Department of Mathematics (Self - Supporting)

Revised M. Sc syllabus with effect from the academic year 2018 - 19 (CBCS – OBE Pattern)

PREAMBLE

As per the guidelines given by the University Grants Commission and the Tamil Nadu State Council for Higher Education, the M. Sc degree programme is designed in such a way that it has an extensive applications in both pure and applied Mathematics; an attitude towards problem formulation and solving; an analytical skill and accuracy; an appreciation of the approaching of mathematical techniques and research aptitude to mathematics. Every effort has been made to present the subject in easy, clear, lucid and systematic manner. References at the end of each syllabus are given to cover more advanced extension of the topics presented.

REGULATIONS

1. ELIGIBILITY FOR ADMISSION:

Candidates for admission to the first year of the degree of M. Sc. course should have Bachelor's degree in Mathematics of University of Madras or some other University accepted by the syndicate as equivalent.

2. ELIGIBILITY FOR THE AWARD OF DEGREE:

The candidate shall be eligible for the award of degree only if she has undergone the prescribed course of study for a period of not less than two academic years, passed the examinations of all the four semesters prescribed, earning 91 credits.

3. DURATION OF THE PROGRAMME : 2 YEARS

Each academic year is divided into two semester sessions. The first academic year shall comprise the first and second semesters. The second academic year comprises third and fourth semesters. Each semester will have a minimum of 90 working days and each day will have 5 working hours. Teaching is organized into a modular pattern of credit courses. Credit is normally related to the number of teaching hours of a particular subject. It is also related to the number of tutorial and practical hours.

4. COURSE OF STUDY :

The main subject of study for Master Degree shall consist of the following :

Courses	Number	Credits per Course	Total Credits
Core Courses			
Theory	15	4	60
Elective Courses			
Major	5	3	15
Non Major	2	3	6
Soft Skill	4	2	8
Internship	1	2	2
Total			**91**

5. PASSING MINIMUM :

A candidate shall be declared to have passed in each paper of the main subject of study wherever prescribed, if she secured NOT LESS THAN 50 % of the marks prescribed for the End Semester Examination and also 50% in the sum of End Semester Examinations and Continuous Assessment. There is no passing minimum for Continuous Assessment.

6. CLASSIFICATION OF SUCCESSFUL CANDIDATES :

Successful Candidates passing the examination and securing the marks

1. 60% and above in aggregate shall be declared to have passed the Examination with first class
2. 50% and above but below 60% in the aggregate shall be declared to have passed the examination in the second class.

Candidates who pass all the examinations prescribed for the course in the **FIRST ATTEMPT ITSELF ALONE** are eligible for ranking.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

On obtaining a postgraduate degree the students will be able to:

PEO1 - Display higher order thinking in the knowledge domain and demonstrate professional skills

PEO2 - Contribute to the advancement and application of relevant knowledge by self-directed learning

PEO3 - Extend and integrate knowledge and skills to design and develop novel products and explore innovative solutions to national and international goals of development.

PEO4 - Exercise management skills and develop social interactions in a responsive, ethical and constructive way to meet global standards of excellence in all spheres of activity.

PEO5 - Strive for social and economic equity based on the need for gender parity and ecological sustainability.

PROGRAMME OUTCOMES (POs)
(Common to all Science Streams)

Upon completion of the Programme, the students will be able :

PO1 – To acquire advanced conceptual knowledge and comprehensive understanding of the fundamental principles in respective discipline.

PO2 – To apply knowledge and critically evaluate the concepts and scientific developments to take up any challenge.

PO3 – To visualize and work on laboratory multidisciplinary tasks related to current research in the fields of Mathematical, Physical and Life sciences.

PO4 – To acquire research based knowledge and design methods to conduct investigations of complex problems in research/ Industrial field and achieve employability / self employment.

PO5 – To communicate effectively ideas verbally in English, leading to Entrepreneurship ventures such as consultancy and training.

PO6 – Employ innovative and environment friendly methods, novel ideas to solve complex and challenging societal and environmental issues.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

Upon completion of the programme M.Sc. Mathematics, the students will be able to:

PSO1 - Apply knowledge of Mathematics in different field of science, business studies and technology.

PSO2 - Acquire knowledge and understanding in advanced areas of Mathematics, from the courses offered.

PSO3 - Provide students with advanced mathematical and computational skills that prepares them to pursue higher studies and conduct research.

PSO4 - Train students to deal with the problems faced by software industry through knowledge of mathematics and scientific computational techniques.

PSO5 - Provide students with knowledge and capability in formulating, analyzing mathematical models of real life applications, to develop abstract mathematical thinking and to crack the competitive examinations.

PROGRAMME PROFILE –M. Sc MATHEMATICS

Sem	Course Code	Course Title	Credits	Hours/ week	Total Hours	C.A	S.E	Total
I	11SP18/1C/AL1	Algebra I	4	6	90	40	60	100
	11SP18/1C/RA1	Real Analysis-I	4	6	90	40	60	100
	11SP18/1C/ODE	Ordinary Differential Equations	4	6	90	40	60	100
	11SP18/1E1/GTY	Graph Theory	3	5	75	40	60	100
	11SP18/1E2/OR1	Operations Research I	3	5	75	40	60	100
	PG18/1S/PEW	Personality Enrichment for Women (Soft Skills)	2	2	30	-	-	50
II	11SP18/2C/AL2	Algebra II	4	5	75	40	60	100
	11SP18/2C/RA2	Real Analysis-II	4	5	75	40	60	100
	11SP18/2C/PDE	Partial Differential Equations	4	5	75	40	60	100
	11SP18/2C/MTA	Mechanics and Tensor Analysis	4	5	75	40	60	100
	11SP18/2E3/OR2	Operations Research II	3	4	60	40	60	100
	11SP18/2E/MCE	Mathematics for competitive examinations	3	4	60	40	60	100
	PG18/2S/LCE PG18/2S/FRE PG18/2S/GER	Language and Communication in English (Soft Skills)	2	2	30	-	-	50
		Internship	2					
		Total	**46**	**60**				

Sem	Course Code	Course Title	Credits	Hours/ week	Total Hours	C.A	S.E	Total
III	11SP18/3C/CA1	Complex Analysis I	4	5	75	40	60	100
	11SP18/3C/TOP	Topology	4	5	75	40	60	100
	11SP18/3C/DGY	Differential Geometry	4	5	75	40	60	100
	11SP18/3C/CVI	Calculus of Variations and Integral Equations	4	5	75	40	60	100
	(Option 1) 11SP18/3E4/MS1 (Option 2) 11SP18/3E4/FDY	Mathematical Statistics I Fluid Dynamics	3	4	60	40	60	100
	11SP18/3E/RMT	Resource Management Techniques	3	4	60	40	60	100
	11SP18/3S/ASN	Analytical Skills for NET/SET. (Soft skills)	2	2	30	-	-	50
IV	11SP18/4C/CA2	Complex Analysis II	4	6	90	40	60	100
	11SP18/4C/FAN	Functional Analysis	4	6	90	40	60	100
	11SP18/4C/FSA	Fuzzy set theory and its applications	4	5	75	40	60	100
	11SP18/4C/PYP	Python Programming	4	6	90	40	60	100
	(Option 1) 11SP18/4E5/MS2 (Option 2) 11SP18/4E5/MTY	Mathematical Statistics II Measure Theory	3	5	75	40	60	100
	11SP18/4S/LAT	LATEX-A Document Preparation System (Soft skills)	2	2	30			50
	Total		**45**	**60**				
	Over all Credits		**91**					

Total minimum credits for the programme: **91 Credits**

EVALUATION PATTERN FOR CONTINUOUS ASSESSMENT

INTERNAL VALUATION BY COURSE TEACHER/S

Core/Elective/Project-Theory Papers

S.No	Component	Units to be Covered	Duration	Max.Marks	CA Marks
1	Test I	I, II	2 hours	50 (to be converted)	**10**
2	Test II	III, IV	2 hours	50 (to be converted)	**10**
3	Assignment/ Seminar/Field visit	-	-	10	**10**
4	Participatory Learning	-	-	10	**10**
				Total	**40**

CORE/ELECTIVE-PRACTICAL PAPERS: NIL

PROJECT : NIL

SOFT SKILL PAPERS : NIL

CA QUESTION PAPER PATTERN

Knowledge level	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	6 x 2	12
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least two question from every Unit	3 (out of 5) x 6	18
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – At least one question from every Unit	2(out of 3) x10	20
			Total	**50**

RUBRICS FOR CONTINUOUS ASSESSMENT

Assignment	Content/originality/Presentation/Schematic Representation and Diagram/Bibliography
Seminar	Organisation/Subject Knowledge/Visual Aids/Confidence level/presentation-Communication and Language
Problem Solving	Understanding Concepts/Formula and Variable Identification/Logical Sequence/Answer
Participation	Answering Questions/Clearing Doubts/Participating in Group Discussions/Regular Attendance
Group Discussion	Preparation/Situation Analysis/Relationship Management/Information Exchange/Delivery Skills
Flipped/Blended Learning	Preparation/Information Exchange/ Group interaction/Clearing doubts

END SEMESTER EVALUATION PATTERN

Semester	Papers	Valuation	Examiner	Max. marks	Passing Min.
I, II, III IV	Theory	Double valuation	Internal & External examiner	100 (to be converted to 60)	50
I, II, III IV	Soft skills	Single valuation	Internal examiner	50	25
	Project	-	-	-	-
End of II Semester	Internship	-	-	Two Credits	

SEMESTER I COURSE PROFILE - M. Sc Mathematics

Course Title & Course Code	Credits	Hours/week	Total Hours	L	T	P	C.A	S.E	Total	Page No.
Algebra I 11SP18/1C/AL1	4	6	90	3	3	0	40	60	100	10
Real Analysis-I 11SP18/1C/RA1	4	6	90	3	3	0	40	60	100	13
Ordinary Differential Equations 11SP18/1C/ODE	4	6	90	3	3	0	40	60	100	16
Graph Theory 11SP18/1E1/GTY	3	5	75	2	3	0	40	60	100	20
Operations Research I 11SP18/1E2/OR1	3	5	75	2	3	0	40	60	100	23

ALGEBRA – I

Core -1 **Total Hours : 90**
Course Code : 11SP18/1C/AL1 **Credits: 4 L- T- P: 3 3 0**

Course Objectives:
To enable the students to

- Understand the concepts of Advanced algebra
- Get knowledge on application of Finite Abelian groups
- Study linear Transformations
- Understand the concepts of Nilpotent transformation.
- Introduce different forms of matrices and quadratic forms.

COURSE OUTLINE:

UNIT I: Group Theory

Sylow's Theorem (For Theorem 2.12.1 First proof only).

Chapter 2 : Sections 2.12 (Omit Lemma 2.12.1, 2.12.2 & 2.12.5)

(20 hrs)

UNIT II : Group Theory(contd.), Modules

Direct Products - Finite Abelian groups - Modules.

Chapter 2 : Sections 2.13 and 2.14 (Theorem 2.14.1 only)
Chapter 4 : Section 4.5

(20 hrs)

UNIT III : Linear Transformations

Canonical Forms: Triangular Form.

Chapter 6 : Section 6.4 (15 hrs)

UNIT IV : Linear Transformations(contd.)

Canonical Forms: Nilpotent Transformations – A Decomposition of V: Jordan Form.

Chapter 6 : Sections 6.5 and 6.6 (15 hrs)

UNIT V : Linear Transformations(contd.)

Hermition, Unitary and Normal Transformations- Real Quadratic Forms.

Chapter 6 : Sections 6.10 and 6.11 (20 hrs)

RECOMMENDED TEXT :
I.N. Herstein, Topics in Algebra(II Edition), Wiley Eastern Limited, New Delhi, 1975

REFERENCE BOOKS:

1. M. Artin, Algebra, Prentice Hall of India, 1991.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Edition)
3. I.S. Luther and I.B.S Passi, Algebra, Vol - I Groups (1996): Vol II Rings, Narosa Publishing House, New Delhi, 1999.
4. N.Jacobson, Basic Algebra, Vol I & II, Hindustan Publishing Company, NewDelhi, 1974.
5. John B. Fraleigh, A First Course in Abstract Algebra, Pearson Education Publishing Company.

Journals:
Journal of Algebra and its applications
Journal of Applied Mathematics
The Mathematics Intelligencer .
Mathematics News letter.

Websites and e- learning sources
http//mathforum.org
http//www.opensource.org
https://brilliant.org/wiki/sylow-theorems/
https://groupprops.subwiki.org/wiki/Finite_abelian_group
http://planetmath.org/nilpotent transformation

Course Outcomes: Upon Completion of this course, the students will be able to

CO No	CO statement
CO 1	Analyze three parts of Sylow's theorem and illustrates a different aspect of group theory.
CO 2	explain on the application of Finite Abelian groups
CO 3	Discuss the concepts of Canonical Forms and Triangular Form.
CO 4	explain the applications of Nilpotent Transformations.
CO 5	compute the problems under Hermitian, Unitary and Normal Transformations.

MAPPING – Course Outcomes With Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO3	PS04	PSO5
CO 1	2	2	2	1	3
CO 2	3	2	2	1	2
CO 3	3	2	3	1	2
CO 4	3	2	2	1	2
CO 5	2	2	2	2	3
Average	**2.6**	**2.0**	**2.2**	**1.2**	**2.4**

Key: **S**trongly Correlated-3, **M**oderately Correlated-2, **W**eakly Correlated-1
No correlation-0

Teaching Methodology

Lecture (chalk and talk, LCD projector), Problem Solving, Discussion and Interactive session, Assignment, Quiz, Seminar.

