS)

CountingPrinciple–1st,2nd and3rd parts of Sylow's Theorems– double coset–the normalize of a group.

UnitII:Abelian Group (21 HOURS)

Solvable groups - Direct products - Finite abelian groups- Modules

UnitIII:Linear Transformation (21HOURS)

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

UnitIV:Jordan Form (21HOURS)

Jordan form - rational canonical form.

UNIT V:Trace and Transpose (21HOURS)

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

TextBook :

[1] I.N.Herstein,'Topics in Algebra',Second Edition,Wiley Eastern Limited 2014.
Unit I-Chapter 2 Section2.11–2.12
UnitII– Chapter 5 Sec 5.7, Chapter2 Section2.13–2.14 & Chapter4 Section4.5
UnitIII-Chapter 6 Section6.4 and 6.5
UnitIV-Chapter 6 Section6.6 and 6.7
UnitV -Chapter 6 Section6.8, 6.10 and 6.11

Reference Books:

1. **Modern Algebra**, Surjeet Singh, Quazizameeudui, Vikas Publishing House Pvt. Ltd.
2. **Contemporary Abstract Algebra**, Gallian, Narosa Publishing House, Fourth Edition, 1999.
3. M.Artin, *Algebra,* Prentice Hall of India, 1991.
4. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition)

e-Resources:

1. https://www.math.stonybrook.edu/~aknapp/download/a2-alg-inside.pdf
2. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
3. http://www.opensource.org, www.algebra.com

Outcomes:

Thelearnerswouldhavetheabilityto,

CO1	Recall basic counting principle, define class equations to solve problems, explain Sylow's theorems and apply the theorem to find number of Sylow subgroups	K4
CO2	Define Solvable groups, define direct products, examine the properties of finite abelian groups, define modules	K3
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.	K2
CO4	Define Jordan,canonical form, Jordan blocks, define rational canonical form, define companion matrix of polynomial, find the elementary devices of transformation, apply the concepts to find characteristic polynomial of linear transformation.	K1
CO5	Understand the concept of solvability by trace, Symmetric etc	K2

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

CO\POMapping:

Title of the Course: Algebraic Structures							Course Code: P1R3MACC1			
Course Outcomes (COs)	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)			Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	
CO1	3	1	3	2	3	3	3	2	1	2.3
CO2	2	1	3	1	3	3	3	2	1	2.1
CO3	3	2	3	1	3	3	3	2	1	2.3
CO4	1	2	3	2	3	3	3	2	1	2.2
CO5	3	1	2	3	3	3	3	2	1	2.3
		Mean Overall Score								2.2
		Result								High

Title of the Course	**:**	**RealAnalysis– I**			
Category of the Course	**:**	**CORE COURSE**	**Semester**	**:**	**I**
Course Code	**:**	**P1R3MACC2**	**Nature of the Course**	**:**	**Skill Development**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**7**
Credits	**:**	**5**	**Total Inst. Hrs.**	**:**	**105**

Objectives:

1. To be familiar with the advanced concepts of Real Analysis
2. To give a systematic study of Riemann stieltjes integral and calculus on R^n
3. To have a brief study of convergence of sequences and series, Functions of several variables
4. To study Fourier Series and Gamma Function
5. To apply the contraction principle

UnitI: **Functions of bounded variation and Infinite series(21HOURS)**

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.

UnitII: **Riemann-Stieltjes integral(21HOURS)**

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.

UnitIII: Riemann-Stieltjes integral (21HOURS)

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

Lebesguecriterion for existence of Riemann integrals.

UnitIV:Infinite Series and Products (21HOURS)

Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series –Cesaro summability - Infinite products.Power series- Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem

UnitV:Sequence of Functions (21HOURS)

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

TextBooks:

[1] Mathematical Analysis, Tom M. Apostal, Addison-Wesley Publishing Company Inc. New York, 1974.

UnitI: Chapter6 Sec 6.1 to 6.8 and Chapter 8 Sec 8.8, 8.15, 8.17 and 8.18
UnitII: Chapter 7 Sec 7.1 to 7.7, 7.10-7.14
UnitIII: Chapter7 Sec7.15to 7.24, 7.26
UnitIV: Chapter8 –Sec 8.20 to 8.26 and Chapter 9 Sec 9.14, 9.15, 9.19, 9.20, 9.22, 9.23
UnitV: Chapter9- Sec9.1to9.2, 9.4 to 9.6, 9.8, 9.9, 9.10, 9.11, 9.13

ReferenceBooks:

1. Analysis I and II, Serge Lang, Addison–Wesley Publishing Company, 1969.
2. Elements of Real Analysis, R.G .Bartle, 2nd Edition, John Wily and Sons, New York, 1976.
3. Rudin, W. Principles of Mathematical Analysis, 3rd Edition. McGraw Hill Company, New York, 1976.

e-Resources:

- http://mathforum.org,
- http://ocw.mit.edu/ocwweb/Mathematics,
- http://www.opensource.org,

- www.mathpages.com

Outcomes:

Thelearnerswouldhavetheabilityto,

CO1	Analyze and evaluate functions of bounded variation and Rectifiable Curves	K5
CO2	Describe the concept of Riemann-Stieltjes integral and its properties.	K2
CO3	Demonstrate the concept of step function, upper function, Lebesgue function and their integrals	K3
CO4	Construct various mathematical proofs using the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.	K6
CO5	Formulate the concept and properties of inner products, norms and measurable functions.	K4

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

CO\POMapping:

Title of the Course: RealAnalysis– I							**Course Code: P1R3MACC2**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	1	3	2	3	3	3	2	1	2.3
CO2	2	1	3	1	3	3	3	2	1	2.1
CO3	3	2	3	1	3	3	3	2	1	2.3
CO4	1	2	3	2	3	3	3	2	1	2.2
CO5	3	1	2	3	3	3	3	2	1	2.3
		Mean Overall Score								**2.2**
		Result								**High**

Title of the Course	**:**	**OrdinaryDifferentialEquations**			
Category of the Course	**:**	**CORE COURSE**	**Semester**	**:**	**I**
Course Code	**:**	**P1R3MACC3**	**Nature of the Course**	**:**	**Employability**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**6**
Credits	**:**	**4**	**Total Inst. Hrs.**	**:**	**90**

Objectives

1. To identify an ordinary differential equation and its order
2. To reduce the order of a homogenous equations
3. To find the general solution of second order linear homogeneous equations with constant coefficients
4. To study the existence of solution of first order equations
5. To use annihilator method to solve non–homogenous equations

Unit I: Linear equations with constant coefficients(18HOURS)

Introduction– Second order homogenous equations- Initial value problem for second order equations- Linear dependence and independence-A formula for Wronskian.

Unit II: Linear equations with constant coefficients (Cont'd.)

(18HOURS)

The Non-homogenous equations of order two-homogenous and Non-homogenous equations of order n – Initial value problems for n^{th} order Equations-Annihilator method to solve non-Homogenous equation.

Unit III: Linear equations with variable coefficients

(18HOURS)

Initial value problem – Existence and uniqueness theorem- The Wronskian and linear independence – Reduction of the order of a homogenous equation -The non-Homogenous equation- Homogenous equations with analytic coefficients-The Legendre equations.

Unit IV: Linear equations with regular singular points (18HOURS)

The Euler equations–Second order equations with regular singular points-Exceptional cases-The Bessel equation–The Bessel equation contd.

Unit V: Existence and uniqueness of solutions to 1st order equations (18HOURS)

Equations with variable separated-Exact equations-The method of successive approximation-The Lipschitz Condition-Convergence of the successive approximation-Non-local existence of solutions-Approximations to and uniqueness of solutions.

TextBook:

1. **An Introduction to Ordinary Differential Equations**, Earl A. Coddington, Prentice Hall of India Private Limited, New Delhi 2013.

Unit I: Chapter 2, section 1 to 5
Unit II: Chapter 2, section 6 to 11
Unit III: Chapter 3, section 1 to 8
Unit IV: Chapter 4, section1to 4, 6 to 8
Unit V: Chapter 5, section 1 to 8

ReferenceBooks:

1. **Ordinary Differential Equations**,W.T. Reid, John Wiley & Sons, New York,1971.
2. **Theory of Ordinary Differential Equations**, E.A. Coddington and N.Levinson, McGraw Hill Publishing Company, NewYork, 1955.
3. **Differential Equations with Applications and Historical notes,** George Simmons, Tata McGraw Hill, Second Edition 2003, 22nd Reprint 2012.

e–Resources:

1. https://users.math.msu.edu/users/gnagy/teaching/ode.pdf
2. https://www.math.uni-bielefeld.de/~grigor/odelec2008.pdf
3. https://nptel.ac.in/courses/111/104/111104031/

Outcomes:

The learners would have the ability to,

CO1	Use the method of variation of parameters to find particular solutions of Second order, linear homogeneous equations.	K3
CO2	Use the method of undetermined co-efficient to solve 2^{nd} order linear homogeneous equations.	K3
CO3	Learn about Legendre Polynomials, Bessels function and Gamma functions	K4
CO4	Acquire the knowledge to solve the equations using Lipschitz condition.	K1
CO5	Use the method of successive approximation Picards theorem.	K3

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

CO\POMapping:

Title of the Course: OrdinaryDifferentialEquations							**Course Code: P1R3MACC3**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	1	3	2	3	3	3	2	1	2.3
CO2	2	1	3	1	3	3	3	2	1	2.1
CO3	3	2	3	1	3	3	3	2	1	2.3
CO4	1	2	3	2	3	3	3	2	1	2.2
CO5	3	1	2	3	3	3	3	2	1	2.3
									Mean Overall Score	**2.2**
									Result	**High**

Title of the Course	**:**	**Number Theory and Cryptography**			
Category of the Course	**:**	**DSE COURSE**	**Semester**	**:**	**I**
Course Code	**:**	**P1R3MADSE1:1**	**Nature of the Course**	**:**	**Employability**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**5**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**75**

Objectives:

1. To illustrate how general methods of analysis can be used to obtain results about integers and prime numbers.
2. To investigate the distribution of prime numbers.
3. To consolidate earlier knowledge of analysis through applications.
4. To study the summation formulas
5. To develop the concepts of L-functions.

