KANNUR UNIVERSITY

FOURYEAR UNDERGRADUATE PROGRAMME

SYLLABUS

COMPUTATIONAL MATHEMATICS
HONOURS/HONOURS WITH RESEARCH

(Effectivefrom2024admissions)

KANNUR UNIVERSITY VISION AND MISSION STATEMENTS

Vision

To establish a teaching, residential and affiliating University and to provide equitable andjust access to quality higher education involving the generation, dissemination and a critical application of knowledge with special focus on the development of higher education in Kasargode and Kannur Revenue Districts and the Manandavady Taluk of Wayanad Revenue District.

Mission

- To produce and disseminate new knowledge and to find novel avenues for application of such knowledge.
- To adopt critical pedagogic practices which uphold scientific temper, the un compromised spirit of enquiry and the right to dissent.
- To up hold democratic, multicultural, secular, environmental and gender sensitive values as the foundational principles of higher education and to cater to the modern notions of equity, social justice and merit in all educational endeavors.
- To affiliate colleges and other institutions of higher learning and to monitor academic, ethical, administrative and infrastructural standards in such institutions.
- To build stronger community networks based on the values and principles of higher education and to ensure the region's intellectual integration with national vision and international standards.
- To associate with the local self-governing bodies and other statutory as well as non-governmental organizations for continuing education and also for building public awareness on important social, cultural and other policy issues.

INTRODUCTION

Kannur University - Four-Year Undergraduate Programme: Backdrop and Context

The implementation of the Four-Year Undergraduate Programme (FYUGP) has been driven by the pressing need to address contemporary challenges ensuring responsive changes to the evolving needs of students, industry, and society at large. Recognizing the curriculum as the cornerstone of any education system, it requires regular refinement to align with evolving socio-economic factors. Higher education must provide students with practical and technical skills relevant to the infields of interest, necessitating the development to a job-oriented curriculum. Despite significant increases in access and expansion of higher education over the years, concerns persist regarding the quality and relevance of educational outcomes, particularly in terms of employability skills. As the world becomes increasingly interconnected, our education system must evolve to instill 21st century skills, enabling students not only to survive but to thrive in this dynamic environment. Moreover, there is a growing need for higher education institutions to embrace social responsibility and contribute to the development of a knowledge society capable of driving sustainable development through innovation. With the central objective of fostering a robust knowledge society to support a knowledge economy, the Government of Kerala has initiated steps to reform higher education. Accordingly, the commissions were established to suggest reforms in higher education policy, legal and regulatory mechanisms, and evaluation and examination systems. It is within this context that a comprehensive reform of the undergraduate curriculum has been proposed, leading to the restructuring of the Four-Year Undergraduate Programme.

KANNUR UNIVERSITY PROGRAMME OUTCOMES

PO1: Critical Thinking and Problem-Solving-

Apply critical thinking skills to analyze information and develop effective problem-solving strategies for tackling complex challenges.

PO2: Effective Communication and Social Interaction-

Proficiently express ideas and engage in collaborative practices, fostering effective interpersonal connections.

PO3: Holistic Understanding-

Demonstrate a multidisciplinary approach by integrating knowledge across various domains for a comprehensive understanding of complex issues.

PO4: Citizenship and Leadership-

Exhibit a sense of responsibility, actively contribute to the community, and show case leadership qualities to shape a just and inclusive society.

PO5: Global Perspective-

Develop a broad awareness of global issues and an understanding of diverse perspectives, preparing for active participation in a globalized world.

PO6: Ethics, Integrity and Environmental Sustainability-

Uphold high ethical standards in academic and professional endeavors, demonstrating integrity and ethical decision-making. Also acquire an understanding of environmental issues and sustainable practices, promoting responsibility towards ecological well-being.

PO7: Lifelong Learning and Adaptability-

Cultivate a commitment to continuous self-directed learning, adapting to evolving challenges, and acquiring knowledge throughout life.

PREFACE

This syllabus serves as a roadmap for academic journey, outlining the courses and objectives designed to cultivate mathematical proficiency and intellectual curiosity.

Mathematics is not merely a collection of techniques and formulae; it is a language for expressing and understanding patterns, structures, and relationships in the world around us. It is the universal language which forms the bedrock of scientific inquiry and technological advancement. As a student embarks on this educational voyage, he/she will explore the beauty and power of mathematical ideas while developing problem-solving skills that are invaluable in both academic and real-world contexts.

This program is structured to provide a comprehensive foundation in core mathematical disciplines, including Algebra, Number Theory, Numerical Analysis, Calculus, Geometry, Abstract Algebra, Linear Algebra, Analysis, Topology, Discrete Mathematics and Programming Languages like Scilab, Python etc. Through a combination of theoretical study and practical applications, students can deepen their understanding of fundamental concepts and sharpen their ability to apply them creatively to solve complex problems.

In addition to core courses, students have the opportunity to tailor their studies through a variety of elective options, allowing to pursue specialized interests in areas such as Artificial Intelligence, Data Science, Optimization, Cryptography, Fuzzy Mathematics, Automata, Mathematical Economics and more, which are necessary to instill 21st century skills.

Also, there is provision to align with interests and career aspirations. Whether passion lies in pure mathematics, applied mathematics, or interdisciplinary fields, one can find courses from Multi-disciplinary/Value-added/Skill-Enhancement courses to suit his/her academic trajectory. Further, assignments, seminars and project work promote self-study and develop research mind in students.

The UG Board of Studies in Mathematics puts forward this syllabus for Four Year Under-Graduate Programme in **Computational Mathematics** for implementation from 2024 onwards. We thank all those who helped us by giving critical suggestions for improvement.

Dr. C.P.Santhosh,

Chairman, UG Board of Studies in Mathematics
Kannur University

PROGRAMME SPECIFIC OUTCOMES

PSO1: Understand basic concepts and tools of Mathematical logic, Set theory, Numbertheory,Geometry,Calculus,Vectorcalculus,Algebra,Abstractstructures,Linear Algebra, Laplace transforms, Differential equations, Numerical Analysis, Fourier series, Real Analysis, Complex Analysis, and applications of these concepts in Computer Science.

PSO2: Develop abstract reasoning and critical thinking skills necessary for advanced mathematical study and applications in various fields like Artificial Intelligence, Data Science, Machine Learning etc.

PSO3: Develop proficiency in defining, formulating and solving problems by applying appropriate mathematical methods and principles.

PSO4: Formulate real world problems into mathematical models and find solutions.

PSO5: Develop proficiency in using mathematical software and programming languages.

PSO6: Understand the interdisciplinary nature of Mathematics and apply Mathematical concepts and techniques to solve problems in other sciences.

PSO7: Get equipped with basic research skills.

KANNURUNIVERSITY

FOUR YEAR UNDERGRADUATE PROGRAMME

COMPUTATIONAL MATHEMATICS

HONOURS/HONOURS WITH RESEARCH PROGRAMME

STRUCTURE

B.Sc. Computational Mathematics Pathway Courses (2024 admission onwards)						
Sl. No.	***Level***	***Course Code***	***Semester***	***Name of course***	***Credits***	***Major Pathway Courses***
1	100-199	KU1DSCCMT101	I	COMPUTATIONAL CALCULUS-I	4	
2	100-199	KU1DSCCMT111	I	FUNDAMENTALS OF MATHEMATICS	4	
3	100-199	KU1DSCCMT112	I	MATHEMATICAL STAISTICS-I	4	
4	100-199	KU1DSCCMT113	I	MATHEMATICS FOR DATASCIENCE - I	4	
5	100-199	KU1DSCCMT114	I	MATHEMATICS FOR ECONOMICS - I	4	
6	100-199	KU2DSCCMT101	II	COMPUTATIONAL CALCULUS-II	4	
7	100-199	KU2DSCCMT111	II	BASIC COMPUTATIONAL MATHEMATICS	4	
8	100-199	KU2DSCCMT112	II	MATHEMATICAL STAISTICS - II	4	
9	100-199	KU2DSCCMT113	II	MATHEMATICS FOR DATASCIENCE – II	4	
10	100-199	KU2DSCCMT114	II	MATHEMATICS FOR ECONOMICS - II	4	
11	200-299	KU3DSCCMT201	III	INTRODUCTION TO GEOMETRY AND ANALYSIS	4	
12	200-299	KU3DSCCMT202	III	ORDINARY DIFFERENTIAL EQUATIONS	4	
13	200-299	KU3DSCCMT211	III	MATHEMATICAL STAISTICS - III	4	
14	200-299	KU3DSCCMT212	III	GRAPH THEORY	4	
15	200-299	KU3DSCCMT213	III	PROGRAMMING IN PYTHON	4	

16	200-299	KU3DSCCMT214	III	MATHEMATICS FOR DATASCIENCE - III	4	
17	200-299	KU3DSCCMT215	III	MATHEMATICS FOR ECONOMICS - III	4	
18	200-299	KU4DSCCMT201	IV	LAPLACE TRANSFORMS, FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS	4	
19	200-299	KU4DSCCMT202	IV	GROUP THEORY	4	
20	200-299	KU4DSCCMT203	IV	MULTIVARIABLE CALCULUS	4	
21	300-399	KU5DSCCMT301	V	REAL ANALYSIS – I	4	
22	300-399	KU5DSCCMT302	V	ALGEBRA AND LINEAR ALGEBRA	4	
23	300-399	KU5DSCCMT303	V	VECTOR CALCULUS	4	
24	300-399	KU5DSECMT301	V	PROGRAMMING USING SCILAB	4	Elective 1
25	300-399	KU5DSECMT302	V	AUTOMATA	4	Elective 2
26	300-399	KU5DSECMT303	V	MATHEMATICAL FINANCE	4	Elective 3
27	300-399	KU5DSECMT304	V	NUMBER THEORY AND CRYPTOGRAPHY	4	Elective 4
28	300-399	KU6DSCCMT301	VI	COMPUTATIONAL LINEAR ALGEBRA	4	
29	300-399	KU6DSCCMT302	VI	ADVANCED OPTIMIZATION TECHINIQUES	4	
30	300-399	KU6DSCCMT303	VI	NUMERICAL ANALYSIS	4	
31	300-399	KU6DSECMT301	VI	COMPLEX ANALYSIS	4	Elective1
32	300-399	KU6DSECMT302	VI	REAL ANALYSIS – II	4	Elective 2
33	300-399	KU6DSECMT303	VI	METRIC SPACES	4	Elective 3
34	300-399	KU6DSECMT304	VI	MATHEMATICAL ECONOMICS	4	Elective 4
35	400-499	KU7DSCCMT401	VII	ABSTRACT ALGEBRA	4	
36	400-499	KU7DSCCMT402	VII	LINEAR ALGEBRA	4	
37	400-499	KU7DSCCMT403	VII	MATHEMATICAL ANALYSIS	4	
38	400-499	KU7DSCCMT404	VII	TOPOLOGY	4	
39	400-499	KU7DSCCMT405	VII	ADVANCED ORDINARY DIFFERENTIAL EQUATIONS	4	
40	400-499	KU8DSCCMT401	VIII	ADVANCED ABSTRACT ALGEBRA	4	
41	400-499	KU8DSCCMT402	VIII	MEASURE THEORY	4	

42	400-499	KU8DSCCMT403	VIII	ADVANCED MATHEMATICAL ANALYSIS	4	
43	400-499	KU8DSECMT401	VIII	ADVANCED TOPOLOGY	4	Elective 1
44	400-499	KU8DSECMT402	VIII	PARTIAL DIFFERENTIAL EQUATIONS	4	Elective 2
45	400-499	KU8DSECMT402	VIII		4	27/28/29 Elective(b)
46	400-499	KU8DSECMT403	VIII		4	27/28/29 Elective(c)
47	400-499	KU8DSECMT404	VIII	MOOC/ Online course I	4	27/28/29 Elective(d)
48	400-499	KU8DSECMT405	VIII	MOOC/Online course II	4	27/28/29 Elective(e)
49	400-499	KU8DSECMT406	VIII	MOOC/Online course III	4	27/28/29 Elective(f)
50	400-499	KU8CIPCMT 400	VIII	Capstone Internship Project in Honours Programme in Mathematics	8	30(a)
51	400-499	KU8PHRCMT400	VIII	Project in Honours with Research Programme in Mathematics	12	30(b)

