J.J. College of Arts and Science (Autonomous)

J.J.Nagar, Sivapuram Post, Pudukkottai - 622 422

PG - Programme **- M.Sc. MATHEMATICS - Under Choice Based Credit System**

For the candidates admitted from the academic year 2022-2025 onwards

Sem.	Course Code	Course Title	Hours/ Week	Credit	Exam Hours	Int.	Ext.	MARKS
I	P1R2MACC1	Abstract Algebra	6	5	3	25	75	100
	P1R2MACC2	Real Analysis – I	6	5	3	25	75	100
	P1R2MACC3	Ordinary Differential Equations	6	5	3	25	75	100
	P1R2MACC4	Mechanics	6	6	3	25	75	100
	P1R2MADSEC1: 1 /1:2	Disciplinary Elective Course-I (Any one from the choice given below)	6	4	3	25	75	100
		TOTAL	**30**	**25**				**500**
II	P2R2MACC5	Linear Algebra	6	6	3	25	75	100
	P2R2MACC6	Real Analysis – II	6	5	3	25	75	100
	P2R2MACC7	Partial Differential Equations	6	5	3	25	75	100
	P2R2MACC8	Topology	6	5	3	25	75	100
	P2R2CAGEC1:1 P/1:2P	Generic Elective Course-I (Any one from the choice given below)	6	2	3	40	60	100
		TOTAL	**30**	**23**				**500**
III	P3R2MACC9	Complex Analysis	6	6	3	25	75	100
	P3R2MACC10	Optimization Techniques	6	5	3	25	75	100
	P3R2MACC11	Mathematical Statistics	6	5	3	25	75	100
	P3R2MACC12	Measure Theory and Integration	6	5	3	25	75	100
	P3R2MASEC1:1 P/1:2P	Skill Enhancement Course-I (Any one from the choice given below)	6	3	3	40	60	100
		TOTAL	**30**	**24**				**500**
IV	P4R2MACC13	Functional Analysis	6	6	3	25	75	100
	P4R2MACC14	Fuzzy Sets and their Applications	6	5	3	25	75	100
	P4R2MACC15PW	Project	*	5	*	40	60	100
	P4R2CMGEC2:1 /2:2	Generic Elective Course-II (Anyone from the choice given below)	6	2	3	25	75	100
		TOTAL	**18**	**18**				**400**
		GRAND TOTAL		**90**				**1900**

ELECTIVE COURSES: Any **Four** to be chosen as DSEC1, GEC1, GEC2 and SEC1

I Semester P1R2MADSEC1:1- Elements of Stochastic Processes P1R2MADSEC1:2 - Ethical Attitude in Mathematical Research	**II Semester** P2R2CAGEC1:1P – Programming in C++ P2R2CAGEC1:2P – Python Programming
III Semester P3R2MASEC1:1P – Programming in MATLAB P3R2MASEC1:2P – Skills in LaTex	**IV Semester** P4R2CMGEC2:1 – Applications of Crypto currency and Block Chain Technology P4R2CMGEC2:2 – GST Theory and Practice

SEM: I	**M.Sc. MATHEMATICS**	**CORE COURSE:1**
Credit: 5	**Abstract Algebra**	**Hours/Week: 6**
Max. Marks: 100	**CODE: P1R2MACC1**	**Int. Marks: 25**
Total Hours: 90	**Skill Development**	**Ext. Marks: 75**

Objectives

- *To educate the advanced level of Groups*
- *To understand the sequential development of Abelian group concepts and skills byusing materials for making the transition from the arithmetic to the symbolic*
- *To understand the concepts of Splitting Field*
- *To have a brief study of polynomial Rings*
- *To study the algebraic structure of finite fields*

Unit I: Sylow's Theorem (18 HOURS)

Another Counting Principle – 1^{st}, 2^{nd} and 3^{rd} parts of Sylow's Theorems –double coset–the normalizer of a group.

Unit II: Finite Abelian Group (19 HOURS)

External and Internal direct Products–structure theorem for finite abeliangroups – non isomorphic abelian groups- polynomial rings.

Unit III: Splitting Field (16 HOURS)

Polynomials over rational fields– the Eisenstein criterion - extension fields–roots of polynomials–splitting fields.

Unit IV: Galois Theory (17 HOURS)

More about roots – simple extension– separable extension–fixed fields– symmetric rational functions– normal extension –Galois group– fundamental theorem of Galois theory.

UNITV: Solvability by radicals (20 HOURS)

Solvable group – the commutator subgroup – Solvability by radicals - finitefields - Wedderburn Theorem.

Text Book :

[1] I.N.Herstein, 'Topics in Algebra', Second Edition, Wiley Eastern Limited 2014.
Unit I - Chapter 2 Section 2.11 – 2.12
Unit II - Chapter 2 Section 2.13 – 2.14 & Chapter 3 Section 3.9
Unit III- Chapter 3 Section 3.10 & Chapter 5 Section 5.1, 5.3
Unit IV- Chapter 5 Section 5.5, 5.6
Unit V - Chapter 5 Section 5.7 & Chapter 7 Section 7.1

Reference Books:

1. **Modern Algebra**, Surjeet Singh, Quazizameeudui, Vikas Publishing House Pvt. Ltd.
2. **Contemporary Abstract Algebra**, Gallian, Narosa Publishing House, Fourth Edition,1999.

e - Resources:

1. https://www.math.stonybrook.edu/~aknapp/download/a2-alg-inside.pdf
2. http://www2.math.umd.edu/~jcohen/402/Pinter%20Algebra.pdf
3. https://nptel.ac.in/content/storage2/111/106/111106131/MP4/mod08lec39.mp4

Outcomes:

The learners would have the ability to,

CO1	Acquire knowledge on Sylow's Theorems.	K4
CO2	Apply the abelian group concept.	K3
CO3	Study the splitting field properties.	K2
CO4	Learn separable extensions in Galois Field.	K1
CO5	Understand the concept of solvability by radicals.	K2

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	1	3	3	3	3	3
CO2	3	2	3	3	2	3	3	1	3	3
CO3	3	2	3	3	2	3	3	2	3	1
CO4	3	1	3	3	3	3	3	3	3	2
CO5	3	3	3	3	3	3	3	3	3	2

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.7 which is **HIGH**

SEM: I	**M.Sc. MATHEMATICS**	**CORE COURSE: 2**
Credit: 5	**Real Analysis – I**	**Int. Marks: 25**
Hours/Week: 6	**CODE:P1R2MACC2**	**Ext. Marks: 75**
Total Hours: 90	**Skill Development**	**Max. Marks: 100**

Objectives

- *To deal primarily with limit and convergence*
- *To discuss vector valued functions and functions with values in an arbitrary metric space*
- *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: Limit and Convergence (20 HOURS)

Real number system and its order completeness - Sequences and series of real numbers : Sequences - convergence -subsequences -Cauchy sequences – Upper and Lower Limits- some special sequences –Tests of convergence- Absolute convergence-Rearrangements.

Unit II: Metric spaces (17 HOURS)

Basic concepts –continuous functions –completeness –Baire category Theorem –Contraction mapping Theorem.

Unit III: Connectedness (16 HOURS)

Limits of Functions – Continuous Functions – Continuity and Compactness – Continuity and Connectedness – Discontinuities – Monotonic functions – Infinite Limits and Limits at Infinity.

Unit IV: Differentiation (19 HOURS)

The Derivative of a real function – Mean Value Theorem – The Continuity of Derivatives – L' Hospital rule – Derivative of higher order – Taylor's theorem – Differentiation of Vector valued function

Unit V: Sequences and series of functions (18 HOURS)

Uniform convergence – power series – Weierstrass approximation theorem – Equi-continuity – Arzela -Ascoli theorem.

Text Books:

[1] "Principles of Mathematical Analysis", Walter Rudin - McGraw Hill Education, 3rd Edition, 2013.

[2] " Real Analysis", H.L. Royden, P.M. Fitzpatrick, PHI Learning Pvt. Ltd, 2010.

Unit I : Chapter 3 [1]
Unit II: Chapter 9 – 9.1 to 9.5 [2]
Unit III: Chapter 4[1]
Unit IV: Chapter 5 [1]
Unit V: Chapter 7 [1]

Reference Books:

1. **Mathematical Analysis**, T.M. Apostol, Narosa Publ. House, New Delhi, 1985.
2. **Real Analysis,** H.L. Royden, Macmillan Publ. Co. Inc. 4th edition, New York, 1993.
3. **Mathematical Analysis,** V. Ganapathy Iyer, Tata McGraw Hill, New Delhi, 1970.

e – Resources:

1. http://ramanujan.math.trinity.edu/wtrench/texts/TRENCH_REAL_ANALYSIS.PDF
2. https://s2pnd-matematika.fkip.unpatti.ac.id/wp-content/uploads/2019/03/Real-Analysis-4th-Ed-Royden.pdf
3. https://nptel.ac.in/courses/111/101/111101100/

Outcomes:

The learners would have the ability to,

CO1	Acquire knowledge on the metric spaces.	K4
CO2	Apply the Mean value theorems in a correct Mathematical way.	K3
CO3	Study cauchy's sequence, upper and lower limits of numerical sequences.	K2
CO4	Learn series, power series Absolute convergent and rearrangement.	K1
CO5	Understand continuity compactness and monotonic functions.	K2

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	1	3	3	3	2	3
CO2	3	3	3	2	3	3	3	2	3	3
CO3	3	3	3	3	2	3	3	2	3	3
CO4	3	2	3	1	3	3	3	1	2	3
CO5	3	3	3	1	3	3	3	3	1	3

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is **2.66** which is **HIGH**

SEM – I	**M.Sc. MATHEMATICS**	**CORE COURSE:3**
Hours/Week: 6	**Ordinary Differential Equations**	**Int. Marks: 25**
Credit : 5	**CODE:P1R2MACC3**	**Ext. Marks: 75**
Total Hours: 90	**Employability**	**Max. Marks: 100**

Objectives

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

Unit I: Linear equations with constant coefficients (16 HOURS)

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.) **(19 HOURS)**

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 (18 HOURS)

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 (17 HOURS)

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 first order equations (20 HOURS)

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.