Unit-I: Arithmetic Functions **(15 hours)**

Introduction – Notations and definitions – Generating series –Dirichlet convolution– Examples– Arithmetic functions of average –Sums of multiplicative functions –Distribution of additive functions.

Unit-II: Elementary Theory of Prime Numbers **(15 hours)**

The Prime Number Theorem–Tchebyshev method– Primes in arithmetic progressions – Reflections of elementary proofs of the Prime Number Theorem.

Unit-III: Characters **(15 hours)**

Introduction – Dirichlet characters – Primitive characters Gauss sums– Real characters – The quartic residue symbol – The Jacobi–Dirichlet and the Jacobi – Kubota symbols –Hecke characters.

Unit-IV: Summation Formulas **(15 hours)**

Introduction –The Euler-Maclaurin formula– The Poisson summation formula– Summation formulas for the ball –Summation formulas for the hyperbola – Functions equations of Dirichlet L–functions– Appendix: Fourier integrals and series.

Unit-V: Cryptography (15 hours)

Some topics in Elementary Number theory- Finite fields and Quadratic Residues- Some Simple Cryptosystems- Enciphering matrices

Text Book:

1. Analytic Number Theory – HenrykIwaniec and Emmanuel Kowalski – Colloquium Publications _ Baba BarkhaNath Printers – 2004.
2. A course in number theory and cryptography, Koblitz. N, Springer verlag, 1994

Unit I – Chapter 1 (Section 1.1 – 1.7) [1]
Unit II – Chapter 2 (Section 2.1 – 2.4) [1]
Unit III – Chapter 3 (Section 3.1 – 3.8) [1]
Unit IV – Chapter 4 (Section 4.1 – 4.6) [1]
Unit V – Chapter 1 to Chapter 3[2]

Reference Books:

1. Analytic Number Theory, Donald J. Newman,Springer-Verlag New York, Inc– 1998
2. Elementary Number Theory, David M. Burton, Tata McGraw-Hill, 7th Edition-2012
3. Basic Number Theory, SB Malik, Vikas Publishing House Pvt. Ltd.Reprint-2015.

e-Resources:

1. https://faculty.math.illinois.edu/~hildebr/tex/examples/books/ant.pdf
2. **http://www.freebookcentre.net/maths-books-download/Introduction-To-Number-Theory-by-Richard-Blecksmith.html**

Outcomes:

The learners would have the ability to,

CO1	Know the basic concepts of analytic number theory	K1
CO2	Understand better the distribution of prime numbers	K2
CO3	Understand the proof of Dirichlet's theorem	K2
CO4	Know the Euler-Maclaurin formula	K1
CO5	Analyze the basic theory of Cryptography	K4

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

CO\POMapping:Title of the Course: Number Theory and Cryptography							**Course Code: P1R3MADSE1:1**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	1	3	3	1	1	3	3	2	2.2
CO2	3	3	3	2	3	3	3	3	2	2.8
CO3	2	3	1	3	2	3	1	2	3	2.2
CO4	3	2	3	1	1	2	3	1	2	2.0
CO5	1	3	3	1	3	3	3	1	2	2.2
		Mean Overall Score								**2.3**
		Result								**High**

Title of the Course	**:**	**Graph Theory and Applications**			
Category of the Course	**:**	**DSE COURSE**	**Semester**	**:**	**I**
Course Code	**:**	**P1R3MADSE1:2**	**Nature of the Course**	**:**	**Employability**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**5**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**75**

Objectives:

1. To understand some applications of Graph Theory to Practical Problems and Branches of Mathematics.
2. To practice creative problem solving and improve skills in this area.
3. To see the simplicity of Graph Theory and combinactorics at make them ubiquitous.
4. To make Graph Theory easier and to be creative in Research fields .
5. To study domination in graphs.

Unit I :Matchings **(15 Hours)**

Matchings – Definitions – examples - Matchings and Coverings in Bipartite Graphs – Perfect Matchings.

Unit II : Edge Colourings, Independent Sets and Cliques **(15 Hours)**

Edge Chromatic Number – Vizing's Theorem – Independent sets – Ramsey's Theorem.

Unit III : Vertex Colourings **(15 Hours)**

Chromatic Number – Brook's Theorem – Hajo's Conjecture – Chromatic Polynomials.

Unit IV : Planar Graphs **(15 Hours)**

Plane and Planar Grpahs – Dual Graphs – Euler's Formulae – Bridges – Kuratowski's Theorem – The Five - Colour Theorem – The Four - Colour conjuncture.

Unit V :Domination in Graphs **(15 Hours)**

Dominating sets in Graphs – Sets of Representatives - Applications of Domination Numbers.

Text Book:

[1] "Graph Theory with Applications" – J.A. Bondy –U.S.R Murty – The Macmillan Press Ltd.
[2] "Fundamentals of Domination in Graphs", T.W.Haynes, S.Hedetniemi and P. J. Slater, 1998, CRC Press.
Unit – I: Chapter 5, Sec: 5.1 – 5.3 [1]
Unit – II: Chapter 6, Sec: 6.1 – 6.2 and Chapter 7, Sec: 7.1 – 7.2[1]
Unit – III: Chapter 8, Sec: 8.1 – 8.4[1]
Unit – IV: Chapter 9, Sec: 9.1 – 9.6 [1]
Unit – V: Chapter 1, Sec: 1.1 – 1.9 [2]

Reference Books:

[1] "Graph Theory" – Harray. F – Addison - Wesley - 1969.
[2] "Graph Theory with Applications to Engineering and Computer" – NarasinghDeo – Prientice Hall of India Pvt. Ltd. – New Delhi - 2000.

e-Resources:

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

Outcomes:

The learners would have the ability to,

CO1	Understand matching and coverings	K6
CO2	Acquire the knowledge of edge coloring and Ramsey's Theorem	K1
CO3	Know about chromatic number and chromatic polynomials	K3
CO4	Characterize planar graphs and solve problems related to trees	K2
CO5	Have a deep knowledge of Dominating and its applications	K4

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

CO\POMapping:

Title of the Course: Graph Theory and Applications							**Course Code: P1R3MADSE1:2**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	2	3	2	2	3	2	1	3	2.3
CO2	3	2	3	2	2	2	1	3	2	2.2
CO3	3	3	2	3	3	2	1	3	3	2.5
CO4	2	3	2	3	3	2	1	2	3	2.3
CO5	3	2	2	2	3	2	1	3	2	2.2
									Mean Overall Score	**2.3**
									Result	**High**

Title of the Course	**:**	**Formal Languages and Automata theory**			
Category of the Course	**:**	**DSE COURSE**	**Semester**	**:**	**I**
Course Code	**:**	**P1R3MADSE1:3**	**Nature of the Course**	**:**	**Employability**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**5**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**75**

Objectives:

1. To construct finite state machines and the equivalent regular expressions.
2. To provide the equivalence of languages described by finite state machines and regular expressions.
3. To construct pushdown automata and the equivalent content tree grammars.
4. To construct model for regular languages
5. To study finite automata and regular expressions.

Unit I: Mathematical Background and Languages (15 Hours)

Sets – Relations – Graphs – proofs – Formalization of languages – Expressions and grammars: Expressions – grammars.

Unit II: Automata (15 Hours)

Conceptualization of automata – Transducers – computability – Exercise.

Unit III: Regular Languages (15 Hours)

Regular Expressions – Finite Automata: Basic Definitions – Elimination of $\in$-moves.

Unit IV: Models for Regular Languages (15 Hours)

Determinism – simplification- Minimization.

Unit V: Finite Automata and regular expressions (15 Hours)

From regular expressions to finite automata: Conversion of regular expressions to finite automata – Scanning.

Text Book:

[1] "Automata and Languages – Theory and Applications", Alexander Meduna, Springer international Edition, 2005.

Unit I : Part I sec 0.1 to 0.4 and Chapter 1 sec 1.1, 1.2: 1.2.1 and 1.2.2 only
Unit II : Chapter 2 sec 2.1 to 2.3
Unit III : Chapter 3 sec 3.1, 3.2: 3.2.1 and 3.2.2 only

Unit IV : Chapter 3 sec 3.2: 3.2.3 to 3.2.5
Unit V : Chapter 3 sec 3.3: 3.3.1 – 3.3.1.1 and 3.3.1.2

Reference Book:

[1] "Introduction to Automata Theory, Languages and Computation", John E. Hopcroft, Rajeev Motwani and Jeffrey D. Uiiman, Pearson publications, 3rd Edition.