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

Real Analysis I

Core - 2 **Course Code: 11SP18/ 1C / RA1**
Teaching hours : 90 hrs **Credits : 4 L T P : 3 3 0**

Course Objectives :
To enable the students to gain knowledge in

- Functions of bounded variation
- Riemann - Stieltjes Integration
- Convergence of Double series & Uniform Convergence
- The interplay between various limiting operations.
- Point wise convergence and Uniform Convergence

UNIT I : Functions of Bounded Variation
Introduction - Properties of monotonic functions - Functions of bounded variation - Total Variation- Additive property of Total variation -Total variation on [a, x] as a function of x, Functions of bounded variation expressed as the difference of increasing functions - Continuous functions of bounded variation.
Chapter 6 : Sections - 6.1 to 6.8 (18 hrs)

UNIT II : The Riemann - Stieltjes Integral
Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts - Change of variable in Riemann- Stieltjes integral - Reduction to Riemann integral- Euler Summation formula - Monotonically increasing integrators-Upper and Lower integrals - Additive and Linearity Properties of Upper and Lower Integrals-Riemann's Conditions.
Chapter - 7: Sections 7.1 to 7.13. (Omit 7.8 & 7.9) (20 hrs)

UNIT III: The Riemann - Stieltjes Integral
Integrators of bounded variation - Sufficient conditions for the existence of Riemann Stieltjes integrals - Necessary conditions for the existence of Riemann Stieltjes integrals - Mean value theorems for Riemann - Stieltjes integrals - The integrals as a function of the interval-Second Fundamental theorem of integral calculus -Second Mean value theorem for Riemann integrals, Lebesgue's criterion for the existence of Riemann integrals.
Chapter-7: Sections7.15 to 7.26 (Omit 7.21,7.23 to7.25) (20 hrs)

UNIT IV: Sequences of Functions
Point - wise convergence of sequences of functions - Examples of sequences of real valued functions - Definition of uniform convergence - Uniform convergence and continuity - The Cauchy condition for uniform convergence -Uniform convergence of infinite series of functions - Uniform convergence and Riemann - Stieltjes integration - Uniform Convergence and Differentiation- Sufficient conditions for uniform convergence of a series
Chapter 9: Sections 9.1-9.11 (Omit 9.7 & 9.9) (18hrs)

UNIT V: Sequences of Functions

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

Chapter 9: Sections 9.14 to 9.23 (Omit 9.16, 9.17, 9.18, 9.21) (14 hrs)

RECOMMENDED TEXT:

1. Mathematical Analysis, 2nd Edition, Tom M. Apostol, Addison Wesley publishing company Inc. New York, 1974.

REFERENCE BOOKS:

1. Real Analysis, Bartle, R.G, John Wiley and sons Inc, 1976.
2. Principles of mathematical Analysis, 3rd Edition, Rudin.W, Mc.Graw Hill Company, NewYork, 1976.
3. Principles of Real Analysis, A.L. Gupta and N.R. Gupta, Pearson Education, (India Print) 2003.
4. Understanding Real Analysis (2 edition) Paul Zorn, (2 edition) ,CRC Press, 2017.
5. Elements Of Real Analysis by Shanthi Narayan and M.D Raisinghania.

JOURNALS:

1. SIAM Journal on Mathematical Analysis
2. Journal of Mathematical Analysis and Applications
3. Real Analysis Exchange
4. Journal of Real Analysis

WEBSITES AND E- LEARNING SOURCES

http://math-forum.org,
http://ocw.mit.edu/ocw web/Mathematics,
http://www.opensource.org,
https://www.elsevier.com/mathematics

COURSE OUTCOMES: Upon Completion of this course, the students will be able to

CO No.	Course Outcome Statement
CO 1	study on functions of bounded variation.
CO 2	analyze and study the theory of Riemann Stieltjes Integration.
CO 3	learn Fundamental theorem of integral calculus Mean value theorems for Riemann Stieltjes integrals
CO 4	learn Uniform convergence and continuity with reference to sequence of functions.
CO 5	discuss the convergence of multiplication of power series.

MAPPING OF CO WITH PSO

CO / PO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	1	1	3	3	2
CO 2	2	2	3	3	2
CO 3	1	2	3	3	2
CO 4	1	1	3	3	2
CO 5	1	1	3	3	2
Average	1.2	1.4	3	3	2

Key: **S**trongly Correlated-3, **M**oderately Correlated-2, **W**eakly Correlated-1
No correlation-0

Lecture (chalk and talk, LCD projector),
Problem Solving,
Discussion and Interactive session,
Assignment,
Quiz,
Seminar.

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

ORDINARY DIFFERENTIAL EQUATIONS

Core-3 **Total Hours : 90**
Course Code : 11SP18/1C/ODE **Credits: 4 L- T- P: 3 3 0**

COURSE OBJECTIVES:

To enable the students to

1. develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points.
2. study the existence and uniqueness of the solutions of first order differential equations.
3. introduce the students to the technique of solving various problems of engineering and science.
4. study the concepts relating to the order and linearity of ODEs, analytic and computational solution methods for ODEs and the real-world applications of ODEs.
5. apply differential equations to problems in engineering, physics, biology and economics.

COURSE OUTLINE:

UNIT I : Linear Differential Equations of Higher Order

Introduction- Higher order equations - A Modelling problem - Linear Independence - Equations with Constant Coefficients.

Chapter 2 : sections 2.1 to 2.5 (15 hrs)

UNIT II:Linear Differential Equations of Higher Order(Contd.)

Equations with variable coefficients - Wronskian - Variation of parameters - Some Standard Methods - Method of Laplace Transforms

Chapter2: sections 2.6 to 2.10 (15 hrs)

UNIT III: Solutions in Power Series

Introduction - Second order Linear Equations with Ordinary Points -Legendre Equation and Legendre Polynomials - Second Order Equation with Regular Singular Points - Properties of Bessel Functions

Chapter 3: sections 3.1 to 3.5 (25 hrs)

UNIT IV: Systems of Linear Differential Equations

Introduction - System of First Order Equations - Existence and Uniqueness Theorem - Fundamental Matrix -. Linear Systems with Constant Coefficients - Linear Systems with Periodic Coefficients

Chapter 4: Section 4.1- 4.8 (Omit 4.3 & 4.6) (20 hrs)

UNIT V: Existence and Uniqueness of Solutions

Introduction - Preliminaries - Successive Approximations - Picard's Theorem - Some Examples.
Chapter 5: Section 5.1 to 5.5 (15 hrs)

RECOMMENDED TEXTBOOK:

S.G. Deo , V. Lakshmikantham ,V .Raghavendra, Text Book of Ordinary Differential Equations(SECOND EDITION), Tata Mc Graw Hill, New Delhi, 1974

REFERENCE BOOKS:

1. Earl A. Coddington, An introduction to ordinary differential equations , (3rd edition), Prentice Hall of India Ltd, New Delhi1987.
2. Williams E. Boyce and Richard C. DI Prima, Elementary differential equations and boundary value Problems, John Wiley and sons, New York1967.
3. George F. Simmons, Differential equations with applications and historical notes, Tata Mc Graw Hill, New Delhi 1974.
4. N.N. Labedev, Special functions and their applications, Prentice Hall of India Ltd, New Delhi1965.
5. W.T. Raid, Ordinary Differential equations, John Wiley and sons, New York 1974.
6. Ordinary Differential Equations, P. Hartman John Wiley and sons, New York 1974.

JOURNALS:

Journal of Differential Equations
International Journal of Differential Equation and Applications

E-LEARNING RESOURCES:

https://www.math.upenn.edu/~moose/240S2015/slides7-28.pdf
http://www.che.ncku.edu.tw/FacultyWeb/ChangCT/html/teaching/Engineering%20Math/Chapter%203.pdf
https://www.et.byu.edu/~vps/ET502WWW/NOTES/CH5.pdf
https://www.ams.org/journals/proc/1966-017-02/S0002-9939-1966-0190442-4/S0002-9939-1966-0190442-4.pdf
http://math.mit.edu/~hrm/18.031/class1-reading.pdf
https://ptolemy.berkeley.edu/projects/embedded/eecsx44/lectures/Spring2013/Picard.pdf

Course Outcomes: Upon Completion of this course, the students will be able to

CO No.	CO Statement
CO 1	Create and analyze mathematical models using higher order differential equations to solve application problems and solve differential equations with constant coefficients
CO 2	Use the Wronskian to determine if a set of functions is linearly independent and solve problems using methods of undetermined coefficients, reduction of the order of equation and Laplace Transform.
CO 3	Evaluate power series solutions about ordinary points and regular singular points and learn the Legendre equations, Legendre polynomial and properties of Bessel functions.
CO 4	Demonstrate the existence and uniqueness of solutions and understand the linear systems of equations
CO 5	Explain the method of successive approximations and Picard's theorem.

MAPPING – Course Outcomes With Programme Specific Outcomes

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	1	3
CO2	1	3	3	1	3
CO3	3	2	3	1	3
CO4	3	3	3	1	2
CO5	2	3	3	1	3
AVERAGE	**2.4**	**2.8**	**2.8**	**1**	**2.8**

Key: Strongly Correlated-3, Moderately Correlated-2, Weakly Correlated-1
No correlation-0

TEACHING METHODOLOGY:
Lecture (Chalk and Talk-OHP-LCD)
Quiz-Seminar
Peer Learning
Assignments

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

GRAPH THEORY

Elective : E1 **Course Code: 11SP18/1E1/GTY**
Teaching hours : 75 **Credits : 3** **L T P: 2 3 0**

Course Objectives: This course will enable the students

1. To have knowledge about graphs and its structure.
2. To understand Trees and Connectivity.
3. To identify Euler tours, Hamilton Cycles and Matchings.
4. To study about colourings and its characterization.
5. To explore and study more about the nature and properties of Planar graphs

UNIT 1: Graphs and Subgraphs

Graphs and simple graphs – Graph Isomorphism – The Incidence and Adjacency Matrices – Sub graphs – Vertex Degrees – Paths and Connection – Cycles

Chapter 1: Sections 1.1 – 1.7 (15 hours)

UNIT 2: Trees, Connectivity

Trees, Cut edges and Bonds, Cut vertices, Connectivity, Blocks.
Chapter 2: Sections 2.1 - 2.3
Chapter 3: Sections 3.1, 3.2 (15 hours)

UNIT 3: Euler Tours And Hamilton Cycles, Matchings

Euler Tours, Hamilton Cycles, Matchings, Matchings and Coverings in Bipartite graphs.
Chapter 4: Sections 4.1, 4.2,
Chapter 5: Sections 5.1, 5.2
(15 hours)

UNIT 4:Edge Colourings, Vertex Colourings

Edge chromatic number, Vizing's theorem, Chromatic number, Brook's Theorem

Chapter 6: 6.1, 6.2, Chapter 8: Sections 8.1, 8.2 (15 hours)

UNIT 5: Planar Graphs

Plane and planar graphs, Dual Graphs, Euler's formula, The five colour theorem and the four colour conjecture.
Chapter 9: Sections 9.1 - 9.6 (Omit 9.4 and 9.5) (15 hours)

RECOMMENDED TEXT:
Graph theory and its applications- J.A. Bondy and U.S.R. Murty, 5th Print, 1982

REFERENCE BOOKS:

1. Doughlas B. West, *Introduction to Graph Theory* –Second edition, PHI learning pvt. ltd, 2011.
2. A.Gibbons, *Algorithmic Graph Theory,* Cambridge University Press, Cambridge,1989.
3. S.A.Choudum, *A First Course in Graph Theory,* MacMillan India Ltd. 1987.
4. Richard J. Trudeau, *Introduction to Graph Theory* (Dover Books on Mathematics) Paperback – 9 Feb 1994.
5. Gary Chartrand, Ping Zhang, *A First Course in Graph Theory*, courier Corporation, 2012.

Journals:
1. Discrete Mathematics- Elsevier publications
2. Journal of Graph Theory
3. Electronic journal of Graph Theory and Applications

Websites and e- learning sources
www.graphtheorysoftware.com
https://www.britannica.com/topic/graph-theory
http://www.elsevier.com/mathematics
https://onlinelibrary.wiley.com /journal/10970118
https://www.ejgta.org

TEACHING METHODOLOGY:
Lecture (Chalk and Talk-OHP-LCD), Problem Solving, Group Discussion, Quiz, Seminar, Peer Learning.

Course Outcomes: Upon Completion of this course, the students will be able to

CO No.	CO Statement
CO 1	analyze various types of graphs and identify bipartite graphs.
CO 2	examine and identify properties of trees. Find out and determine vertex and edge connectivity of all simple graphs.
CO 3	apply the analytical techniques and theoretical knowledge in solving many real life problems. To prove theorems related to Hamiltonian, Eulerian graphs and matching.
CO 4	solve and analyze the colouring problem and apply them in the Timetabling problem and the Storage Problem.
CO 5	apply Euler's formula and Four Colour Conjecture in various problems and in many practical situations. To analyse and find a solution to planarity Algorithm.

Mapping of CO with PSO

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	3	3	4
CO 2	3	2	2	2	2
CO 3	3	2	2	2	2
CO 4	3	2	2	2	2
CO 5	3	2	2	2	2
Average	**3**	**2**	**2.2**	**2.2**	**2.2**

Key: **S**trongly Correlated-3, **M**oderately Correlated-2, **W**eakly Correlated-1
No correlation-0

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

OPERATIONS RESEARCH I

Elective : E2 **Course Code: 11SP18/1E2/OR1**
Teaching hours : 75 **Credits : 3** **L T P: 2 3 0**

Course Objectives :

This course will enable the students

1. To gain knowledge in concepts and tools of Operations Research
2. To apply cutting plane methods to obtain optimal integer solution values of variables in an Linear Programming.
3. To make distinction between linear programming and dynamic programming approaches for solving a problem and to provide a quantitative approach for effective decision making.
4. To find optimal value for both constrained and unconstrained objective functions.
5. To learn optimality conditions for single and multivariable constrained and unconstrained non linear optimization problems and corresponding solution methodologies.

UNIT I: Integer Linear Programming

Introduction – Types of Integer Programming Problems – Enumeration and Cutting Plane Solution Concept – Gomory's All Integer Cutting Plane Method – Gomory's Mixed-Integer Cutting Plane Method.

Chapter7: Sections 7.1 - 7.5 (15 hrs)

UNIT II : Dynamic Programming

Introduction – Dynamic Programming Terminology – Developing Optimal Decision Policy - Dynamic Programming under Certainty – Shortest Route Problem(Model I) – Multiplicative Separable Return Function and Single Additive Constraint(Model II)

Chapter 22: Sections 22.1 - 22.4 (Model I and Model II only) (15 hrs)

UNIT III : Dynamic Programming

Dynamic Programming under Certainty – Additive Separable Return Function and Single Additive Constraint (Model III) – Additively Separable Return Function and Multiplicative constraint(Model IV).

Chapter 22: Section 22.4 (Model III and IV only) (15 hrs)

UNIT IV : Classical Optimization Methods

Introduction – Unconstrained Optimization- Constrained Multivariable Optimization with Equality Constraints.

Chapter 23: Sections 23.1 - 23.3 (15 hrs)

UNIT V : Non-Linear Programming Methods:

Introduction – The General Non Linear Programming Problem –Graphical Solution Method- Quadratic Programming – Kuhn-Tucker Conditions – Wolfe's Modified Simplex Method.