Text Book:

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 10

Unit III: Chapter 3, section 1 to 8

Unit IV: Chapter 4, section 1 to 8

Unit V: Chapter 5, section 1 to 8

Reference Books:

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, New York, 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 2nd 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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	1	3	3	3	3	3	1	2	3
CO2	3	2	2	3	1	3	3	3	3	3
CO3	3	1	2	3	2	3	2	3	3	1
CO4	3	3	3	3	1	3	3	3	3	3
CO5	3	3	3	3	3	1	3	2	3	2

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.56 which is **HIGH**

SEM – I	**M.Sc. MATHEMATICS**	**CORE COURSE:4**
Hours/Week: 6	**Mechanics**	**Int. Marks: 25**
Credit : 5	**CODE:P1R2MACC4**	**Ext. Marks: 75**
Total Hours: 90	**Employability**	**Max. Marks: 100**

Objectives

- *To deals with some of the key ideas of classical mechanics*
- *To understand the concepts covered in the course include generalized coordinates, Lagrange's equations, Hamilton's equations and Hamilton - Jacobi theory*
- *To develop skills in formulating and solving physics problems*
- *To represent the equations of motion for complicated mechanical systems using the Lagrangian*
- *To study Hamiltonian formulations of classical mechanics*

Unit I: Introductory concepts (20 HOURS)

Mechanical system – generalized coordinates – constraints – virtual work – d'Alembert's principle – energy and momentum–equilibrium and stability–kinetic energy – angular momentum.

Unit II: Lagrange's equations (17 HOURS)

Derivation of Lagrange's equations for different conditions–Lagrange equations for some simple systems-integrals of motion–Routhian procedure–natural system–Liouville's system–small oscillations.

Unit III: Hamilton's equations (22 HOURS)

Stationary values- Hamilton's principle under different conditions–Hamilton's equations – the Legendre transformation–modified Hamilton's principle–principle of least action.

Unit IV: Hamilton - Jacobi theory (19 HOURS)

Hamilton's principle function –canonical integral–Pfaffian differential form–Hamilton-Jacobi equation–Jacobi's theorem –modified Hamilton-Jacobi equation–separability –Liouville's system Stackel's theorem.

Unit V: Canonical Transformations (12 HOURS)

Differential forms and generating functions – some simple, point and momentum transformations- Lagrange and Poisson brackets.

Text Book:

1. **Classical Mechanics**, D. T. Greenwood, Classical Dynamics, Prentice Hall of India Pvt. Ltd, New Delhi,1979.

Unit I: Chapter 1

Unit II: Chapter 2

Unit III: Chapter 4 section 4.1 to 4.3

Unit IV: Chapter 5

Unit V: Chapter 6 section 6.1 to 6.3

Reference Books:

1. **Classical Mechanics**, H.Goldstein,C.Poole & J.Safko, Pearson Education, New Delhi, 2002.
2. **Classical Mechanics**, N. C. Rane and P. S. C. Joag, Tata McGraw Hill, 1991.
3. **Principles of Mechanics**, J. L. Synge and B. A. Griffth, (3rd Edition) McGraw Hill Book Co., New York,1970.

e - Resources:

1. https://www.physics.rutgers.edu/~shapiro/507/book.pdf
2. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf
3. https://nptel.ac.in/courses/115/103/115103115/

Outcomes:

The learners would have the ability to,

CO1	Have a deep understanding of Mechanics of a system of practical and D'Alemberts principle.	K2
CO2	Solve the differential equation for the orbit.	K5
CO3	Be familiar with Kepler problem used in physics.	K4
CO4	Know about Euler's Equation on the notation of rigid body.	K2
CO5	Study about Routh procedure to derive Hamiltons Equations.	K2

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	1	2	3	3	3	3
CO2	3	3	3	3	2	3	3	1	3	2
CO3	1	1	2	3	1	1	3	1	3	2
CO4	2	2	2	3	2	2	3	3	3	1
CO5	3	3	1	3	1	3	3	3	3	3

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.4 which is **HIGH**

SEM – I	**M.Sc. MATHEMATICS**	**DSE Course:1:1**
Hours/Week: 6	**Elements of Stochastic Processes**	**Int. Marks: 25**
Credit : 4	**CODE:P1R2MADSEC1:1**	**Ext. Marks: 75**
Total Hours: 90	**Entrepreneurship**	**Max. Marks: 100**

Objectives:

- *To understand the notion of a Markov chain*
- *To understand how simple ideas of conditional probability can be used to give a thorough and effective account of discrete-time Markov chains*
- *To apply these ideas to answer basic questions in several applied situations including genetics, branching processes and random walks*
- *To develop skills in analysing and interpreting the results*
- *To discuss steady state Transient behaviour of M/M/1 model*

Unit I: Stochastic Processes (22 HOURS)

Introduction – Specification of Stochastic processes – Stationary Processes – stationary – Gaussian processes - Markov Chains – Definitions and Examples – Higher Transition Probabilities – Generalization of Independent Bernoulli trails – Sequence of Chain – Dependent trails.

Unit II :Classification of states and chains (19 HOURS)

Communication relations – class property – classification of chains – transient and Persistent (recurrent) states – related theorems - Determination of Higher Transition Probabilities – Stability of a Markov system – Stationary distribution – Theorem and problems.

Unit III : Markov Processes with Discrete State space (17 HOURS)

Poisson Process – Postulates for poison process – Theorems and problems – Properties of poisson process – Poisson processes and related distributions – Generalisation of poisson process – Time dependent poisson processes – Birth and death process.

Unit IV: Renewal Processes and Theory (18 HOURS)

Renewal Process in discrete time – Relation between F(s) and P(s) - Renewal Processes in continuous time – Renewal equation – Stopping time – Wald's equation – Renewal theorems.

Unit V**: Stochastic Processes in Queuing (14 HOURS)**

Queuing systems: General concepts – Queueing processes – steady state distribution – Little's formula – The Queueing model M/M/1: study state behaviour – steady state solution – waiting time distributions – Transient behaviour of M/M/1 model.

Text Books:

1. **Stochastic Processes**, J.Medhi, , Second edition, 1994 - Wiley Eastern limited, Chennai.

Unit I - Chapter 2, Sec 2.1 – 2.3 & Chapter 3, Sec 3.1 – 3.3
Unit II - Chapter 3, Sec 3.4 – 3.6, 3.8 – 3.11
Unit III- Chapter 4, Sec 4.1 – 4.4
Unit IV- Chapter 6. Sec 1 - 6.5
Unit V - Chapter, Sec 10.1 – 10.3.

Reference Books:

1. **A First course in Stochastic Processes,** Samuel Kolri ,Howard M.Taylor ,2nd Edition.
2. **Stochastic Processes**, Srinivasan and Medha, N.V Prabhu , Macmillan New York.

e – Resources:

1. https://nptel.ac.in/courses/111/102/111102014/#
2. http://home.ustc.edu.cn/~alex2014/SPpdf/Stochastic%20Processes%20SM.pdf
3. https://web.ma.utexas.edu/users/gordanz/notes/introduction_to_stochastic_processes.pdf

Outcomes:

The learners would have the ability to,

CO1	*Acquire the knowledge of stochastic process, transition probabilities.*	K2
CO2	*Understand transient and persistent state , stability of a Markov system.*	K3
CO3	*Be familiar with Poisson process – Birth and death process.*	K1
CO4	*Know about renewal process and renewal theorem.*	K4
CO5	*Study about Queuing system – M/M/1: steady state behavior.*	K4

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	1	3	3	3	2	3
CO2	3	3	3	2	3	3	3	2	3	3
CO3	3	3	3	3	2	3	3	2	3	3
CO4	3	2	3	1	3	3	3	1	2	3
CO5	3	3	3	1	3	3	3	3	1	3

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is **2.66** which is **HIGH**

SEM: I	**M.Sc. MATHEMATICS**	**DSE Course:1:2**
Hours/Week: 6	**Ethical Attitude in Mathematical Research**	**Int. Marks: 25**
Credit: 4		
	CODE: P1R2MADSEC1:2	**Ext. Marks: 75**
Total Hours: 90	**Skill Development**	**Max.Marks: 100**

Objectives :

- *To provide systematic structure*
- *To enhance the Research Quality*
- *To find a solution to Theoretical and Practical problems*
- *To gain familiarity with a phenomena*
- *To verify and test existing facts and theory*

Unit I : An Introduction (15 HOURS)

Meaning of Research - Objectives of Research - Motivation in Research - Types of Research - Research Approaches - Significance of Research – Research Methods versus Methodology - Research and Scientific Method - Importance of knowing How Research is Done – Research Process - Criteria of Good Research - Problems Encountered by Researchers in India Defining the Research problem :Selecting the Problem - Necessity of Defining the Problem - Technique involved in defining a problem.