Outcomes:

The learners would have the ability to,

CO1	Apply Automata concepts and techniques in designing systems that address real world problems	K6
CO2	Understand the connection between language and computation	K1
CO3	Analyze the computational strengths and weakness of these machines	K3
CO4	Demonstrate an in-depth understanding of theories, concepts and techniques in automata and their link to computation.	K2
CO5	The conversion of regular expression to finite automata – scanning	K4

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

CO\POMapping:

Title of the Course: Formal Languages and Automata Theory							**Course Code: P1R3MADSE1:3**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	2	1	3	2	1	3	1	3	2.0
CO2	2	2	3	2	2	2	1	3	2	2.1
CO3	3	2	2	2	3	2	1	1	2	2.0
CO4	2	3	2	3	2	2	1	2	3	2.2
CO5	3	2	3	2	3	3	1	3	2	2.4
		Mean Overall Score								**2.1**
		Result								**High**

Title of the Course	**:**	**Programming in C++and Numerical Methods**			
Category of the Course	**:**	**DSE COURSE**	**Semester**	**:**	**I**
Course Code	**:**	**P1R3MADSE1:4P**	**Nature of the Course**	**:**	**Employability**
Marks	**:**	**CIA:40+Ext:60= 100**	**Hrs/Week**	**:**	**5**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**75**

Objectives:

1. To gain Basic knowledge in C++ Programming such as, Expressions, Structure, Classes and Objects
2. To solve problems in C++ using different numerical methods
3. To make the mathematical calculations simpler
4. To give the awareness of the object oriented programming
5. To make applications using C++ programs

LIST OF PRACTICALS

Algebraic and transcendental equations

1. To find the roots of an equation(algebraic or transcendental) by Bisection Method.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

2. To find the roots of an equation(algebraic or transcendental) by Secant Method.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

3. To find the roots of an equation(algebraic or transcendental) by Newton-Raphson Method.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

Linear Equations & Eigenvalue Problem

1. To find the roots of linear equations by Gauss Elimination Method.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

2. To find the roots of linear equations by Gauss Seidel Iterative Method.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

3. To find the eigen value and eigen vector of matrix by iterative method.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

Interpolation:

1. To find the forward difference table from a given set of data values.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

2. To find the backward difference table from a given set of data values.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

Curve fitting

1. To fit a straight line to a given set of data values.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

2. To fit a polynomial to a given set of data values.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

3. To fit an exponential function to a given set of data values.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

Differentiation

1. To find the first and second derivatives near the beginning of the table values of (x,y).

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

2. To find the first and second derivatives near the end of the table values of (x,y).

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

Integration

1. To evaluate a definite integral by trapezoidal rule.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

2. To evaluate a definite integral by Simpson's 1/3 Rule.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

3. To evaluate a definite integral by Simpson's 3/8 Rule.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

Differential Equations

1. To solve a differential equation by Euler's Method.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

2. To solve a differential equation by Modified Euler's Method.

   Links: *C++ Program* *Lab Write-Up*(Flow-Chart and Algorithm)

Text Books:

1. "**Object–Oriented Programming with C++**", E. Balaguruswamy, Sixth Edition, Tata McGraw-Hill Publishing Company Limited.
2. **"Programming in C &C++"**, Pooja Srivastava, Khanna Publishing House, First Edition 2014.
3. Numerical Recipes in C W. H. Press, B. P. Flannery, S. A. Teukolsky, W. T. Vetterlingwww.nr.com

Reference Books

1. "**Object Oriented Programming with C++**" by S.S.Vinod Chandra, New age.
2. "**C++ Programming**", D.S. Malik.

e -Resources:

1. https://nptel.ac.in/courses/106/105/106105151/
2. https://youtu.be/1rJZb_Ugc4E
3. .https://books.google.com.et/books?id=pDWqpqCGLK4C&lpg=PP1&pg=PA14#v=onepage&q&f=false

Outcomes:

The learners would have the ability to,

CO1	Understand and apply the C++ structure, tokens, expressions, control structures.	K2, K3
CO2	Ability to declare various prototyping, friend and virtual functions.	K3
CO3	Create Classes, objects, arrays of objects, constructors, and Destructors.	K3, K4
CO4	Analyze over loading operators and inheritance.	K4
CO5	Deliberate files, pointers and templates. Create, design and develop quality programs in C++.	K4, K5

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

CO\POMapping:

Title of the Course: Programming in C++and Numerical Methods							**Course Code:P1R3MADSE1:4P**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	3	3	3	1	3	3	2	1	2.4
CO2	3	2	3	3	2	3	3	1	3	2.5
CO3	3	2	3	3	2	3	3	2	1	2.3
CO4	3	1	3	3	3	2	1	2	3	2.3
CO5	3	2	2	3	3	1	2	3	3	2.4
		Mean Overall Score								**2.4**
		Result								**High**

Title of the Course	**:**	**Lie Groups and Lie Algebras**			
Category of the Course	**:**	**DSE COURSE**	**Semester**	**:**	**I**
Course Code	**:**	**P1R3MADSE2:1**	**Nature of the Course**	**:**	**Skill Development**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**5**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**75**

Objectives:

1. To construct finite state machines and the equivalent regular expressions.
2. To provide the equivalence of languages described by finite state machines and regular expressions.
3. To construct pushdown automata and the equivalent content tree grammars.
4. To construct model for regular languages
5. To study finite automata and regular expressions.

Unit : I Lie Algebras (15 Hours)

Definitions and basic properties –Nilpotent Lie algrbras: Engel's theorem – Solvable Lie algebras: Lie's theorem – Semi simple Lie algebras – Representation of Lie algebras: Weyl's Theorem.

Unit: II Lie Algebras Ctd (15 Hours)

Reductive Lie algebras: Levi sub algebras; Ado's theorem – Root systems and their classification – Split semi simple lie algebras – Representation of split semisimple Lie algebras.

Unit: III Algebraic groups (15 Hours)

Algebraic groups – Representations of algebraic groups, tensor categories – The lie algebra of an algebraic group – Semi simple algebraic groups.

Unit: IV Algebraic groups and Lie Groups (15 Hours)

Reductive groups – Algebraic groups with unipotent centre –Real Algebraic groups – Classical Algebraic Groups - Lie groups – Lie groups and algebraic groups – Compact topological groups.

Unit: V Arithmetic Subgroups (15 Hours)

Commensurable groups – Definitions and examples – Independence of ρ and L – Behaviour with respect to homomorphisms – Adelic description of Congruence subgroups – Applications to manifolds – Torsion-free arithmetic groups – A fundamental domain for SL_2 – Application to quadratic forms – "Large" discrete subgroups – Reduction theory.

Text Book:

1. Lie Algebras, Algebraic Groups and Lie Groups, J. S. Milne, 2013
   UnitI: Chapter1,Section1to5
   UnitII: Chapter1,Section6to9
   UnitIII: Chapter2,Sections 1to 4
   UnitIV: Chapter2,Sections 5to8, Chapter3,Sections 1to3
   UnitV: Chapter3A,Sections1, 2, 4to 12

Reference Books:

1. J.P. Serre, "Complex Semi Simple Lie Algebras"
2. J.E. Humphreys, "Introduction to Lie Algebras and Representation Theory"
3. A.L. Onishchik, E.B. Vinberg, "Lie Groups and Algebraic Groups"

e -Resources:

1. https://www.math.stonybrook.edu/~kirillov/mat552/liegroups.pdf
2. https://link.springer.com/book/10.1007/978-3-540-70634-2

Outcomes:

The learners would have the ability to,

CO1	Understand Lie group, Lie algebra, representation of a Lie algebra	K2, K3
CO2	Ability to declare various prototyping, friend and virtual functions.	K3
CO3	Create Classes, objects, arrays of objects, constructors, and Destructors.	K3, K4
CO4	Analyze over loading operators and inheritance.	K4
CO5	Deliberate files, pointers and templates. Create, design and develop quality programs in C++.	K4, K5

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

CO\PO Mapping:

Title of the Course: Lie Groups and Lie Algebras							**Course Code: P1R3MADSE2:1**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	2	2	2	1	2	2	3	2	1	1.9
CO2	2	2	2	1	3	3	3	2	1	2.1
CO3	3	2	2	1	1	2	3	2	1	1.9
CO4	3	2	3	1	2	2	3	2	1	2.1
CO5	3	2	3	1	3	2	3	2	1	2.2
								Mean Overall Score		**2.0**
								Result		**High**

Title of the Course	**:**	**Mathematical Programming**			
Category of the Course	**:**	**DSE COURSE**	**Semester**	**:**	**I**
Course Code	**:**	**P1R3MADSE2:2**	**Nature of the Course**	**:**	**Employability**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**5**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**75**

Objectives:

1. To describe the need and importance of Operations Research
2. To discuss the basic concepts and techniques for solving particular Operations Research problem
3. To develop are search proposal using the general approach for Operations Research
4. To maximize the utility of limited resources
5. To Characterize the Queueing System

UnitI:Integer Programming (15HOURS)

Introduction – Pure and Mixed Integer Programming Problems - Gomory'sALLI.P.P.Method-ConstructionofGomory'sConstraints– Fractionalcutmethod - All Integer LPP– Mixed Integer LPP – Branch–and–Bound Technique.

UnitII: Dynamic Programming (15HOURS)

Introduction – The Recursive equation approach – Characteristics of Dynamicprogramming – Dynamic programming Algorithm – Solution of Discrete D.P.P – Someapplications– Solution of LPP by Dynamicprogramming.

Unit III:QueuingTheory (15 HOURS)

Introduction–Queuing System–Elements Of Queuing System–Operating Characteristics of Queuing System–Classification of Queuing Models–Model–I(M/M/1):(∞/FIFO),Model–III(M/M/1):(N/FIFO),ModelV(M/M/C):(∞/FIFO), Model–VI(M/M/C):(N/FIFO)-Problems in above four models.

Unit IV: Non-Linear Programming (15Hours)

Introduction – Formulation a NLPP – General NLPP – Constrained Optimizationwith equality constraints – Constrained Optimization with inequality constraints GraphicalSolution– Saddlepointproblem – SaddlepointsandNLPP.