General Foundation Courses offered by Department of Mathematics

Sl. No.	*Level*	*Course Category*	*Course Code*	*Semester*	*NameofCourse*	*Credits*
1	100-199	MDC	KU1MDCCMT101	I	LOGIC, LATTICES AND BOOLEAN ALGEBRA	3
2	100-199	MDC	KU1MDCCMT102	I	THEORY OF MATRICES	*3*
3	100-199	MDC	KU2MDCCMT101	II	NUMERICAL ABILITY	3
4	100-199	MDC	KU2MDCCMT102	II	VECTOR ALGEBRA	3
5	200-299	MDC	KU3MDCCMT201	III	FOUNDATIONS OF HIGHER MATHEMATICS	3
6	200-299	VAC	KU3VACCMT201	III	PROBABILITY THEORY	3
11	200-299	VAC	KU4VACCMT201	IV	CODING THEORY	3
12	200-299	VAC	KU4VACCMT202	IV	COMPLEX NUMBERS AND THEORY OF EQUATIONS	3
13	200-299	VAC	KU4VACCMT203	IV	LINEAR PROGRAMMING	3
15	200-299	SEC	KU4SECCMT201	IV	LINEAR PROGRAMMING PROBLEMS	3
17	300-399	SEC	KU5SECCMT301	V	MATHEMATICAL TRANSFORMS	3
20	300-399	SEC	KU6SECCMT301	VI	FUZZY SET THEORY	3

SEMESTER WISE DISTRIBUTION OF COURSES FOR FOUR YEAR UG PROGRAMME (FYUGP) MATHEMATICS

(2024ADMISSIONONWARDS)

SEMESTER 1

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	AEC1(English)	3	3	25	50	75
2	AEC2(Additional Language)	3	3	25	50	75
3	MDC1	3	3	25	50	75
4	DSC	4	4	30	70	100
5	DSC	4	4	30	70	100
6	DSC	4	4	30	70	100
	Total credits		21			

SEMESTER II

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	AEC3(English)	3	3	25	50	75
2	AEC4(Additional Language)	3	3	25	50	75
3	MDC2	3	3	25	50	75
4	DSC	4	4	30	70	100
5	DSC	4	4	30	70	100
6	DSC	4	4	30	70	100
	Total credits		21			

SEMESTER III

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	MDC3	3	3	25	50	75
2	VAC1	3	3	25	50	75
3	DSC	4	4	30	70	100
4	DSC	4	4	30	70	100
5	DSC	4	4	30	70	100
6	DSC	4	4	30	70	100
	Total credits		22			

SEMESTER IV

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	SEC1	3	3	25	50	75
2	VAC2	3	3	25	50	75
3	VAC3	3	3	25	50	75
4	DSC	4	4	30	70	100
5	DSC	4	4	30	70	100
6	DSC	4	4	30	70	100
	Total credits		21			

SEMESTER V

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	SEC2	3	3	25	50	75
2	DSC	4	4	30	70	100
3	DSC	4	4	30	70	100
4	DSC	4	4	30	70	100
5	DSE(Major Elective)	4	4	30	70	100
6	DSE(Major Elective)	4	4	30	70	100
	Total credits		23			

SEMESTER VI

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	SEC3	3	3	25	50	75
2	DSC	4	4	30	70	100
3	DSC	4	4	30	70	100
4	DSC	4	4	30	70	100
5	DSE(Major Elective)	4	4	30	70	100
6	DSE(Major Elective)	4	4	30	70	100
7	Internship	2	2			
	Total credits		25			

EXIT WITH UG DEGREE / PROCEED TO FOURTH YEAR WITH 133 CREDITS

23 DSC courses *: 23x4=92credits*

13 foundation courses (AEC(4),SEC(3),VAC(3),MDC(3)) *:13x3=39credits*

1Internship *: 2x1 =2credits*

Total ***: 133 credits***

SEMESTER VII

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	DSC	4	4	30	70	100
2	DSC	4	4	30	70	100
3	DSC	4	4	30	70	100
4	DSC	4	4	30	70	100
5	DSC	4	4	30	70	100
	Total credits		20			

SEMESTER VIII

	Total Credit	Total Marks for CE	Total Marks for ESE	Total marks
Project and Courses as per the FYUGP Regulation	24	180	420	600

DISCIPLINE SPECIFIC COURSES

SEMESTER - 1

KU1DSCCMT101: COMPUTATIONAL CALCULUS-I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCCMT101	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course is to introduce the notion of limits, continuity, derivatives, optimization problem, antiderivatives and to discuss applications of differentiation

Course Prerequisite

Functions

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Comprehend exponential functions, inverse functions, logarithmic function and hyperbolic functions	Understand
2	Understand the notion of limit and limit laws	Understand
3	Understand continuity of a function	Understand
4	Comprehend the notion of derivative of a function and differentiation rules	Understand
5	Understand indeterminate forms	Understand
6	Understand the effect of derivative on the shape of graph of a function	Understand Apply
7	Comprehend the antiderivatives	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓	✓			✓	
CO 2	✓	✓	✓			✓	
CO 3	✓		✓				
CO 4	✓	✓	✓			✓	
CO 5	✓	✓	✓				
CO 6	✓	✓	✓	✓			
CO 7	✓	✓	✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Functions and Limits**		**14**
	1	**Functions**	
		a) Exponential functions	
		b) Inverse functions	
		c) Logarithmic functions	
	2	**Limits**	
		a) Limit of a function and limit laws	
		b) Continuity	
		c) Horizontal Asymptotes	
II	**Differentiation of functions and Extreme values of a function**		**14**
	1	Derivatives and rate of change	
	2	Hyperbolic functions	
	3	Extreme values of a function	
	4	Maximum values	
	5	Minimum values	

	6	The Mean Value Theorem	
III	**Application of derivatives**		14
	1	Shape of graph of a function	
	2	Indeterminate forms	
		a) L 'Hospital rule	
IV	**Optimization problems and antiderivatives**		13
	1	Optimization problems	
	2	Antiderivatives	
V	**Teacher Specific Module**		5
	Directions		
	Summary of curve sketching, graphing with calculus and calculator (Sections 4.5 to 4.6), Illustration of the topic in module I to module IV using software like GeoGebra, Desmos Calculator etc.		

Essential Readings:

1. James Stewart Calculus; Early Transcendentals; 9th Edition; Cengage Learning; 2021.

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections 1.4, 1.5	
	2	1	Section 2.2,2.3, 2.5, 2.6	
II	1	1	Section 2.7, 3.11	
	2	1	Sections 4.1, 4.2	
III	1	1	Section 4.3	
	2	1	Sections 4.4	
IV	1	1	Sections 4.7, 4.9	

Suggested Readings:

1. B.S. Grewal; Higher Engineering Mathematics; (43rd edition); Khanna Publishers.
2. G.B. Thomas Jr., M.D. Weir and J.R. Hass; Thomas' Calculus: Early Transcendentals (12th edition); Pearson Education.
3. H. Anton, I. Bivens and S. Davis; Calculus; 10th edition; Willey.
4. S. Narayan and P.K. Mittal; Integral calculus; Revised Edition; S. Chand & Company Ltd.
5. S Narayan and P.K. Mittal; Differential calculus; Revised Edition; S. Chand & Company Ltd.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

KU1DSCCMT111: FUNDAMENTALS OF MATHEMATICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCCMT111	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course is to introduce the notion of Functions Different types of functions Relations, Partial Order relations, Well-ordering theorem, Countability and uncountability of sets.

Course Pre-requisite

Sets, Relations and Functions

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the concepts of Relations	Understand
2	How to apply induction hypothesis in proof making	Apply
3	Understand the concept of well ordering principle	Understand
4	Understand the concept of cardinality of sets	Understand
5	Comparing the cardinality of two sets	Apply
6	Understand the concept of partially ordered sets	Understand Apply

7	Application of axiom of choice	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓	✓				
CO 2	✓	✓	✓			✓	
CO 3	✓	✓	✓				
CO 4	✓	✓	✓				
CO 5	✓	✓	✓			✓	
CO 6	✓	✓	✓				
CO 7	✓	✓	✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Relations**		**14**
	1	Relations on sets	
	2	Types of relations	
	3	Equivalence relations	
	4	Equivalence classes and partitions of a set	
II	**Induction Principles**		**14**
	1	The Induction Principle	
	2	The Strong Induction Principle	
	3	The Well-ordering Principle	
	4	Equivalence of the three principles	
III	**Countability of Sets**		**14**
	1	Sets with same cardinality	

	2	Finite sets	
	3	Countable sets	
	4	Comparing cardinality	
IV	**Order Relations**		**13**
	1	Partial and Total Orders	
	2	Chains, bounds and maximal elements	
	3	Axiom of Choice and its Equivalents	
V	**Teacher Specific Module**		**5**
	Directions		
	Functions, One-one, onto functions and bijections, Composition of functions, Inverse of a function, Image of subsets under functions, Inverse image of subsets under functions		

Essential Readings:

1. Ajit Kumar, S. Kumaresan, Bhaba Kumar Sarma; A Foundation Course in Mathematics, 9th Edition; Alpha Science International Ltd.; Oxford, U.K.; 2018.

Module	Unit	Essential Reading No.	Sections	Remarks
I	1 to 4	1	*Sections 4.1 to 4.4*	
II	1 to 4	1	*Sections 5.1 to 5.4*	
III	1 to 4	1	*Sections 6.1 to 6.4*	
IV	1 to 3	1	*Sections 7.1 to 7.3*	
V		1	*Sections 3.1 to 3.4*	TSM

Suggested Readings:

6. Kenneth Kunen; The Foundation of Mathematics; College Publications 2009
7. John Peterson; Building a Foundation in Mathematics; Delmar Cengage Learning 2011.
8. K A Stroud; Foundation Mathematics; Bloomsbery; 2009
9. S Lipschutz; Set Theory & Related Topic; 2nd Edition; Schoum's Outline Series;

Assessment Rubrics:

Evaluation Type	Marks
End Semester Evaluation	**70**

Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

KU1DSCCMT112: MATHEMATICAL STAISTICS - I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCCMT112	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course provides an elementary introduction to probability and statistics with applications. Topics include random variables, probability distribution *Functions,* Mathematical Expectations, Joint Probability Law and Covariance

Course Prerequisite

Set Theory, Multi-Variable calculus

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Comprehend Basic concepts in Probability	Understand
2	Understand continuous and Discrete Distribution Functions	Understand
3	Understand the Expected value of a Random Variable	Understand
4	Bivariate random variables and joint probability Law	Understand
5	Understand Covariance between two Random variables	Understand
6	Understand Jenson's Inequality	Understand
7	Use software and simulation to do statistics (R).	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓		✓		✓		
CO 3	✓		✓			✓	
CO 4	✓		✓				
CO 5	✓		✓		✓		
CO 6	✓		✓				
CO 7	✓		✓		✓		✓

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Basic concepts in Probability**		**14**
	1	a)Random Variables	
		b)Distribution Functions	
	2	a)Discrete Random Variables and Examples	
II	**Continuous Random Variables and Bivariate Distribution**		**14**

	1	a) Continuous Random Variables and Examples	
	2	a) Joint Probability Law	
III	**Combination of random variables and it's pdf**		**14**
	1	a) Transformation of one dimensional Random variables	
		b) Mathematical Expectation	
	2	a)Expectation of a function of Random Variables	
		b)Addition Theorem of Expectation	
		c)Multiplication Theorem of Expectation	
IV	**Expectation, Covarience and Jenson's Inequality**		**13**
	1	a)Expectations of a linear combination of Random Variables	
		b)Covariance	
	2	a)Jenson's inequality	
V	**Teacher Specific Module**		**5**
	Directions		
	R programming		

Essential Readings:

1. S C Gupta & V K Kapoor; Fundamentals of Mathematical Statistics (10^{th} revised edition); S Chand and Sons; 2002

2. Peter Dalgard; Introductory Statistics with R; Springer (2008)

Module	Unit	Reference No.	Sections	Remarks
I	1	1	Sections 5.1, 5.2	Proof of all the Theorems in this unit are omitted
	2	1	Section 5.3	Proof of all the Theorems in this unit are omitted
II	1	1	Section 5.4	Proof of all the Theorems in this unit are omitted, Quartiles omitted
	2	1	Sections 5.5	
III	1	1	Section 5.6, 6.1	
	2	1	Sections 6.2, 6.3, 6.4	

IV	1	1	Sections 6.5, 6.6	Proof of all the Theorems in this unit are omitted
	2	1	Sections 6.7	Proof of all the Theorems in this unit are omitted

Suggested Readings:

1. Dennis Wackerly, William Mendenhall Ill and Richard S, Mathematical Statistis with Application (Seventh Edition); Duxbury Press, 2007
2. Robert. V. Hogg and Allen T. Craig, Introduction to mathematical Statistics (Fifth Edition); Higher education press, 1978
3. G Shankar Rao, probability and statistics for Science and Engineering; University press, 2011
4. Maria Dolores Ugarte, Ana F.Militino, Alan T.Amholt Probability and Statistics with R,CRC Press, A Chapman & Hall Book
5. Frank S Emmert-Streib, Salissou Moutari, Matthias Dehmer-Mathematical Foundations of Data Science Using R, De Gruyter (2022)
6. Meatloaf, Norman S, Probability and Statistics for data Science-math+R+data; CRC press(2020)

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Scientific Calculators below 100 functions (that is, upto *fx 99*) shall be permitted.**

KU1DSCCMT113:MATHEMATICS FOR DATA SCIENCE -I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCCMT113	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

This course is designed to introduce the concept of group theory and to find solutions of system of linear equations. It also deals with extreme value problems and numerical solutions of transcendental equations.