Unit-II : Research and Sampling Design (18 HOURS)

Meaning of Research Design - Need for Research Design - Features of a Good Design - Important Concepts Relating to Research Design - Different Research Designs - Basic Principles of Experimental Designs – Design of Sample Survey: Introduction – Sample Design – Sampling and Non Sampling Errors - Census and sample survey - Types of sample Designs.

Unit III: Measurement and scaling Techniques (17 HOURS)

Quantitative and Qualitative Data – Classification of Measurement Scale – Goodness of Measurement scale - Sources of Error in Measurement - Technique of Developing Measurement Tools - scaling - scale classification Bases - scaling Techniques – Multidimensional Scaling – Deciding the Scale.

Unit IV: Method of data collection (20 HOURS)

Introduction – Experiments and Surveys - Collection of primary data – Collection of secondary Data - Selection of Appropriate Method for data collection - case study method.

Unit V: Interpretation and Report writing (20 HOURS)

Meaning of Interpretation - Technique of Interpretation - Precaution in interpretation - Significance of Report writing - Difference steps in Writing Report -Layout of the Research Report - Types of Reports – Oral Presentation - Mechanics of Writing a Research Report - Precautions for Writing Research Reports - Conclusion.

Text Book:

1. **Research Methodology** (second Revised Edition), C.R.Kothari ; New Age Publishers, 3rd edition, 2014.

Unit I : Chapter 1 & Chapter 2, Section 2.1 to 2.4
Unit II : Chapter 3, Section 3.1 to 3.6 & Chapter 4, Section 4.1 to 4.5
Unit III : Chapter 5
Unit IV : Chapter 6
Unit V : Chapter 19

Reference Books:

1. Research Methodology, R. Pannerselvam, PHI Publications, 7th edition, 2009.

2. **Fundamental of Research Methodology and Statistics**, Y.K. Singh, New Age International Publishers, 2006.

e – Resources:

1. **https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=8547&context=libphilprac**
2. **https://www.academia.edu/34065815/In_Search_of_Defining_Ethics_in_Mathematics_Education_Research_Editorial_**

Outcomes:

The learners would have the ability to,

CO1	Organize, co-ordinate and focus the research aptitude with confidence	K3
CO2	Improve the concepts of Research Design	K5
CO3	Select appropriate method for data collection	K5
CO4	Collect and Analyze data to support Business for Decision Making Process	K4
CO5	Create suitable mechanics for report writing	K3

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	1	2	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	2
CO3	1	1	2	3	1	2	3	3	3	2
CO4	2	2	2	3	2	1	3	1	3	1
CO5	3	3	1	3	1	3	3	1	3	3

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.4 which is **HIGH**

SEM – II	**M.Sc. MATHEMATICS**	**CORE COURSE:5**
Hours/Week: 6	**Linear Algebra**	**Int. Marks: 25**
Credit : 6	**CODE: P2R2MACC5**	**Ext. Marks: 75**
Total Hours: 90	**Skill Development**	**Max. Marks: 100**

Objectives:

- *To develop mathematical maturity and ability on vector spaces*
- *To study algebraic structure of a linear transformation*
- *To diagonalize the transformations*
- *To educate advanced level of ideals*
- *To be better equipped in Jordan forms of various transformations*

Unit I: Linear Transformations (20 HOURS)

Linear transformations – Isomorphism of vector spaces–Representations of linear transformations by matrices – Linear functionals.

Unit II: Algebra of polynomials (12 HOURS)

The algebra of polynomials – Polynomial ideals-The prime factorization of a polynomial – Determinant functions.

Unit III: Determinants (22 HOURS)

Permutations and the uniqueness of determinants – Classical adjoint of a (square) matrix – Inverse of an invertible matrix using determinants – Characteristic values–Annihilating polynomials.

Unit IV: Diagonalization (17 HOURS)

Invariant subspaces – Simultaneous triangulations – Simultaneous diagonalization – Direct - sum decompositions – Invariant direct sums–Primary decomposition theorem.

Unit V: The Rational and Jordan forms (19 HOURS)

Cyclic subspaces – Cyclic decompositions theorem (Statement only) – Generalized Cayley – Hamilton theorem – Rational forms–Jordan forms.

Text Book :

[1] **Linear Algebra**, Kenneth M. Hoffman and Ray Kunze, 2nd Edition, Prentice – Hall of India Pvt. Ltd, New Delhi, 2013.

Unit I - Chapter 3 Section 3.1 – 3.5
Unit II - Chapter 4 Section 4.1, 4.2, 4.4, 4.5 & Chapter 5 Section 5.1, 5.2
Unit III- Chapter 5 Section 5.3 & Chapter 6 Section 6.1 - 6.3
Unit IV- Chapter 6 Section 6.4 – 6.8
Unit V - Chapter 7 Section 7.1 – 7.3

Reference Books:

1. **Algebra,** M. Artin, Prentice Hall of India Pvt. Ltd., 2005.
2. **Linear Algebra**, S. H. Friedberg, A. J. Insel and L. Espence, 4th Edition, Pritice – Hall of India Pvt. Ltd., 2009.

3. **Topics in Algebra,** I.N. Herstein, 2nd Edition, Wiley Eastern Ltd, New Delhi, 2013.
4. **Advanced Modern Algebra**, J.J. Rotman, 2nd Edition, Graduate Studies in Mathematics, Vol. 114, AMS, Providence, Rhode Island, 2010.

e - Resources:

1. https://joshua.smcvt.edu/linearalgebra/book.pdf

2. https://open.umn.edu/opentextbooks/textbooks/13

3. https://nptel.ac.in/courses/111/106/111106051/

Outcomes:

The learners would have the ability to,

CO1	Have a deep understanding of vector spaces.	K2
CO2	Understand the concept of Extension field, Splitting field and Root field.	K2
CO3	Explain the notion of Permutations.	K5
CO4	Describe the structure of modules.	K4
CO5	Apply the concept of the Decomposition and Nilpotent transformations.	K3

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	3	1	3	3	3	3	3	1
CO2	3	3	3	2	1	2	3	2	3	3
CO3	3	2	3	3	2	3	3	2	3	1
CO4	3	3	2	1	2	3	1	1	3	2
CO5	2	3	3	1	2	3	3	3	2	3

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.8 which is **HIGH**

SEM – II	**M.Sc. MATHEMATICS**	**CORECOURSE:6**
Hrs/Week: 6	**Real Analysis – II**	**Int. Marks: 25**
Credit : 5	**Code: P2R2MACC6**	**Ext. Marks: 75**
Total Hrs: 90	**Skill Development**	**Max. Marks:100**

Objectives:

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

Unit I: **Functions of bounded variation** **(19 HOURS)**

Introduction – properties of monotonic functions–Functions of bounded variation – Total variation – Additive property of total variation–Total variation of [a, x] as a function of x – function of bounded variation expressed as the difference of two increasing functions. Riemann – Stieltjes Integral: Definition and Existence – Properties – Integration and Differentiation–Integration of vector valued functions – Rectifiable curves.

Unit II: **Functions of several variables** **(12 HOURS)**

Linear transformation – Differentiation – The inverse function theorem – The implicit function theorem.

Unit III: Reimann- Stieltjes integral **(17 HOURS)**

Definition and existence of the Integral – Properties of the Integral – Integration and Differentiation- Integration of vector – valued Functions.

Unit IV: Sequences and Series of functions **(22 HOURS)**

Discussion of main problem – Uniform convergence – Uniform convergence and Continuity – Uniform convergence and Integration – Uniform convergence and Differentiation - Equi-continuous families of functions – The Stone-Wierstrass theorem.

Unit V: Some Special Functions **(20 HOURS)**

Power series – The Exponential and Logarithmic Functions – The Trigonometric Functions – The Algebraic Completeness of the Complex Field – Fourier Series – The Gamma Function.

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Text Books:

1. **Principles of Mathematical Analysis**, Walter Rudin, McGraw Hill, Third Edition,2014.
2. **Mathematical Analysis**, Tom P. Apostal, Narosa Publishing House, Delhi, 2002.