Unit V: Non-Linear Programming– Methods (15Hours)

Introduction–Graphical Solution– Kuhn-Tucker conditions with non-negative constraints–Quadratic Programming–Wolfe's Modified Simplex Method–Beale's Method-Separable Convex Programming –Separable Programming Algorithm.

TextBook:

1. Operations Research, Kanti Swarup, P. K. Gupta, ManMohan, Sultan Chand & Sons, Educational Publishers, New Delhi.

UnitI: Chapter7, Section7.1to7.7

UnitII: Chapter13, Section13.1to13.7

UnitIII: Chapter21, Sections 21.1–21.4,21.7–21.9.

UnitIV: Chapter27, Sections 27.1–21.7.

UnitV: Chapter28, Sections28.1–28.8.

Reference Books:

1. **Operations Research**, Hamdy A. Taha, (sixthedition) Prentice–Hall of India private Limited, New Delhi, 1997.
2. **OperationsResearch**,Panneerselvam.R,2ndEdition,PHILearningPrivateLimited,Delhi,2015
3. **Operations Research**, Prem Kumar Gupta. Er, Hira D. S. 7th Edition, S. Chand & Company Pvt. Ltd. 2014.

e-Resources:

1. **http://www.math.chalmers.se/Math/Grundutb/CTH/tma947/0405/kompendium_sub.pdf**
2. **https://core.ac.uk/download/pdf/153409843.pdf**
3. **https://youtu.be/4H9dMn919cs**

Outcomes:

The learners would have the ability to,

CO1	Underst and the different methods of I.P.P method and mixed integer LPP.	K2
CO2	Acquire knowledge about Dynamic programming.	K2
CO3	Study about Inventor with price breaks.	K4
CO4	Understand the concepts of Queuing system –Poisson Queuing system.	K2
CO5	Discuss Branch and Bound echniques.	K4

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

CO\POMapping:

Title of the Course: Mathematical Programming							**Course Code: P1R3MADSE2:2**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	1	3	2	2	1	3	2	2	2.1
CO2	2	2	3	2	1	3	1	3	2	2.1
CO3	2	3	3	3	2	3	3	3	2	2.7
CO4	3	2	2	2	3	3	2	1	3	2.3
CO5	2	2	2	3	3	3	2	2	3	2.4
		Mean Overall Score								**2.3**
		Result								**High**

Title of the Course	**:**	**FuzzySetsandtheirApplications**			
Category of the Course	**:**	**DSE COURSE**	**Semester**	**:**	**I**
Course Code	**:**	**P1R3MADSE2:3**	**Nature of the Course**	**:**	**SkillDevelopment**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**5**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**75**

Objectives:

1. To provide the knowledge of operations on fuzzy sets
2. To introduce the mathematical field on the concept of a fuzzy numbers
3. To enable the students to develop fuzzy relations
4. To use direct methods with one expert and multiple experts
5. To now the applications of fuzzy methodology

UnitI:FromCrisp Sets toFuzzy Sets (15HOURS)

Introduction – Crisp Sets : An overview – Fuzzy sets : Basic Types - Fuzzysets:BasicConcepts.

UnitII:OperationonFuzzySets (15HOURS)

Types of Operations – Fuzzy complements – Fuzzy Intersections – t norms -Fuzzyunions– tconforms–CombinationsofOperations.

UnitIII:FuzzyRelations(15HOURS)

Crisp versus Fuzzy Relations – Projections and cylindric extensions – BinaryFuzzyRelations–BinaryRelationsonaSingleset–FuzzyEquivalenceRelations– FuzzyCompatibilityRelations–FuzzyOrderingRelations–Fuzzymorphisms.

UnitIV:Decisionmakingin Fuzzyenvironments (15HOURS)

General Discussion – Individual Decision making – multi person decisionmaking – multi criteria decision making – multi stage decision making – fuzzyrankingmethods–fuzzylinearprogramming.

UnitV :Application (15HOURS)

Introduction-Medicine–Economics –Fuzzy Systems and GeneticAlgorithms– FuzzyRegression–InterpersonalCommunication – OtherApplications.

TextBook:

1.**FuzzysetsandFuzzyLogicTheoryandApplications,**GeorgeJ.KlirandBoYuan,PHI LeaningPrivateLimited,NewDelhi(2009).

UnitI: Chapter1,Section1.1to1.4

UnitII: Chapter3,Section3.1to3.5

UnitIII: Chapter5,Section5.1to5.8

UnitIV: Chapter15, Section 15.1to 15.7
UnitV: Chapter17, Section17.1to17.7

ReferenceBooks:

1. **Fuzzy SetTheory, Fuzzy Logic andtheirApplications, A.**K.Bhargava, S.ChandPvt.Limited(2013).
2. **Fuzzysetsandtheirapplication,**K.PundirandR.Pundir,-Pragatiedition2012.
3. **Fuzzysettheoryanditsapplications,**H.J.Zimmermann,Springer,2012.

e-Resources:

1. **https://cours.etsmtl.ca/sys843/REFS/Books/ZimmermannFuzzySetTheory2001.pdf**
2. **https://shahroodut.ac.ir/fa/download.php?id=1111124084**
3. https://nptel.ac.in/courses/108/104/108157/

Outcomes:

Thelearnerswouldhavetheabilityto,

CO1	Discussthetypesofoperationsonfuzzysets,t-normsandfuzzy arithmetic.	K1
CO2	Studyknowledgeoffuzzyequivalencerelations.	K2
CO3	Identifyfuzzyrelations,binaryfuzzyrelationsandfuzzyequivalencerelations.	K2
CO4	Gaintheknowledgeofconstructingfuzzysetsandoperations onfuzzysets.	K4
CO5	Applythefuzzymodelstonaturalscienceandtechnicalfields.	K3

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

CO\POMapping:

Title of the Course: FuzzySetsandtheirApplications							**Course Code: P1R3MADSE2:3**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	2	1	3	3	3	2	3	2	2	2.3
CO2	3	3	2	2	3	3	2	2	3	2.5
CO3	2	3	1	2	2	1	3	3	1	2.0
CO4	2	3	1	2	3	2	2	3	2	2.2
CO5	2	3	3	2	1	2	3	1	3	2.1
		Mean Overall Score								**2.2**
		Result								**High**

Title of the Course	**:**	**Discrete Mathematics**			
Category of the Course	**:**	**DSE COURSE**	**Semester**	**:**	**I**
Course Code	**:**	**P1R3MADSE2:4**	**Nature of the Course**	**:**	**Skill Development**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**5**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**75**

Objectives:

1. To study the basic concepts of Algebra.
2. To introduce a number of Discrete mathematics structure found to be serving as tools even today in the development of theoretical Computer science.
3. To solve problems occurred in the development of programming languages.
4. To know the importance of discrete structures towards simulation of problems in computer science and engineering in near future.
5. To provide the knowledge of recurrence relations.

UNIT – I Mathematical Logic (15 hours)

Statement and notations – Connectives – Well formed, Logic operators, Truth tables - Tautology – Normal forms, Theory of inference for the statement calculus

UNIT – II Lattices and Boolean Algebra (15 hours)

Lattices as a partial ordering sets – Definitions and Examples – Some propertics of lattices – Lattices as algebraic systems, Sub Lattices – Discrete product and homomorphism – Some special Lattices – Boolean Algebra – Definition – sub algebra – Direct product and homomorphism – Boolean functions – Representation and minimization of Boolean functions – Karnaugh Map.

UNIT – III Generating Function and Recurrence Relations (15 hours)

Generating Function – Recurrence Relations – linear Recurrence relation with constant coefficients – Homogeneous solutions – Particular solutions –Solution by the method of Generating Functions.

UNIT – IV Languages and Grammar (15 hours)

Introduction- Language- Operations on Languages- Power of a language- Regular expression and Regular sets-Regular Languages- Grammar- Language L(G) of a grammar- Types of structure grammars- Derivation tree of context free grammars- Backus Naur form- Finite state Machine- State table and state diagram- Input and Output tapes- Machine minimization.

UNIT – V Automata **(15 hours)**

Deterministic finite state Automata-Transition Graph- Language Accepted- Finite state Language- Kleene's theorem- Non Deterministic finite state automata- Pumping Lemma

Text Books

[1] Tremly. J.P and Manohar.P.,Discrete Mathematics Structures with Application to computer Science, MCGraw Hill 1987.

[2] Hari Kishan, Shiv Raj Pundir, 'Discrete Mathematics', Pragati Prakashan,2015

UNIT – I : Chapter I - Section 1.1-1.4 except (1.4.4) [1]

UNIT – II : Chapter IV – Section 4.1 – 4.4 [1]

UNIT – III: Chapter 5- Section 14 -19 [2]

UNIT – IV: Chapter 9 – Section 1-15 [2]

UNIT – V :Chapter 9 – Section 19-25 [2]

References:

1) James C.Abboh, Sets, Lattices and Boolean Algebra, Allya and Bacon Bortou, 1969.
2) G.S.S BhishmaRao, Discrete Structures and Graph theory, Scitech Publications pvt., Ltd.,

Outcomes:

The learners would have the ability to,

CO1	Understand the ideas of relations and functions.	K2
CO2	Acquire knowledgeabout logical arguments and logical constructs.	K2
CO3	Discuss semi groups and normal subgroups.	K4
CO4	Have a deep knowledge of lattices and its applications	K2
CO5	Know about recurrence relations and generating functions.	K2

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

CO\POMapping:

Title of the Course: Discrete Mathematics							**Course Code: P1R3MADSE2:4**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	3	3	2	3	2	3	1	1	2.3
CO2	3	2	2	1	-	-	3	2	1	1.5
CO3	3	2	1	2	-	-	2	3	2	1.7
CO4	2	3	1	2	1	1	3	2	2	1.9
CO5	2	3	2	2	1	1	2	2	3	2.0
		Mean Overall Score								**1.9**
		Result								**Medium**

Title of the Course	**:**	**Advanced Algebra**			
Category of the Course	**:**	**CORE COURSE**	**Semester**	**:**	**II**
Course Code	**:**	**P2R3MACC4**	**Nature of the Course**	**:**	**Skill Development**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**6**
Credits	**:**	**5**	**Total Inst. Hrs.**	**:**	**90**

Objectives:

- *To develop computational skill in abstract algebra*
- *To study field extension ,finite fields, division rings*
- *To have a brief study of roots of polynomials*
- *To discuss about Galois Theory*
- *To apply the radicals in solvability*

Unit I: **Extension fields** **(15 HOURS)**

Extension fields – Transcendence of e.