Chapter 24: Sections 24.1 - 24.4 (upto Wolfe's Modified Simplex Method) (15 hrs)

RECOMMENDED TEXT

J.K Sharma, Operations Research Theory and Applications 4th edition Macmillan Publishers India Ltd,2009.

REFERENCE BOOKS

1.Hamdy A. Taha Operations Research (9th Edition), Prentice Hall of India Private Limited, New Delhi,2013.
2.S.D. Sharma, Operations Research, Kedar Nath Ram Nath and Co., Meerut, 2010.
3.F.S Hiller and J. Liberman Introduction to Operations Research (7th edition),2010
4. G Hadley ,Nonlinear and Dynamic Programming, Addison-Wesley Publishing Company, Inc.
5. Ronald L. Rardin , Optimization in Operations Research ,Pearson Paperback – 2018.

Periodicals:
The Mathematics Intelligencer
Mathematics News letter.
American Journal of Operations Research
International Journal of Operations Research and Information Systems
RAIRO - Operations Research

Websites and e-Learning Sources

https://www.doc.ic.ac.uk/~br/berc/integerprog.pdf
universe.bits-pilani.ac.in/uploads/DP.pdf
https://nptel.ac.in/courses/106101060/18
https://www.brainkart.com/article/Classical-Optimization-Theory_11259/
https://www.researchgate.net/...programming/.../Chap12+Nonlinear+Progra...

Course Outcomes: Upon Completion of this course, the students will be able to

CO No.	CO Statement
CO 1	Solve Integer Programming by Gomory's cutting plane method
CO 2	Examine the technologies of Dynamic Programming and solves the shortest route problem.
CO 3	Able to solve an Linear programming problem using the dynamic programming approach.
CO 4	Analyze and solve multivariable optimization with equality constraints
CO 5	Formulate the general Non Linear Programming Problem and able to solve by Wolfe's modified simplex method.

Teaching Methodology: Lecture (chalk and talk, LCD projector), Problem Solving, Assignment, Seminar.

Mapping of CO with PSO

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	3	2	3
CO 2	2	3	3	3	3
CO 3	3	3	2	2	3
CO 4	2	2	2	2	3
CO 5	3	3	3	2	3
Average	**2.6**	**2.6**	**2.6**	**2.2**	**3**

Key: **S**trongly Correlated-3, **M**oderately Correlated-2, **W**eakly Correlated-1
No correlation-0

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15
		Total	100

SEMESTER II - COURSE PROFILE - M. Sc Mathematics

Course Title & Course Code	Credits	Hours/ week	Total Hours	L	T	P	C.A	S.E	Total	Page No
Algebra II 11SP18/2C/AL2	4	5	75	3	2	0	40	60	100	**27**
Real Analysis-II 11SP18/2C/RA2	4	5	75	3	2	0	40	60	100	**30**
Partial Differential Equations 11SP18/2C/PDE	4	5	75	3	2	0	40	60	100	**33**
Mechanics and Tensor Analysis 11SP18/2C/MTA	4	5	75	3	2	0	40	60	100	**36**
Operations Research II 11SP18/2E3/OR2	3	4	60	2	2	0	40	60	100	**39**
Mathematics for Competitive Examinations 11SP18/2E/MCE	3	4	60	2	2	0	40	60	100	**42**
Internship	2									**45**
Total	**46**	**60**								

ALGEBRA –II

Core - 4 **Total Hours : 75**
Course Code : 11SP18/2C/AL2 **Credits: 4 L- T- P: 3 2 0**

Course Objectives

To enable the students

- To impart important applications in the theory of numbers
- To impart knowledge on Galois group.
- To emphasize the aspects of field theory.
- To get introduced to finite fields.
- To get the knowledge of Frobenius theorem, Integral Quaternion's and Four-Square theorem.

COURSE OUTLINE:

UNIT I: Fields

Extension fields
Chapter 5: Section 5.1 (12 hrs)

UNIT II: Fields (contd.)

Roots of polynomials - More about roots

Chapter 5: Sections 5.3 and 5.5 (18 hrs)

UNIT III: Fields (contd.)

The Elements of Galois Theory - Solvability by Radicals.

Chapter 5: Sections 5.6and 5.7
(Omit Lemma 5.7.1, Lemma 5.7.2.,Theorem 5.7.1) (18 hrs)

UNIT IV: Finite fields

Finite fields - Wedderburn's theorem on finite Division Rings.

Chapter 7: Sections 7.1 and 7.2
(Omit Lemma 7.2.1,7.2.2 and Theorem 7.2.2) (12 hrs)

UNIT V:Finite fields(contd.)
A Theorem of Frobenius - Integral Quaternions and Four-Square theorem
Chapter 7 : Sections 7.3 and 7.4 (15 hrs)

RECOMMENDED TEXT :

I.N. Herstein, Topics in Algebra(II Edition), Wiley Eastern Limited, New Delhi, 1975

REFERENCE BOOKS:

1. M. Artin, Algebra, Prentice Hall of India, 1991.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Edition)
3. I.S. Luther and I.B.S Passi, Algebra, Vol - I Groups (1996): Vol II Rings, Narosa Publishing House, New Delhi, 1999.
4. N.Jacobson, Basic Algebra, Vol I & II, Hindustan Publishing Company, NewDelhi,1974.
5. John B. Fraleigh, A First Course in Abstract Algebra, Pearson Education Publishing Company.

Journals:
Journal of Algebra and its applications
Journal of Applied Mathematics
The Mathematics Intelligencer .
Mathematics News letter.

Websites and e-Learning Sources
http:// mathforum.org,
http://ocw.mit.edu/ocwweb/mathematics.
http:// www.opensource.org. www. algebra.com
https://brilliant.org/wiki/finite-fields/
https://nrich.maths.org/1422

Course Outcomes: Upon completion of this course the students will be able to

CO No.	CO statement
CO 1	Apply the relation of one field to another.
CO 2	Discuss about roots and knows to solve problems under splitting field.
CO 3	Identify the relationship between the roots of the polynomial and its Galois group.
CO 4	Discuss all possible finite fields with important properties.
CO 5	Explain Frobenius theorem , Integral Quaternions and Four-Square theorem and its applications.

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO3	PS04	PSO5
CO 1	3	2	2	1	3
CO 2	2	2	2	1	3
CO 3	2	2	3	1	2
CO 4	3	2	2	1	3
CO 5	3	2	2	2	2
Average	**2.6**	**2.0**	**2.2**	**1.2**	**2.6**

Key: Strongly Correlated-3, Moderately Correlated-2, Weakly Correlated-1
No correlation-0

Teaching Methodology

Lecture (chalk and talk, LCD projector),
Problem Solving,
Discussion and Interactive session,
Assignment,
Quiz,
Seminar.

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

Real Analysis II

Core - 5 **Course Code: 11SP18/2C/ RA2**
Teaching hours : 75 hrs **Credits : 4 L T P : 3 2 0**

Course Objectives : Enable the students to gain knowledge in

- The study of Fourier series and Integrals.
- Multivariable differential calculus.
- The study of Implicit Function theorem and Inverse Function theorem
- Measure theory.
- Riemann Integrals and Lebesgue Integrals

UNIT I: Fourier Series

Introduction - Orthogonal systems 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 for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals(definition only) - An integral representation for the partial sums of a Fourier series - Riemann's Localization theorem. Sufficient conditions for convergence of a Fourier series at a particular point.

Chapter 11: Sections 11.1 to 11.12 (Omit sec-11.9) (15hrs)

UNIT II : Multivariable Differential Calculus

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

Chapter 12: Sections 12.1 to 12.14 (17 hrs)

UNIT III: Implicit Functions

Introduction-Functions with non – Zero Jacobian determinants - The Inverse Function theorem - The Implicit Function Theorem.

Chapter 13: Sections 13.1 to 13.4 (13 hrs)

UNIT IV: Measure on the Real Line

Measures on the Real line: Lebesgue outer measure - Measurable sets - Regularity - Measurable functions .

Chapter 2 : Sections 2.1 to 2.4 (15 hrs)

UNIT V: Integration of Functions of a Real Variable

Integration of non-negative functions - The General integral - Riemann and Lebesgue Integrals

Chapter - 3 Sections 3.1, 3.2 and 3.4 (15 hrs)

RECOMMENDED TEXTS:

1. Mathematical Analysis, 2nd Edition, Tom M. Apostol, Addison Wesley publishing company Inc. New York, 1974. (UNITS- I to III).
2. Measure Theory and Integration G. de. Barra , Wiley, Eastern Ltd. New Delhi, 1981(UNITS-IV and V)

REFERENCE BOOKS:

1. Real Analysis, Bartle, R.G, John Wiley and sons Inc, 1976.
2. Principles of Mathematical Analysis, 3rd Edition, Rudin.W, Mc.Graw Hill Company, NewYork, 1976.
3. Principles of Real Analysis, A.L. Gupta and N.R. Gupta, Pearson Education, (India Print) 2003.
4. Understanding Real Analysis (2 edition) Paul Zorn.
5. Elements Of Real Analysis by Shanthi Narayan and M.D Raisinghania.

JOURNALS:

1. SIAM Journal on Mathematical Analysis
2. Journal of Mathematical Analysis and Applications
3. Journal of Real Analysis
4. Real Analysis Exchange

WEBSITES AND E- LEARNING SOURCES

http://math-forum.org,
http://ocw.mit.edu/ocw web/Mathematics,
http://www.opensource.org,
https://www.elsevier.com/mathematics
http//www.opensource.org

Course Outcomes: Upon Completion of this course, the students will be able to

CO NO.	Course Outcome Statement
CO 1	Learn convergence of the Fourier Series
CO 2	Analyze and study multivariable differential calculus
CO 3	Study Jacobians, Implicit Function theorem and Inverse Function theorem.
CO 4	Explain the notion of Measure theory
CO 5	Study Riemann and Lebesgue Integrals

Mapping of CO WITH PSO

CO / PO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	1	1	3	2	2
CO 2	2	2	3	2	2
CO 3	1	2	3	2	2
CO 4	1	1	3	2	2
CO 5	1	1	3	2	2
Average	1.2	1.4	3	2	2

Key: **S**trongly Correlated-3, **M**oderately Correlated-2, **W**eakly Correlated-1
No correlation-0

Teaching Methodology

Lecture (chalk and talk, LCD projector),
Problem Solving,
Discussion and Interactive session,
Assignment,
Quiz,
Seminar.

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

PARTIAL DIFFERENTIAL EQUATIONS

Core : 6 **Total Hours: 75 Hours**
COURSE CODE: 11SP18/ 2C /PDE **CREDITS: 4 L-T-P: 3 2 0**

COURSE OBJECTIVES:

To enable the students to

1. formulate physical problems mathematically and develop a systematic approach of solving partial differential equations.
2. develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points.
3. study the existence and uniqueness of the solutions of first order differential equations Cauchy problem, boundary value problems and method of separation of variables.
4. use appropriate methods to solve specific problems.
5. extract information from partial derivative models in order to interpret reality and identify real phenomena as models of partial derivative equations.

COURSE OUTLINE:

UNIT I : Mathematical models
Classification of second order equations, the classical equations, vibrating string, vibrating membrane, second order equation in two independent variables, canonical forms, equations with constant coefficients, general solution.

Chapter 2: Section 2.1 - 2.3
Chapter 3: Section 3.1 - 3.4 (15 hrs)

UNIT II: Cauchy problem

Cauchy problem, Cauchy Kowalewsky theorem, Homogeneous wave equation, initial Boundary value problems, finite string with fixed ends.

Chapter 4: Sections 4.1 - 4.6 (omit 4.5) (15 hrs)

UNIT III: Method of Separation of variables

Separation of variables, vibrating string problem, existing and uniqueness of solutions of the vibrating string problem, Heat conduction problem, The Laplace and Beam equations.

Chapter 6: Section 6.1- 6.6 (Omit 6.5) (15 hrs)

UNIT IV:Boundary value problems

Boundary value problems, maximum and minimum principles, uniqueness and continuity theorem, Dirichlet problem for a circle, a circular annulus.

Chapter8: Section 8.1 - 8.5 (15 hrs)

UNIT V: Green's function

Green's function, the Delta function, Methods of Green's function, Dirichlet problem for the Laplace&Helmholtz operators.

Chapter 10: Section 10.1- 10.5 (15 hrs)

RECOMMENDED TEXTBOOK:

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

REFERENCE BOOKS:

1. W.E. Williams, Partial Differential Equations, Oxford, 1990.
2. N. Sneddon, The use of integral forms, Tata Mcgraw Hill, New Delhi, 1985.
3. M.M.Smirnov, Second order Partial Differential Equations, NewDelhi, 1983.
4. R.Dennemayer, Introduction toPartial Differential Equations, New York, 1968.
5. M. D. Rai Singhania, Advanced Differential Equations, S.Chand & Company Ltd, New Delhi, 2001.

JOURNALS:

Journal of Partial Differential Equation
International Journal of Partial Differential Equations and Applications
Communications in Partial Differential Equation

E-LEARNING RESOURCES:

https://nptel.ac.in/courses/111103021/14
https://projecteuclid.org/download/pdf_1/euclid.pja/1195513312
https://www.slideshare.net/mayur1347/laplace-transform-and-its-application
https://nptel.ac.in/courses/111103021/32.pdf
https://deepblue.lib.umich.edu/bitstream/handle/2027.42/46171/205_2004_Article_BF00285433.pdf?sequence=1
http://staff.matapp.unimib.it/~stefanom/didattic/matematica/anSup2013-2014/appunti/AnalisiSuperiore.pdf

Course Outcomes: Upon completion of this course, the students will be able to

CO No.	CO Statement
CO 1	Develop knowledge about second order equation in two independent variables, their canonical forms and equations with constant coefficients.
CO 2	Evaluate Cauchy problem of infinite strings and finite strings with fixed ends.
CO 3	Evaluate initial boundary value problem using the method of separation of variables.
CO 4	Explain and use Dirichlet problem for a circle and circular annulus.
CO 5	Recognize the concept of Green's function and apply Green's function method to determine the Greens function solution of the Dirichlet involving the Laplace and Helmholtz operator.