Unit I: Chapter 6 Section 6.1 to 6.10 [2]

Unit II: Chapter 9 Page No. 204 to 230 [1]

Unit III: Chapter 6- Sec 6.1 to 6.25 [1]

Unit IV: Chapter 7 - Sec 7.1 to 7.27 [1]

Unit V: Chapter 8 - Sec 8.1 to 8.22 [1]

Reference Books:

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.

e - Resources:

1. **https://s2pnd-matematika.fkip.unpatti.ac.id/wp-content/uploads/2019/03/Real-Analysis-4th-Ed-Royden.pdf**
2. **http://www.freebookcentre.net/Mathematics/Real-Analysis-Books.html**
3. https://nptel.ac.in/courses/111/101/111101100/

Outcomes:

The learners would have the ability to,

CO1	Evaluate the proof techniques in Analysis.	K5
CO2	Acquire knowledge on Differentiations and Integrations.	K2
CO3	Prepare for the advanced courses like Functional Analysis and Advanced Analysis.	K3
CO4	Create the measurable functions.	K6
CO5	Remember the convergence theorem.	K4

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	1	2	3	3	3	3	1
CO2	2	3	3	2	1	3	2	2	3	3
CO3	3	2	3	1	2	2	3	1	3	2
CO4	3	3	2	1	1	2	3	2	2	3
CO5	3	2	3	1	1	1	3	1	3	2

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.24 which is **HIGH**

SEM – II	**M.Sc. MATHEMATICS**	**CORECOURSE:7**
Hrs/Week: 6	**Partial Differential Equations**	**Int.Marks: 25**
Credit : 5	**Code: P2R2MACC7**	**Ext.Marks: 75**
Total Hrs: 90	**Employability**	**Max.Marks:100**

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 of solutions*
- *To use the Laplace transform to compute solutions of equations involving impulse functions*
- *To find solutions of the Boundary value problems*
- *To obtain the solution of heat equation and wave equation subject to boundary conditions*

Unit I: Partial Differential Equations of the First Order (17 HOURS)

Partial Differential Equations – Origins of First Order Differential Equations – Cauchy's Problem for first order equations – Linear Equations of the first order – Non linear partial differential equations of the first order – Cauchy's method of characteristics – Compatible system of First order Equations – Solutions satisfying Given Condition, Jacobi's method

Unit II: Partial Differential Equations of the 2nd Order (22 HOURS)

The Origin of Second Order Equations– Linear partial Differential Equations with constant coefficients – Equations with variable coefficients–Separation of variables – The method of Integral Transforms –Non – linear equations of the second order.

Unit III: Laplace's Equation (19 HOURS)

Elementary solutions of Laplace equation–Families of Equipotential Surfaces – Boundary value problems – Separation of variables – Problems With Axial Symmetry–The Theory of Green's Function for Laplace Equation.

Unit IV: The Wave Equation (20 HOURS)

The Occurrence of the wave equation in Physics–Elementary Solutions of the One – dimensional Wave equations – Vibrating membrane - Application of the calculus of variations – Three dimensional problem –General solutions of the Wave equation.

Unit V: The Diffusion Equation (12 HOURS)

Elementary Solutions of the Diffusion Equation – Separation of variables – The use of Integral Transforms–The use of Green's functions.

Text Book:

Unit I: Chapter 2: Sections 1 to 4 & 7 to 9 & 12, 13

Unit II: Chapter 3 : Sections 1, 4, 5, 9 to 11

Unit III: Chapter 4 Sections 2 to 6, 8

Unit IV: Chapter 5: Sections 1, 2, 4 to 6

Unit V: Chapter 6 : Sections 3 to 6.

Reference Books:

1. **Elements of Partial Differential Equations**, Ian Sneddon, McGraw Hill International Book Company, New Delhi,1983
2. **An Elementary Course in Partial Differential equations,** T.Amarnath, Narosa, 1997.
3. **Elements of Partial Differential Equations**, Sneddon, McGraw Hill, New York.
4. **Partial Differential Equations**, P. Prasad and R. Ravindran, Wiley Eastern, New Delhi.

e - Resources:

1. **https://s2pnd-matematika.fkip.unpatti.ac.id/wp-content/uploads/2019/03/Walter-A-Strauss-Partial-differential-equations-_-an-introduction-Wiley-2009.pdf**
2. **http://www.math.toronto.edu/ivrii/PDE-textbook/PDE-textbook.pdf**
3. **https://www.math.uni-leipzig.de/~miersemann/pdebook.pdf**
4. **https://youtu.be/oSoqGs-ZMmk**

Outcomes:

The learners would have the ability to,

CO1	Create first order linear differential equations using charpit's method & Jacobi's Method.	K6
CO2	Remember the quasi linear equations and non linear first order PDE.	K1
CO3	Acquire knowledge to solve second order PDE.	K3
CO4	Understand the Laplace transform to compute solutions of equations involving impulse functions.	K2
CO5	Learn about Duhamel's principle and wave and heat conduction equation.	K4

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	2	3	1	3	3	3	2	3
CO2	3	2	3	3	1	3	2	3	3	1
CO3	2	1	3	3	2	3	3	3	3	1
CO4	3	2	1	3	2	1	3	1	3	2
CO5	3	1	3	3	2	2	3	3	2	3

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.4 which is **HIGH**

SEM – II	**M.Sc. MATHEMATICS**	**CORE COURSE:8**
Hours/Week: 6	**TOPOLOGY**	**Int. Marks: 25**
Credit : 5	**CODE:P2R2MACC8**	**Ext. Marks: 75**
Total Hours: 90	**Entrepreneurship**	**Max. Marks: 100**

Objectives:

- *To develop the Topological spaces including connectedness and compactness*
- *To apply the continuous functions on the topological spaces and study their homeomorphisms*
- *To study regular second countable spaces which are metrizable*
- *To be familiar with compactness*
- *To understand countability axioms and normal spaces*

Unit I: Topological Spaces (22 HOURS)

Types of Topological Spaces and Examples –Basics for a topology - The order topology -The product topology on X x Y - The subspace topology-Closed sets and limits points.

Unit II: Continuous Functions (13 HOURS)

Continuous functions - The Product Topology - The metric topology - Sequence lemma-Uniform limit theorem- Connected spaces - Connected subspaces of the real line-Components and Local connectedness.

Unit III: Compactness and Complete Metric Spaces (15 HOURS)

Compact spaces - Compact subspaces of the real line –Uniform continuity theorem - Limit Point Compactness – complete metric spaces –compactness in metric spaces.

Unit IV: Countability and Separation Axioms (20 HOURS)

First and Second countable spaces - Lindeloff and Separable spaces- Countability axioms - The separation axioms - Normal spaces –The Uryshon's lemma.

Unit V: Tychonoff Theorem (20 HOURS)

The Urysohn Metrization Theorem - Tietze Extension Theorem –The Tychonoff theorem – Stone Cech compactifications.

Text Book:

1. **Topology**, James R. Munkres, Pearson Education Pvt. Ltd. II Edition. (2002)

Unit I: Chapter 2, Sec 12 to 17
Unit II: Chapter 2, Sec 18 to 25
Unit III: Chapter 3, Sec 26 to 28 & Chapter 7, Sec 43, 45.
Unit IV: Chapter 4, Sec 30 to 33
Unit V: Chapter 4, Sec 34 to 36 & Chapter 5.

Reference Books:

1.**Topology**, J. Dugunji, Prentice Hall of India, 1966.

2.**Introduction to Topology and Modern Analysis**, George F. Simmons, McGraw Hill Book co.,1963.

3.**General Topology**, J. C. Kelly, Van Nostrand, Reinhold Co., Newyork, 1955.

e - Resources:

1. https://www.maths.ed.ac.uk/~v1ranick/papers/seifthreng.pdf
2. https://www.math.colostate.edu/~renzo/teaching/Topology10/Notes.pdf
3. https://onlinecourses.nptel.ac.in/noc22_ma25/preview
4. https://onlinecourses.nptel.ac.in/noc22_ma36/preview

Outcomes:

The learners would have the ability to,

CO1	the knowledge of fundamental concepts and methods in general topology.	K5
CO2	Acquire knowledge about product topology and metric topology .	K2
CO3	Know about connectedness and intermediate theorem.	K2
CO4	Study about compactness-extreme value theorem and uniform continuity theorem.	K2
CO5	Learn about normal spaces and Tietz extension theorem.	K4

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	3	3	2	3	2	3
CO2	3	3	2	3	2	3	1	3	3	3
CO3	3	3	3	2	2	3	1	3	3	2
CO4	3	2	3	3	1	1	3	2	3	2
CO5	1	2	3	3	1	3	3	3	3	3

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.52 which is **HIGH**

SEM: II	**M.Sc. MATHEMATICS**	**GE Course:1:1P**
Credit: 2	**Programming in C++**	**Hours/Week: 6**
Max. Marks: 100	**CODE: P2R2CAGE1:1P**	**Int. Marks: 40**
Total Hours: 90	**Employability**	**Ext. Marks: 60**

Objectives

- *To gain Basic knowledge in C++ Programming such as Tokens, Expressions, Control Structure, Classes and Objects*
- *To solve problems in C++ using different numerical methods*
- *To make the mathematical calculations simpler*
- *To give the awareness of the object oriented programming*
- *To make applications using C++ programs*

LIST OF PRACTICALS

1. Write a class to represent a vector (a series of float values). Include member functions to perform the following tasks: To create the vector, To modify the value of a given element, To multiply by a scalar value, To display the vector in the form (10, 20, 30,…). Write a program to test your class.
2. Create a class FLOAT that contains one float data member. Overload all the four arithmetic operators so that they operate on the objects of FLOAT.
3. Write a program which shows the days from the start of year to date specified. Hold the number of days for each month in an array. Allow the user to enter the month and the day of the year. Then the program should display the total days till the day.
4. Write a program to include all possible binary operator overloading using friend function.
5. Write a program to read an array of integer numbers and sort it in descending order. Use readdata, putdata, and arraymax as member functions in a class.
6. Write a program to read two character strings and use the overloaded '+' operator to append the second string to the first.
7. Develop a program Railway Reservation System using Hybrid Inheritance and Virtual Function.
8. Using overloaded constructor in a class write a program to add two complex numbers.
9. Create a class MAT of size (m, n). Define all possible matrix operations for MAT type objects.
10. Write a program that determines whether a given number is a prime number or not and then prints the result using polymorphism.
11. Write a program to illustrate the dynamic initialization of constructors.
12. Write a program to illustrate the use of pointers to objects.
13. Write a program to illustrate how to construct a matrix of size m x n.
14. Write a program to arrange the given data in ascending / descending order using various sorting algorithms.
15. Write a program to find the biggest /smallest number in the given data using various search algorithms.