Unit II: **Polynomials** **(15 HOURS)**

Roots or Polynomials.- More about roots

Unit III: Galois Theory **(15 HOURS)**

Elements of Galois theory.

Unit IV: Fields **(15 HOURS)**

Finite fields - Wedderburn's theorem on finite division rings.

Unit V:Radicals **(15 HOURS)**

Solvability by radicals - A theorem of Frobenius - Integral Quaternion and the Four - Square theorem..

Text Books:

1. N. Herstein. *Topics in Algebra* (II Edition) Wiley EasternLimited, New Delhi, 1975.
   - **Unit I** : Chapter 5 Sec 5.1 to 5.2
   - **Unit II** : Chapter 5 Sec 5.3 and 5.5
   - **Unit III** : Chapter 5 Sec 5.6
   - **Unit IV** : Chapter 7 Sec 7.1 and 7.2 (Theorem 7.2.1 only)
   - **Unit V** : Chapter 5 Sec 5.7 (omit Lemma 5.7.1, Lemma 5.7.2 and Theorem 5.7.1) Chapter 7 Sec 7.3 and 7.4

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.

e - Resources:

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
2. http://www.opensource.org, www.algebra.com

Outcomes:

The learners would have the ability to,

CO1	Prove theorems applying algebraic ways of thinking	K3
CO2	Connect groups with graphs and understanding about Hamiltonian graphs.	K2
CO3	Compose clear and accurate proofs using the concepts of Galois Theory	K3
CO4	Bring out insight into Abstract Algebra with focus on axiomatic theories.	K5
CO5	Demonstrate knowledge and understanding of fundamental concepts including extension fields, Algebraic extensions, Finite fields, Class equations and Sylow's theorem.	K2

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

Title of the Course: Advanced Algebra							**Course Code: P2R3MACC4**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	1	3	2	3	3	3	2	1	2.3
CO2	2	1	3	1	3	3	3	2	1	2.1
CO3	3	2	3	1	3	3	3	2	1	2.3
CO4	1	2	3	2	3	3	3	2	1	2.2
CO5	3	1	2	3	3	3	3	2	1	2.3
									Mean Overall Score	**2.2**
									Result	**High**

Title of the Course	**:**	**Real Analysis-II**			
Category of the Course	**:**	**CORE COURSE**	**Semester**	**:**	**II**
Course Code	**:**	**P2R3MACC5**	**Nature of the Course**	**:**	**Skill Development**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**6**
Cred	**:**	**5**	**Total Inst. Hrs.**	**:**	**90**
Its					

Objectives

- *To deal primarily with limit and convergence*
- *To discuss vector valued functions and functions with values in an arbitrary metricspace*
- *To confine our attention to real functions defined on intervals or segments*
- *To understand numerical series and power series*
- *To focus on continuity and connectedness*

Unit I: Measures on the Real line (15 HOURS)

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

Unit II: Integration of Functions of a Real Variable (15 HOURS)

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

Unit III: Fourier series and Fourier integrals (15 HOURS)

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 Theorem - The convergence and representation problems in for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point –Cesaro summability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem

Unit IV: Multivarible Differential Calculus (15 HOURS)

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

Unit V: Implicit Functions and Extremum Problems (15 HOURS)

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

Text Books:

[1] G. de Barra, *Measure Theory and Integration*, Wiley Eastern Ltd., New Delhi, 1981.

[2] Tom M. Apostol *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Co. Inc. New York, 1974.

Unit I : Chapter 2 Sec 2.1 to 2.5 [1]
Unit II : Chapter 3 – 3.1, 3.2 and 3.4 [1]
Unit III : Chapter 11.1 to 11.15 [2]
Unit IV : Chapter 12.1 to 12.14 [2]
Unit V : Chapter 13.1 to 13.7 [2]

Reference Books:

1. Burkil 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 Ltd. New Delhi,1991.
6. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi,1991

e – Resources:

- http://mathforum.org,
- http://ocw.mit.edu/ocwweb/Mathematics,
- http://www.opensource.org

Outcomes:

The learners would have the ability to,

CO1	Understand and describe the basic concepts of Fourier series and Fourier integrals with respect to orthogonal system.	K2
CO2	Analyze the representation and convergence problems of Fourier series	K4
CO3	Analyze and evaluate the difference between transforms of various functions	K4
CO4	Formulate and evaluate complex contour integrals directly and by the fundamental theorem	K2
CO5	Apply the Cauchy integral theorem in its various versions to compute contour integration	K3

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

PROGRAM SPECIFIC OUTCOMES

Title of the Course: Real Analysis – II							**Course Code: P2R3MACC5**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	1	3	2	3	3	3	2	1	2.3
CO2	2	1	3	1	3	3	3	2	1	2.1
CO3	3	2	3	1	3	3	3	2	1	2.3
CO4	1	2	3	2	3	3	3	2	1	2.2
CO5	3	1	2	3	3	3	3	2	1	2.3
									Mean Overall Score	**2.2**
									Result	**High**

Title of the Course	**:**	**Partial Differential Equations**			
Category of the Course	**:**	**CORE COURSE**	**Semester**	**:**	**II**
Course Code	**:**	**P2R3MACC6**	**Nature of the Course**	**:**	**Employability**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**6**
Credits	**:**	**4**	**Total Inst. Hrs.**	**:**	**90**

Objectives:

- *To classify Partial differential equations into linear and nonlinear equation*
- *To understand the notion of linear independence and the notion of a fundamental set ofsolutions*
- *To use the Laplace transform to compute solutions of equations involving impulsefunctions*
- *To find solutions of the Boundary value problems*
- *To obtain the solution of heat equation and wave equation subject to boundaryconditions*

Unit I: Mathematical Models and Classification of second order equation(15 HOURS)

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

Unit II: Cauchy Problem (15 HOURS)

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

Unit III: Method of Separation of Variables (15 HOURS)

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

Unit IV: Boundary Value Problems (15 HOURS)

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

Unit V: Green's Function (15 HOURS)

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.

Text Book:

[1] TynMyint-U and LokenathDebnath, *Partial Differential Equations for Scientists and Engineers* (Third Edition), North Hollan, New York, 1987

Unit I: Chapter 2: Sect 2.1 t o 2.6 and Chapter 3- Sec 3.1 to 3.4

Unit II: Chapter 4 : Sections 4.1 to 4.11

Unit III: Chapter 6 Sec 6.1 to 6.6

Unit IV: Chapter 8: Sec 8.1 to 8.9

Unit V : Chapter 10, Sec 10.1 to 10.9

Reference Books:

1. M.M.Smirnov, *Second Order partial Differential Equations*, Leningrad, 1964.

2. I.N.Sneddon, *Elements of Partial Differential Equations*, McGraw Hill, New Delhi, 1983.
3. R. Dennemeyer, *Introduction to Partial Differential Equations and Boundary Value Problems*, McGraw Hill, New York, 1968.
4. M.D.Raisinghania,*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.
6. M.M.Smirnov, *Second Order partial Differential Equations*, Leningrad, 1964.
7. I.N.Sneddon, *Elements of Partial Differential Equations*, McGraw Hill, New Delhi, 1983.

e - Resources:

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

Outcomes:

The learners would have the ability to,

CO1	To understand and classify second order equations and find general solutions	K6
CO2	To analyse and solve wave equations in different polar coordinates	K1
CO3	To solve Vibrating string problem, Heat conduction problem, to identify and solve Laplace and beam equations	K3
CO4	To apply maximum and minimum principle's and solve Dirichlet, Neumann problems for various boundary conditions	K2
CO5	To apply Green's function and solve Dirichlet, Laplace problems, to apply Helmholtz operation and to solve Higher dimensional problem	K4

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

PROGRAM SPECIFIC OUTCOMES

Title of the Course: Partial Differential Equations							**Course Code: P2R3MACC6**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	1	3	2	3	3	3	2	1	2.3
CO2	2	1	3	1	3	3	3	2	1	2.1
CO3	3	2	3	1	3	3	3	2	1	2.3
CO4	1	2	3	2	3	3	3	2	1	2.2
CO5	3	1	2	3	3	3	3	2	1	2.3
									Mean Overall Score	**2.2**
									Result	**High**

Title of the Course	**:**	**Algebraic Topology**			
Category of the Course	**:**	**ELECTIVE**	**Semester**	**:**	**II**
Course Code	**:**	**P2R3MADSE3:1**	**Nature of the Course**	**:**	**Employability**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**4**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**60**

Objectives:

1. To introduce the notion of homotopy and covering spaces.
2. To Demonstrate fundamental group of circle and punctured plane.
3. To Study the essential and Inessential maps.
4. To Know the Jordan separation theorem.
5. To study the Jordan curve theorem.