MAPPING - Course Outcome with Programme Specific Outcome

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	2	3	3	1	3
CO2	3	3	3	1	3
CO3	3	3	3	1	3
CO4	3	3	3	1	3
CO5	3	3	3	1	3
AVERAGE	**2.8**	**3**	**3**	**1**	**3**

Key: **S**trongly Correlated-3, **M**oderately Correlated-2, **W**eakly Correlated-1
No Correlation-0

Teaching Methodology: Lecture (Chalk and Talk-OHP-LCD), Quiz, Seminar, Peer Learning, Assignments

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

MECHANICS AND TENSOR ANALYSIS

Core - 7 **Course Code : 11SP18/2C/MTA**
Teaching hours : 75 **Credits : 4 LTP: 3 2 0**

Course Objectives

This course will enable the students

1. To understand the concept of fundamentals of classical mechanics.
2. To study about Hamilton's equation
3. To inculcate the concepts of Hamilton's Jacobi theory and Canonical transformation
4. To know the idea of Tensor Analysis
5. To perceive the knowledge of Christoffel's Symbols, Ricci's Theorem and Riemann Christoffel Tensor

COURSE OUTLINE:

UNIT - I : Introductory Concepts, Lagrange's Equations

The Mechanical System – Generalized Coordinates – Constraints – Virtual work – Derivation of Lagrange's Equations – Examples .

Chapter 1: Sections : 1.1,1.2, 1.3,1.4.
Chapter 2: Sections : 2.1 , 2.2 (15 hrs)

UNIT - II : Hamilton's Equations

Hamilton's Principle - Hamilton's equations – Other variational principles.
Chapter-4: Sections: 4.1, 4.2 ,4.3 (15 hrs)

UNIT - III : Hamilton Jacobi Theory, Canonical Transformations

Hamilton's Principal function – The Hamilton – Jacobi Equation - Special Transformations.

Chapter 5: Section : 5.1 & 5.2, Chapter 6: Section : 6.2 (15 hrs)

UNIT IV: Tensor Theory

Scope of tensor analysis -Transformation of coordinates – Properties of admissible transformations of coordinates – Transformation by invariance – Transformation by covariance and contravariance – The tensor concept – Tensor character of covariant and contravariant laws – Algebra of tensors – quotient laws – symmetric and skew - symmetric tensors – Relative tensors.

Chapter 2 : Sections18 - 28 (15 hrs)

UNIT V: Tensor Theory (Contd)

The Metric tensor - The fundamental and associated Tensors - Christoffel's Symbols - Transformation of Christoffel's. Symbols - Covariant differentiation of tensors - Formulas for covariant Differentiation - Ricci's Theorem - Riemann Christoffel Tensor properties of Riemann - Christoffel Tensors.

Chapter 2: Sections: 29 - 37 (15 hrs)

RECOMMENDED TEXTS:

1. Classical Dynamics, Donald. T. Greenwood, Prentice Hall of India, New Delhi 1985.
2. Tensor Analysis, I .S. Sokolnikoff, John Wiley and Sons, New York ,1964

Reference Books

1. The Mathematical Theory of Relativity, A.S.Eddington, Cambridge University Press,1930
2. An Introduction to Theory of Relativity, P.G.Bergman, New York, 1942
3. Riemannian Geometry and the Tensor Calculus, C.E.Weatherburn, Cambridge University Press,
4. Tensor Calculus, U.C. De, Absos Ali Shaikh and Joydeep Sengupta, Narosa Publishing House, New Delhi, 2004.
5. Tensor Calculus, J.L.Synge and A.Schild, Toronto, 1949.

Journals

Mechanics of Materials
Tensor analysis with its Applications in Mechanics
The Mathematics Intelligencer .
Mathematics News letter.

Course Outcomes Upon Completion of this course, the students will be able to

CO No.	CO Statement
CO 1	Discuss about the conservation principles and Lagrangian of Classical Mechanics.
CO 2	Use the knowledge of the Hamiltons principle and Hamilton's equations.
CO 3	Compute Canonical Transformations and special transformations
CO 4	Explain the concepts of tensors and algebra of tensors.
CO 5	Describe about the Riemann Christoffel tensors and Ricci's theorem

Websites And E- Learning Sources:
http://math-forum.org,
https://www.sciencedirect.com/journal
https://link.springer.com/chapter/10.1007/978-94-015-9912-2_2
http://ocw.mit.edu/ocw web/Mathematics,
http://www.opensource.org,

MAPPING-Course Outcome With Programme Specific Outcome

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	3	2	3
CO 2	3	3	3	2	2
CO 3	2	3	3	2	2
CO 4	3	3	3	2	3
CO 5	2	3	3	2	2
Average	**2.6**	**2.8**	**3**	**2**	**2.4**

Key: **S**trongly Correlated-3, **M**oderately Correlated-2, **W**eakly Correlated-1
No correlation-0

Teaching Methodology: Lecture (chalk and talk, LCD projector), Problem Solving, Discussion and Interactive session, Assignment, Quiz, Seminar.

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

OPERATIONS RESEARCH II

Elective - E3 **Course Code : 11SP18/2E3/OR2**
Teaching Hours : 60 **Credits: 3 LT P: 2 2 0**

Course Objectives

This course will enable the students

1. To understand the need of Operations Research.
2. To develop problem solving and decision making skill to optimum effect.
3. To make distinction between deterministic and probabilistic inventory control models.
4. To understand various components of a queueing system and description of each of them.
5. To realize the need to study replacement and maintenance analysis techniques.

UNIT I : Decision Theory and Decision Trees

Introduction – Steps of Decision Making Process – Types of Decision Making Environments – Decision Making Under Uncertainty.

Chapter 11 Sections 11.1 - 11.4 (12 hrs)

UNIT II : Decision Theory and Decision Trees (Contd.)

Decision Making Under Risk - Decision Tree Analysis.

Chapter 11 Sections 11.5, 11.7 (12 hrs)

UNIT III: Probabilistic Inventory Control Models

Continuous Demand Inventory control models without Set-up Cost (Model IV(a) and Model IV(b)) – Instantaneous Demand Inventory Control Model with Set - up Cost (Model V).

Chapter 15 Sections 15.3, 15.4 (12 hrs)

UNIT IV: Queuing Theory

Finite Calling Population Queuing Models
Chapter 16 Section 16.8 (12 hrs)

UNIT V: Replacement and Maintenance Models

Introduction – Types of Failure- Replacement of Items Whose Efficiency Deteriorates with Time.

Chapter 17 Sections 17.1 - 17.3 (12 hrs)

RECOMMENDED TEXT:

J.K Sharma, Operations Research Theory and Applications 4th edition Macmillan Publishers India Ltd,2009.

REFERENCE BOOKS

1.Hamdy A. Taha Operations Research (9th Edition), Prentice Hall of India Private Limited, New Delhi,2013.
2. S.D. Sharma, Operations Research, Kedar Nath Ram Nath and Co., Meerut, 2010.
3. F.S Hiller and J. Liberman Introduction to Operations Research (7th edition),2010
4. G Hadley ,Nonlinear and Dynamic Programming, Addison-Wesley Publishing Company, Inc.
5. Ronald L. Rardin , Optimization in Operations Research ,Pearson Paperback – 2018.

Periodicals:

The Mathematics Intelligencer
Mathematics News letter.
American Journal of Operations Research
International Journal of Operations Research and Information Systems
RAIRO - Operations Research

Course Outcomes Upon Completion of this course, the students will be able to

CO No.	CO Statement
CO 1	Determine the expected value of perfect information ,expected opportunity loss and expected monetary value associated with any decision
CO 2	Able to construct decision trees for making accurate decision .
CO 3	Determine optimal order quantity when demand is instantaneous and replenishment is either discrete or continuous ,with or without set up cost
CO 4	Analyse the basic characteristic features of a queueing system and acquire skills in analyzing queueing models.
CO 5	Apply replacement policy for items whose efficiency deteriorates with time and for items that fail completely.

Websites and e-Learning Sources

1.https://hbr.org/1964/07/decision-trees-for-decision-making
2. https://en.wikipedia.org/wiki/Decision_theory
3.https://www.rajeshtimane.com/replacement_theory/
4.. http:// ocw.nctu..edu.tw/uploads/classfbs
5. http://www.opensource.org

Mapping of CO with PO

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	2	2
CO 2	3	3	3	2	3
CO 3	2	3	3	2	3
CO 4	3	2	3	2	3
CO 5	2	2	3	2	3
Average	**2.6**	**2.6**	**3**	**2**	**2.8**

Key: Strongly Correlated-3, Moderately Correlated-2, Weakly Correlated-1
No correlation-0

Teaching Methodology

Lecture (chalk and talk, LCD projector)
Problem Solving
Assignment
Seminar.

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15
		Total	100

MATHEMATICS FOR COMPETITIVE EXAMINATIONS

(offered to other PG departments)

Elective – EDE 1
Teaching hours : 60

Course Code : 11SP18/2E/MCE
Credits : 3 LTP : 2 2 0

COURSE OBJECTIVES

To enable the students to

1. To apply knowledge and skill in logical reasoning and problem solving.
2. To understand general aptitude techniques.
3. To identify business applications in Mathematics.
4. To know about various concepts in statistics.
5. To explore and study how to calculate percentage, profit and loss, ratio and proportions.

COURSE OUTLINE

UNIT I: Logical Reasoning

Problems of Ages, Problem of Time, Average, Grouping, Ranking, Arithmetic Reasoning, True discount, Banker's discount, Odd man out. (15 hrs)

UNIT II: Logical Reasoning(contd.)

Time & work, Time & distance, Pipe & cisterns. (15 hrs)

UNIT III: Quantitative Aptitude

Percentage, Profit and Loss, Ratio and Proportions (10 hrs)

UNIT IV: Business Applications

Permutations & Combinations, Stocks and Shares (10 hrs)

UNIT V: Statistics

Basic concepts in testing of hypothesis, Type I Error and Type II error, Level of significance, ANOVA classification-One way classification and Two way classification (Only Simple Problems)

(10 hrs)

RECOMMENDED TEXTBOOK :

Quantitative aptitude by R.S. Agarwal, S.Chand & Co, Ltd., 2007.

REFERENCE BOOKS:

1. Business Mathematics by P.R. Vittal, Margham Publicationa,1999.
2. Statistics by P.Sivarama Krishna Das, C.Vijayakumari ,Viji's academy 2010.
3. Quantitative Aptitude by U Mohan Rao , Scitech Publication, 2007.
4. Allied Mathematics by P.R.Vittal, Margham Publications, 2009.
5. A modern approach to logical reasoning R.S. Agarwal, S.Chand & Co, Ltd., 1999.

JOURNALS:

Ratio and proportion. Pmd-ncert
Aptitude made easy- Ratio and proportions-1, Basics and Methods
The Mathematics Intelligencer
Mathematic News Letter.

WEBSITES AND E-LEARNING SOURCES

1. http// mathforum.org
2. http:// ocw.mit edu/ocwweb/mathematics
3. http:// www.opensource.org, www.casact
4. https://digital.com/blog/profit-loss-statement/
5. https://www.khanacademy.org/math/pre-algebra/pre-algebra-ratios-rates

COURSE OUTCOMES Upon Completion of this course, the students will be able to

CO NO.	CO Statement
CO1	Analyse various types of problems with logical reasoning
CO2	Examine and identify the techniques
CO3	Apply the analytical techniques and knowledge in business.
CO4	Analyse the various concepts in statistics
CO5	Apply the formula and perform calculations through quantitative aptitude

MAPPING OF CO WITH PSO

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	3
CO2	3	3	3	2	3
CO3	3	3	2	3	2
CO4	3	2	2	3	2
CO5	3	1	2	3	3
Average	3	2.2	2.4	2.6	2.6

Key: Strongly Correlated-3, Moderately Correlated-2, Weakly Correlated-1
No correlation-0

TEACHING METHODOLOGY:

Lecture (chalk and talk)
Problem Solving,
Discussion and Interactive session,
Assignment, Quiz, Seminar

QUESTION PAPER PATTERN

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15
		Total	100

INTERNSHIP

Credits : 2 **Duration: 21 working days**

Students have to undergo an Internship Programme during the summer vacation immediately after the second semester and are required to submit a project report.

Viva voce will be conducted and students will be awarded two credits.

SEMESTER III COURSE PROFILE

Course Title & Course Code	Credits	Hours/ week	Total Hours	L	T	P	C.A	S.E	Total	Page No
Complex Analysis I 11SP18/3C/CA1	4	5	75	3	2	0	40	60	100	**47**
Topology 11SP18/3C/TOP	4	5	75	3	2	0	40	60	100	**50**
Differential Geometry 11SP18/3C/DGY	4	5	75	3	2	0	40	60	100	**53**
Calculus of Variations and Integral Equations 11SP18/3C/CVI	4	5	75	3	2	0	40	60	100	**56**
(Option 1) Mathematical Statistics I 11SP18/3E4/MS1 **(Option 2) Fluid Dynamics** 11SP18/3E4/FDY	3	4	60	2	2	0	40	60	100	**59** **62**
Resource Management Techniques 11SP18/3E/RMT	3	4	60	2	2	0	40	60	100	**65**
Analytical Skills for NET/SET (Soft Skills) 11SP18/3S/ASN	2	2	30	2	0	0			50	**68**

COMPLEX ANALYSIS – I

CORE : 8 **COURSE CODE: 11SP18/3C/CA1**
TOTAL HOURS: 75 hrs **CREDITS: 4 L-T-P : 3 – 2 - 0**

COURSE OBJECTIVES:

To enable the students to

- Impart knowledge and skills in Cauchy integral formula and local properties of analytic functions.
- Expose to general form of Cauchy's theorem.
- Understand properties of Harmonic functions on a disc and concerned results.
- Introduce series and product developments.
- Understand Hadamard's three circle theorem.

COURSE OUTLINE:

Unit I : Complex Integration

Cauchy's Integral Formula: The index of a point with respect to a closed curve - The integral formula – Higher derivatives.

Local properties of Analytical functions: Removable singularities --Taylor's theorem – Zeros and poles – The Local mapping – The Maximum principle.

Chapter 4 : Section 2: 2.1 – 2.3
Section 3: 3.1 – 3.4 (15 hrs)

Unit II : The General Form of Cauchy's Theorem

Chains and cycles – Simple connectivity – Homology – The General statement of Cauchy's theorem – Proof of Cauchy's Theorem – Locally Exact Differentials – Multiply connected regions.

The calculus of Residues: The Residue Theorem – The Argument Principle.