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.

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

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	1	3	3	3	3	3
CO2	3	2	3	3	2	3	3	1	3	3
CO3	3	2	3	3	2	3	3	2	3	1
CO4	3	1	3	3	3	3	3	3	3	2
CO5	3	3	3	3	3	3	3	3	3	2

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.7 which is **HIGH**

SEM: II	**M.Sc. MATHEMATICS**	**G E Course: 1:2P**
Credit:2	**Python Programming**	**Hours/Week: 6**
Max. Marks:100	**Code: P2R2CAGE1:2P**	**Int. Marks: 40**
Total Hours: 90	**Employability**	**Ext. Marks: 60**

Objectives:

- *To build basic program using fundamental programming concepts*
- *To work with user input*
- *To create an interactive program*
- *To system automation and administration*
- *To development web design program*

LIST OF PRACTICALS

1. Write a Program to demonstrate the use of integer types and operators that can be used on them.
2. Write a program to demonstrate the use of float, complex and bool types and operators that can be used on them.
3. Write a program to demonstrate how to convert from one number type to another.
4. Write a program that makes use of built-in mathematical function and functions in the math module.
5. Write a program that generates float and integer random numbers.
6. Write a program that demonstrates how to create simple and multi-line strings and whether a string can change after creation.
7. For a given string "bamboozled", write a program to obtain the desired output that use multiple ways.
8. Form the given string write a program that find out which are having only alphabets, numeric, alpha numeric, lowercase and uppercase.
9. Write a program to produce the desired output using appropriate string functions.
10. While purchasing certain items, a discount of 10% is offered if the quantity purchased is more than 1000. If quantity and price item are input through the keyboard, write the program to calculate the total expenses.
11. In a company an employee is paid as under:
    If his basic salary is less than Rs.1500, then HRA=10% of basic salary and DA=90% of basic salary. If his salary is either equal to or above Rs.1500, then HRA=Rs.500 and DA=98% of basic salary. If the employees' salary is input through the keyboard. Write a Program to find his gross salary.
12. Write a program to calculate division obtained by the student if the percentage marks are input through the keyboard.
13. Write a program to determine whether the driver should be insured or not according to the company rules.
14. Write a program that receives 3 sets of values of p, n and r and calculate simple interest for each.
15. Write a program that prints numbers from 1 to 10 using an infinite loop. All numbers should get printed in the same line.
16. Write a program that prints all unique combinations of 1, 2 and 3.
17. Write a program that obtains decimal value of a binary numeric string. For example, decimal value of " 1111" is 15.
18. Write a program that receives an integer and determines whether it is prime number or not.

19. Write a Program that generates the output of alphabets both in order and reverse order using for loop.
20. Suppose there are four flag variables w, x, y, z. Write a program to check in multiple ways whether one of them is true.

Text Book:

[1] **"Let us Python",** Yashavant Kanetkar, Aditya Kanetkar, BPB Publications, New Delhi, India, 2019.

1. Page No. 11
2. Page No. 12
3. Page No. 13
4. Page No. 15
5. Page No. 17
6. Page No. 22
7. Page No. 24
8. Page No. 25
9. Page No. 27
10. Page No. 35
11. Page No. 35
12. Page No. 36
13. Page No. 37
14. Page No. 37
15. Page No. 38
16. Page No. 39
17. Page No. 40
18. Page No. 40
19. Page No. 40
20. Page No. 41

Reference Books:

[1] **"Problem solving and programming with Python"**, Reema Thareja, Second Edition, Oxford University Press, 2021.

[2] **"Problem Solving and Python Programming"** K. Nageswara Rao, Shaik Akbar, Immadi Murali Krishna, Scitech Publications, India, 2018.

e- Resources:

1. https://www.tutorialsduniya.com/notes/python-notes/
2. https://www.guru99.com/python-tutorial.html

Outcomes:

The Learners would have the ability to,

CO1	Use Indexing and Slicing to access data in Python.	K1
CO2	Design and Program Python object types.	K5
CO3	Write Functions and pass arguments in Python.	K6
CO4	Build and Package Python modules for reusability.	K3
CO5	Learn Lists, Tuples and Dictionaries in Python programs.	K2

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome(CO)	**Programme Outcomes(PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	3	2	1	2	3	3	3	2
CO2	3	2	1	3	2	3	2	3	2	2
CO3	1	2	2	1	3	3	3	2	3	3
CO4	2	3	3	2	3	2	3	2	2	2
CO5	2	3	3	2	3	2	2	3	2	1

3-Strong; 2-Medium;1-Low

Mean Overall Relationship is 2.34 which is **HIGH**.

SEM – III	**M.Sc. MATHEMATICS**	**CORE COURSE:9**
Hours/Week: 6	**Complex Analysis**	**Int. Marks: 25**
Credit : 6	**Code:P3R2MACC9**	**Ext. Marks: 75**
Total Hours: 90	**Skill Development**	**Max. Marks: 100**

Objectives:

- *To understand the concepts of Analytical function*
- *Apply cauchy's integral formula to evaluate complex line integrals*
- *Expand functions in Taylor's and Weirstrass theorems*
- *Apply the Residue theorem to evaluate real integrals*
- *To use the two dimension Laplace's equation in Cartesian or polar co-ordinates to determine whether a real valued is harmonic or not*

Unit I: Complex functions (13 HOURS)

Introduction to the concept of Analytical function – Elementary theory of Power series – The exponential and Trigonometric Functions.

Unit II: Fundamental Theorems and Cauchy's Integral Formula (22 HOURS)

Line Integrals- Rectifiable Arc's – Line Integrals as Functions of Arcs-Cauchy's Theorem for a Rectangle – Cauchy's Theorem in a Disk – The Index of a point with respect to a closed curve – The Integral Formula –Higher Derivatives.

Unit III: Local Properties of Analytic Functions (15 HOURS)

Removable singularities, Taylor's Theorem – Zeros and Poles – Weirstrass Theorem – The Local Mapping-The Maximum Principle – Schwartz Lemma.

Unit IV: General Form of Cauchy's Theorem and the Calculus of Residues (20 HOURS)

Chains and Cycles – Simple Connectivity – Locally Exact Differentials-Multiply Connected Regions – The Residue Theorems – The Argument Principle – Evaluation of Definite Integrals.

Unit V: Harmonic Function (20 HOURS)

Definition and Basic Properties – Interpretation – The Mean Value Property – Maximum Principle – Poisson's Formula-Schwarz's Theorem – The Reflection Principle.

Text Book:

[1]"Complex Analysis", Lars V.Ahlfors, III edition McGraw Hills Education(India) 2013.
Unit I : Chapter 2 – All sections
Unit II : Chapter 4- Sec 1(1.1 to 1.5),Sec2 (2.1 to 2.3)
Unit III : Chapter 4- Sec 3(3.1 to 3.4)
Unit IV : Chapter 4- Sec 4(4.1,4.2,4.6 and 4.7) and Sec 5(5.1 to 5.3)
Unit V : Chapter 4- Sec 6(6.1 to 6.5)

Reference Books:

1. **Complex Analysis**, Sarge Lang, Addision Weslay, 1977.
2. **Foundations of Complex Analysis**, S.Ponnusamy, Narosa Publishing House, New Delhi.

e – Resources:

1. https://www.oulu.fi/sites/default/files/151/complex_book.pdf

2. https://www.fing.edu.uy/~cerminar/Complex_Analysis.pdf

3. https://www.iitg.ac.in/physics/fac/charu/courses/ph503/book.pdf

4. https://nptel.ac.in/courses/111/103/111103070/

Outcomes:

The learners would have the ability to,

CO1	Recognize the concept of Analytical function.	K1
CO2	Study cauchy's theorem for a rectangle in a disk.	K2
CO3	Use Taylor's theorem and the maximum principle.	K3
CO4	Have a deep understanding of Residues to evaluate definite integrals.	K2
CO5	Know about Schwarz's theorem and reflection principle.	K4

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	2	1	2	1	3	3	2	3
CO2	3	3	3	2	2	2	3	2	3	2
CO3	2	2	3	1	2	3	2	3	2	1
CO4	3	3	3	2	1	3	2	3	3	1
CO5	3	2	3	1	1	3	3	2	3	3

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.34 which is **HIGH**

SEM – III	**M.Sc. MATHEMATICS**	**CORE COURSE:10**
Hours/Week: 6	**Optimization Techniques**	**Int. Marks: 25**
Credit : 5	**Code:P3R2MACC10**	**Ext. Marks: 75**
Total Hours: 90	**Employability**	**Max. Marks: 100**

Objectives:

- *To describe the need and importance of Operations Research*
- *To discuss the basic concepts and techniques for solving particular Operations Research problem*
- *To develop a research proposal using the general approach for Operations Research*
- *To maximize the utility of limited resources*
- *To Characterize the Queueing System*

Unit I: Integer Programming (22 HOURS)

Introduction – Pure and Mixed Integer Programming Problems - Gomory's ALL I.P.P. Method - Construction of Gomory's Constraints – Fractional cut method - All Integer LPP– Mixed Integer LPP – Branch–and–Bound Technique.