Course Prerequisite

Matrices

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the basic concepts in group theory	Understand

2	Apply matrix operations to solve system of linear equations.	Apply
3	Apply the concept of derivatives to find extreme values.	Apply
4	Understand how to find solutions of transcendental equations.	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓	✓		✓		✓	
CO 3	✓				✓		✓
CO 4	✓	✓		✓			

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Group Theory**	**14**
	1.1	Binary operations	
	1.2	Groups, Sub groups	
	1.3	Cyclic groups	
	1.4	Groups of Permutations, Orbits, Cycles	
	1.5	Rings & Fields (Definition & Examples only)	
II		**Matrix Theory**	**14**
	2.1	Row-echelon form, Elementary row and column operations	
	2.2	Rank of the matrix	
	2.3	Simultaneous linear equations, Matrix Notations, Theory of solutions	
	2.4	Simplifying operations, Gauss elimination algorithm	
III		**Differential Calculus**	**14**
	3.1	Extreme values of functions	
	3.2	The Mean value theorem	
	3.3	Monotonic functions and the first derivative test	
	3.4	Concavity	
IV		**Numerical Analysis**	**13**

	4.1	Bisection Method	
	4.2	Regula-falsi method	
	4.3	Newton- Raphson Method	
V	**Teacher Specific Module**		**5**
	5.1	Curve sketching, Applied optimization	

Essential Readings

1. John B. Fraleigh, A First Course in Abstract Algebra , Seventh edition. Pearson
2. Richard Bronson, Schaum's outline of Theory and Problems of Matrix operations , Schaum's outline series, McGraw-Hill
3. George B. Thomas, Jr, Mauric D. Weir, Joel Hass, Thomas' Calculus – Early transcendentals Twelfth edition
4. S.K.R. Iyengar, R. K. Jain - Mathematical Methods,Second Edition, Narosa Publications.

Module	Unit	Reference No.	Chapters	Remarks
I	1.1	1	Chapter 1; Section 1.2	All proofs are omitted
	1.2	1	Chapter 1; Section 1.4, 1.5	
	1.3	1	Chapter 1; Section 1.6	
	1.4	1	Chapter 2; Section 2.8, 2.9	
	1.5	1	Chapter 4; Section 4.18 (Relevant topic)	
II	2.1	2	Related Topics and problems in Chapter 1	
	2.2	2	Related Topics and problems in Chapter 1	
	2.3	2	Related Topics and problems in Chapter 2	
	2.4	2	Related Topics and problems in Chapter 2	
III	3.1	3	Chapter 4; Section 4.1	All proofs are omitted
	3.2	3	Chapter 4; Section 4.2	
	3.3	3	Chapter 4; Section 4.3	
	3.4	3	Chapter 4; Section 4.4(Relevant topics)	
IV	4.1	4	Chapter 3; Section 3.3	
	4.2	4	Chapter 3; Section 3.4	
	4.3	4	Chapter 3; Section 3.5	
V		1	Chapter 4; Section 4.4 (Relevant topics) Section 4.6	

Suggested Readings

1. Joseph A. Gallian, Contemporary Abstract Algebra, Forth edition, Narosa Publications.
2. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth edition, Wiley publication
3. B. S Grewal, Higher Engineering Mathematics, Forty second edition, Khanna publishers.
4. James Stewart, Daniel Clegg, Saleem Watson, Calculus Early transcendentals, Ninth edition, Cengage

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Calculators shall not be permitted.**

KU1DSCCMT114: MATHEMATICS FOR ECONOMICS - I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCCMT114	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

This course is to introduce Sets, Functions, Limits, and Continuity and applications of these Concepts in Economics.

Course Prerequisite

Basic Mathematics

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand Sets, Subsets	Understand
2	UnderstandFunctions	Understand
3	Understand Graph of a function	Understand
4	Understand Limit of a function	Understand
5	Understand Continuity of a Function	Understand
6	Understand Discontinuous Functions	Understand
7	Application of these concepts in Economics	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2						✓	
CO 3	✓						
CO 4	✓		✓				

CO 5	✓						
CO 6	✓						
CO 7						✓	

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Sets and Functions**		**14**
	1	a) Sets and Subsets	
	2	a) Constants and Variables	
		b) Functions and Graphs	
II	**Limits**		**14**
	1	a) Limit of a Function	
	2	a) Method of Finding Limits	
III	**Some Important Limits**		**14**
	1	a) Infinite Limits	
		b) Some Results on Limits	
	2	a) Some Important Limits	
IV	**Continuous and Discontinuous Functions**		**13**
	1	a) Properties of Continuous Functions	
V	**Teacher Specific Module**		**5**
	Economic Application of Continuous and Discontinuous Functions		

Essential Readings:

1. Michael Hoy, John Livernois, Chris McKenna, Ray Rees, Thanasis Stengos, Mathematics for Economics Third Edition, PHI Learning Pvt. Ltd
2. B M Aggarwal, Business Mathematics & Staistics , Ane Books Pvt.Ltd
3. Edward T Dowling, Introduction To Mathematical Economics (3rd Edition), Schaum's out Lines

Reference Distribution:

Module	Unit	Reference No.	Sections	Remarks
I	1	1	Section 2.1	
	2	2	Sections 3.1, 3.2, 3.3, 3.4	
II	1	2	Section 3.6, 3.9	
	2	2	Section 3.10	Excluding L'Hospital's Rule

III	1	2	Section 3.11, 3.12, 3.13	
	2	2	Sections 3.14	Problems related to L'Hospital's Rule omitted
IV	1	2	Section 3.15	
V	1	1	Section 4.2	

Suggested Readings:

1. Mehta -Madani, Mathematics for Economics, Sultan Chand and Sons, Educational Publishers New Delhi

2. AllenR.G.D (1956) Mathematical Analysis For Economists

3.Yamane, Taro (2004) Mathematics For Economists: An Elementary Survey

4.ChiangA.C (1988) Fundamental Methods of Mathematical Economics, McGraw Hill

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

SEMESTER - 2

KU2DSCCMT101: COMPUTATIONAL CALCULUS - II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
2	DSC	100	KU2DSCCMT101	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

In this course the student will learn the definite integral of a function, techniques to evaluate trigonometric integrals, and applications of integration. Also to approximate the value of a definite integral using the different methods of numerical integration.

Course Prerequisite

Integrals of basic functions and rules of integration

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the fundamental theorem of calculus and apply it to find the derivatives and integrals of certain functions.	Understand, Apply
2	Apply the notion of definite integrals to find area between curves, volumes using cross-sections, arc length and areas of surfaces of revolution	Apply
3	Understand integration by successive reduction and apply reduction formulas to evaluate trigonometric integrals	Understand, Apply

4	Understand the concept of polar coordinates and apply it to find areas under thecurves and length of curves	Understand, Apply
5	Understand numerical integration and apply the different numerical integration methods to approximate the value of a definite integral.	Understand, Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓	✓				✓
CO 2						✓	
CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Integrals and it's applications**	**14**
	1	a) Definite integral,	
		b) The Fundamental theorem of Calculus,	
		c) Indefinite integrals and the Net change theorem	
	2	**Application of Integration**	
		a) Area between curves	
II		**Application of Integration,Reduction formulas and trigonometricIntegrals**	
	1	**Applications of Integration**	
		a)Volumes,	

		b) Volumes by cylindrical shells	**14**
		c) Work	
		d) Average value of a function,	
	2	**Reduction formulas and trigonometric Integrals**	
		a) Reduction formulas and corresponding problems (From the exercise only)	
		b) Trigonometric integrals	
III	**Further applications of integration, Polar Co-ordinates**		**14**
	1	**Applications of integration**	
		a) Arc length	
		b) Area of a surface of revolution	
	2	**Polar Coordinates**	
		a) Polar Coordinates	
		b) Areas and Lengths in Polar Coordinates	
IV	**Numerical Integrations.**		**13**
	1	a) Numerical Integration,	
		b) Left End Points, Right End Points and Midpoint Sums	
		c) Trapezoidal Sums	
		d) Simpson's Rule	
		e) Gaussian Quadrature	
V	**Additional Topic offered by teacher**		**5**
	Directions		
	Discuss the geometry of problems solved in Unit I to Unit III using various software like Geogebra, Desmos Calculator etc.		
	Relevant Problems in Unit IV from the reference books to be discussed		

Essential Readings:

1. James Stewart,Daniel Clegg, Saleem Watson; Calculus Early Transcedentals -Metric version; 9th Edition; Cengage Learning 2021.

2. William C. Bauldry; Introduction to computational Mathematics; First edition; CRC Press.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections 5.2, 5.3, 5.4	
	2	1	Section 6.1	
II	1	1	Section 6.2, 6.3, 6.4, 6.5	
	2	1	Sections 7.1, 7.2	*Only reduction formulas from section7.1 and it's exercises*
III	1	1	Sections 8.1, 8.2	
	2	1	Sections 10.3, 10.4	
IV	1	2	sections 1, 2, 3, 4, 5 from Chapter V	

Suggested Readings:

1. H. Anton, I. Bivens and S. Davis; Calculus; 10th edition; Willey
2. G.B Thomas Jr., M.D Weir and Joel R.Hass; Thomas' Calculus(12th edition); Pearson,2009
3. S.K Stein; Calculus and Analytic Geometry; McGraw Hill, 1992.
4. G.F Simmons; Calculus with analytic Geometry (second edition); McGraw Hill,1995.
5. S.S Sastry; Introductory methods of numerical analysis; Fifth edition; PHI
6. M.K Jain, S.R.K. Iyengar, R.K. Jain; Numerical Methods For Scientific And Engineering Computation (4th Edition); New Age International Publications.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.

KU2DSCCMT111: BASIC COMPUTATIONAL MATHEMATICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCCMT111	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course is to introduce basic concepts of sets and relations and how they are used in computer language.

Course Prerequisite

1. Basic Set Theory

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of Sets and Relation	Understand
2	Comparing growth rates and functions.	Understand, Apply
3	Understand the concept of Functions.	Understand
4	Understand the concept of Pigeon hole Principle.	Understand
5	Apply Recurrence relation for solving various problems.	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓		✓		✓	
CO 2						✓	
CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Set Theory**		**14**
	1	a) Basic Definitions b) Operations on Sets. c) Principle of Inclusion -Exclusion.	
II	**Functions**		**14**

	1	a) Basic Definitions. b) Operations on Functions c) Pigeon hole Principle.	
III	**Comparing Growth Rates of Functions**		**14**
	1	a) A Measure for Comparing Growth Rates b) Properties of Asymptotic Domination. c) Polynomial Functions d) Exponential and Logarithmic Functions	
IV	**Recurrence Relations**		**13**
	1	a) The Tower of Hanoi Problem. b) Solving First - Order Recurrence Relations. c) Fibonacci Recurrence Relation.	
V	**Teacher Specific Module**		**5**
	a) Introduction to Propositional Logic. b) Truth and Logical Truth.		

Essential Readings:

1.Gary Haggard, John Schlipf, Sue Whitesides; Discrete Mathematics for Computer Science; Thomson Brooks/Cole.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections 1.1, 1.3, 1.5	
II	1	1	Section 4.1, 4.3, 4.6	
III	1	1	Sections 5.1.1, 5.1.2, 5.1.3, 5.1.4	
IV	1	1	Sections 9.1, 9.2, 9.4	
V	1	1	Relevant Topics	

Suggested Readings:

1. Seymour Lipschutz, Marc Lars Lipson; Schaum's Outline of Theory and Problems of Discrete Mathematics, Third edition; McGRAW-HILL
2. Seymour Lipschutz; Schaum's Outlines Set Theory and Related Topics, Second Edition; McGRAW-Hill.
3. Ralph P Grimaldi; Discrete and Combinatorial Mathematics An Applied Introduction, Fifth Edition; Addison-Wesley.
4. V K Balakrishnan; Introductory Discrete Mathematics; Dover Publications, INC

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

Use of Scientific Calculators below 100 functions (that is, upto *fx 99*) shall be permitted.