Chapter 4 : Section 4: 4.1 – 4.7
Section 5: 5.1 – 5.2 (15 hrs)

Unit III : Harmonic Functions

Definition and Basic properties – The mean value property – Poisson's formula - Schwartz's Theorem – The reflection principle

Chapter 4 : Section 6: 6.1 – 6.5 (15 hrs)

Unit IV: Series and Product Developments

Power series Expansions : The Weierstrass's theorem – The Taylor series – The Laurent series

Chapter 5 : Section 1: 1.1 – 1.3 (15 hrs)

Unit V: Partial Fractions and Factorization

Partial fractions – Infinite products – Canonical Products – The Gamma function.
Entire functions: Jenson's formula -- Hadamard's theorem (Statement only)

Chapter 5 : Section 2: 2.1 -2.4
Section 3: 3.1,3.2 (15 hrs)

RECOMMENDED TEXT:

1. Lars.V.Ahlfors, Complex Analysis(3rd Edition)Mc Graw Hill Co., New York,1979.

REFERENCE BOOKS:

1. H.A. Prestly, Introduction of Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of one complex variable, Springer-Verlag, International Student Edition, Narosa Publishing Co.,
3. E.Hille, Analytic function theory (2 Vols.) Gonm & Co. 1959.
4. M.Heins, Complex function theory, Academic Press New york, 1968.
5. Tom Apostol, Introduction to Analytic Number Theory, Narosa Publications, New Delhi.

Periodicals:

Complex Analysis and its synergies
Complex Analysis and Operator Theory
Complex Manifolds
The Mathematics Intelligencer
Mathematic News Letter

COURSE OUTCOMES:

Upon Completion of this course, the students will be able to

CO Number	CO STATEMENT
CO 1	Identify how analytic functions are useful in complex integration
CO 2	Find parametrizations of curves and compute line integrals directly and also solving problems involving residues
CO 3	Effectively locate and use the information needed to prove theorem and establish mathematical results
CO 4	Manipulate and use power series
CO 5	represent rational functions

Websites and e- learning sources

http//mathforum.org
http//www.opensource.org
http//www.math.stackexchange.com
http//www.mathfaculty.fullerton.edu
http//www.researchgate.net
http//www.maths.ed.ac.uk

MAPPING-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	1	1	2
CO2	2	2	3	1	2
CO3	3	2	2	1	1
CO4	2	2	2	1	2
CO5	2	1	1	1	2
AVERAGE	2.4	1.8	1.8	1	1.8

Key: Strongly Correlated-3, Moderately Correlated-2, Weakly Correlated-1
No correlation-0

TEACHING METHODOLOGY:

Lecture (chalk and talk, LCD projector),
Problem Solving,
Discussion and Interactive session,
Assignment,
Quiz, Seminar

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

TOPOLOGY

Core - 9 **Course Code : 11SP18/3C/TOP**
Teaching hours : 75 **Credits : 4** **LTP: 3 2 0**

This course will enable the students

- To understand about the topological spaces and continous functions.
- To have a clear picture of connectedness and local connectedness
- To get knowledge on compact spaces and Hausdorff spaces
- To learn about Countability and Separation Axioms.
- To introduce the concept of normal and metrizable spaces

COURSE OUTLINE:

UNIT I :Topological Spaces and Continuous Functions

Topological spaces, Basis for a topology, The order Topology, The product Topology on X x Y, The subspace Topology.

Chapter 2 : Sections : 12 - 16 (15 hrs)

UNIT II :Connectedness and Compactness

Connected spaces and Connected subspaces of the Real line, Components and Local Connectedness.
Chapter 3 : Sections : 23 - 25 (15 hrs)

UNIT III :Connectedness and Compactness(Contd.)

Compact spaces, Compact subspaces of the Real line and Limit point Compactness, Local Compactness.

Chapter 3 : Sections: 26- 29 (15 hrs)

UNIT IV:Countability and Separation

The Countability Axioms, The separation Axioms, Normal spaces.

Chapter 4 : Sections : 30 -32 (15 hrs)

Unit V: Countability and Separation Axioms(Contd.)

The Urysohn Lemma, The Urysohn Metrization Theorem, The Tietze ExtensionTheorem.

Chapter 4 : Sections : 33, 34 and 35 (15 hrs)

RECOMMENDED TEXT:
James R. Munkres, Topology, Second Edition, 2002.

REFERENCE BOOKS

1. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill International Book Company, New York, 1963
2 .W. Rudin, Functional Analysis, Tata McGraw-Hill Publishing Company, New Delhi, 1973.
3. G. Bachman and L. Narici, Functional Analysis Academic Press, New York, 1966.
4. H.C. Goffman and G. Fedrick, First course in Functional Analysis, Prentice Hall of India, New Delhi, 1987.
5. E. Kreyszig, Introductory Functional Analysis with Application, John Wiley & Sons, New York, 1978.

Periodicals

The Mathematics Intelligencer .
Mathematics News letter.
Journal of topology and analysis
Topology and its applications.

Websites and e-Learning Sources

http://mathworld.wolfram.com/
http://mathonline.wikidot.com/bases-of-a-topology-
https://www.sciencedirect.com/science/article/pii/S0166864112003331
https://faculty.etsu.edu/gardnerr/5357/notes/Munkres-Chapter4-intro.pdf
https://faculty.etsu.edu/gardnerr/5210/notes/12-1.pdf

COURSE OUTCOMES:

Upon Completion of this course, the students will be able to

CO NO	COURSE OUTCOME STATEMENT
CO 1	Outline terms, definitions and theorems related to topology.
CO 2	Use continuous functions and homeomorphisms to understand connectedness and local connectedness
CO3	Demonstrate knowledge and understanding of compact spaces and Hausdorff spaces
CO4	Discuss and illustrate the concepts of the countability and separation axioms
CO5	Explain a selection of theorems concerning normal and metrizable spaces,

MAPPING-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	2	2	2
CO 2	3	3	3	2	2
CO 3	3	2	3	2	2
CO 4	3	2	2	2	2
CO 5	3	2	2	2	2
Average	3	2.4	2.4	2	2

Key: Strongly Correlated-3, Moderately Correlated-2, Weakly Correlated-1
No correlation-0

TEACHING METHODOLOGY:

Lecture (chalk and talk, LCD projector),
Problem Solving,
Discussion and Interactive session,
Assignment, Quiz, Seminar

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

DIFFERENTIAL GEOMETRY

Core - 10 **Course Code:11SP18/3C/DGY**
Teaching hours : 75 **Credits : 4 LTP: 3 2 0**

Course Objectives

1. To introduce space curves and the intrinsic properties of surface and geodesics.
2. To derive the theorem for Fundamental theorem for space curves .
3. To have the knowledge about Non intrinsic properties of surface.
4. To derive the Involutes and Evolutes of the curves .
5. To derive the Differential equations for geodesic.

COURSE OUTLINE:

UNIT - I : Space Curves: Definition of Space Curve - Arc length - tangent, normal and binormal - Curvature and torsion - Contact between curves and surfaces
Chapter 1: Sections 1 to 5. (15 hrs)

UNIT – II : Tangent surface - involutes - Evolutes - Intrinsic equation - Fundamental Existence Theorem for space curves - Helices.
Chapter 1: Section 6 to 9. (15 hrs)

UNIT - III: Intrinsic properties of a surface.
Definition of a surface - Curves on a Surface - Surface of revolution - Helicoids.
Chapter II: Sections 1 to 4. (20 hrs)

UNIT - IV: Metric - Direction Coefficients - Families of curves - Isometric correspondence - Intrinsic properties.
Chapter II: Section 5 to 9 (20hrs)

UNIT V: GEODESIC Geodesics - Canonical Geodesic equations - Normal property of Geodesics - Geodesic Parallels - Geodesic Curvature - Gauss - Bonnet Theorem - Gaussian Curvature - Surface of constant curvature.
Chapter II: Sections 10 to 18 (Omit 13) (20 hrs)

RECOMMENDED TEXT

T.J. Willmore, An introduction to Differential Geometry Oxford University Press (17th Impression) New Delhi-2002 Indian Print

REFERENCE BOOKS

1. Stuik, D.T. Lectures on Classical Differential Geometry Addision - Wesley Mass, 1950.

2. Mittal & Agarwal, Differential Geometry, Krishna Prakasham Media Pvt. Ltd., 27th edition (1999).
3. S.G. Venkatachalapathy , Differential Geometry, Margam Publications, 2007
4. ROHIT GARG A BASICS OF Differential Geometry, 2002.
5. D.SOMASUNDARAM, Differential Geometry_Narosa Publication Housing ltd, 2015.

JOURNALS

Differential geometry and its applications
Journal of differential geometry
The Mathematics Intelligencer .
Mathematics News letter.

WEBSITES AND e-LEARNING SOURCES

http://ocw.mit.edu/ocwweb/Mathematics
https://www.math.upenn.edu/~siegelch/Notes/diffgeo.pdf
http://math.uchicago.edu/~may/REU2017/REUPapers/Cruz.pdf
http://mathworld.wolfram.com/SurfaceofRevolution.html
https://web.stanford.edu/~ajlucas/The%20Geodesic%20Equation.pdf

COURSE OUT COMES: Upon Completion of this course, the students will be able to

CO No.	CO Statement
CO 1	explain the concept of 3D in Frenet Serret formula.
CO 2	explain the fundamental Existence theorem for space curves.
CO 3	analyse the concept of anchor rings,helicoids,surface of revolution.
CO 4	establish basic properties of geodesics, evolutes and minimal surfaces.
CO 5	compute the differential equations for a geodesic.

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	2	3	3	4	3
CO 2	2	2	3	2	2
CO 3	2	2	3	2	2
CO 4	2	2	3	2	2
CO 5	2	2	3	2	2
Average	**2**	**2.2**	**3**	**2.2**	**2.2**

Key: **S**trongly Correlated-3, **M**oderately Correlated-2, **W**eakly Correlated-1
No correlation-0

TEACHING METHODOLOGY:

Lecture (Chalk and Talk LCD)
Problem Solving
Seminar
Peer Learning

Template – End Semester Examination

Knowledge level	Component	Nature of the question	Maximum marks
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15
		Total	100

CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

CORE : 11 **COURSE CODE : 11SP18/3C/CVI**
TOTAL HOURS : 75 **CREDITS: 4 L- T- P : 3 - 2 - 0**

COURSE OBJECTIVES : To enable the students to

1. understand the basic techniques and results of the Calculus of Variations and Integral Equations.
2. acquire knowledge about the integral equation, its classification ,different kinds of kernels.
3. know about successive approximations, resolvent kernel of a integral equation,
4. formulate important results and theorems
5. use the theory, methods and techniques of integral equations to solve problems;

COURSE OUTLINE:

UNIT I Variational Problems With Fixed and Moving Boundaries

The Concept of Variation and its properties – Euler's equation – Variational problems for functional of form – Functionals dependent on higher order derivatives – Functional of form I(y(x))=$\int_{x_1}^{x_2} F(x, y, y')dx$. – Movable boundary for a functional dependent on two functions.

Chapter 1 : 1.1 to 1.4 & 2.1-2.2 (15 hrs)

UNIT II Sufficient Conditions For an Extremum

Field of Extremals-Jacobi Condition - Weistrass function -Legendre Condition-problems.

Chapter 3 : 3.1 to 3.4 (10 hrs)

UNIT III Integral Equations

Introduction – Definition– Special kinds of Kernals – Eigen values and eigen functions – Convolution integral – Reduction to a system of algebraic equations – Examples – Fredholm alternative – Examples .

Chapter 1 : 1.1 , 1.3 to 1.5 & Chapter 2 : 2.1 to 2.4 (15 hrs)

Unit– IV Method Of Successive Approximations and Fredholm Theory

Iterative scheme – Examples – Volterra integral equations – Examples – Some results about the resolvent kernel – The method of solution of Fredholm equation –

Fredholm First theorem(statement only) – Examples- Fredholm Second &Third theorems(Statement only)

Chapter 3 : 3.1 to 3.5 & Chapter 4 : 4.2 to 4.5 (20 hrs)

UNIT V Applications To Ordinary Differential Equations

Introduction – Fundamental properties of Eigen values and Eigen functions for symmetric kernels- Hilbert Schmidt Theorem(Statement only)-Solution of a Symmetric Integral Equation-Examples-Abel Integral Equation-Examples.

Chapter 7 : 7.1 , 7.2 , 7.4 , 7.5
Chapter 8 : 8.1 , 8.2 (15 hrs)

RECOMMENDED TEXT

1. A. S. Gupta, Calculus of Variations with Applications, PHI, New Delhi, 2005. (for Units I and II)
2. Ram P. Kanwal, Linear Integral Equations, Theory and Techniques, Academic Press, New York, 1971. (for Units III, IV and V)

REFERENCE BOOKS

1. L. Elsgolts, Differential Equations and Calculus of Variations, Mir Publishers, Moscow, 1973.
2. M. D. Raisinghania, Integral Equations and Boundary Value Problems, S. Chand & Co., New Delhi, 2007.
3. Sudir K. Pundir and Rimple Pundir, Integral Equations and BoundaryValue Problems , Pragati Prakasam, Meerut. 2005.
4. Israel M.Gelfand and S.V.Forum, Calculus of Variations .
5.A First Course in Integral Equations , Abdul Majid Wazwaz,Second edition,

COURSE OUTCOMES

Upon Completion of this course, the students will be able to

CO NO	COURSE OUTCOME STATEMENT
CO 1	Apply Euler-Lagrange equation or its first integral to find differential equations for stationary paths Demonstrate a depth of understanding in advanced mathematical topics in relation to geometry of curves and surfaces
CO 2	Find the extremal of a functional.
CO3	Acquire sound knowledge of different types of Integral equations: Fredholm and Volterra integral equations. Represent integral equations to algebraic system of equations
CO4	Evaluates the solution to an integral equation using successive approximation.
CO5	Finds solution to a symmetric integral equation.

Periodicals:

The Mathematics Intelligencer .
Mathematics News letter.
www.researchgate.net/journal/1864-8258

Websites and e-Learning Sources:

mathworld.forum.com
www.colorado.edu
www.science direct.com
www.hindawi.com
www.gregschool.org/lagrangian - mechanics/2017

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	1	3
CO2	2	2	2	1	2
CO3	3	2	3	1	3
CO4	3	3	3	1	3
CO5	3	3	2	1	2
Average	2.8	2.6	2.6	1	2.6

Key: Strongly Correlated-3, Moderately Correlated-2, Weakly Correlated-1
No correlation-0

TEACHING METHODOLOGY: Lecture (Chalk and Talk LCD)
Problem Solving, Seminar, Peer Learning

Template – End Semester Examination

Knowledge level	Component	Nature of the question	Maximum marks
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15
		Total	100

(Option 1)
MATHEMATICAL STATISTICS I

TOTAL HOURS: 60 hrs **COURSE CODE:11SP18/3E4/MS1**
CREDITS : 3 **L-T-P : 2-2-0**

COURSE OBJECTIVES:

1. To learn the significance of characteristic functions.
2. To study about various discrete and continuous type distributions.
3. To understand about special cases of limit theorems.
4. To understand more about the limit theorems pertaining to limit distribution function.
5. To learn the importance of the theory of Markov Stochastic processes.