Unit II: Dynamic Programming (20 HOURS)

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

Unit III: Queuing Theory (20 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), Model–V(M/M/C):(∞/FIFO), Model–VI(M/M/C):(N/FIFO) - Problems in above four models.

Unit IV: Non-Linear Programming (13 Hours)

Introduction – Formulation a NLPP – General NLPP – Constrained Optimization with equality constraints – Constrained Optimization with inequality constraints Graphical Solution – Saddle point problem – Saddle points and NLPP.

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

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.

Text Book:

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

Unit I: Chapter 7, Section 7.1 to 7.7

Unit II: Chapter 13, Section 13.1 to 13.7

Unit III: Chapter 21, Sections 21.1 – 21.4, 21.7 – 21.9.

Unit IV: Chapter 27, Sections 27.1 – 21.7.

Unit V: Chapter 28, Sections 28.1 – 28.8.

Reference Books:

1. **Operations Research**, Hamdy A. Taha, (sixth edition) Prentice–Hallof India private Limited, New Delhi, 1997.
2. **Operations Research**, Panneerselvam. R, 2nd Edition, PHI Learning Private Limited, 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	Understand 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 Techniques.	K4

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	3	3	2	3	3	3
CO2	3	2	3	3	3	3	2	1	3	3
CO3	3	1	2	3	2	3	3	3	1	3
CO4	3	1	3	3	3	2	1	3	3	3
CO5	3	3	3	2	3	3	3	3	3	1

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.6 which is **HIGH**

SEM – III	**M.Sc. MATHEMATICS**	**CORE COURSE: 11**
Hours/Week: 6	**Mathematical Statistics**	**Int. Marks: 25**
Credit : 5	**Code:P3R2MACC11**	**Ext. Marks: 75**
Total Hours: 90	**Employability**	**Max.Marks: 100**

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 of adequate statistical techniques*
- *To compute analysis data generated by functional experiments by using analysis of variance*

Unit I: Correlation and Regression (20 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 (21 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 (22 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 (12 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/cjTgvRUaD1s

Outcomes:

The learners would have the ability to,

CO1	Acquire the knowledge of multiple and partial correlation.	K1
CO2	Analyze the Theory of Estimation and methods of estimating a parameter through sampling and test their Goodness.	K4
CO3	Study the advantages and drawbacks of Non – parametric method and test for randomness.	K3
CO4	Demonstrate the ability to use the methods of statistical process control.	K5
CO5	Know about analysis of one way and two way classifications.	K4

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	3	3	2	3	3	3
CO2	3	2	3	3	3	3	2	1	3	3
CO3	3	1	2	3	2	3	2	3	1	2
CO4	3	1	3	3	3	2	1	3	3	3
CO5	3	1	3	2	3	3	3	3	3	1

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.56 which is **HIGH**

SEM – III	**M.Sc. MATHEMATICS**	**Core Course: 12**
Hours/Week: 6	**Measure Theory and Integration**	**Int. Marks: 25**
Credit : 5	**Code: P3R2MACC12**	**Ext. Marks: 75**
Total Hours: 90	**Skill Development**	**Max. Marks: 100**

Objectives:

- *To understand the concept of Measure Theory, Definitions and Main Properties of the Integral.*
- *To construct Lebegsue's Measure on a Real line and in n – dimension Euclidean Space.*
- *To overcome the limitation using more abstract space.*
- *To provide a concise introduction to Measure Theory in the context of Abstract Algebra.*
- *To Focus on the Development of Measure and Integration Theory.*

Unit I : Measure on Real Line **(19 Hours)**

Lebesgue outer measure – Measurable sets – Regularity – Measurable Functions – Borel and Lebesgue Measurability.

Unit II : Integration of Functions of a Real Variable **(20 Hours)**

Integration of non-negative functions – The General Integral - Integration of Series – Riemann and Lebesgue Integrals.

Unit III : Convergence **(20 Hours)**

Meaures and Outer Measures – Extension of a Convergence in Measure – Almost Uniform Convergence – Measure – Uniqueness of the Extension.

Unit IV : Signed Measures and their Derivatives **(18 Hours)**

Hahn Decomposition Theorem – The Jordan Decomposition – The Radon Nikodym Theorem.

Unit V : Measure & Integration in a Product Space **(13 Hours)**

Measurability in a product space – The Product Measure and Fubini's Theorem.

Text Book:

[1] "Measure Theory and Integration" by G. De. Barra – New Age International Private Ltd.

Unit I : Chapter 2, Sec 2.1 – 2.5
Unit II : Chapter 3, Sec 3.1 – 3.4
Unit III : Chapter 5, Sec 5.1 – 5.3 and
Chapter 7, Sec 7.1 – 7.2
Unit IV : Chapter 8, Sec 8.1 – 8.3
Unit V : Chapter 10, Sec 10.1 – 10.2

Reference Books:

[1] "An Introduction to Measure and Integration" – Inder, K. Ranna, Narosa Publishing House – New Delhi - 1997.

[2] "Lebesgue Measure and Integration" – P.K.Jain, V.P.Gupta – New Age International Pvt. Ltd – 2000

e - Resources:

1. https://nptel.ac.in/courses/111/101/111101100/
2. https://www.youtube.com/watch?v=Y5yEMXZnzYw

Outcomes:

The learners would have the ability to,

CO1	Understand the basis of measure theory.	K2
CO2	Study about Riemann and Lebesgue integrals.	K1
CO3	Acquire the knowledge on convergence in measure.	K5
CO4	Apply the Hahn decomposition theorem & Jordan decomposition theorem.	K3
CO5	Learn about measurability and Fubini's theorem.	K1

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	3	3	2	3	3	3
CO2	3	3	3	3	3	3	2	1	3	3
CO3	3	1	2	3	2	3	2	1	3	2
CO4	2	1	3	3	3	2	1	3	3	3
CO5	3	1	3	2	3	3	3	3	3	1

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.54 which is **HIGH.**

SEM – III	**M.Sc. MATHEMATICS**	**SE Course:1:1P**
Hours/Week: 6	**Programming in MATLAB**	**Int. Marks: 40**
Credit : 3	**Code:P3R2MASEC1:1P**	**Ext. Marks: 60**
Total Hours: 90	**Employability**	**Max. Marks: 100**

Objectives:

- *To apply Computer theory and algorithmic aspects in various situations*
- *To develop program skills independently themselves*
- *To understand the concept of transcendental and polynomial equations*
- *To know the eigen values and eigen vectors of matrices*
- *To study the techniques of Numerical Differentiation and Numerical Integration*

LIST OF PRACTICALS

1. MATLAB program involving matrix manipulation.
2. MATLAB program to find Eigen Values and Eigen Vectors
3. MATLAB program to solve a system of linear equations using matrix method.
4. MATLAB program to solve polynomial equation.
5. MATLAB program to draw two-dimensional plots.
6. MATLAB program to draw multiple plots.
7. MATLAB program to draw style options, legend command and sub plots.
8. MATLAB program to draw Three Dimensional plots.
9. MATLAB program to solve constrained optimization.
10. MATLAB program to solve Graphical LPP.
11. MATLAB program to solve Laplace Transform and Inverse Laplace Transform.
12. MATLAB program to solve partial Fractions expansion.
13. MATLAB program to solve transfer function representation
14. MATLAB program to solve Zeros, Poles and Pole – Zero map of a transfer function

TEXT BOOKS:

[1] **"**MATLAB and Its Applications in Engineering**"** By Raj Kumar Bansal, Ashok Kumar Goel, Manoj Kumar Sharma - Dorling Kindersely (India) Pvt. Ltd.,

[2] **"**Applied Numerical Methods using MATLAB**"** By Won Young Yang, Wenwu Cao, Tae – Sang Chung, John Morris, A John Wiley and sons Inc Publications

1. Sec: 3.7 - 3.10.3 [1], Page: 48 – 68
2. Sec: 8.1 [2], Page: 371 – 373
3. Sec: 2.3 [2], Page: 92
4. Sec: 4.1 – 4.11 [1], Page: 81 – 89.
5. Sec: 6.1 and 6.2[1], Page: 120 – 129.
6. Sec: 6.3[1] Page: 129 – 131
7. Sec: 6.4 – 6.6, Page: 132 – 135
8. Sec: 6.8.1 – 6.8.8, Page: 146 – 151
9. Sec: 7.3.2[2], Page: 352 – 355
10. Sec: 7.3.3[2], Page: 355 – 357
11. Sec: 11.2[1] Page: 265 – 266
12. Sec: 11.4[1], Page: 267 – 269

13. Sec: 11.5[1], Page: 270 – 271
14. Sec: 11.6[1], Page: 272

REFERENCE BOOKS:

1. **"MATLAB Programming",** Y. Kirani Singh, B. B. Chaudhuri, Prentice Hall of India, Pvt. Ltd., New Delhi, 2008.
2. "**Applied Numerical Methods with MATLAB**", Steven C Chapra, Tata McGraw – Hill Publishing Company Limited, New Delhi, 2007.