UNIT: I

Homotopy of Paths-The Fundamental Group-Covering spaces.

UNIT: II

The Fundamental group of the circle – The Fundamental group of the punctured plane-The Fundamental group of S^n.

UNIT: III

Fundamental groups of surfaces- Essential and Inessential maps-The Fundamental theorem of algebra.

UNIT: IV

Homotopy type – The Jordan separation theorem.

UNIT: V

The Jordan Curve Theorem.

TEXTBOOK:

1. Topology – A first course by James R.Munkres, Prentice-Hall of India Pvt Ltd, Third print.

REFERENCE BOOKS:

1. A basic course in Algebraic Topology by William S Massey,Springer , First Edition.
2. Lecture notes on Elementary Topology and Geometry(Under graduate Texts in Mathematics) by I.M.Singer and John A Thorpe,Springer-Verlag,New York.
3. Elements of Algebraic Topology by James R. Munkres ,Addition-Wesley Publishing Company-1984

e-Resources:

1. https://pi.math.cornell.edu/~hatcher/AT/AT.pdf
2. https://www.maths.ed.ac.uk/~v1ranick/papers/diecktop.pdf

Outcomes:

The learners would have the ability to,

CO1	Explain the fundamental concepts of Algebraic topology.	K5
CO2	Demonstrate accurate and efficient use of Algebraic topology techniques.	K5
CO3	Demonstrate capacity for Mathematical Reasoning through analyzing, proving and explaining concepts from Algebraic topology.	K5
CO4	Applying problem solving using algebraic topology techniques.	K3
CO5	Acquire roles in modern mathematics and applied contexts	K2

PROGRAM SPECIFIC OUTCOMES

Title of the Course: Algebraic Topology							**Course Code: P2R3MADSE3:1**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	1	3	2	3	3	3	2	1	2.2
CO2	2	1	3	1	3	3	3	2	1	2.1
CO3	3	2	3	1	3	3	3	2	1	2.3
CO4	1	2	3	2	3	3	3	2	1	2.2
CO5	3	1	2	3	3	3	3	2	1	2.3
									Mean Overall Score	**2.2**
									Result	**High**

Title of the Course	**:**	**Mathematical Statistics**			
Category of the Course	**:**	**ELECTIVE**	**Semester**	**:**	**II**
Course Code	**:**	**P2R3MADSE3:2**	**Nature of the Course**	**:**	**Employability**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**4**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**60**

Objectives:

- *To Compute and interpret a correlation coefficient and linear regression analysis*
- *To understand the relationship between point estimate and interval estimation*
- *To understand the purpose of analysis of variance*
- *To Achieve quality in production and service organizations, through the use ofadequate statistical techniques*
- *To compute analysis data generated by functional experiments by using analysis of variance*

Unit I: Correlation and Regression **(15 HOURS)**

Multiple and partial correlation – Yule's Notation – Plane of Regression – Generalization – Properties of residuals – Coefficient of multiple correlation – Properties of multiple correlation-coefficient of partial correlation.

Unit II: Theory of Estimation **(15 HOURS)**

Method of estimation – Method of maximum likelihood Estimation - Method of minimum variance – Method of moments – Confidence intervals and confidence limits – confidence intervals of large sample.

Unit III: Non-Parametric Methods **(15 HOURS)**

Introductions - Advantages and Drawbacks of Non-parametric methods over parametric methods – Basic distribution – Wald - Wolfowitz Run test – test for randomness – median test – sign test – Mann-Whitney – Wilcoxon U Test.(Related simple problems)

Unit IV: Statistical Quality Control **(15 HOURS)**

Introduction – Definition - Basic of statistical quality control – Benefits – Process Control and Product Control – Control limits – Specification Limits and Tolerance Limits- $3-\sigma$ Control Limits – Tools for S.Q.C – Control charts for variables $\bar{X}$and R Charts – Criterion for Detecting Lack of Control in $\bar{X}$and R Charts – Interpretation- Control Charts for Standard Deviation σ Charts (Related simple problem)

Unit V: Analysis of Variance **(15 HOURS)**

Introduction – One way classification – Statistical Analysis of the model – Two Way classification – Statistical Analysis of the Model – Analysis of Two-Way classified data with K-Observation per cell.(Related simple problems)

Text Books:

1. **Fundamentals of Mathematical Statistics,** S.C Gupta and V.K Kapoor, Sultan Chand & Sons, New Delhi, 2002.

2. **Fundamentals of Applied Statistics,** S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi, 2007.

Unit I : Chapter : 12sec:12.4 to 12.11 [1]
Unit II : Chapter: 17 sec: 17.6 to 17.7.1 [1]
Unit III: Chapter:18 sec: 18.7 to 18.7.7 [1]
Unit IV**:** Chapter : 1 sec 1.1 to 1.8.4 [2]
Unit V: Chapter: 5 sec: 5.1 to 5.4[2]

Reference Books:

1. **Statistics for Management,** K.Subramani and A. Santha, Scitech Publications Pvt.Ltd., 2nd Edition.
2. **Mathematical Statistics,** J. N. Kapur, H .C. Saxena, Chand and Co. Publication Ltd.

e - Resources:

1. **http://dcpehvpm.org/E-Content/Stat/FUNDAMENTAL%20OF%20MATHEMATICAL%20STATISTICS-S%20C%20GUPTA%20&%20V%20K%20KAPOOR.pdf**
2. **http://www.ru.ac.bd/wp-content/uploads/sites/25/2019/03/201_04_01_Bijma-An-Introduction-to-Mathematical-Statistics-2017.pdf**
3. **https://youtu.be/cjTgyRUaD1s**

Outcomes:

The learners would have the ability to,

CO1	Acquire the knowledge of multiple and partial correlation.	K2
CO2	Analyze the Theory of Estimation and methods of estimating a parameterthrough sampling and test their Goodness.	K5
CO3	Study the advantages and drawbacks of Non – parametric method and test forrandomness.	K5
CO4	Demonstrate the ability to use the methods of statistical process control.	K3
CO5	Know about analysis of one way and two way classifications.	K2

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

PROGRAM SPECIFIC OUTCOMES

Title of the Course: Mathematical Statistics							**Course Code: P2R3MADSE3:2**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	2	3	3	3	2	3	3	3	2.8
CO2	3	2	3	3	3	3	2	1	3	2.5
CO3	3	1	2	3	2	3	3	1	2	2.2
CO4	3	1	2	3	3	3	1	2	2	2.2
CO5	3	1	2	2	3	3	2	2	3	2.3
									Mean Overall Score	**2.4**
									Result	**High**

Title of the Course	**:**	**Statistics data analysis using R- Programming**			
Category of the Course	**:**	**ELECTIVE**	**Semester**	**:**	**II**
Course Code	**:**	**P2R3MADSE3:3P**	**Nature of the Course**	**:**	**Employability**
Marks	**:**	**CIA:40+Ext:60= 100**	**Hrs/Week**	**:**	**4**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**60**

Objectives

- *To learn the open source platform*
- *To be familiar with the workspace in R*
- *To understand the Arithmetic and Logarithms concepts*
- *To interact with Vectors*
- *To work with matrices in R-programming*

Unit I: **(15 HOURS)**

Introduction to R programming: R-introduction – Uses of R – advantages and Disadvantages -Installing R – Installing R packages -Basic Syntax-Data types-Import and Export Data.

Unit II: **(15 HOURS)**

Data Structures and variables: Creating variables-Operators of R -Decision making of R – R-loops- Functions of R

Unit III: **(15 HOURS)**

Descriptive statistics in R: Mean, median, Variance, Standard Deviation and range. Statistical Graphs in R: Histogram, Bar Charts, Pie Charts, Box plot, Scatter plot. Sampling- simple Random Sampling, Stratified random sampling

Unit IV: **(15 HOURS)**

Coding of Discrete Distribution – Bernoulli, Binomial, Poisson, Geometric and hyper Geometric Distributions.

Unit V: **(15 HOURS)**

Coding of Continuous Distribution -Normal, Lognormal, Exponential, Cauchy , Gamma and beta Distributions

Text Book:

1. Gareth james, Daniela witten, Trevor hastie and Robert tibshirani (2017): An introduction to statistical learning with Applications in R
2. Mariz , L: Rizzo statistical computing with R , Chapman & hall/crc.

Reference Books:

[1] **"The Book of R - A First Course in Programming and Statistics",**Tilman M. Davies, William Pollock publisher 2016.

Reference Books:

[2] **"R Fundamentals and Programming Techniques",** Thomas Lumley, R Core Development Team and UW Dept of Biostatistics, 2006.