KU2DSCCMT112: MATHEMATICAL STATISTICS - II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCCMT112	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	

4		1	30	70	100	2

Course Description

This course is to introduce and understand MGF, Cumulants, Chebychev's Inequality and Different types of Discrete and Continuous distributions,

Course Prerequisite

Integral and differential Calculus

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand M.G.F	Understand
2	Understand Discrete Distribution	Understand
3	Understand Continuous distributions	Understand
4	Apply discrete distribution to solve real life problems	Apply
5	Apply Continuous distribution to solve real life problems	Apply
6	Understand and apply Central limit Theorem	Understand, Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓		✓				
CO 3	✓		✓				
CO 4	✓		✓		✓		✓
CO 5	✓		✓		✓		✓
CO 6	✓		✓		✓		✓

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	MGF, Cumulants and Chebychev's Inequality		
	1	a)Moment generating functions	**14**

		b) Cumulants	
	2	a)Chebychev's Inequality	
II	**Discrete distributions part I**		
	1	a) Bernoulli's distribution	14
	2	a)Binomial distribution	
III	**Discrete distributions part II**		
	1	a)Poisson distribution	**14**
	2	a)Geometric distribution	
IV	Continuous Distributions and Central Limit Theorem.		
	1	a)Rectangular Distribution	
		b)Normal Distribution	**13**
	2	a) Central Limit Theorem	
V	**Teacher Specific Module**		**5**
	Directions		
	R programming		

Essential Readings:

1. S C Gupta, V K Kapoor; Fundamentals of Mathematical Statistics (10th revised edition); S Chand and Sons; 2002

2. Peter Dalgard; Introductory Statistics with R; Springer (2008)

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections 6.10, 6.11	Sections 6.10.1 ,6.11.2 are omitted
	2	1	Section 6.13	
II	1	1	Section 7.1.	
	2	1	Sections 7.2, 7.2.1, 7.2.2, 7.2.6, 7.2.7, 7.2.9	
III	1	1	Section 7.3	Sections 7.3.1, 7.3.3, 7.3.6, 7.3.9, 7.3.10 are omitted
	2	1	Sections 7.5	7.5.1, 7.5.2 are omitted

IV	1	1	Section 8.1, 8.2	Section 8.1, 8.2, 8.2.1(derivation omitted) 8.2.14(fitting omitted) Sections8.2.9,8.2.10, 8.2.12, 8.2.15 are omitted
	2	1	Sections 8.10	Proof of C.L.T omitted; 8.10.1, 8.10.2, 8.10.3 and 8.10.4 are omitted
V	1	2	Relevant sections	

Suggested Readings:

1. Dennis Wackerly, William Mendenhall Ill and Richard S; Mathematical Statistics with Application (Seventh Edition); Duxbury Press; 2007
2. Robert. V. Hogg, Allen T. Craig; Introduction to mathematical Statistics (Fifth Edition); Higher education press; 1978
3. G Shankar Rao; Probability and statistics for Science and Engineering; University press; 2011
4. Maria Dolores Ugarte, Ana F.Militino, Alan T Amholt; Probability and Statistics with R; CRC Press, A Chapman & Hall Book
5. Frank S Emmert-Streib, SalissouMoutari, Matthias Dehmer; Mathematical Foundations of Data Science Using R; De Gruyter (2022)
6. Meatloaf, Norman S; Probability and Statistics for data Science-math+R+data; CRC press (2020)

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

KU2DSCCMT113: MATHEMATICS FOR DATA SCIENCE - II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCCMT113	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

This course is designed to introduce vector space, random variables ,partial derivatives and to find extreme values of functions of two or more variables. It also include iteration methods to solve system of linear equations.

Course Prerequisite

KU1DSCCMT111: Mathematics for Data Science 1

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of solving system of linear equations using iteration method.	Understand
2	Understand the basic concepts of linear algebra.	Understand
3	To extend the concept of limit continuity and differentiability to more than one variables.	Understand
4	Apply Lagrange's multipliers to find extreme values	Apply
5	Understand discrete and continuous random variables and its probability distribution	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓			✓	✓
CO 2	✓		✓				
CO 3	✓		✓				✓
CO4	✓				✓		
CO 5	✓	✓				✓	

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Numerical Analysis**	14
	1.1	LU decomposition	
	1.2	Gauss Jacobi iteration method	
	1.3	Gauss – Seidel iteration method	
II		**Linear Algebra**	**14**
	2.1	Vector spaces	
	2.2	Subspaces	
	2.3	Linear combinations and system of linear equations	
	2.4	Linear dependence and Linear independence	
	2.5	Basis and Dimension	
III		**Partial Derivatives**	**14**
	3.1	Functions of severable variable	
	3.2	Partial derivatives	
	3.3	Chain Rule	
	3.4	Extreme values and saddle points	

	3.5	Lagrange's multipliers	
IV	**Random Variables & Distribution Functions**		
	4.1	Random variable – continuous and discrete random variable	
	4.2	Discrete probability distribution, mean and variance of random variables	
	4.3	Theoretical distribution	
	4.4	Binomial probability distribution	
	4.5	Poisson distribution	
	4.6	Normal distribution	
V	**Teacher Specific Module**		5
		Visualization of Distribution Functions.	

Essential Readings

1. S.K.R. Iyengar, R. K. Jain - Mathematical Methods, Second Edition, Narosa Publications.
2. Stephen H. Friedberg, Arnold J. Insen, Lawrence E. Spence, Linear Algebra, Forth edition, Pearson Education.
3. George B. Thomas, Jr, Mauric D. Weir, Joel Hass, Thomas' Calculus – Early transcendentals Twelfth edition
4. N.P. Bali, Dr. Manish Goyal , A textbook of Engineering Mathematics Ninth Edition Lakshmi Publications.

Module	Unit	Reference No.	Chapters	Remarks
I	1.1	1	Chapter 1; Section 1.6.2	
	1.2	1	Chapter 1; Section 1.7.1	
	1.3	1	Chapter 1; Section 1.7.2	
II	2.1	2	Chapter 1; Section 1.2	All proofs are omitted
	2.2.	2	Chapter 1; Section 1.3	
	2.3	2	Chapter 1; Section 1.4	
	2.4	2	Chapter 1; Section 1.5	
	2.5	2	Chapter 1; Section 1.6	
III	3.1	3	Chapter 14; Section 14.1	All proofs are omitted
	3.2	3	Chapter 14; Section 14.3	
	3.3	3	Chapter 14; Section 14.4	
	3.4	3	Chapter 14; Section 14.7	
	3.5	3	Chapter 14; Section 14.8	
IV	4.1	4	Chapter 21; Section 21.51	
	4.2	4	Chapter 21; Section 21.52,21.53	
	4.3	4	Chapter 21; Section 21.54	
	4.4	4	Chapter 21; Section 21.55 to 21.57	
	4.5	4	Chapter 21; Section 21.58 to 21.60	
	4.6	4	Chapter 21; Section 21.61 to 21.63	
V				

Suggested Readings

1 Erwin Kreyszig, Advanced Engineering Mathematics, Tenth edition, Wiley publication

2. Kenneth Hoffman & Ray Kunze: *linear Algebra* (Second Edition), Prentice-Hall of India *Pvt.* Ltd, 2015
3. Martin Anthony and Michele Harvey, Linear Algebra: Concepts and Methods, Cambridge University Press, 2012
4. S.C Gupta , V.K Kapoor , Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
5. B. S Grewal, Higher Engineering Mathematics, Forty second edition, Khanna publishers.

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Calculators shall not be permitted.**

KU2DSCCMT114: MATHEMATICS FOR ECONOMICS - II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCCMT114	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

This course is to introduce Differentiation, Rules for Differentiation and its application in Economics

Course Prerequisite

Sets, Functions

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand Differentiation	Understand
2	Understand Rules of Differentiation	Understand
3	Understand the concept of Maxima and Minima	Understand
4	Understand the concept of Concavity and Convexity	Understand
5	Understand Points of Inflection	Understand
6	Understand Critical Point	Understand
7	Application of these concepts in Economics	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						

CO 2						✓	
CO 3	✓		✓				
CO 4	✓	✓					
CO 5	✓		✓				
CO 6	✓						
CO 7		✓				✓	

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Differentiation and Rules of Differentiation**		**14**
	1	**Derivatives**	
		a) Theorem 4.2	
	2	**Rules of Differentiation**	
		a) Derivative x^n	
		b) Derivative of sum of Functions	
		c) Derivative of Product of two Functions	
		d) Derivative of Quotient of two Functions	
		e) Chain Rule	
		f) Parametric Functions	
II	**Geometrical meaning of Derivatives and Successive Differentiation**		**14**
	1	**Standard Results**	
		a) Formulas and Examples	
	2	Logarithmic Differentiation	
	3	Successive Differentiation	
III	**Applications of Differentiation**		**14**
	1	**Maxima and Minima**	
		a) Definition of Extrema	
		b) Determination of Extrema	
	2	**Concavity, Convexity and Points of Inflection**	
	3	**L' Hospital' s Rule**	
IV	**Calculus of Multivariable Functions**		
	1	**Functions of several variables**	

	2	**Rules of Partial Differentiation**	13
		a) Product Rule	
		b) Quotient Rule	
		c) Generalized Power Function Rule	
V	**Teacher Specific Module**		**5**
	Economic Application of Derivative and Differential of functions of one Variable		

Essential Readings:

1. Michael Hoy, John Livernois, Chris McKenna, Ray Rees, Thanasis Stengos, Mathematics for Economics Third Edition, PHI Learning Pvt Ltd
2. B M Aggarwal, Business Mathematics &Staistics ,Ane Books Pvt.Ltd
3. Edward T Dowling, Introduction To Mathematical Economics (3rd Edition), Schaum's ouT Lines

Reference Distribution:

Module	Unit	Reference No.	Sections	Remarks
I	1	2	Section 4.1, 4.2	Proof of Theorems Omitted
	2	2	Sections 4.3, 4.4	Proof of Theorems Omitted
II	1	2	Section 4.5, 4.6	Proof of Theorems Omitted
	2	2	Section 4.7, 4.8	Second order Derivative only
III	1	2	Section 5.1, 5.2	
	2	2	Sections 5.3	
	3	3	Section 15.7	
IV	1	3	Section 5.1	
	2	3	Section 5.2	
	3	3	Section 5.3	
V	1	1	Section 5.1, 5.2, 5.3	Examples only

Suggested Readings:

1. Mehta -Madani, Mathematics for Economics, Sultan Chand and Sons, Educational Publishers New Delhi

2. Allen.R.G.D (1956) Mathematical Analysis For Economists

3.Yamane,Taro (2004) Mathematics For Economists : An Elementary Survey

4..Chiang.A,C (1988) Fundamental Methods of Mathematical Economics, McGraw Hill

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

SEMESTER - 3

KU3DSCCMT201: INTRODUCTION TO GEOMETRY AND ANALYSIS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCMT201	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course is to introduce the notion of sequences and series, convergence tests of sequences and series in analysis and different coordinate systems such as polar coordinate

system, cylindrical coordinate system, spherical coordinate system and sketching of cylinders and quadratic surfaces in analytic geometry.

Course Prerequisite

Elementary calculus including Functions, limits, integrals and geometric concepts including Cartesian coordinate system, lines, planes, conics.

Course Outcomes

CO No	Expected Outcome	Learning Domains
1	Understand sequences, series and their convergence and divergence.	Understand
2	Apply convergence tests to sequences and series to test convergence	Apply
3	Understand the polar coordinate system and the relation between polar and cartesian coordinate system	Understand
4	Understand Cylindrical coordinate system and spherical coordinate system .	Understand
5	Understand the cylinders and quadratic surfaces	Understand
6	Identify the cylindrical surfaces and quadratic surfaces.	Understand
7	Sketch the graph of cylinders and quadratic surfaces	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2						✓	
CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7						✓	

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Sequences and series**		**14**
	1	Sequences	
		a) Infinite sequences	
		b) The limit of a sequences	
		c) Properties of convergent sequences	
		d) Monotonic and bounded sequences	
	2	**Series**	
		a) Infinite series	
		b) Geometric series	
		c) Test for divergence	
		d) Properties of convergent series	
		e) Integrals Test and estimates of sum	
		f) The direct comparison test and Limit comparison test	
II	**Alternating series, Absolute Convergence and Convergence tests for series**		**14**
		Alternating series and Absolute convergence	
	1	a) Alternating series	
		b) Estimating sum of Alternating series	
		c) Absolute convergence and conditional convergence	
		d) Rearrangements	
	2	a) Ratio and Root tests	
	3	a) Strategy for testing series	
III	**Coordinate systems**		**14**
	1	**Polar coordinates**	
		a) Polar coordinate system	
		b) Relationship between Polar and Cartesian coordinates	
	2	**Cylindrical coordinates and Spherical coordinates**	

		a) Cylindrical coordinates	
		b) Spherical coordinates	
IV	**Cylinders and Quadratic surfaces**		13
	1	a) Cylinders	
	2	a) Quadratic surfaces	
		b) Application of quadratic surfaces	
V	**Teacher Specific Module**		**5**
	Polar curves, Symmetry of polar curves, Conics sections in polar curves, Polar equations of conics.		