e – Resources:

1. http://www.ikiu.ac.ir/public-files/profiles/items/090ad_1410599906.pdf
2. https://perhuaman.files.wordpress.com/2014/07/metodos-numericos.pdf
3. http://www.math.iitb.ac.in/~baskar/book.pdf
4. https://youtu.be/i_VKsST3kkQ

Outcomes:

The learners would have the ability to,

CO1	*Understand the basic coding of MATLAB.*	K2
CO2	*Use MATLAB for interactive computations.*	K2
CO3	*Generate plots and export this for use in reports and presentations.*	K2
CO4	*Program Script using the MATLAB development environment.*	K1
CO5	*To design and debug the programs.*	K3

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	2	2	3	3	3	3	1
CO2	2	3	3	1	1	3	2	2	3	3
CO3	3	2	3	1	2	2	3	1	3	3
CO4	3	3	2	1	1	2	3	2	2	2
CO5	3	2	1	3	1	1	3	1	3	2

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.24 which is **HIGH**

SEM: III	**M.Sc. MATHEMATICS**	**SE Course: 1:2P**
Credit: 3	**Skills in LaTex**	**Int. Marks: 40**
Hours/Week: 6	**CODE: P3R2MASEC1:2P**	**Ext. Marks: 60**
Total Hours: 90	**Employability**	**Max. Marks: 100**

Objectives:

- *To Understand richness of Latex rather than using M.S word for documentation*
- *To learn the basic functions of Latex and 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*
- *Proficient in documentation using mathematical symbols, graphs and tables*

Unit 1: Introduction (18 HOURS)

Just what is LaTex? – Markup Languages – TEX and its offspring – How to use this book - Basics of a LaTex file – TEX processing Procedure.

Unit 2: Text, Symbols and Commands (19 HOURS)

Command names and arguments, Environments, Declarations, Lengths, Special Characters – Spaces and carriage returns, Quotation marks, Hyphens and dashes, Printing command characters, The date, Fine –tuning text – word Division.

Unit 3: Document Layout and Organization, Displayed Text (21 HOURS)

Document class, Page style, Parts of the document, Table of contents – Changing font –Centering and indenting - Lists – Generalized Lists.

Unit 4: Displayed Text (Continued) (15 HOURS)

Theorem – like Declarations – Tabulator Stops – Boxes – Tables - Printing literal text - Footnotes and marginal notes – Comments within Text.

Unit 5: Mathematical Formulae (17 HOURS)

Mathematical Environments - Main elements of math mode - Mathematical symbols – Additional elements - Fine–tuning mathematics.

Text Books:

1. **"A Guide to LATEX"**, Helmut Kopka and Patrick W. Daly, Third Edition, Addison – Wesley, London, 2004.

Unit I : Chapter 1
Unit II : Chapter 2
Unit III : Chapter 3 & Chapter 4, Sections 4.1 – 4.4
Unit IV: Chapter 4, Sections 4.5 – 4.11
Unit V : Chapter 5, Sections 5.1 – 5.5.

Reference Books:

1. Velusamy Kavitha and Mani Mallikarjunan, Fundamentals of Latex for Mathematicians, Physicists and Engineers, LAP LAMBERT Academy Publishing, Germany, 2013.
2. Kottwitz, S.(2011).*Latex Beginners Guide*. Packt publishing.
3. Lamport, L.(1994).*Latex: A document preparation system*. Addison Wesley Professional.
4. Mittelbach, F.(2007).*The Latex Graphics Companion* (2nd ed.). Addison-Wesley Professional.
5. Mittelbach, F., Goossens, M., Braams, J., Carlisle, D., Rowley, C.(2004).*The Latex Companion*. Addison-Wesley Professional.

e-Resources:

1. https://www.youtube.com/watch?v=Q4FozDTRE_4
2. https://www.youtube.com/watch?v=DvDO1mea1w0

Outcomes:

The learners would have the ability to,

CO1	Understand basic concepts of Text formatting and LaTex file	K2
CO2	Demonstrating command names and arguments, Special characters.	K3
CO3	Create document layout and displayed output	K6
CO4	Create Table, Printing Text, Foot notes and marginal notes	K6
CO5	Apply LaTex commands to mathematical formulae	K3

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	1	2	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	2
CO3	1	1	2	3	1	2	3	3	3	2
CO4	2	2	2	3	2	1	3	1	3	1
CO5	3	3	1	3	1	3	3	1	3	3

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.4 which is **HIGH**

SEM – IV	**M.Sc. MATHEMATICS**	**CORE COURSE:13**
Hours/Week: 6	**Functional Analysis**	**Int. Marks: 25**
Credit : 6	**Code:P4R2MACC13**	**Ext. Marks: 75**
Total Hours: 90	**Skill Development**	**Max. Marks: 100**

Objectives:

- *To understand the definition and fundamental properties of metric spaces, including the ideas of convergence, continuity, completeness, compactness and connectedness*
- *To understand the definition and fundamental properties of Hilbert spaces, and bounded linear maps between them*
- *To generalize the basic concepts of geometry and linear algebra can be generalized to infinite dimensional spaces*
- *To study Banach Algebras*
- *To study Picard's theorem and stone's theorem*

Unit I : Banach Spaces (19 HOURS)

The definition and some examples – continuation linear transformations – The Hahn-Banach theorem – The natural imbedding of N in N** – The open mapping theorem – The conjugate of an operator.

Unit II : Hilbert Spaces (22 HOURS)

Definition and properties – Orthogonal complements and direct sums– Orthonormal sets and sequences – Series related to orthonormal sets and sequences – Maximal orthonormal sets and sequences – Projection theorem – Representationof functionals on Hilbert spaces.

Unit III : Operators on Hilbert Spaces (18 HOURS)

The adjoint of an operator– Self adjoint operator- Normal and Unitary operators – Projections – The spectrum of bounded operator-Spectral theorem for normal and self adjoint operator.

Unit IV: Finite Dimensional Spectral Theory (15 HOURS)

Matrices – Determinants and the spectrum of an operator – The spectral Theorem

Unit V: Banach Algebras (16 HOURS)

Introduction to Banach Algebras - Definition, Examples and some related basic results – Regular and singular elements– The spectrum – The formula for the spectral radius.

Text Book:

1. **Introduction to topology and Modern Analysis,** G.F. Simmons , Mc Graw Hill Education (India) Edition 2004.

Unit I : Chapter 9 Fully (page No. 211-242)
Unit II : Chapter 10 (Page No. 243-261)
Unit II : Chapter 10 (Page No. 262-277)
Unit IV : Chapter 11 Fully(Page No. 278-294)
Unit V : Chapter 12 Fully (Page No. 301-317)

Reference Books:

1. **Functional Analysis**, Walter Rudin, TMH Edition 1974.
2. **Functional Analysis**, B.V Linaye, Functional Analysis, Wiley Eastern limited, Bombay, second Edition 1985

e – Resources:

1. https://docs.ufpr.br/~eidam/2019/2/CM075/Kreyszig.pdf
2. http://www.freebookcentre.net/maths-books-download/Functional-Analysis-pdf.html
3. https://youtu.be/nE67uQPfRbI

Outcomes:

The learners would have the ability to,

CO1	Understand the concept of Banach spaces & Hilbert spaces.	K2
CO2	Acquire knowledge about Hilbert spaces.	K2
CO3	Describe the structure of finite dimensional spectral theory.	K5
CO4	Study about Regular, singular elements and the spectrum.	K4
CO5	Learn about fixed point theorem, Picard's theorem and Stone's theorem.	K2

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	3	3	2	3	3	3
CO2	3	2	3	3	3	3	2	1	3	3
CO3	3	1	2	3	2	3	2	3	1	2
CO4	3	1	3	3	3	2	1	3	3	3
CO5	3	1	3	2	3	3	3	3	3	1

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.54 which is **HIGH**

SEM – IV	**M.Sc. MATHEMATICS**	**Core Course:14**
Hours/Week: 6	**Fuzzy Sets and their Applications**	**Int. Marks: 25**
Credit : 5	**Code:P4R2MACC14**	**Ext. Marks: 75**
Total Hours: 90	**Skill Development**	**Max. Marks: 100**

Objectives:

- *To provide the knowledge of operations on fuzzy sets*
- *To introduce the mathematical field on the concept of a fuzzy numbers*
- *To enable the students to develop fuzzy relations*
- *To use direct methods with one expert and multiple experts*
- *To know the applications of fuzzy methodology*

Unit I: From Crisp Sets to Fuzzy Sets (20 HOURS)

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

Unit II : Operation on Fuzzy Sets (12 HOURS)

Types of Operations – Fuzzy complements – Fuzzy Intersections – t norms - Fuzzy unions – t conforms – Combinations of Operations.

Unit III : Fuzzy Relations (21 HOURS)

Crisp versus Fuzzy Relations – Projections and cylindric extensions – Binary Fuzzy Relations – Binary Relations on a Single set – Fuzzy Equivalence Relations – Fuzzy Compatibility Relations – Fuzzy Ordering Relations – Fuzzy morphisms.

Unit IV : Decision making in Fuzzy environments (22 HOURS)

General Discussion – Individual Decision making – multi person decision making – multi criteria decision making – multi stage decision making – fuzzy ranking methods – fuzzy linear programming.