COURSE OUTLINE:

UNIT I : Characteristic Functions

Properties of characteristic functions-The characteristic functions and their moments-Semi-invariants-The characteristic function of the sum of independent random variables-Determination of the distribution function by the characteristic functions-The characteristic function of multidimensional random vectors-Probability generating functions.

Chapter 4: Sections 4.1to 4.7.

(12 hrs)

UNIT II : Some Probability Distributions

One-point and two -point distributions-The Bernoulli scheme. The Binomial Distribution-The Polya and hypergeometric distributions-The Poisson distribution-The uniform distribution-The normal distribution-The gamma distribution-The Beta distribution-The Cauchy and Laplace distributions.

Chapter-5: Sections:5.1 to 5.10 (omit5.3)

(12 hrs)

UNIT III : Limit Theorems

Preliminary remarks -Stochastic convergence-Bernoulli's law of large numbers-The convergence of a sequence of distribution functions-The Riemann-Stieljies integral-The Levy-Cramer theorem.

Chapter 6: Section 6.1 to 6.6

(12 hrs)

UNIT IV: Limit Theorems(Contd.)

The De-Moivre - Laplace theorem - The Lapunov theorem-The Gnedenko theorem-Poisson's, Chebychev's and Khintchin's laws of large numbers-The strong law of large numbers.

Chapter 6 Sections 6.7 to 6.12.

(12 hrs)

UNIT V: Markov Chains

Preliminary remarks-Homogeneous Markov chains-The transition matrix-The ergodic theorem-Random variables forming a homogeneous Markov chain.
Chapter7:Sections7.1to7.5 (12 hrs)

RECOMMENDED TEXTBOOKS:

M.Fisz, Probability Theory and Mathematical Statistics, John Wiley and sons, New York, 1963.

REFERENCE BOOKS:

1. R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972
2. K.L.Chung, A course in Probability, Academic Press, New York, 1974.
3. Y.S.Chow and H.Teicher, Probability Theory, Springer Verlag. Berlin, 1988 (2nd Edition)
4. R.Durrett, Probability : Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996.
5. V.K.Rohatgi An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988(3rd Print).
6. S.I.Resnick, A Probability Path, Birhauser, Berlin,1999.
7. B.R.Bhat ,Modern Probability Theory (3rd Edition), New Age International (P)Ltd, New Delhi, 1999
8. J.P. Romano and A.F. Siegel, Counter Examples in Probability and Statistics, Wadsworth and Brooks / Cole Advanced Books and Software, California, 1968

JOURNALS:

1. Journal of Mathematics and Statistics, Science Publications.
2. International Journal of Mathematics and Statistics™
3. The Mathematics Intelligencer .
4. Mathematics News letter.

E-LEARNING RESOURCES:

1. https://nptel.ac.in/courses/108106083/lecture26_CF.pdf
2. https://en.wikipedia.org/wiki/Poisson_binomial_distribution
3. https://www.math.uh.edu/~climenha/blog-posts/ergodic-theorem.pdf
4. https://www.math.unl.edu/~sdunbar1/ProbabilityTheory/Lessons/BernoulliTrials/DeMoivreLaplaceCLT/demoivre
5. http://www.math.uchicago.edu/~may/VIGRE/VIGRE2007/REUPapers/FINALFULL/Casarotto.pdf

COURSE OUTCOMES: Upon Completion of this course, the students will be able to

CO Number	CO STATEMENT
CO 1	Investigate the expected value of certain function of a random variable.
CO 2	Analyze some probability distributions of special importance in either theory or practice.
CO 3	Apply the limit theorems in problems.
CO 4	explain the significance of the law of large numbers.
CO 5	Apply the knowledge of Markov chain in the problems.

MAPPING-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	2	1	2	2	2
CO2	1	3	2	2	2
CO3	2	2	2	2	2
CO4	3	2	3	2	2
CO5	3	2	2	2	2
Average	**2.2**	**2**	**2.2**	**2**	**2**

Key: **S**trongly Correlated-3 **M**oderately Correlated-2**w**eakly Correlated-1 **N**o Correlation-0

TEACHING METHODOLOGY: Lecture (Chalk and Talk-OHP-LCD) Problem Solving-Group Discussion, Quiz-Seminar

Template – End Semester Examination

Knowledge leve	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

(Option 2)
FLUID DYNAMICS

TOTAL HOURS : 60 **COURSE CODE : 11SP18/3E4/FDY**
CREDITS: 3 **L- T- P : 2 - 2 - 0**

COURSE OBJECTIVES : To enable the students to

1. understand the basic techniques and results of the Fluid dynamics
2. familiarize with the properties of fluids and the applications of fluid mechanics.
3. understand the concept of fluid measurement, types of flows and dimensional analysis
4. formulate important results and theorems
5. use the theory, methods and techniques of fluid dynamics to solve problems

COURSE OUTLINE:.

UNIT-I : Kinematics of Fluids in motion

Real fluids and Ideal fluids - Velocity of a fluid at a point, Stream lines , path lines steady and unsteady flows - Velocity potential – The vorticity vector- Local and particle rates of changes - Equations of continuity – Worked examples

Chapter 2. Sec 2.1 to 2.8

UNIT-II: Equations of motion of a fluid

Pressure at a point in a fluid at rest.- Pressure at a point in a moving fluid - Conditions at a boundary of two inviscid immiscible fluids - Euler's equation of motion .

Chapter 3 Sec 3.1 to 3.4

UNIT-III : Some three dimensional flows.

Introduction- Sources, sinks and doublets - Images in a rigid infinite plane – Axi- symmetric flows – Stoke's stream function

Chapter 4 Sec 4.1, 4.2, 4.3, 4.5.

UNIT- IV : Some two dimensional flows

Meaning of two dimensional flow - Use of Cylindrical polar coordinate - The stream function - The Complex potential for two dimensional , irrotational in compressible flow - The Milne Thompson circle Theorem.

Chapter 5 Sec 5.1 – 5.4 , 5.8

UNIT-V: Viscous flows

Stress components in a real fluid. - Relations between Cartesian components of stress- Translational motion of fluid elements - The rate of strain quadric and principle stresses - Some further properties of the rate of strain quadric The Navier – Stoke's equations of motion of a Viscous fluid.

Chapter 8 Sec 8.1 – 8.5, 8.9

Recommended Text

F. Chorlton, *Text Book of Fluid Dynamics* ,CBS Publications. Delhi ,1985

Reference Books

1. R.W. Fox and A.T. McDonald. Introduction to Fluid Mechanics, Wiley, 1985.
2. E. Krause, Fluid Mechanics with Problems and Solutions, Springer, 2005.
3. B.S. Massey, J.W. Smith and A.J.W. Smith, Mechanics of Fluids, Taylor and Francis, New York, 2005
4. P. Orlandi, Fluid Flow Phenomena, Kluwer, New Yor, 2002.
5. M.D.Raisinghania ,Fluid Dynamics ,S.Chand Publishing,2003

COURSE OUTCOMES

Upon Completion of this course, the students will be able to

CO NO	COURSE OUTCOME STATEMENT
CO 1	Identifies the values of fluid properties and relationship between them and understands the principles of continuity, momentum, and energy as applied to fluid motions.
CO 2	Understands the pressure of fluids at rest and at all points.
CO3	Uses the condition at a boundary of immiscible fluids to solve problems
CO4	Predicts physical parameters that influence the flow in fluid mechanics.
CO5	Knows the relation between Cartesian components of stress

Periodicals:

International journal of computational fluid dynamics
Structural analysis of axisymmetric solids/AIAA Journal
Journal of applied fluid mechanics- SCI mago

Websites and e-Learning Sources:

http://mathworld.wolfram.com/Euler-LagrangeDifferentialEquation.html
https://www.mathwarehouse.com › geometry › parabola › axis-of-symmetry
https://www.sciencedirect.com › topics › engineering › immiscible-liquid
https://math.stackexchange.com › questions › milne-thomson-method--...
https://www.comsol.co.in › multiphysics › navier-stokes-equations

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	1	1
CO2	2	2	1	1	1
CO3	2	2	1	1	2
CO4	1	1	2	1	2
CO5	2	2	1	1	2
Average	1.8	1.6	1.2	1	1.6

Key: **S**trongly Correlated-3, **M**oderately Correlated-2, **W**eakly Correlated-1
No correlation-0

TEACHING METHODOLOGY: Lecture (Chalk and Talk LCD)
Problem Solving, Seminar, Peer Learning

Template – End Semester Examination

Knowledge level	Component	Nature of the question	Maximum marks
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15
		Total	100

RESOURCE MANAGEMENT TECHNIQUES

(offered to other PG departments)

Elective – EDE 2 **Course Code : 11SP18/3E/RMT**
Teaching hours : 60 **Credits : 3 LTP : 2 2 0**

COURSE OBJECTIVES

To enable the students to

1. To have knowledge and skill in the basics of Linear Programming Problem.
2. To expose how to formulate maximize and minimize problems through various techniques.
3. To introduce applications in transportation problem.
4. To study various concepts in sequencing problems.
5. To know how to apply maximin - minimax principle in game theory.

UNIT I : LINEAR PROGRAMMING PROBLEM

Formulation - Maximization Problems and Minimization problems - Solutions by Graphical Method,(simple problems). (10 hrs)

UNIT II: TRANSPORTATION PROBLEM

Northwest Corner Rule - Least Cost Method - Vogel's Approximation Method - Modi Method (degeneracy included)

(15 hrs)

UNIT III: ASSIGNMENT PROBLEM

Hungarian Assignment Method (balanced problem and unbalanced problem)

(10 hrs)

UNIT IV: GAME THEORY

Two person Zero Sum game, The maximin-minimax principle, saddle point and value of the games, Games without saddle points, mixed strategies, Dominance property.

(15 hrs)

UNIT V: SEQUENCING

Introduction, Sequencing Problem, General Assumptions, Sequencing decision problems for n jobs on two machines and three machines. (10 hrs)

RECOMMENDED TEXT

R.K. Gupta, Linear Programming, Krishna Prakashan media pvt ltd., 2012.

REFERENCE BOOKS

1. S.K. Kalavathy, Operations Research, Vikas publishing house pvt ltd., 2008.
2. Hira & Gupta,Operations Research , S. Chand & Sons publications, 1991.
3. V.K. Kapoor , S.C.Gupta, Problems and Solutions in Operations Research , S.Chand & Sons publications, 2012.
4. Resource Management Techniques by V. Sundaresan, Ganapathy Subramanian, Ganesan, AR Publications, Chennai.
5. Statistical numerical methods by P.R. Vittal, and Malini.

JOURNALS

The Mathematics Intelligencer .
Mathematics News letter.

WEBSITES AND E-LEARNING SOURCES

http:// mathforum.org,
http://ocw.mit.edu/ocwweb/mathematics
http:// www.opensource.org
https://digital.com/blog/profit-loss-statement/
https://www.khanacademy.org/math/pre-algebra/pre-algebra-ratios-rates

COURSE OUTCOMES : Upon Completion of this course, the students will be able to

CO NO.	CO Statement
CO1	Identify problems with fundamentals of LPP
CO2	Create and solve problems by various techniques
CO3	Use the applications in transportation problem.
CO4	Select various concepts in sequencing problems
CO5	Explain calculations through game theory

Mapping of CO with PSO

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	2	3	2
CO2	2	3	3	2	2
CO3	3	2	2	3	2
CO4	2	2	3	2	2
CO5	1	1	3	2	3
Average	2	2.2	2.3	2.4	2.2

Key: Strongly Correlated-3, Moderately Correlated-2, Weakly Correlated-1
No correlation-0

TEACHING METHODOLOGY:

Lecture (chalk and talk)
Problem Solving,
Discussion and Interactive session,
Assignment,
Quiz, Seminar

Question Paper Pattern – End Semester Examination

Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
Section – B	Analysis / Evaluation Problems- At least one question from every Unit	5 (out of 8) x 7= 35
Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

ANALYTICAL SKILLS FOR NET/SET

TOTAL HOURS: 30 hrs **COURSE CODE: 11SP18/3S/ASN**
CREDITS: 2 **L-T-P: 2 – 0 - 0**

COURSE OBJECTIVES:

To enable the students to

- Know the pattern of various examinations
- Get the information about the exams conducted for research and entry into jobs
- Use time effectively and become aware about the various analytical skills

COURSE OUTLINE:

UNIT I: Analysis

Sequences and Series-Continuity- Differentiability- Cauchy-Riemann Equations-Singularities-Residues (10 hrs)

UNIT-II: Algebra

Groups-Cyclic Groups-Class Equations-Sylow Theorems-Rings-Fields (10 hrs)

UNIT-III: Differential Equations

First Order Ordinary Differential Equations-First Order Partial Differential Equation-Heat Equation-Wave Equations (10 hrs)

RECOMMENDED TEXTS

1. N.P.Bali ,Real Analysis , Laxmi Publications, 2009.
2. Arumugam,Complex Analysis , Scitech , 2007.
3. I.N.Herstein,Topics in Algebra, John Wiley & Sons, 2nd Edition, 2012.
4. Rai Singhania, Advanced Differential Equations S. Chand Ltd., 1995.

REFERENCE BOOKS

1. Robert G. Bartle, Introduction to Real Analysis John Wiley & Sons, 4th Edition.
2. Ponnusamy , First Course in Complex Analysis , Narosa Publishing House, 2nd Edition, 2005.
3. Joseph.A.Gallian , Contemporary Abstract Algebra, Cengage, India.
4. ShepleyRoss , Differential Equations John Wiley & Sons, 3rd Edition.
5. Tom Apostol, Introduction to Analytic Number Theory, Narosa Publications, New Delhi.