Essential Readings:

1. G.B. Thomas Jr., M.D. Weir and J.R. Hass; Thomas' Calculus: Early Transcendentals (12^{th} edition); Pearson Education
2. H. Anton, I. Bivens and S. Davis; Calculus (Tenth Edition); John Wiley & Sons Inc; 2012.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Section 11.1	Proof Omitted
	2	1	Sections 11.2, 11.3, 11.4	Proof Omitted
II	1	1	Section 11.5	Proof Omitted
	2	1	Section 11.6	Proof Omitted
	3	1	Section 11.7	Proof Omitted
III	1	1	Section 10.3	Polar Curves excluded
	2	1	Sections 15.7, 15.8	Relevant topics only
IV	1	1	Section 12.6	
V		2	Relevant topics	TSM

Suggested Readings:

1. S.K. Stein; Calculus and Analytic Geometry; McGraw Hill; 1992.
2. G.F. Simmons; Calculus with Analytic Geometry (Second Edition); McGraw Hill; 1995.
3. Richard A Silverman; Modern Calculus and Analytic Geometry; Dover Publications Inc.

4. Earl Swokowski; Calculus with Analytic Geometry; Second edition; Brooks/ Cole.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

KU3DSCCMT202: ORDINARY DIFFERENTIAL EQUATIONS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCMT202	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course is to introduce the concepts of ordinary differential equations, modelling, different methods to solve first order ODE and second order ODE.

Course Prerequisite

Differentiation, Integration

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the basic concepts of ordinary differential equations	Understand
2	Understand Modelling	Apply
3	Understand various methods to solve first order ODE	Understand
4	Understand various methods to solve second order ODE	Understand
5	Comprehend the concepts of existence and uniqueness of solution of an initial value problem	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓		✓			✓	
CO 3	✓		✓				

CO 4	✓		✓				
CO 5	✓		✓				
CO 6	✓		✓				
CO 7	✓		✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**First order Ordinary Differential Equations**	**14**
	1	**Basic concepts of first order ODE**	
		a)Basic concepts	
		b) Modelling	
	2	**Methods of solving first order ODE**	
		a) Separable ODEs; modelling	
		b) Exact ODEs	
		c) Integrating factors	
		d) Linear ODEs	
II		**First order Ordinary Differential Equations**	**14**
	1	a) Bernoulli equation	
		b) Population dynamics	
		c) Orthogonal trajectories	
	2	Existence and uniqueness of solutions	
III		**Second order Ordinary Differential Equations**	**14**
	1	a) Homogeneous linear ODEs of second order	
		b) Homogeneous linear ODEs with constant coefficients	
	2	a) Differential operators	

		b) Euler-Cauchy equations	
IV	**Second order Ordinary Differential Equations**		**13**
	1	a) Existence and uniqueness of solutions (Proof omitted)	
		b) Wronskian	
		c) Nonhomogeneous ODEs	
		d) Solution by Variation of Parameters	
V	**Teacher Specific Module**		**5**
	Directions		
	Discuss and visualize the solutions of ODE using various softwares like Geogebra, Scilab, Python etc.		

Essential Readings:

1. Erwin Kreyzig; Advanced Engineering Mathematics (Tenth Edition); John Wiley & Sons.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Section 1.1	
	2	1	Section 1.3 to 1.5	
II	1	1	Section 1.5 to 1.6	
	2	1	Sections 1.7	Proof omitted
III	1	1	Sections 2.1, 2.2	
	2	1	Sections 2.3, 25	
IV	1	1	Sections 2.6	Proof omitted
	2	1	Sections 2.7, 2.10	

Suggested Readings:

1. S.L.Ross; Differential Equations (Third Edition); Wiley & Sons; 1984.
2. A.H.Siddiqi&P.Manchanda; A First Course in Differential Equations with Applications; Macmillan, 2006.
3. E.A. Coddington; An Introduction to Ordinary Differential Equation; PHI; 2009.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

KU3DSCCMT211: MATHEMATICAL STATISTICS - III

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCMT211	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course is to introduce Sampling, Null Hypothesis, Level of Significance, critical region, Standard Error and Chisquare distribution and also testing Hypothesis using Normal and Chisquare distribution

Course Prerequisite

Integration

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand Sampling and Types of Sampling	Understand

2	Understand Null Hypothesis	Understand
3	Understand Error in statistic	Understand
4	Understand Critical region	Understand
5	Understand level of significance	Understand
6	Testing of Hypothesis	Understand, Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓			✓	
CO 2	✓		✓			✓	
CO 3	✓	✓	✓			✓	
CO 4	✓		✓				
CO 5	✓		✓			✓	
CO 6	✓		✓		✓	✓	
CO 7	✓		✓			✓	

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**sampling and Testing of Hypothesis for large samples**		14
	1	a) Sampling and Types of Sampling	
	2	a) Testing of Hypothesis for large samples	
II	**Test for single proportion and Unbiased Estimate**		14
	1	a) Test for single proportion	
	2	a)Unbiased Estimate for population mean	
		b) Unbiased Estimate for Population Variance	
III	.	**Standard error of Sample mean Test of significance for mean and difference of Standard deviation**	**14**
	1	a)Standard error of Sample mean	
		b)Test of significance for mean	
		c) Test of significance for difference of means	

	2	a) Test of significance for difference of Standard deviations	
IV	**Chisquare distribution andApplications Chisquare distribution**		13
	1	a) Chisquare distribution	
		b) Applications ofChisquare distribution	
	2	a) Yates correction	
V	**Teacher Specific Module**		5
	Directions		
	R programming		

Essential Readings:

1. S C Gupta & V K Kapoor; Fundamentals of Mathematical Statistics (10 th revised edition);
2. Peter Dalgard -Introductory Statistics with R-Springer (2008)

Module	**Unit**	Essential Reading **No.**	**Sections**	**Remarks**
I	1	1	Sections 12.1, 12.2	
	2	1	Sections 12.3 to 12.8	
II	1	1	Section 12.9	Section 12.9.1 omitted
	2	1	Sections 12.10, 12.11	
III	1	1	Sections 12.12 to 12.14	
	2	1	Sections 12.15	
IV	1	1	Sections 13.1,13.2, 13.3, 13.7	Sections 13.3.3 and 13.3.4 are omitted
	2	1	Section 13.8	
V	1	2	Relevant topics	

Suggested Readings:

1. Dennis Wackerly, William Mendenhall Ill and Richard S; Mathematical Statistics with Application (Seventh Edition), Duxbury Press, 2007
2. Robert. V. Hogg and Allen T. Craig; Introduction to Mathematical Statistics (Fifth Edition); Higher education press, 1978
3. G Shankar Rao; probability and statistics for Science and Engineering; University press, 2011
4. Maria Dolores Ugarte, Ana F.Militino, Alan T. Amholt; Probability and Statistics with R; CRC Press, A Chapman & Hall Book
5. (De Gruyter STEM) Frank S Emmert-Streib, SalissouMoutari, Matthias Dehmer; Mathematical Foundations of Data Science Using R; De Gruyter (2022)
6. Matloff, Norman S; Probability and Statistics for data Science, Math+R+Data; CRC press(2020)

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		70
Continuous Evaluation		30
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

KU3DSCCMT212: GRAPH THEORY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCMT212	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course is to introduce the notion of Graph Theory, the basic concepts and definitions examples and its applications to daily life.

Course Prerequisite

Higher Secondary Mathematics

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Comprehend the basic concepts and definitions of Graph theory.	Understand
2	Apply Graph theory in daily life by Mathematical Modelling.	Apply
3	Understand sub graphs, paths and cycles in a graph	Understand
4	Comprehend the notion of Matrix representation of graphs	Understand
5	Understand Trees, Connectivity, Bridges, Spanning Trees	Understand
6	Apply the notion of Cut vertices and connectivity,	Apply
7	Understand Eulerian graphs and Hamiltonian graphs,	Understand
8	Apply the notion of the Chinese Postman Problem and The Travelling Salesman Problem	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓		✓			✓	
CO 3	✓		✓				
CO 4	✓		✓				
CO 5	✓		✓				
CO 6	✓		✓				
CO 7	✓		✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**An Introduction to Graphs**		**14**
	1	**Introduction**	
		a)The definition of a graph	
		b) Graphs as models	
		c) More definitions	
		d) vertex degrees	
		e) Sub graphs	
	2	**Paths and cycles ,Matrix representation of graphs, fusion**	
		a)Paths and cycles2	
		b) Matrix representation of graphs	
		c) Fusion	
II	**Trees and Connectivity: Definitions and simple properties, Bridges, Spanning Trees**		**14**

	1	Trees and Connectivity	
		c) Definitions and simple properties	
		d) Bridges	
		c) Spanning Trees	
III	**Cut vertices and connectivity, Euler tours (Fleury's algorithm omitted), the Chinese Postman Problem**		**14**
	1	e) Cut vertices and connectivity	
		f) Euler tours (Fleury's algorithm omitted)	
		g) The Chinese Postman Problem	
		h) The Hamiltonian Graphs	
IV			**13**
	Directions		
	1.Fusion algorithm for connectedness		
	2 Connector Problems: Algorithms for finding minimal spanning trees in a graph		
	a) Kruskal's Algorithm,		
	b) Primes Algorithm		
V	**Teacher Specific Module** **Shortest Path Problem** a)The Breadth First Search algorithm		
	b) The Back- TrackingT algorithm		
	c)The Dijkstra's algorithm		

Essential Readings:

1. John Clark and Derek Allan Holton. "A First Look at Graph Theory" (1995), Allied Publishers Ltd. In association with World Scientific.Publishing Co. Pte Ltd..

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections 1.1to 1.5	

II	1	1	Section 1.6	
	2	1	Sections 1.7	
	3	1	Sections 1.8	Fusion Algorithm for connectedness omitted
III	1	1	Sections 2.1	
		1	Sections 2.2	
	2	1	Sections 2.3	Connector problems omitted
IV	1	1	Sections 2.6	
	2	1	Sections 3.1	(Fleury's algorithm omitted)
	3	1	Sections 3.2	
	4	1	Sections 3.3	Proof of theorem 3.6 excluded

Suggested Readings:

4. K.R. Parthasarathy Basic Graph Theory; Tata-McGraw Hill; 1994
5. R. Balakrishnan and K. Ranganathan; A Text Book of Graph Theory (2nd edition); Springer.
6. J.A. Bondy and U.S.R. Murthy; Graph Theory with Applications; Macmillan.
7. F. Harary; Graph Theory;Narosa.
8. NarsinghDEO; Graph Theory with Applications to Engineering and computer Science; PHI Pvt. Ltd.
9. G. Chartrand and P. Zhang; Introduction to Graph Theory; TataMcGraw Hill.
10. J. A. Dossey et al.; Discrete Mathematics; Pearson Education; 2005.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

KU3DSCCMT213: PROGRAMMING IN PYTHON

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
3	DSC	200	KU3DSCCMT213	3+1	75

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical	Tutorial	CE	ESE	Total	
3	1+1	1	35	65	100	1.5

Course Description

This course is designed to understand the concept of Python programming and solving mathematical problems related with symbolic computations

Course Prerequisite

Operating a Computer, A Basic Course in Calculus and Higher Secondary Linear Algebra