Unit V : Applications (15 HOURS)

Introduction - Medicine – Economics – Fuzzy Systems and Genetic Algorithms – Fuzzy Regression – Interpersonal Communication – Other Applications.

Text Book:

1. **Fuzzy sets and Fuzzy Logic Theoryand Applications,** George J.Klir and Bo Yuan , PHI Leaning Private Limited, New Delhi (2009).

Unit I: Chapter 1, Section 1.1 to 1.4
Unit II: Chapter 3, Section 3.1 to 3.5
Unit III: Chapter 5, Section 5.1 to 5.8
Unit IV: Chapter 15
Unit V: Chapter 17.

Reference Books:

1. **Fuzzy Set Theory, Fuzzy Logic and their Applications,** A. K. Bhargava, S. Chand Pvt. Limited (2013).
2. **Fuzzy sets and their application,** K.Pundir and R.Pundir, A - Pragati edition 2012.
3. **Fuzzy set theory and its applications,** 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/108/104/108104157/

Outcomes:

The learners would have the ability to,

CO1	Discuss the types of operations on fuzzy sets, t- norms and fuzzy arithmetic.	K1
CO2	Study knowledge of fuzzy equivalence relations.	K2
CO3	Identify fuzzy relations, binary fuzzy relations and fuzzy equivalence relations.	K2
CO4	Gain the knowledge of constructing fuzzy sets and operations on fuzzy sets.	K4
CO5	Apply the fuzzy models to natural science and technical fields.	K3

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

PROGRAM SPECIFIC OUTCOMES

Course Outcome (CO)	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	3	3	2	3	3	3
CO2	3	2	3	3	3	3	2	1	3	3
CO3	3	1	2	3	2	3	3	3	1	3
CO4	3	1	3	3	3	2	1	3	3	3
CO5	3	3	3	2	3	3	3	3	3	1

3-Strong; 2-Medium; 1-Low

Mean Overall Relationship is 2.6 which is **HIGH.**

Course Name	APPLICATIONS IN CRYPTO CURRENCY AND BLOCK CHAIN TECHNOLOGY					
Course Code	P4R2CMGEC2:1		Ex. Hrs.	L	P	C
Category	Generic Elective Course		3	6		3
Nature of Course	Skill Development					
Maximum Marks	CIA: 25	End SEM: 75	Total Marks:100			
Passing Minimum	CIA: 10	End SEM: 30	Total Marks:50			

Course objectives

1. Students can have basic set of skills to understand crypto currencies and block chain/DLT
2. students can understand Block Chain applications in Various Sectors
3. Students are able to learn the Current state of the crypto currency
4. Students can develop their Investment in alt coins and mining
5. students can understand ICO Regulation

UNIT I	Block Chain Fundamentals	10 Hours

Block Chain Overview – Basis of Cryptography in the Block chain – Decentralized digital identity- transactions – block Buildingand Consensus mechanism – coding with solidity on Ethereum Block chain.

UNIT II	Enterprise Applications of Block Chain	20 Hours

Pros and cons of using Block Chain - Block Chain applications in Various Sectors – notable block Chain consortium- Business decisions about Block Chain

UNIT III	Block Chain and Crypto Currency overview	20 Hours

What is cryptocurrency and Blockchain? - History of cryptocurrency - How is it different from fiat currency? - Current state of the field

UNIT IV	Practical Use of Crypto Currency	10 Hours

The cryptocurrency ecosystem – Cryptocurrency and anonymity – Cryptocurrency wallets -Investment in altcoins and mining - Tax and inheritance

UNIT V	Token Offering	12 Hours

What is an Initial Coin Offering? - Advantage and Disadvantage of ICO - ICO Regulation - Securities Token Offering – Regulated ICOs - Trends in Token Offering

(Theory 75Marks)	Total Hours 72

Book for Study

Bitcoin and Cryptocurrency Technologies. Princeton University Press -Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder.

Books for Reference

1. Mastering Bitcoin. -Andreas M. Antonopoulos
2. The Age of Crypto currency: How Bitcoin and Digital Money Are Challenging the Global Economic Order (by *Wall Street Journal* writers Paul Vigna and Michael J. Casey, explains crypto currency)

Web Resources

1) Untraceable Electronic Cash (Chaum, Fiat and Naor 1990)
2) SEC Release No. 81207 (The DAO)
3) https://github.com/bitcoinbook/bitcoinbook
4) The Truth Machine: The Blockchain and the Future of Everything.

Course Outcomes		**K Level**
After completion of the course the student will be able to		
CO1	Have exposure to Basis of Cryptography in the Block chain	K2 &K3
CO2	Create a block Chain consortium.	K4
CO3	Learn Current state of the crypto currency	K5
CO4	Able to construct Cryptocurrency wallets and investments	K6
CO5	Assess the Trends in Token Offering	K5

Title of the Course: Application in Crypto currency and Block chain Technologies						**Course Code: P2R2CMGEC1**					
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	3	3	3	3	3	3	2	2.8
CO2	3	3	3	3	3	3	2	3	3	3	2.9
CO3	3	3	2	2	3	3	2	3	3	2	2.6
CO4	3	2	3	2	2	3	3	2	2	2	2.4
CO5	3	3	2	3	3	3	3	3	3	3	2.9
										Mean Overall Score	**2.98**
										Result	**High**

Course Name	GST THEORY AND PRACTICE					
Course Code	P4R2CMGEC2:2		Ex. Hrs.	L	P	C
Category	Employability		3	6		5
Nature of Course	GEC					
Maximum Marks	CIA: 25	End SEM: 75	Total Marks:100			
Passing Minimum	CIA: 10	End SEM: 30	Total Marks:40			

Course objectives

1. To understand the concepts of Goods and Services and Tax Act.
2. To gain knowledge on Levy collection and tax and time and place of supply.
3. To understand the basic concepts related to GST.
4. To acquaint with the latest amendments made in connection with indirect taxation.
5. To update the procedural part of GST.

UNIT I	Introduction, Overview and Evolution of Goods and Services Tax	15 Hours

Introduction – Direct tax and Indirect tax – meaning - Stages of Evolution of Goods and Services Tax - Subsuming of taxes - constitutional background - Structure of GST – CGST, SGST, UTGST and IGST – Benefits of implementing GST – GSTN – Structure, features and functions – HSN Code – SAC code – GST council and its structure – power and functions of GST Council – Important concepts and definitions under CGST Act and IGST.

UNIT II	Levy Collection and Tax and Time and place of Supply	20 Hours

Levy and collection of tax – Rates of GST – Scope of Supply – Composite and mixed supplies and E-Commerce – under GST regime – Liability to pay tax – Reverse change Mechanism and Composition scheme – Time of supply of goods – place of supply- Cascading Effect of Taxation – Input Tax Credit – Manner of claiming input tax credit in different situations – Tax Invoice – credit and debit notes – Electronic ledger.

UNIT III	Registration and Payment of Tax	15 Hours

Registration – persons liable for Registration – Compulsory registration – Deemed registration – Procedure for registration – GSTIN and its structure – Amendment of registration – Revocation of cancellation – Returns – finishing details of supplies – Payment of Tax, Interest, Penalty – Tax Deduction at Source – Collection of tax at source – Refunds.

UNIT IV	Assessment and Audit	12 Hours

Assessment – Meaning – Types of Assessment – Self Assessment – Provisional Assessment – Scrutiny Assessment – Types of Assessment – Audit – Search and Seizure – Inspection of goods in movement – Power of Authorities – Demands and Recovery – Fraud and Suppression of facts – Liabilities – Provisional.

UNIT V	Appeals	15 Hours

Appellate Authorities – powers – Procedure for appeal – Appeals before Tribunal – Appeals by the Department (CGST/SGST) before the AA/ Tribunal – Revision to high court – Supreme court – Offences and Penalities.

100% Theory	Total Hours:72

Book for Study

H.C Mehrotra, Indirect Taxes, SahityaBhavan Publications, New Delhi, 2018.

Books for Reference

1. Vinod K Singania, Indirect Taxes, Taxmann's Publications, New Delhi, 2018
2. Rakesh Kumar, Goods and Services Tax, Diamond Pocket Books Pvt Ltd.
3. Indirect Taxes: V.S. Datey – Taxman Publication.
4. Bare Act SGST
5. Bare Act IGST

Web Resources

Website of Custom Department, Website of Excise Department, Website of Sales Tax Department.

Course Outcomes		**K Level**
After completion of the course the student will be able to		
CO1	To acquire knowledge about the GST.	K2
CO2	To enable the students to **Levy Collection and Tax and Time and place of Supply.**	K3
CO3	To gain the knowledge in Registration and Payment of Tax**.**	K5
CO4	To familiarize the students with the concepts of Assessment and Audit.	K4
CO5	To know the techniques of Appeals.	K6

Title of the Course: GST Theory and Practices						**Course Code: P4R2CMGEC1:2**					
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	3	3	3	1	3	3	3	2.7
CO2	3	3	3	2	3	2	3	1	2	1	2.3
CO3	2	3	3	3	3	3	2	3	3	3	2.8
CO4	3	1	3	2	3	3	3	3	2	3	2.6
CO5	3	2	3	3	1	3	3	3	3	2	2.6
									Mean Overall Score		**2.60**
									Result		**High**