Periodicals:

Journal of Algebra and its Applications
Complex Analysis and Operator Theory
Journal of Differential equations
International Journal of Differential equations
The Mathematics Intelligencer
Mathematic News Letter

Websites and e- learning sources

http//mathforum.org
http//www.opensource.org
http//www.khanacademy.org
http//in.ixl.com
http//www.learningwave.org

COURSE OUTCOMES: Upon Completion of this course, the students will be able to

CO Number	CO STATEMENT
CO 1	apply principles of Mathematics
CO 2	Demonstrate the understanding of the algebraic concepts
CO 3	Prepare to classify the Differential Equations with respect to their order and linearity and solve problems with initial and boundary conditions

MAPPING-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	3	1	3
CO2	2	3	3	1	3
CO3	2	2	3	1	3
AVERAGE	2.3	2.3	3	1	3

Key: Strongly Correlated-3, Moderately Correlated-2, Weakly Correlated-1
No correlation-0

TEACHING METHODOLOGY: Lecture (chalk and talk, LCD projector), Problem Solving, Discussion and Interactive session, Assignment, Quiz, Seminar.

Knowledge Level	Section	Marks	Total
K_1, K_3, K_5	A 50x 1 = 50 mark	50	50

SEMESTER IV COURSE PROFILE

Course Title	Credits	Hours/ week	Total Hours	L	T	P	C.A	S.E	Total	Page NO
Complex Analysis II 11SP18/4C/CA2	4	6	90	3	3	0	40	60	100	**71**
Functional Analysis 11SP18/4C/FAN	4	6	90	3	3	0	40	60	100	**74**
Fuzzy set theory and its applications 11SP18/4C/FSA	4	5	75	3	2	0	40	60	100	**77**
Python Programming 11SP18/4C/PYP	4	6	90	1	3	2	40	60	100	**80**
(Option 1) Mathematical Statistics II 11SP18/4E5/MS2 **(Option 2) Measure Theory** 11SP18/4E5/MTY	3	5	75	2	3	0	40	60	100	**83** **86**
LATEX - A Document Preparation System (Soft skills) 11SP18/4S/LAT	2	2	30	0	0	2			50	**89**

COMPLEX ANALYSIS – II

CORE :12 **COURSE CODE: 11SP18/4C/CA2**
TOTAL HOURS: 90 hrs **CREDITS: 4 L-T-P: 3 – 3 - 0**

COURSE OBJECTIVES:

To enable the students to

1. Lay the foundation for topics in Advanced Complex Analysis
2. Develop clear thinking and analyzing capacity for research
3. Introduce Riemann Zeta function
4. Impart knowledge on normal families and family of analytic functions
5. Expose to Elliptic functions

COURSE OUTLINE:

UNIT I: Series and Product Developments

The Riemann Zeta Function: The Product Development-Extension of ς (s) to the whole plane- The functional equation - The Zeroes of the Zeta function.

Chapter 5: Section 4: 4.1 - 4.4 (15 hrs)

UNIT II: Normal Families

Equicontinuity-Normality and Compactness-Arzela's theorem-Families of Analytic functions-The Classical Definition.

Chapter 5: Section 5: 5.1 to 5.5 (20 hrs)

UNIT III: Conformal Mapping

The Riemann Mapping Theorem: Statement and Proof- Boundary Behaviour-Use of the Reflection Principle.

Conformal Mapping of Polygons : The Behaviour at an angle – The Schwarz-Christoffel Formula –Mapping on a Rectangle.

Chapter 6: Section 1: 1.1 to 1.3, Section 2: 2.1 to 2.3. (15 hrs)

UNIT IV: Conformal Mapping(Contd.,), Elliptic functions

A Closer Look at Harmonic Functions: Functions with the Mean Value Property-Harnack's Principle.

Simply Periodic Functions:Representation by Exponentials-The Fourier Development-Functions of Finite Order.

Doubly Periodic Functions: The Period Module-Unimodular Transformations.

Chapter 6: Section 3: 3.1, 3.2,
Chapter 7: Section 1: 1.1 to 1.3, Section 2: 2.1, 2.2 (20 hrs)

UNIT V: Elliptic functions (contd.,)

Doubly Periodic Functions : The Canonical Basis-General Properties of Elliptic Functions.

The Weierstrass's Theory: The Weierstrass ρ- function-The functions ς (z) and σ(z)-The Differential Equation.

Chapter 7: Section 2: 2.3, 2.4
Section 3: 3.1 to 3.3 (20 hrs)

RECOMMENDED TEXTS:

1. Lars.V.Ahlfors, Complex Analysis(3rd Edition)Mc Graw Hill Co., New York,1979.

REFERENCE BOOKS:

1. H.A. Prestly, Introduction of Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of one complex variable, Springer-Verlag, International Student Edition, Narosa Publishing Co.,
3. E. Hille, Analytic function theory (2 Vols.) Gonm & Co. 1959.
4. M. Heins, Complex function theory, Academic Press New york, 1968.
5. Tom Apostol, Introduction to Analytic Number Theory, Narosa Publications, New Delhi.

Periodicals:

Complex Analysis and its synergies
Complex Analysis and Operator Theory
Complex Manifolds
The Mathematics Intelligencer
Mathematic News Letter

COURSE OUTCOMES: Upon Completion of this course, the students will be able to

CO Number	CO STATEMENT
CO 1	describe the connection between prime distribution and Zeta function
CO 2	Analyze about family of functions defined in complex domain
CO 3	Discuss mapping properties of elementary functions and some special functions
CO 4	Recognize simple periodic and doubly periodic functions
CO 5	Identify the functions which have either a double pole with zero residue or two simple poles with equal residues but opposite in signs

Websites and e- learning sources
http//mathforum.org
http//www.opensource.org
http//www.mathworld.wolfram.com
http//www.iitg.ac.in
http//www.maths.leeds.ac.uk
http//www.maths.tcd.ie

MAPPING-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	1	2	1	1	1
CO2	2	2	2	1	2
CO3	2	2	1	1	1
CO4	2	2	1	1	2
CO5	2	1	1	1	1
AVERAGE	1.8	1.8	1.2	1	1.4

Key: **S**trongly Correlated-3, **M**oderately Correlated-2, **W**eakly Correlated-1
No correlation-0

TEACHING METHODOLOGY:

Lecture (chalk and talk, LCD projector),Problem Solving, Discussion and Interactive session, Assignment, Quiz, Seminar

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

FUNCTIONAL ANALYSIS

Core - 13 **Course Code : 11SP18/4C/FAN**
Teaching hours : 90 **Credits : 4** **LTP: 3 3 0**

Course Objectives: This course will enable the students

1. To understand the hard core of Functional Analysis.
2. To have a clear picture about Banach spaces and theorems related to it.
3. To know the ideas of Complex Banach spaces.
4. To realize deeply about Hilbert spaces and its properties.
5. To explore and study about the nature and properties of Banach Algebra.

COURSE OUTLINE:

UNIT I : Banach Spaces
The definition and some examples - Continuous linear transformations, The Hahn – Banach theorem.

Chapter : 9 Section : 46 , 47, 48 (20 hrs)

UNIT II : Banach Spaces (Contd..)
The natural imbedding of N in N**- The Open mapping theorem- The Conjugate of an operator

Chapter : 9 Section : 49 - 51 (20 hrs)

UNIT III : Hilbert Spaces
The definition and some simple properties - Orthogonal Complements – Orthonormal sets

Chapter : 9 Section : 52 - 54 (20 hrs)

UNIT IV: Hilbert Spaces (Contd..)
The Conjugate space H* - The adjoint of an operator - Self – adjoint operators

Chapter : 10 Section : 55 - 57 (15 hrs)

UNIT V: Hilbert Spaces & Banach Algebra
Normal and unitary operators – Projections - Banach algebra Definition and some examples – Regular and singular elements – topological divisors of zero.

Chapter : 10 Section : 58, 59
Chapter :12 Sections : 64 - 66 (15 hrs)

RECOMMENDED TEXT:
G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill International Book Company, New York, 1963.

REFERENCE BOOKS

1. W.Rudin, Functional Analysis, Tata McGraw-Hill Publishing Company, New Delhi, 1973.
2. G. Bachman and L. Narici, Functional Analysis, Academic Press, New York, 1966.
3. H.C. Goffman and G. Fedrick, First course in Functional Analysis, Prentice Hall of India, New Delhi, 1987.
4. E. Kreyszig , Introductory Functional Analysis with Application, John Wiley & Sons, NewYork, 1978.
5. Balmohan Vishnu Limaye, *Functional Analysis*, Second edition, New Age International(P) Limited, 2004.

Journals

Journal of Functional Analysis-Elsevier
Journal of Functional Analysis and Applications - Springer
Mathematics News letter.

Websites And E- Learning Sources:
http://math-forum.org,
https://www.sciencedirect.com/journal/journal-of-functional-analysis
http://ocw.mit.edu/ocw web/Mathematics,
http://www.opensource.org,
https://nptel.ac.in /courses/111105037/31
https://www.elsevier.com/mathematics

TEACHING METHODOLOGY: Lecture (Chalk and Talk-OHP-LCD)
Problem Solving - Group Discussion- Quiz-Seminar - Peer Learning.

Course Outcomes: Upon completion of this course the students will be able to

CO No.	CO Statement
CO 1	Identify Banach spaces and analyse their properties with other types of spaces.
CO 2	Examine and identify properties of complex Banach spaces-Hilbert spaces.
CO 3	Apply the analytical techniques and theoretical knowledge in Hilbert Spaces. Find out and determine orthonormal sets.
CO 4	Explain various properties of Hilbert spaces.
CO 5	Gain knowledge and experience of working with many pure mathematical problems.

Mapping of CO with PSO

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	3	3	2
CO 2	3	2	2	2	2
CO 3	3	2	2	2	2
CO 4	3	2	2	2	2
CO 5	3	2	2	2	2
Average	**3**	**2**	**2.2**	**2.2**	**2**

Key: **S**trongly Correlated-3, **M**oderately Correlated-2, **W**eakly Correlated-1
No correlation-0

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

FUZZY SET THEORY AND ITS APPLICATIONS

Core -14 **Course Code:11SP18/4C/FSA**
Teaching Hours : 75 **Credits: 4** **LTP: 3 2 0**

COURSE OBJECTIVES

To enable the students to

1. To introduce fuzzy concepts and it's applications.
2. To expose how to do fuzzy operations on sets.
3. To know about fuzzy numbers and their operations.
4. To study about fuzzy logic fuzzy propositions and fuzzy quantifiers.
5. To apply fuzzy at various fields in engineering.

UNIT I: INTRODUCTION TO FUZZY SET

Fuzzy sets- Basic Types and Basic Concepts, Paradigm Shift, Additional Properties Of Alpha Cut, Representation of fuzzy sets.
Chapter 1 & 2 Sections 1.3,1.4,1.5,2.1,2.2 (15 hrs)

UNIT II: OPERATION ON FUZZY SETS

Types of operations, Fuzzy Compliments t -norm , t- conorm.
Chapter 3: Sections 3.1, 3.2, 3.3, 3.4 (20 hrs)

UNIT III : FUZZY ARITHMETIC

Fuzzy numbers, Arithmetic Operations On Intervals, Arithmetic Operations On Fuzzy Numbers
Chapter 4 Sections: 4.2, 4.3, 4.4 (15 hrs)

UNIT IV : FUZZY LOGIC

Classical logic, Multivalued logic, Fuzzy propositions, Fuzzy quantifiers
Chapter 8 Sections 8.1, 8.2, 8.3, 8.4 (15 hrs)

UNIT V :APPLICATIONS

Civil, Industrial & Mechanical Engineering. (10 hrs)
Chapter 16 Sections 16.2, 16.3, 16.4

RECOMMENDED TEXT :

George j klir/ boyuan, Fuzzy sets and fuzzy logic- theory and its applications,Prentice hall of India, New Delhi 2001.

REFERENCE TEXTBOOKS:

1. Fuzzy arithmetic by Kauffman
2. Fuzzy Set Theory – and its Applications, 4th edition, by L.A. Zadeh.
3. Introduction to Fuzzy Logic by Rajjan Shinghal.
4. Timothy J. Ross, Fuzzy Logic with Engineering Applications.
5. Fuzzy Set Theory, Fuzzy Logic and their Applications by Dr. A.K. Bhargava, S. Chand.

JOURNALS:

International Journal of Fuzzy Logic Systems (IJFLS) - Wireilla
Journal of Intelligent & Fuzzy Systems - IOS Press
The Mathematics Intelligencer.
Mathematics News letter.

WEBSITES AND e-LEARNING SOURCES

http://mathforum.org,
https://cours.etsmtl.ca/sys843/REFS/Books/ZimmermannFuzzySetTheory2001.pdf
http://OCW.mit.edu/ocwweb/Mathematics
www.iaeng.org/IJCS/issues_v39/issue_1/IJCS_39_1_07.pdf
https://sci2s.ugr.es/fss

COURSE OUTCOMES : Upon Completion of this course, the students will be able to

CO NO.	CO Statement
CO1	Create problems using fuzzy concepts.
CO2	Identify and implement the fuzzy operations on sets.
CO3	Use the fuzzy numbers and their operations.
CO4	Discuss fuzzy logics with propositions and quantifiers.
CO5	Predict the logic of fuzzy in engineering fields.

MAPPING OF CO WITH PSO

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	2	3
CO2	2	3	3	2	3
CO3	3	3	2	3	2
CO4	2	2	2	3	2
CO5	1	1	2	3	3
Average	2	2.2	2.4	2.6	2.6

Key: Strongly Correlated-3, Moderately Correlated-2, Weakly Correlated-1
No correlation-0

TEACHING METHODOLOGY:

Lecture (chalk and talk)
Problem Solving,
Discussion and Interactive session,
Assignment,
Quiz, Seminar

Question Paper Pattern – End Semester Examination

Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
Section – B	Analysis, Evaluation Problems- At least one question from every Unit	5 (out of 8) x 7= 35
Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

PYTHON PROGRAMMING

Core - 15 **Course Code : 11SP18/4C/PYP**
Total Hours : 90 **Credits : 4 L- T- P : 1 3 2**

OBJECTIVES :

To enable the students to

1. To do input/output with files in Python.
2. To develop Python programs with conditionals and loops.
3. To define Python functions and call them.
4. To use Python data structures - lists, tuples, dictionaries.
5. To read and write simple Python programs.

COURSE OUTLINE:

UNIT I : Program, variables, expressions and statements

The way of the program – The Python programming language - formal and natural languages. **variables, expressions and statements** – values and types- variables- variable names and keywords - statements- Evaluating expressions- operators and operands- Order of operations - operations on strings.

(15 hrs)

UNIT II :Functions, Conditionals and recursion

Functions- Function calls- Type conversion- Math functions- Composition- Adding new functions- Definitions and use- Flow of execution- Parameters and arguments- Variables and parameters are local- stack diagrams- Functions with results.