[3] **"Hands-On Programming with R"**, Garrett Grolemund, O'Reilly Media publication, 2014.

e-Resources:

1. https://youtu.be/mqaffQZ-U3M
2. https://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf

Outcomes:

The learners would have the ability to,

CO1	Show the installation of R programming Environment	K5
CO2	Utilize and R Data types for developing programs	K3
CO3	Make use of different R Data Structures	K3
CO4	Develop programming logic using R packages	K6
CO5	Analyze the datasets using R programming capabilities.	K4

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

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Title of the Course: Statistics Data Analysis using R Programming							**Course Code: P2R3MADSE3:3P**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	2	1	3	1	2	3	3	2	3	2.2
CO2	2	2	3	3	3	2	3	2	2	2.4
CO3	3	2	3	3	3	1	2	3	2	2.4
CO4	3	3	2	1	2	2	2	2	2	2.1
CO5	3	2	2	2	3	2	1	2	1	2.0
		Mean Overall Score								**2.2**
		Result								**High**

Title of the Course	**:**	**Tensor Analysis and Relativity**			
Category of the Course	**:**	**ELECTIVE**	**Semester**	**:**	**II**
Course Code	**:**	**P2R3MADSE3:4**	**Nature of the Course**	**:**	**Employability**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**4**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**60**

Unit I: Tensor Algebra **(15 HOURS)**

Systems of Different orders-Summation convention – Kronecker symbols – Transformation of coordinates in S_n – Invariants -Covariant and contravariant vectors –Tensors of Second order - mixed tensors -zero tensor -tensor field -Algebra of tensor – Equality of tensor-Symmetric and skew – symmetric tensor-outer multiplication – Quotient law of atensor- Reciprocal tensor of tensor – Relative tensor – cross products of vector

Unit II: Tensor Calculus **(15 HOURS)**

Riemannian space – Christoffel symbols and their properties

Unit III: Tensor Calculus cont. **(15 HOURS)**

Covariant Differentiation of tensors – Riemann – Christoffel curvature tensor – intrinsic Differentiation.

Unit IV: Special theory of Relativity **(15 HOURS)**

Galilean transformation – Maxwell's Equation – The Ether theory – the principle of Relativity Relativistic kinematics – Lorentz Transformation equations – Events and simultaneity – Example – Einstein train – time dilation – Longitudinal Contraction – Invariant intensity – proper time and proper distance – world line – example – twin paradox -addition velocities – Relativistic doppler effects

Unit V: **Relativistic Dynamics** **(15 HOURS)**

Momentum – energy – momentum – energy four vector -force -conversation of energy – mass and energy – example – inelastic collision – principle of equivalence – Lagrange and Hamiltonian formulations.

Text Book:

1. U.C. de , Absosali shaikh and joydeep Sengupta, tensor calculus, Narosa publishing house, New Delhi 2004
2. D. Greenwood, classical Dynamics, prentice hall of india , New Delhi 1985.

Unit I: Chapter 1, 1.1 -1.3, 1.7and 1.8, Chapter 2, 2.1 – 2.19[1]

Unit II: Chapter 3, 3.1-3.2[1]

Unit III: Chapter 3, 3.3-3.5[1]

Unit IV: Chapter 7, 7.1-7.2[2]

Unit V: Chapter 7, 7.3-7.4[2]

Reference Books:

[1] **"Tensor Calculus",**JL Synge and A.Schild, Toronto, 1949
[2] **"The Mathematical theory of Relativity",** A.S. Eddington, Cambridge University press, 1930.

e-Resources:

1. https://youtu.be/mqaffQZ-U3M
2. https://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf

Outcomes:

The learners would have the ability to,

CO1	Do computations with tensors, both in coordinates and in a coordinate-free form	K2,k3
CO2	Know the mathematical language needed to formulate the Maxwell equations for electromagnetism	K3
CO3	Demonstrate the ability to linear elasticity equations and other field equations.	K2
CO4	Be able to define curved spaces and be able to compute the curvature tensor for simple geometries.	K4
CO5	Important Approach is to Line arise the Field Equations	K5

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

Title of the Course: Tensor Analysis and Relativity							**Course Code: P2R3MADSE3:4**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	2	2	3	3	1	1	3	2	2	2.1
CO2	3	2	2	3	2	3	3	1	2	2.3
CO3	3	2	1	2	3	3	1	2	3	2.2
CO4	2	3	1	2	3	2	1	1	3	2.0
CO5	3	2	3	1	2	3	2	3	2	2.3
		Mean Overall Score								**2.2**
		Result								**High**

Title of the Course	**:**	**Wavelets**			
Category of the Course	**:**	**ELECTIVE**	**Semester**	**:**	**II**
Course Code	**:**	**P2R3MADSE4:1**	**Nature of the Course**	**:**	**Skill Development**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**4**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**60**

Objectives:

- To present a mathematical introduction to the wavelet theory.
- To extend the students knowledge with continuous and discrete wavelet transforms.
- To develop and strengthen the wavelet base and wavelet packages, wavelets and singular integrals.
- To study the applications related for example to signal analysis, image processing.
- To discuss numerical analysis.

Unit I: Introduction **(15 HOURS)**

Stationary and non-stationary signals, Signal representation using basis and frames, Brief introduction to Fourier transform and Short time Fourier transform, Time-frequency analysis, Bases of time frequency: orthogonal, Filter banks, Multi resolution formulation: Wavelets from filters.

Unit II: Continuous Wavelet Transform **(15 HOURS)**

Continuous wavelet transform (CWT), Time and frequency resolution of the continuous wavelet transform, Construction of continuous wavelets: Spline, orthonormal, bi-orthonormal, Redundancy of CWT, Zoom property of the continuous wavelet transform, Filtering in continuous wavelet transform domain.

Unit III: Discrete Wavelet Transform And Filter banks **(15 HOURS)**

Orthogonal and bi- orthogonal two-channel filter banks, Design of two-channel filter banks, Tree-structured filter banks, Discrete wavelet transform, Non-linear approximation in the Wavelet domain, multi resolution analysis, Construction and Computation of the discrete wavelet transform.

Unit IV: Multi Resolution Analysis **(15 HOURS)**

Multirate discrete time systems, Parameterization of discrete wavelets, Bi-orthogonal wavelet bases, Two dimensional, wavelet transforms and Extensions to higher dimensions, wave packets.

Unit V: Applications **(15 HOURS)**

Signal and Image compression, Detection of signal changes, analysis and classification of audio signals using CWT, Wavelet based signal de-noising and energy compaction, Wavelets in adaptive filtering, Adaptive wavelet techniques in signal acquisition, coding and lossy transmission, Digital Communication and Multicarrier Modulation, Trans multiplexers , Image fusion, Edge Detection and object isolation.

Text Books:

1. A Wavelet Tour of Signal Processing, 2nd edition, S. Mallat, Academic Press, 1999.
2. Wavelets and Sub band Coding, M. Vetterli and J. Kovacevic, Prentice Hall, 1995.
3. Wavelet transforms: Introduction, Theory and applications, Raghuveer rao and AjitS. Bopardikar, Pearson Education Asia, 2000.

References

1. Fundamentals of Wavelets: Theory, Algorithms, and Applications, J.C. Goswami and A.K.Chan, 2nd ed., Wiley, 2011.
2. Wavelets and their Applications, Michel Misiti, Yves Misiti, Georges Oppenheim, Jean-Michel Poggi, John Wiley & Sons, 2010 .
3.A premier on Wavelets and their scientific applications, J S Walker, CRC press, 2002.
4.Multirate Systems and Filter Banks, P. P. Vaidyanathan, Pearson Education, 2004.
5.Wavelets : from math too practice, Desanka.P.Radunovik, springer, 2009.
6.Insight into wavelets from theory to practice, K P Soman and KL Ramachandran, PHI,2008.

e-Resources:

1.https://www.google.co.in/books/edition/A_Friendly_Guide_to_Wavelets/rfRnrhJwoloC?hl=en&gbpv=1&dq=A+friendly+guide+to+Wavelets,+Gerald+keiser,+Springer,+2011+pdf&printsec=frontcover

2.https://www.google.co.in/books/edition/Wavelets_and_Signal_Processing/IYUMyVRdJjkC?hl=en&gbpv=1&dq=Wavelets+and+signal+processing:+An+application+based+introduction,+Stark,+Springer,+2005.&pg=PP4&printsec=frontcover

Outcomes:

The learners would have the ability to,

CO1	Presents a mathematical introduction to the wavelet theory: Continuous and discrete wavelet transform	K2
CO2	Applications related for example to signal analysis, image processing, numerical analysis	K3
CO3	Handle problems and conduct researches related to theoretical and applied problems related to wavelet theory	K5
CO4	In particular techniques connected with signal and image processing, data banks should be studied	K4
CO5	Participate in scientific discussions and conduct researches on high international level in wavelet theory	K4

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

Title of the Course: Wavelets							**Course Code: P2R3MADSE4:1**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	2	3	3	3	2	2	2	3	2	2.4
CO2	2	3	3	3	2	2	2	3	2	2.4
CO3	2	3	3	3	2	2	2	3	2	2.4
CO4	3	2	2	2	-	1	2	3	2	1.9
CO5	2	3	3	3	2	2	2	3	2	2.4
									Mean Overall Score	**2.3**
									Result	**High**

Title of the Course	**:**	**Modeling and Simulation with Excel**			
Category of the Course	**:**	**ELECTIVE**	**Semester**	**:**	**II**
Course Code	**:**	**P2R3MADSE4:2P**	**Nature of the Course**	**:**	**Employability**
Marks	**:**	**CIA:40+Ext:60= 100**	**Hrs/Week**	**:**	**4**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**60**

Objectives:

- Understand the fundamentals of data analysis and modeling concepts.
- To apply statistical methods to analyze and interpret data accurately.
- To build predictive models to forecast trends and make informed decisions.
- To develop simulation models to evaluate scenarios and assess risks.
- To utilize Excel's built-in tools and add-ins for data analysis and modeling.