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the fundamentals to advanced Python programming concepts	Understand
2	Develop proficiency in sympolic computation with SymPy	Understand
3	Develop skills to solve numerical problems in Mathematics using Python	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓					
CO 2	✓	✓	✓				
CO 3	✓	✓	✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Introductory Python**	**11**
	1.1	Getting started with Python, Variables and Data Types, Keywords, Operators and their Precedence, Python String, Python Lists, Mutable and Immutable Types	
	1.2	Input from the Keyboard, Iteration: while and for loops, Conditional Execution: if, elif and else, Modify loops: break and continue, Line Joining, Exercises	
II		**Advanced Programing in Python**	**11**
	2.1	Functions, More on Strings and Lists, Python Modules and Packages, File Input/Output, Formatted Printing, Exception Handling	
	2.2	The Numpy Module, Vectorized Functions	
III		**Data Visualization**	**11**
	3.1	The Matplotlib Module, Plotting Mathematical Functions, Famous Curves, Power Series, Fourier Series	
	3.2	2D plot using colours, Fractals, Meshgrids, 3D Plots, Mayavi, 3D Visualization, Exercises	
IV		**Numerical Methods**	**12**
	4.1	Derivative of a function, Numerical Integration, Ordinary Differential Equations	

	4.2	Polynomials, Finding roots of an equation, System of linear equations, Interpolations, Exercises	
V	**Teacher Specific Module**		**30**
	5.1	Evaluate a Taylor series numerically	
	5.2	Interpolate a function using	
	a) Newton's forward interpolation b) Newton's backward interpolation c) Lagrange's interpolation d) Newton's general interpolation		
	5.3	Find integrals of functions using	
	a) Trapezoidal rule b) Simpson's 1/3-rule		
	5.4	Find derivative of function numerically	
	5.5	Solve first order differential equations numerically	
	a) Euler method b) Fourth order Runge-Kutta method		
	5.6	Solve algebraic equations numerically	
	a) The Bisection method b) Regula Falsi method		
	5.7 Various vector operations such as dot product, cross product and divergent using numpy module		
	5.8 Various matrix operations such as determinant, inverse and transpose using numpy module		
	5.9 Solve system of linear equations using numpy module		

Essential Readings

1. Ajith Kumar B. P, Python for Education, Inter University Accelerator Centre- New Delhi, 2010

Reference Distribution

Module	Unit	Reference No.	Chapters	Remarks
I	1.1	1	Chapter 2; Sections 2.1-2.6	
	1.2	1	Chapter 2; Sections 2.7-2.12	
II	2.1	1	Chapter 2; Sections 2.13-2.18	
	2.2	1	Chapter 3; Sections 3.1-3.2	
III	3.1	1	Chapter 4; Sections 4.1-4.5	
	3.2	1	Chapter 4; Sections 4.6-4.11	
IV	4.1	1	Chapter 6; Sections 6.1-6.3	
	4.2	1	Chapter 6; Sections 6.4-6.6, 6.8,6.9	
V		1	Relevant Chapters from the Book	

Suggested Readings

1. Eric Matthes, Python Crash Course : A hands-on project based introduction to programming- 3rd edition, no starch press, 2023
2. Wes Mckinney, Python for Data Analysis, O'Reilly Media Inc, 2022
3. Robert Johansson, Numerical Python: A Practical Technique Approach for Industry, Apress, 2015
4. Amit Saha, Doing Math with Python, No Starch Press, 2015
5. Vernon L Ceder, The Quick Python Book, Second Edition, Manning
6. Python tutorial online, https://www.geeksforgeeks.org/python-programming-language/

Evaluation Type		**Marks**
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation(CCA)		**35 (25T + 10P)**
Theory		
a)	Test Paper *	10
b)	Assignment	10
c)	Viva-Voce, Seminar	5
Practical		
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Calculators shall not be permitted.**

KU3DSCCMT214: MATHEMATICS FOR DATA SCIENCE - III

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCMT214	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

This course is designed to introduce basic concepts in graph theory,linear transformation and to understand the mathematical modelling of linear programming problems and its graphical solution. It also aims to identify the correlation between two variables.

Course Prerequisite

KU2DSCCMT113-Mathematics for Data Science -II

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the formulation of linear programming problems mathematically	Understand
2	Apply graphical method to solve linear programming problems	Apply
3	Understand linear transformation and its matrix representation	Understand
4	Apply matrix operations to find eigen values and eigen vectors.	Apply
5	To understand the basic concepts of graph theory	Understand

6	Identify the relationship between two variables	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓			✓		✓	
CO 2	✓	✓					✓
CO 3	✓		✓			✓	
CO 4	✓				✓		
CO 5	✓		✓			✓	
CO 6	✓	✓			✓		✓

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Linear Programming Problems**	**14**
	1.1	Structure of Linear programming model	
	1.2	General mathematical model of Linear programming problems	
	1.3	Guidelines on Linear programming model formulation	
	1.4	Linear Programming: Graphical method	
II		**Linear Algebra**	**14**
	2.1	Linear Transformations, Null Spaces, and Ranges	
	2.2	The Matrix Representation of a Linear Transformation	
	2.3	The change of coordinate matrix	
	2.4	Eigenvalues and Eigenvectors	
	2.5	Inner Products and Norms	
III		**Graph Theory**	**14**
	3.1	Definitions and Examples	
	3.2	Subgraphs, Complements and graph isomorphisms	

	3.3	Vertex degree: Eulers- trails and circuits.	
IV	**Correlation & Regression**		**13**
	4.1	Correlation	
	4.2	Scatter or dot diagrams	
	4.3	Karl Pearson's co-efficient of correlation	
	4.4	Computation of Correlation co-efficient.	
	4.5	Regression, Linear regression, Lines of regression.	
	4.6	Properties of regression co-efficient.	
V	**Teacher Specific Module**		5
		Dijkstra's – Shortest path algorithm	

Essential Readings

5. J K Sharma, Operations Research Theory and Applications, Sixth edition, (Trinity press)
6. Stephen H. Friedberg, Arnold J. Insen, Lawrence E. Spence, Linear Algebra, Forth edition, Pearson Education.
7. Ralph- P. Grimaldi, Discrete and Combinatorial Mathematics an Applied introduction, Third edition, Addison- Wesley publishing Company.
8. N.P. Bali, Dr. Manish Goyal , A textbook of Engineering Mathematics Ninth Edithion Lakshmi Publications.

Module	Unit	Reference No.	Chapters	Remarks
I	1.1	1	Chapter 2; Section 2.2	
	1.2	1	Chapter 2; Section 2.6	
	1.3	1	Chapter 2; Section 2.7	
	1.4	1	Chapter 3; All Sections except 3.3.5	
II	2.1	2	Chapter 2; Section 2.1	All proofs are omitted
	2.2	2	Chapter 2; Section 2.2	
	2.3	2	Chapter 2; Section 2.5	
	2.4	2	Chapter 5; Section 5.1	
	2.5	2	Chapter 6; Section 6.1	
III	3.1	3	Chapter 11; Section 11.1	All proofs are omitted
	3.2	3	Chapter 11; Section 11.2	
	3.3	3	Chapter 11; Section 11.3	
IV	4.1	4	Chapter 21; Section 21.24	
	4.2	4	Chapter 21; Section 21.25	
	4.3	4	Chapter 21; Section 21.26	
	4.4	4	Chapter 21; Section 21.27	
	4.5	4	Chapter 21; Section 21.31 to 21.33	
	4.6	4	Chapter 21; Section 21.34	
V		1	13.1-13.2	

Suggested Readings

1 H.A. Thaha, Operations Research, An Introduction (10 th edition), Pearson
2 G. Hadley, Linear Programming, Oxford & IBH Publishing Company**.**
3 Kenneth Hoffman &Ray Kunze: *linear Algebra* (Second Edition), Prentice- Hall of India *Pvt.* Ltd, 2015
4 Martin Anthony and Michele Harvey, *Linear Algebra: Concepts and Methods,Cambridge* University Press, 2012

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Calculators shall not be permitted.**

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCMT215	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course is to understand the notion of Integration and Application of integration in Economics

Course Prerequisite

Sets, Functions, Differentiation

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand Indefinite Integrals	Understand
2	Understand Definite Integrals	Understand
3	Understand Rules of Integration	Understand
4	Understand Partial Fraction	Understand
5	Understand Integration by Parts	Understand
6	Apply these concepts in Economics.	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓		✓				
CO 3	✓		✓			✓	
CO 4	✓		✓		✓		
CO 5	✓		✓				
CO 6	✓		✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Indefinite Integration**		**14**
	1	a) Introduction.	
		b) General Rules For Integration	
	2	a) Some Standard Results	
II	**Methods of Finding Indefinite Integrals**		**14**
	1	a) Method of Substitution	
		b) Partial Fractions	
	2	a) Problems Solving Using Partial Fractions	
		b) Some Standard Substitution	
III	**Definite Integration**		14
	1	a) Integration by Parts	
	2	a) Introduction	
		b) Properties of Definite Integrals	
IV	**Application of Integration to Economics**		13
	1	a) Introduction	
		b) Consumers' Surplus	
	2	a) Producers' Surplus	
		b) Consumers' Surplus Under Monopoly	
V	**Teacher Specific Module**		5
	The Riemann Definite Integral		

Essential Readings:

1. Michael Hoy, John Livernois, Chris McKenna, Ray Rees, Thanasis Stengos, Mathematics for Economics Third Edition, PHI Learning Pvt. Ltd
2. B M Aggarwal, Business Mathematics &Staistics, Ane Books Pvt.Ltd
3. Edward T Dowling, Introduction To Mathematical Economics (3rd Edition), Schaum's ouT Lines

Module	Unit	Reference No.	Sections	Remarks

I	1	2	Sections 6.1, 6.2	
	2	2	Sections 6.3, 6.4	
II	1	2	Sections 6.5, 6.6, 6.7	
	2	2	Sections 6.8, 6.9	
III	1	2	Section 6.10,	
	2	2	Sections 6.11, 6.12	
IV	1	2	Section 7.1, 7.2	
	2	2	Sections 7.3, 7.4, 7.5	
V	1	1	Section 16.2	

Suggested Readings:

1. Mehta -Madani, Mathematics for Economics, Sultan Chand and Sons, Educational Publishers New Delhi
2. Allen.R.G.D(1956) Mathematical Analysis For Economists
3. Yamane,Taro (2004) Mathematics For Economists : An Elementary Survey
4. Chiang.A.C (1988) Fundamental Methods of Mathematical Economics, McGraw Hill

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

SEMESTER - 4

KU4DSCCMT201: LAPLACE TRANSFORMS, FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	DSC	200	KU4DSCCMT201	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

This course is to introduce Laplace Transforms, Fourier Series, partial Differential Equations, methods to solve ordinary and partial differential equations as well as integral equations

Course Prerequisite

Integration and Differentiation

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand Laplace Transforms	Understand
2	Apply Laplace Transforms to find solution of Initial value problems	Apply
3	Demonstrate Fourier Series to study the behaviour of periodic functions	Understand
4	Understand the formation and solutions of P.D.E of first and higher order	Understand
5	Apply various methods to obtain solutions to P.D.E. of first and second order which occur in Science and Engineering	Apply
6	Understand Fourier transforms	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2	✓		✓				

CO 3	✓		✓				
CO 4	✓						
CO 5	✓		✓				
CO 6	✓		✓				
CO 7	✓		✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Laplace Transforms**		**14**
	1	a) Laplace and inverse Transforms	
		b) S Shifting	
		c) Transforms of derivatives	
		d) Differential equations, Initial value problems	
	2	a) Unit Step function	
II	**Short impulses, System of O.D. Es**		**14**
	1	a) Dirac's Delta function	
		b) Convolution and integral equations	
	2	a) Differentiation and integration of Transforms	
		b) System O D.Es	
III	**Fourier Analysis**		**14**
	1	a)Fourier series of functions of period 2π	
	2	a)Fourier series of Functions of any period	
		b) Even Half range expansion	
		c) Odd Half range expansion	
IV	**Partial Differential Equations**		**13**

	1	a) Basic concepts of P.D.E	
		b) Modelling Vibrating String, Wave Equation	
	2	a) Solution by Separating Variables, Fourier series	
		b) Heat equation Solution by Fourier Series	
V	**Teacher Specific Module**		**5**
	Directions		
	Fourier Transforms, Fourier cosine and Sine transforms, Linearity of Transforms and Transforms of derivatives (Section 11.8)		

Essential Readings:

1. Erwin. Kreyszig; Advanced Engineering Mathematics (10th edition); John Willey & Sons; INC.

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections 6.1, 6.2	
	2	1	Section 6.3	
II	1	1	Section 6.4,6.5	
	2	1	Sections 6.6, 6.7	
III	1	1	Section 11.1	
	2	1	Sections 11.2	
IV	1	1	Sections 12.,12.2	
	2	1	sections 12.3, 12.6	

Suggested Readings:

1. Erwin. Kreyszig; Advanced Engineering Mathematics (9th edition); John Wiley & Sons
2. G. Birkhoff & G.C Rota; Ordinary Differential Equations (Third Edition); Wiley & Sons; 1978
3. E.A Codington; An Introduction to Ordinary Differential Equations; Prentice Hall of India, New Delhi; 1974
4. Courant R and Hilbert D; Methods of Mathematical Physics, Vol.1; Wiley Eastern Reprint; 1975

5. W.E.Boyce & R.C. Deprima; Elementary Differential Equations and boundary value Problems (Second editon); John Wiley & Sons, NY; 1969.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Scientific Calculators below 100 functions (that is, upto *fx 99*) shall be permitted.**

KU4DSCCMT202: GROUP THEORY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	DSC	200	KU4DSCCMT202	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course aims to provide a comprehensive introduction to the fundamental concepts and structures in Group Theory.