Conditionals and recursion – The modulus operator- Boolean expressions- Logical operators- Conditional execution- Alternative execution- Chained conditionals- Nested conditionals- The return statement- Recursion- Stack diagrams for recursive functions- Infinite recursion.

(20 hrs)

UNIT III: Fruitful functions and Iteration

Fruitful functions – Return values- program development- composition- Boolean functions- More recursion- Leap of faith,examples.

Iteration – Multiple assignment- The while statement- Tables- Two – dimensional tables- Encapsulation and generalization- more encapsulation- local variables- more generalization functions. (15 hrs)

UNIT IV:Tuples and Dictionaries

Tuples – Mutability and tuples- Tuple assignment – Tuples as return values – Random numbers – List of random numbers – Counting – Many buckets – a single –pass solution.

Dictionaries - Dictionary operations – Dictionary methods – Aliasing and copying – Sparse matrices – Hints – Long integers – Counting letters.

(20 hrs)

UNIT V: Files,Exception,Classes and Objects

Files and exception : Text files – Writing variables – Directories- pickling – Exceptions.

Classes and objects: User-defined compound types – Attributes – Instances as arguments – Sameness – Rectangles – Instances as return values-Objects are mutable-copying. (20 hrs)

RECOMMENDED TEXT :

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 1st edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 .

REFERENCES:

1. Wesley J. Chun , Core Python Programming" , Prentice Hall Pub, Second Edition, 2006.
2. Charles Dierbach, "Introduction to Computer Science using Python: A Computational
Problem-Solving Focus, Wiley India Edition, 2013.
3. John V Guttag, "Introduction to Computation and Programming Using Python'', Revised
and expanded Edition, MIT Press , 2013.
4. Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An
Introduction to Computer Science using Python 3", Second edition, Pragmatic Programmers, LLC,2013.
5. Harsh Bhasin, "Python for Beginners", ,New Age International Publishers, 2018.

PERIODICALS:

International journal of computer science
Acta informatica

Course Outcomes: Upon Completion of this course, the students will be able to

CO Number	CO statement
CO 1	Discuss on variables, expressions and statements of Python programming
CO 2	Identify different Decision Making statements, Functions, Conditionals and recursion statement.
CO 3	enable the students to develop programs and simple application using python
CO 4	Develop knowledge on Tuples and Dictionaries.
CO 5	Explain different File handling operations , classes and objects.

WEBSITES AND e-LEARNING SOURCES

www.udemy.com/Python/Online-Course
http://greenteapress.com/wp/think- python
https://docs.python.org/3/tutorial/
https://beginnersbook.com/2018/01/introduction-to-python-programming/
https://www.afternerd.com/blog/difference-between-list-tuple/

MAPPING - COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO3	PS04	PSO5
CO 1	2	1	2	3	2
CO 2	2	2	2	2	2
CO 3	1	2	2	3	1
CO 4	2	1	1	3	1
CO 5	1	2	2	3	2
Average	**1.6**	**1.6**	**1.8**	**2.8**	**1.6**

Key: Strongly Correlated-3, Moderately Correlated-2, Weakly Correlated-1
No correlation-0

Teaching Methodology: Lecture (chalk and talk, LCD projector), Problem Solving, Discussion and Interactive session, Assignment, Seminar.

Template – End Semester Examination

Knowledge level	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

(Option 1)
MATHEMATICAL STATISTICS II

TOTAL HOURS: 75 hrs **COURSE CODE:11SP18/4E5/MS2**
CREDITS:3 **L-T-P : 2-3-0**

COURSE OBJECTIVES:

1. To learn various problems using probability theory.
2. To explore various small sample distributions.
3. To learn the importance of limit theorems.
4. To learn the applications of hypothesis testing.
5. To apply the relevant methods in estimating the unknown parameter

COURSE OUTLINE:

UNIT I : Sample Moments and their Functions

The notion of a sample-The notion of a statistic-The distribution of the arithmetic mean of the independent normally distributed random variables-The χ^2 distribution-The distribution of the statistic ($\bar{X}$,S)

Chapter 9: Sections 9.1 to 9.5. (15 hrs)

UNIT II :Sample Moments And Their Functions(Continued)

Student's t-distribution-Fisher's Z-distribution-The distribution of $\bar{X}$for some non-normal populations-The distribution of sample moments and sample correlation coefficients of a two-dimensional normal population-The distribution of regression coefficients.

Chapter-9: Sections 9.6 to 9.10 (15 hrs)

UNIT III : Significance Tests

The concept of a statistical test-Parametric tests for small samples-Parametric tests for large samples- The χ^2 test-Tests of the Kolmogorov and Smirnov type The Wald-Wolfovitz and Wilcoxon-Mann-Whitney tests-Independence tests by contingency tables.

Chapter 12: Sections 12.1 to 12.7 (15 hrs)

UNIT IV:The Theory Of Estimation

Preliminary notions-consistent estimates-Unbiased estimates-The sufficiency of an estimate-The efficiency of an estimate- Asymptotically most efficient estimates-Methods of finding estimates-Confidence intervals.

Chapter 13: Sections 13.1 to 13.8. (15 hrs)

UNIT V:Theory of Hypothesis Testing:

The power function and the OC function-Most powerful tests-Uniformly most powerful test-Unbiased tests
Chapter 16: Sections 16.2 to 16.5 (15 hrs)

RECOMMENDED TEXTBOOK:

M. Fisz, Probability Theory and Mathematical Statistics, John Wiley and sons, New York, 1963.

REFERENCE BOOKS:

1. R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972
2. K.L.Chung, A course in Probability, Academic Press, New York, 1974.
3. Y.S.Chow and H.Teicher, Probability Theory, Springer Verlag. Berlin, 1988 (2nd Edition)
4. R.Durrett, Probability : Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996.
5. V.K.Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988(3rd Print).
6. S.I.Resnick, A Probability Path, Birhauser, Berlin,1999.
7. B.R.Bhat ,Modern Probability Theory (3rd Edition), New Age International (P)Ltd, New Delhi, 1999
8. J.P. Romano and A.F. Siegel, Counter Examples in Probability and Statistics, Wadsworth and Brooks / Cole Advanced Books and Software, California, 1968

JOURNALS:

1. Journal of Mathematics and Statistics, Science Publications.
2. International Journal of Mathematics and Statistics™
3. The Mathematics Intelligencer
4. Mathematic News letter.

E-LEARNING RESOURCES:

1. https://www.le.ac.uk/users/dsgp1/COURSES/LEISTATS/Lecture8.pdf
2. https://en.wikipedia.org/wiki/Fisher%27s_z-distribution
3. https://www.statisticssolutions.com/tests-for-two-independent-samples/
4. https://www.analytics-toolkit.com/glossary/efficient-estimator/
5. https://www.stat.washington.edu/jaw/COURSES/580s/581/LECTNOTES/ch6a.pdf

COURSE OUTCOMES: Upon Completion of this course, the students will be able to

CO Number	CO STATEMENT
CO 1	Apply the methods of solving many statistical problems by means of probability theory.
CO 2	Investigate statistical problems to draw conclusions about the unknown part.
CO 3	Explain about special cases of limit theorems.
CO 4	apply the procedures of significance tests in problems
CO 5	Analyze the theory dealing with the theory of estimation to estimate the unknown parameter.

MAPPING-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	3	2	2
CO2	2	2	2	2	2
CO3	3	3	3	2	2
CO4	2	2	2	1	2
CO5	2	2	2	2	2
AVERAGE	**2.4**	**2.2**	**2.4**	**1.8**	**2**

Key: **S**trongly Correlated-3, **M**oderately Correlated-2, **W**eakly Correlated-1
No correlation-0

TEACHING METHODOLOGY: Lecture (Chalk and Talk-OHP-LCD) Problem Solving-Group Discussion, Quiz -Seminar.

Template – End Semester Examination

Knowledge leve	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

(Option 2)

MEASURE THEORY

TOTAL HOURS: 75 hrs **COURSE CODE:11SP18/4E5/MTY**
CREDITS : 3 **L-T-P : 2-3-0**

COURSE OBJECTIVES

To enable students to

1. Understand basics in Lebesgue measure and integration.
2. Introduce Borel sets and Hausdorff measure.
3. Know about integration with respect to measure.
4. Have knowledge on convergence in measure.
5. Understand integration in Product space.

UNIT I: The Lebesgue Integral:

The class of Lebesgue-integrable functions on a general interval-Basic properties of the Lebesgue integral-Lebesgue integration and sets of measure zero.

(15 hrs)

Book 1: Chapter 10: Sections: 10.6, 10.7, 10.8

UNIT II: Measure on a Real Line:

Measurable sets on the real line-The Lebesgue integral over arbitrary subsets of R-Lebesgue integrals of complex valued functions-Borel and Lebesgue measurability-Hausdorff measures on the real line. (20 hrs)

Book 1: Chapter 10: Sections: 10.18, 10.19, 10.20
Book 2: Chapter 2: Sections: 2.5, 2.6

UNIT III: Abstract Measure Spaces:

Measures and Outer Measures- The L^p Spaces-Convex functions. (10 hrs)

Book 2: Chapter 5:5.1, 5.5, 5.6; Chapter 6:6.1, 6.2

UNIT IV: Convergence and Lebesgue-Stieltjes integration:

Convergence in Measure- Almost Uniform Convergence- Counter examples.

(15 hrs)

Book 2: Chapter 7: Sections: 7.1, 7.2, 7.4

UNIT V: Convergence and Lebesgue-Stieltjes integration:

Convergence in Measure- Almost Uniform Convergence- Counter examples - Lebesgue-Stieltjes Measure.

(15 hrs)

Book 2: Chapter 7: Sections: 7.1, 7.2, 7.4; Chapter 9: Sections: 9.1

RECOMMENDED TEXTS:

1. Tom M. Apostol, Mathematical Analysis, Narosa Publishing House Pvt., Ltd., 2002.
2. G.de Barra, Measure Theory and Integration, New Age International Publishers, 2009.

REFERENCE BOOKS:

1. H.L.Royden, P.M.Fitzpatrick, Real Analysis, Pearson Education, 2011.
2. W.Rudin, Real and Complex Analysis, Mc Graw Hill International Editions, 1987.
3. Richard R. Goldberg, Method of Real Analysis, Oxford and IBH Publisher Company, New Delhi.
4. Robert G. Bartle, The Elements of Integration and Lebesgue Measure, Wiley Classics Library.
5. Alan J. Weir, Lebesgue Integration and Measure, Cambridge University Press, 1973.

PERIODICALS:

The Mathematics Intelligencer.
Mathematics News Letter.

WEBSITES AND E-LEARNING SOURCES:

https://www.math.ucdavis.edu/~hunter/measure_theory/measure_theory.html
http://mathworld.wolfram.com/MeasureTheory.html
http://mathworld.wolfram.com/LebesgueMeasure.html
http://mathworld.wolfram.com/ProductMeasure.html
https://www.sciencedirect.com/topics/mathematics/hausdorff-measure

Course Outcomes:

Upon completion of this course the student will be able to

CO Number	CO statement
CO 1	Analyse the difference between Riemann integral and Lebesgue integral.
CO 2	Distinguish the relation between the class of Borel sets and the class of Lebesgue measurable sets.
CO 3	Extend the measure on a ring of sets to one on a generated σ-ring.
CO 4	Use the convergence of measurable functions in the theory of Probability.
CO 5	Compute multiple integrals which deals with measure and integration on the Cartesian product of spaces.

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO3	PS04	PSO5
CO 1	1	2	2	1	3
CO 2	1	2	2	1	1
CO 3	1	1	2	1	1
CO 4	1	1	1	1	2
CO 5	2	1	1	1	2
Average	**1.2**	**1.4**	**1.6**	**1**	**1.8**

Key: **S**trongly Correlated-3, **M**oderately Correlated-2, **W**eakly Correlated-1
No correlation-0

Teaching Methodology

Lecture (chalk and talk),
Problem Solving,
Discussion and Interactive session,
Assignment, Seminar.

Template – End Semester Examination

Knowledge leve	Section	Nature of the question	Maximum Marks	
K_3	A	Understanding Description/Problems- Two questions from every Unit	10 x 2	20
K_4, K_5	B	Analysis, Evaluation, Description/Problems- At least one question from every Unit	5 (out of 8) x 7	35
K_4, K_5	C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15	45
			Total	100

LATEX- A DOCUMENT PREPARATION SYSTEM

Total Hours : 30 **Course Code : 11SP18/4S/LAT**
Credits: 2 **L- T- P : 0 0 2**

Course Objectives :

To enable the students

1. To introduce the basic concepts of Latex , a typesetting software
2. To get knowledge about creating a bibliographic database.
3. To impart knowledge on New operators, Symbols, Footnotes, Margin pars, and Endnotes in Mathematics.

COURSE OUTLINE:

UNIT I

The Basics- Document class – Page style – Page numbering – Formatting lengths – Parts of a document – Dividing the document –Bibliography. (10hrs)

UNIT II

The BIBTEX program – BIBTEX style files –Creating a bibliographic database - Table of contents, Index and Glossary, Keeping tabs - Tables .Floats-Cross References In Latex. (10hrs)

UNIT III

Typesetting Mathematics- The basics - Custom commands - More on mathematics - New operators –Symbols -Theorems in LATEX–Designer theorems, Several kinds of boxes. Footnotes, Marginpars, and Endnotes. (10 hrs)

REFERENCE BOOKS:

1. LATEX: A document preparation system (2nd edition) by Leslie.

2. A beginner's introduction to typesetting with LATEX Peter Flynn.

Websites and E-Learning Sources:
https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf

Course Outcomes: Upon Completion of this course, the students will be able to

CO Number	CO statement
CO 1	Create Page numbering , Formatting lengths Dividing the document and Bibliography using Latex.
CO 2	Create a bibliographic database, Table of contents, Index and Glossary.
CO 3	Design New operators, Symbols, Footnotes, and Endnotes in Mathematics and apply these ideas in writing journals and books.

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO3	PS04	PSO5
CO 1	2	1	1	3	2
CO 2	2	2	1	2	1
CO 3	1	2	1	3	2
Average	1.6	1.6	1.0	2.6	1.6

Key: Strongly Correlated-3, Moderately Correlated-2, Weakly Correlated-1
No correlation-0

Teaching Methodology

Lecture (chalk and talk, LCD projector),
Problem Solving,
Discussion and Interactive session,

QUESTION PAPER PATTERN

Duration – 2 hours.
Practical examination will be conducted for 50 marks. (Internal valuation).