Practicals:

1. Introduction to data analysis and modeling
2. Advanced formulas and functions in Excel
3. Data Cleaning techniques
4. Descriptive statistics and data visualization
5. Statistical Analysis in Excel
6. Predictive Modeling with Excel
7. Optimization Modeling in Excel
8. Simulation Modeling in Excel
9. Data analysis in Excel for Finance
10. Data Analysis in Excel for Education

Text Books:

1. Excel Data Analysis Modeling and Simulation, Hector Guerrero, Springer

Reference Books:

1. **Data Analysis with Microsoft Excel, Berk & Carey,**

e-Resources:

1. https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjducqBhviCAxWmSmwGHQCdCaoQFnoECA4QAQ&url=https%3A%2F%2Fdocushare.sfu.ca%2Fdsweb%2FGet%2FVersion-493516%2FData%2520Analysis%2520and%2520Business%2520Modelling.pdf&usg=AOvVaw27xjWCnlWO8h8U-KkC4vWB&opi=89978449

2. https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjducqBhviCAxWmSmwGHQCdCaoQFnoECA8QAQ&url=https%3A%2F%2Fdocushare.sfu.ca%2Fdsweb%2FView%2FCollection-17540&usg=AOvVaw0geccHB4Zkx8Zsm53e-Q37&opi=89978449

COURSE OUTCOMES:

At the end of this course, the students will be able to:

CO1	Describe the roll of important elements of discrete event simulation and modelling paradigm.	K2
CO2	Conceptualize real world situations related to systems development decisions from source of requirements.	K2
CO3	Interpret the model and apply the results to resolve critical issues in a real world environment.	K6
CO4	Apply random number variates to develop simulation models	K4
CO5	Analyze output data produced by a model and test validity of the model.	K4

Title of the Course: Modeling and Simulation with Excel							**Course Code: P2R3MADSE4:2P**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	2	3	1	2	1	3	2	1	2.0
CO2	3	2	3	1	2	1	3	2	1	2.0
CO3	3	3	3	3	2	1	3	3	1	2.4
CO4	3	3	3	3	1	1	3	3	1	2.3
CO5	3	3	3	3	2	1	3	3	1	2.4
		Mean Overall Score								**2.2**
		Result								**High**

Title of the Course	**:**	**Machine Learning and Artificial Intelligence**			
Category of the Course	**:**	**ELECTIVE**	**Semester**	**:**	**II**
Course Code	**:**	**P2R3MADSE4:3**	**Nature of the Course**	**:**	**Employability**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**4**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**60**

Objectives:

- Study about uninformed and Heuristic search techniques.
- Learn techniques for reasoning under uncertainty
- Introduce Machine Learning and supervised learning algorithms
- Study about ensembling and unsupervised learning algorithms
- Learn the basics of deep learning using neural networks

UNIT I PROBLEM SOLVING (15 HOURS)

Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP)

UNIT II PROBABILISTIC REASONING (15 HOURS)

Acting under uncertainty – Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.

UNIT III SUPERVISED LEARNING (15 HOURS)

Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random forests

UNIT IV ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING (15 HOURS)

Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization

UNIT V NEURAL NETWORKS (15 HOURS)

Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error bac kpropagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach", Fourth Edition, Pearson Education, 2021.
2. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Fourth Edition, 2020.

REFERENCES:

1. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Pearson Education, 2007
2. Kevin Night, Elaine Rich, and Nair B., "Artificial Intelligence", McGraw Hill, 2008
3. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, "Foundations of Machine Learning", MIT Press, 2012.

COURSE OUTCOMES:

At the end of this course, the students will be able to:

CO1: Use appropriate search algorithms for problem solving K2
CO2: Apply reasoning under uncertainty K3
CO3: Build supervised learning models K4
CO4: Build ensembling and unsupervised models K4
CO5: Build deep learning neural network models K4

Title of the Course: - Machine Learning and Artificial Intelligence							**Course Code: P2R3MADSE4:3**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	1	3	2	1	2	3	2	1	2.0
CO2	3	1	3	2	1	1	3	2	1	1.9
CO3	3	1	3	2	1	2	3	3	1	2.0
CO4	3	1	3	2	2	1	3	3	1	2.1
CO5	3	1	3	2	2	1	3	3	1	2.1
									Mean Overall Score	**2.0**
									Result	**High**

Title of the Course	**:**	**Neural Network**			
Category of the Course	**:**	**ELECTIVE**	**Semester**	**:**	**II**
Course Code	**:**	**P2R3MADSE4:4**	**Nature of the Course**	**:**	**Skill Development**
Marks	**:**	**CIA:25+Ext:75= 100**	**Hrs/Week**	**:**	**4**
Credits	**:**	**3**	**Total Inst. Hrs.**	**:**	**60**

Objectives:

- Study about uninformed and Heuristic search techniques.
- Learn techniques for reasoning under uncertainty
- Introduce Machine Learning and supervised learning algorithms
- Study about ensembling and unsupervised learning algorithms
- Learn the basics of deep learning using neural networks

Unit I: Perception and Adeline (15 Hours)

Network with threshold activation functions – Perception learning rule and convergence theorem – The adaptive linear element – Networks with linear activation functions: the delta rule – Exclusive – OR problem - Multi layer perception can do everything.

Unit II: Back Propagation (15 Hours)

Multi layer feed-forward networks – The generalized delta rule – Working with back propagation – An example – Other activation functions – Deficiencies of back propagation – Advanced Algorithms – How good are multi-layer feed-forward networks? – Applications.

Unit III: Recurrent Networks (15 Hours)

The generalized delta-rule in recurrent networks – The Hopfield network – Boltzmann machines.

Unit IV: Self Organizing Networks (15 Hours)

Competitive Learning – Kohonen network – Principal component networks – Adaptive resonance theory.

Unit V: Applications (15 Hours)

Robot Control – End – effector positioning – Camera-robot coordination is function approximation – Robot arm dynamics – Mobile robots – Model based navigation – Sensor based control.

Text Book:

1. An Introduction to Neural Networks, Ben Krose and Patrick van der Smagt, Eigth Edition, November 1996.

Unit: 1 sec: 3 3.1 to 3.6
Unit II sec: 4 fully
Unit III sec: 5 fully
Unit IV Sec: 6 fully
Unit V Sec: 8 fully

Reference Books:

1. Neural Networks and Deep learning, Charu C. Aggarwal, Springer International Publishing, 2018.

e – Resources:

https://neuralnetworksandlearning.com

Outcomes:

The learners would have the ability to,

CO1	Acquire the knowledge of Networks with linear activation functions	K2
CO2	Understand about multi-layer feed-forward networks	K5
CO3	Learn about primitive roots and indices.	K3
CO4	Acquire the knowledge of Kohonen network	K2
CO5	Application of Camera-robot coordination	K5

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

Title of the Course: Neural Networks							**Course Code: P2R3MADSE4:4**			
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	3	2	3	2	1	3	2	1	2.2
CO2	3	3	2	3	2	1	3	2	1	2.2
CO3	3	2	2	3	2	1	3	1	1	2.0
CO4	2	3	3	2	2	1	3	2	1	2.1
CO5	3	2	2	3	2	1	3	2	1	2.1
		Mean Overall Score								**2.1**
		Result								**High**

Title of the Course	**:**	**Mathematical Documentation using LATEX**			
Category of the Course	**:**	**Skill Enhancement**	**Semester**	**:**	**II**
Course Code	**:**	**P2R3MASEC1P**	**Nature of the Course**	**:**	**Employability**
Marks	**:**	**CIA:40+Ext:60= 100**	**Hrs/Week**	**:**	**4**
Credits	**:**	**2**	**Total Inst. Hrs.**	**:**	**60**

Objectives:

- To learn the basic functions of Latex
- To explore some of the more advanced features available.
- To develop their skills in order to more fully utilize its functions in particular using Bibtex to help manage their references in relation to the Latex document.
- To Typeset complex mathematical formulae.
- Main objective for typesetting to journal articles.

Unit – I Text, Symbols and Commands (8 hours)

Command names and arguments – Environments-Declarations – Lengths – Special characters – Fine-tuning text – Word division.

Unit-II Document Layout and Organization(7 hours)

Document class – Page style – Parts of the document – Table of contents.

Unit – III Displayed Text (6 hours)

Changing font – Centering – indenting.

Unit – IV Listing the Text (7 hours)

Lists – Generalized lists -Theorem like declarations – Tabulator stops-Boxes – Tables.

Unit – V Mathematical Formulas (8 hours)

Mathematical environments - Main elements of Math mode -Mathematical symbols – Additional elements – Fine tuning Mathematics– Beyond standard latex.

Text Book:

1. Kopka, H., Daly, P.W. (2003) *A Guide to LATEX*, Fourth Edition, London: Addision Wesley.

2. Lamport, L.(1994).*Latex: A document preparation system*. Addison Wesley Professional.

Reference Book:

1. Mittelbach, F.(2007).*The Latex Graphics Companion* (2nd ed.). Addison-Wesley Professional.
2. Mittelbach, F., Goossens, M., Braams, J., Carlisle, D., Rowley, C.(2004).*The Latex Companion*. Addison-Wesley Professional.

e – Resources:

https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf

Outcomes:

The learners would have the ability to,

CO1	Typeset mathematical formulae using LaTeX.	K3
CO2	Use the preamble of LaTeX file to define document class and layout options.	K3
CO3	Use nested list and enumerate environments within a document.	K3
CO4	Acquire the knowledge of tabular and array environments within LaTeX document.	K2
CO5	Use various methods to either create or import graphics into a LaTeX document.	K5

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

Title of the Course: Mathematical Documentation using LATEX							**Course Code: P2R3MASEC1P**		
Course Outcomes (COs)	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**			**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	
CO1	3	2	2	2	2	1	3	2	1	2.0
CO2	3	2	2	3	2	1	3	2	1	2.1
CO3	3	2	2	3	2	1	3	1	1	2.0
CO4	2	3	2	2	2	1	3	2	1	2.0
CO5	3	2	3	3	2	1	2	2	1	2.1
		Mean Overall Score								**2.0**
		Result								**High**