Course Prerequisite

Elementary Algebra including sets, relations, functions, equations and basic algebraic structures.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Comprehend the binary operations and their properties in the context of group theory	Understand
2	Recognize and explain the fundamental properties of groups, such as closure, associativity, identity and inverses	Understand
3	Classify and work with finite groups, understanding their structure and significance	Apply
4	Identify and prove isomorphisms between groups, recognizing the importance of structural similarities	Apply
5	Comprehend the notion of subgroups, including the criteria for a subset to be a subgroup	Understand
6	Comprehend the cyclic groups, understanding their generation and properties	Understand
7	Apply Lagrange's theorem to various problems, particularly in the context of finite groups and permutation groups	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						

CO 2	✓						
CO 3						✓	
CO 4						✓	
CO 5	✓						
CO 6	✓						
CO 7						✓	

COURSECONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Introduction to Group**	**14**
	1	**Groups**	
		a) Binary Operations	
		b) Groups: Definition and Examples	
		c) Elementary Properties of Groups	
		d) finite Groups and Group Tables	
II		**Subgroups**	**14**
	1	Isomorphic Binary Structures	
	2	Subgroups, Cyclic subgroups	
		a) Subgroups	
		b) Cyclic subgroups	
III		**Cyclic Groups & Groups of Permutations**	**14**
	1	Cyclic Groups	
	2	Groups of Permutations	
IV		**The Alternating Group**	**13**

	1	a) Orbits	
		b) Cycles	
		c) The Alternating Groups	
V	**Teacher Specific Module**		**5**
	The notion of Coset, Properties of Coset		
	Lagrange's theorem		
	Application of Cosets to Permutation groups: the rotation group of a Cube and Soccer Ball(Relevant Sections from Chapter 7)		

Essential Readings:

1. John B. Fraleigh; A First Course in Abstract Algebra; 7th Ed.; Pearson; 2002**.**
2. Joseph A Gallian; Contemporary Abstract Algebra; 9th Edition; Cenage Learning; 2017

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections 2,4	
II	1	1	Section 3	
	2	1	Sections 5	
III	1	1	Sections 6	
	2	1	Sections 8	
IV	1	1	Sections 9	

Suggested Readings:

1. Charles C Pinter; A book of Abstract Algebra;Dover Publications, Inc., Mineola, NewYork; 2010.
2. David S Dummit, Richard M Foote; Abstract Algebra; John Wiley & Sons Inc; 2004.
3. I N Herstein; Topics in Algebra; Wiley India Pvt Ltd; 2006
4. M Artin; Algebra(Second Edition); Pearson Education India; 2015.

Assessment Rubrics:

Evaluation Type	Marks

End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

KU4DSCCMT203: MULTI VARIABLE CALCULUS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	DSC	200	KU4DSCCMT203	4	60

Learning Approach (Hours/ Week)	Marks Distribution	Duration of

Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	ESE (Hours)
4		1	30	70	100	2

Course Description

This course is to introduce the notion of multivariable functions, their limits, continuity, partial derivatives and multiple integrals and to discuss applications of double and triple integration.

Course Prerequisite

1. Limit and continuity of single variable function.
2. Differentiation and integration of single variable function.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of multivariable functions, their limit and continuity	Understand
2	Understand the concept of Partial derivative and apply it to functions	Understand, Apply
3	Understand the concept of directional derivative and gradient vector.	Understand
4	Apply the concept of gradient vectors to find maxima and minima.	Apply
5	Understand double and triple integrals, and apply multiple integrals to find surface area	Understand, apply
6	Understand spherical and cylindrical coordinates	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓	✓	✓		✓	
CO 2	✓		✓			✓	
CO 3	✓		✓				
CO 4	✓		✓				

CO 5	✓		✓				
CO 6	✓		✓				
CO 7	✓		✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Multi variable Functions and Partial derivatives.**		**14**
	1	a) Functions of Several Variables	
		b) Limits and continuity	
	2	Partial Derivatives	
		a) Partial Derivatives	
II	**Tangent Planes and Directional Derivatives**		**14**
	1	a) Tangent Planes and Linear Approximations	
		b) The Chain Rule	
		c) Directional Derivatives and the Gradient Vector	
		d) Maximum and Minimum Values	
III	**Lagrange Multipliers, Multiple Integrals**		**14**
	1	Lagrange Multipliers	
		a) Lagrange Multipliers	
	2	Multiple Integrals	
		a) Double integrals over rectangles	
		b) Double integrals over general regions.	
		c) Double integrals in Polar coordinates	
		d) Applications of double integrals.	
IV	**Applications of double integrals** ,Triple integrals(15.5 to 15.8)		**13**
	1	a) Surface area	
	2	Triple Integrals	
		a) Triple integrals	

		b) Triple integrals in cylindrical coordinates	
		c) Triple integrals in spherical coordinates	
V	**Teacher Specific Module**		**5**
	Jacobian, Change of Variables in Multiple Integrals		

Essential Readings:

1:Calculus Early Transcendental, Metric version, James Stewart, Daniel Clegg, Saleem Watson 9th Edition, Cengage Learning 2021.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections 14.1,14.2	
	2	1	Section 14.3	
II	1	1	Section 14.4,14.5	
	2	1	Sections 14.6,14.7	
III	1	1	Sections 14.8	
	2	1	Sections 15.1 to 15.4	
IV	1	1	Sections 15.5	
	2	1	Sections 15.6,15.7,15.8	

Suggested Readings:

1. H. Anton, I. Bivens and S. Davis; Calculus; 10th edition; Willey
2. G.B Thomas Jr.,M.D Weir and Joel R.Hass; Thomas' Calculus (12th edition),Pearson,2009
3. S.K Stein; Calculus and Analytic Geometry; McGraw Hill, 1992.
4. G.F Simmons; Calculus with analytic Geometry (second edition); McGraw Hill, 1995.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12

c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

SEMESTER - 5

KU5DSCCMT301: REAL ANALYSIS - I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	300	KU5DSCCMT301	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

This course aims to introduce properties of real line $\mathbb{R}$*., basic concepts and techniques of real analysis. Also it aims to introduce real sequences, subsequence and to establish convergence of sequences using theorems.*

Course Prerequisite

KU3DSCCMT201: INTRODUCTION TO GEOMETRY AND ANALYSIS

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Recognize the fundamental properties of the real numbers, including algebraic, order and completeness properties of R.	Knowledge
2	Identify sequences in terms of functions from $\mathbb{N}$ to a subset of $\mathbb{R}$ and find the limit	Understand
3	Classify whether a sequence is bounded , convergent, divergent, monotone and Cauchy	Understand
4	Apply the Archimedean property and the density theorem in real numbers	Apply
5	Apply Bolzano Weierstrass Theorem and the Cauchy's convergence criterion in real sequences	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2	✓			✓			✓
CO 3	✓			✓		✓	
CO 4		✓			✓	✓	
CO 5	✓		✓				✓
CO 6	✓		✓			✓	
CO 7		✓			✓	✓	✓

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**The Real Numbers**	**14**
	1	a) The algebraic and order properties of R	
		b) Absolute Value and the Real Line	
		c) Completeness Property of R	
II		**The Real Numbers**	**14**
	1	a) Applications of the Supremum Property	
		b) Intervals	
III		**Sequences And Series**	**14**
	1	a) Sequence and Their Limits	
		b) Limit Theorems	
		c) Monotone Sequences	
IV		**Sequences And Series**	**13**
	1	a) Subsequences and Bolzano Weierstrass Theorem	
		b) The Cauchy Criterion	
V	**Teacher Specific Module**		**5**
	Finite Infinite, Countable &Uncountable sets		

Essential Readings:

1. R.G Bartle and D.R Sherbert; Introduction to Real Analysis (Fourth edition); Wiley& Sons.
2. Ajit Kumar, S. Kumaresan and Bhaba Kumar Sarma; A Foundation Course in Mathematics; Narosa Publishing House; 2018.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections2.1, 2.2, 2.3	
II	1	1	Section 2.4,2.5	
III	1	1	Sections 3.1, 3.2, 3.3	
IV	1	1	Sections 3.4, 3.5	

Suggested Readings:

5. David Alexander Brannan; A First Course in Mathematical Analysis;Cambridge University Press; US (2006).
6. John M. Howie; Real Analysis; Springer.
7. Sudhir R., Ghorpade, Balmohan V. Limaye; A Course in Calculus and RealAnalysis; Springer; 2006.
8. Houshang H. Sohrab; Basic Real Analysis;Birkhäuser.
9. K.A. Ross; Elementary Analysis: The Theory of Calculus; Springer; 2013.
10. J.V. Deshpande; Mathematical Analysis and Applications; Alpha ScienceInternational Ltd.; 2004.
11. Charles G. Denlinger; Elements of Real Analysis; Jones and Bartlett Publishers Sudbury; Massachusetts (2011).

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

KU5DSCCMT302: ALGEBRA AND LINEAR ALGEBRA

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	300	KU5DSCCMT302	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

This course is to introduce the notion of multivariable functions

Course Prerequisite

1. Binary Operation. 2. Group Theory.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of Rings and Fields	Understand
2	Apply the concept of Rings and Fields to solve Linear Congruence.	Understand, Apply
3	Understand the concept of Vector Space.	Understand
4	Understand the concept of Basis and Dimension.	Understand
5	Understand the concept of Linear Transformation.	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓		✓		✓	
CO 2						✓	
CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Rings And Fields**		**14**
	1	a) Rings and Fields	
		b) Integral Domains	
II	**Rings of Polynomials**		**14**
	1	a) Fermat's and Euler's Theorem	
III	**Vector Spaces**		**14**
	1	a) Vector Spaces, Subspaces, Linear Span.	
IV	**Change of Basis**		**13**
	1	Linear Independence, Basis, Coordinates, Dimension, Basis and dimension in R^n.	
V	**Teacher Specific Module**		**5**
	Linear Transformation		

Essential Readings:

1:J.B Fraleigh; A First Course in Abstract Algebra (7th Edition); Pearson Education Limited; 2014.
2: M. Anthony and M. Harvey; Linear Algebra- Concepts and Methods; Cambridge University Press; 2012.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections 18,19	
II	1	1	Section 20	
III	1	2	Sections 5.1- 5.7	
IV	1	2	Sections 6.1-6.9	

Suggested Readings:

1. I. N Herstein; Topics in Algebra; Wiley India Pvt. Ltd; 2006.
2. M. Artin; Algebra (Second Edition); Pearson Education India;2015..
3. Stephen H. Friedberg, Lawrence E. Spence and Arnold J. Insel; Elementary Linear Algebra - A Matrix Approach (Second Edition); Pearson India Inc., 2019.
4. Kenneth Hoffmann and Ray Kunze, Linear Algebra (Second Edition), PHI, 2015.

Assessment Rubrics:

Evaluation Type	Marks

End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.

KU5DSCCMT303: VECTOR CALCULUS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	300	KU5DSCCMT303	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

This course is to introduce the concept of vector valued functions, their differentiation and integration. The course also discuss the line integrals and surface integrals of vector fields and the techniques to evaluate them.

Course Prerequisite

1. Multiple integrals2.Polar coordinates, Spherical coordinates, cylindrical coordinates.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of Parametric curves	Understand
2	Understand the concept of Vector functions, their derivatives and integrals.	Understand,
3	Understand the concept of vector fields and evaluate the line integrals of vector fields	Understand, Apply
4	Understand curl ,divergence and surface, integrals of vector fields	Understand,
5	Apply Green's theorem, Stokes theorem, Divergence theorem to evaluate integrals.	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓		✓		✓	
CO 2						✓	
CO 3	✓						
CO 4	✓						

CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Parametric curves and vector functions**	**14**
	1	a)curves defined by parametric equations	
		b)calculus with parametric curves	
	2	a) Vector Functions and space curves	
		b) Derivatives and integrals of vector functions.	
II		**Vector fields and Line integrals**	**14**
	1	**Vector fields**	
		a) Vector fields	
	2	**Line integrals**	
		a) Line integrals	
		b) Fundamental theorem for line integrals	
III		**Green's Theorem, Curl and divergence ,Parametric surfaces**	**14**
	1	a) Green's Theorem	
		b) Curl and divergence	
	2	a) Parametric surfaces and areas	
IV		**Surface integrals, Stokes theorem and Divergence theorem**	**13**
	1	a) Surface integrals	
	2	The stokes theorem and divergence theorem	
		a) Stokes Theorem	
		b) The Divergence theorem	
V		**Teacher Specific Module**	**5**
		Graphs of three dimensional surfaces, Relevant problems from the reference books	

Essential Readings:

1. Calculus Early Transcendental, Metric version, James Stewart, Daniel Clegg, Saleem Watson 9th Edition, Cengage Learning 2021.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections 10.1,10.2	
	2	1	Section 13.1,13.2	
II	1	1	Section 16.1	
	2	1	Sections 16.2,16.3	
III	1	1	Sections 16.4,16.5	
	2	1	Section 16.6	
IV	1	1	Section 16.7	
	2	1	Sections 16.8,16.9	

Suggested Readings:

1. H. Anton, I. Bivens and S. Davis; Calculus; 10th edition; Willey.
2. G.B Thomas Jr., M.D Weir and Joel R.Hass; Thomas' Calculus(12th edition); Pearson; 2009
3. S.K Stein; Calculus and Analytic Geometry; McGraw Hill; 1992.
4. G.F Simmons; Calculus with Analytic Geometry(second edition); McGraw Hill; 1995.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

****Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

KU5DSECMT301: PROGRAMMING USING SCILAB

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSECMT301	4	75

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical	Tutorial	CE	ESE	Total	
3	1+1	1	35	65	100	1.5

Course Description

This course is to learn a programming language and to visualize the known concepts and results in Mathematics through programming.

Course Prerequisite

Calculus, numerical integration, numerical differentiation, solution of ODE, PDE, system of equations, system of ODE.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand programming language	Understand
2	Comprehend the conversion of mathematical problems to programmes	Apply
3	Apply the language to visualize the solutions of various problems.	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2						✓	

CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	PART	DESCRIPTION	HOURS
1	1	**Introduction to Scilab and basic operations**. a) The general environment and the console b) Basic data types c) Constants, variables d) Basic input output using *disp* and *input*.	11
II	1	**Matrices and arrays** a) Matrices of numbers b) Matrix operations c) Matrix functions	11
III	1	**Scilab programming fundamentals** a) Conditional statements b) Looping constructs c) Break and continue statements	11
IV	1	**Graphics and visualization** a) The graphic window b) 2-D plotting c) 3-D plotting	12

V		**Teacher specific module** 1. Program to reverse a given number 2. Program to generate first '*n*' Fibonacci numbers 3. Program to generate first '*n*' prime numbers 4. Program to generate first '*n*' perfect numbers 5. Program to multiply two matrices without using Scilab matrix multiplication command 6. Program to solve a linear system of equations 7. Program to find a root of an algebraic/transcendental equation by 1) iteration method 2) bisection method 3) Newton-Raphson method 8. Program to sketch a surface of the type $z=f(x,y)$	30

		9. Program to evaluate line integral by 1) midpoint rule and find the error. 2) trapezoidal rule and find the error. 3) Simpson's 1/3-rule and find the error. 10. Program for double integration with 1) limits fixed 2) limits varying 11. Program to evaluate the *y*-value at any point *x* and to sketch the curve by 1) Lagrange's interpolation 2) Newton's divided difference formula 3) Newton's Forward Interpolation formula 4) Newton's Backward Interpolation formula 12. Program to evaluate the derivative numerically 13. Program to solve a n Initial value problem	

Essential Readings:

2. Claude Gomez, C. Bunks, J.P. Chancelier, F. Delebecque, M. Goursat, R. Nikoukhah, S. Steer; Engineering and Scientific Computing With Scilab; Birkhauser Boston; 1999.

Reference Distribution

Module	Unit	Reference No.	Chapters	Remarks
I	1	1	Chapters 1, 2.1	
II	1	1	Chapters 2.2, 4.1	
III	1	1	Chapter 2.3, 2.4	
IV	1	1	Chapter 3	
V		1	Relevant Chapters from the Book	

Suggested Readings:

1. The Scilab Consortium. Scilab. http://www.scilab.org.
2. Text Book Companion in https://scilab.in
3. Sandeep Nagar; Introduction to Scilab- For Engineers and Scientists; Apress; 2017.
4. RajanGoyal and Mansi Dhingra; Programming in Scilab; Alpha Science Int. Ltd.; 2019

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation (ESE)		**65(50T+15P)**
Continuous Evaluation(CCA)		**35(25T + 10P)**
Theory		
a)	Test Paper *	10
b)	Assignment	10
c)	Viva-Voce,Seminar	5
Practical		
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

****Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

KU5DSECMT302: AUTOMATA

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSECMT302	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description:

Formal languages and automata theory deals with the concepts of automata, formal languages, grammar, and computability. Automata theory provides a simple, elegant view of the complex machine that we call a computer. This course gives a pathway to advanced studies in theoretical computer science.

Course Prerequisite:

Basics in discrete mathematics.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	To provide basic understanding of Discrete Mathematics	Understand
2	To connect regular expressions, Languages and automata	Understand, Apply
3	Develop the ability to categorise different types of mathematical models of computation.	Analyse, Skill
4	To develop the skill of solving real life problems through mathematical modelling	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓					
CO 2		✓	✓				
CO 3		✓	✓				✓
CO 4	✓	✓	✓				
CO 5							
CO 6							
CO 7	✓			✓	✓		

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		a) Automata, Computability and complexity	14

		b) Mathematical notations and terminology	
		c) Relations, Functions and Graphs	
		d) Strings Languages, Boolean logic.	
II			14
		a) Regular Languages: Finite Automata	
		b) Non determinism	
		c) Regular expressions	
		d) Non-regular languages	
III			14
	1	a) Context free languages and grammars(2.2- 2.3)	
		b) Pushdown Automata	
		c) Non-context free languages	
IV			13
	1	a) Turing Machine	
		b) Variants of Turing Machines	
V	Teacher Specific Module		5
	Directions		
	Problem discussions from Module 1,2 and 3		

Essential Readings:

1. Michael Sipser; Introduction to the Theory of Computation; Cengage Learning; 3rd Edition; 2012

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	0.1,0.2	
II	1	1	1.1 -1.4	
III	1	1	2.1- 2.3	
IV	1	1	3.1-3.2	

Suggested Readings:

1) G.E.Revesz; Introduction to Formal Languages; Dover, 2012.
2) K. L. P. Mishra, N. Chandrasekharan; Theory of Computer Science: AutomataLanguages and Computation; PHI; 2006.
3) P.Linz; An Introduction to Formal Languages and Automata; 6th edition, Jones and Bartlettudent Edition; 2012
4) Hop Croft J.E Motwani R, Ullman J.D; Introduction to Automata Theory, Languagesand Computation, 2nd Edition, Pearson 2001

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** Use of Scientific Calculators below 100 functions (ie up to *fx*99) shall be permitted.

KU5DSECMT303: MATHEMATICAL FINANCE

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSECMT303	4	60

Learning Approach (Hours/ Week)	Marks Distribution	Duration of ESE (Hours)

Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

This course is designed to understand the applications of Mathematical tools in Economics

Course Prerequisite

Matrices, Integration, Basic Economics

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Apply the concept of single variable and several variable calculus to the problems in economics	Apply
2	Analyse the money market and goods market and understand the trade strategy and use it effectively	Analyze
3	Create an optimum solution in terms of productivity and profitability for economic problems	Create
4	Apply Pareto optimality conditions	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓	✓				
CO 2		✓					
CO 3	✓	✓	✓	✓			
CO 4	✓	✓	✓	✓			

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
		Applications of Calculus in Finance	
		Production Functions, Cost Functions, Revenue and Profit Functions, Demand Functions and Elasticity	

I		Base10 Logarithms, Base e Logarithms, Present Value, Annuities, Optimal Holding Time	**14**
		Economic Intepretation, Marginal Products, Elasticity, Geometric Intepretation, An Application of higher derivative in Economics	
		System of implicit functions(Proof excluded), Comparative Statics, Simpson's Paradox	
II		**Linear Algebra in Finance**	**14**
		Examples of Linear Models	
		Applications to Portfolio Theory IS-LM analysis via Cramer's rule	
		Budget Sets in Commodity Space, Input Space, Probability Simplex	
		The Investment Model, IS-LM Analysis, Supply Demand	
III		**Optimization in Finance**	**14**
		Quadratic Forms, Definiteness of Quadratic Forms, Second Order Conditions and Convexity, Conic Sections, The Definiteness of matrix	
		Definiteness and Optimality One Constraint, Other Approaches, Profit-Maximizing Firm, Discriminating Monopolist, Least Squares Analysis	
		Homogeneous Functions, Definition and Examples, Homogeneous Functions in Economics, A Calculus Criterion for Homogenity	
		Economic Applications of Euler's theorem, Economic Applications of Homogenization	
IV		**Advanced Calculus in Finance**	**13**
		Concave functions in Economics, Quasi Concave and Quasi Convex Functions, Calculus Criteria, Pseudo Concave Functions	
		Concave Programming-Unconstrained Problems, Constrained Problems, Saddle Point Approach	
		Utility Maximization, The Demand Function, The Indirect Utility Function, The Expenditure and Compensated Demand Functions, The Slutsky Equation, The Cost Function	
		Necessary and Sufficient Condition for a Pareto Optimum, The Fundamental Welfare Theorems, Fundamental Theorem of Welfare Economics	
V		Teacher Specific Module	
		Fundamentals of Economics	5

Essential Readings:

1. Carl P.Simon and Lawrence, Mathematics for Economists, Blume Viva Books, 2018
2. Knut Sydsaeter, Peter Hammond, Arne Strom, Essential Mathematics for Economic Analysis(4th

Edition), Pearson Publication, 2012

Reference Distribution:

Module	Unit	Essential Reading No.	Chapters	Remarks
I		1	Sections: 3.6, 5.3, 5.6, 14.2,14.3,14.8,15.3,15.4,15.6	
II		1	Sections: 6.2, 7.4,9.3,10.7,26.4	
III		1	Sections: 16.1-16.3,17.5, 20.1-20.3	
IV		1	Sections: 21.2,21.3-21.5,22.1-22.4	

Suggested Readings

1. Chiang C; Fundamental Methods of Mathematical Economics; McGraw Hills.
2. Budnick, Frank; Applied Mathematics for Business, Economics and Social Sciences; McGraw Hills Education; 2017.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Calculators shall not be permitted.**

KU5DSECMT304: NUMBER THEORY AND CRYPTOGRAPHY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSECMT304	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

This course is to introduce Divisibility property, Congruence and its application in Cryptography.

Course Prerequisite

1. Basic number theoretic concepts. 2. Congruence

Course Outcomes

CO No.	EXPECTED OUTCOME	LEARNING DOMAINS
1	Understand the concept of Divisibility.	Understand
2	Apply the concept of Division Algorithm to find G.C.D.	Understand, Apply
3	Understand the concept of Congruence.	Understand
4	Understand how to apply Euler's and Fermat's theorem .	Understand
5	Understand how to encrypt and decrypt ising various crypto system.	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓		✓		✓	
CO 2						✓	
CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Divisibility Theory in Integers**	**14**
	1	The Division Algorithm	
		The Greatest Common Divisor	
		The Euclidean Algorithm	
II	1	The Diophantine Equation ax+by=c.	**14**
	2	The Fundamental Theorem of Arithmetic.	
III		**Congruences**	**14**
	1	Basic Properties of Congruences.	
		Linear Congruence and Chinese Remainder Theorem.	
IV		**Cryptography**	**13**
	1	The Shift Cipher.	
		The substitution Cipher	
		The Affine Cipher	
		The Vigenere Cipher	
		The Hill Cipher	
		The Permutation Cipher	
		Stream Ciphers	
V		**Teacher Specific Module**	**5**
	1	Fermat's Little Theorem and Pseudo primes.	
		Wilson's Theorem.	

Essential Readings:

1. David . M. Burton , Elementary Number Theory (Seventh Edition), Mc Graw Hill, 2010.
2. Douglas R. Stinson, Cryptography - Theory and Practice, Third Edition, CRC Press, 2006.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections 2.2, 2.3, 2.4	
II	1,2	1	Sections 2.5, 3.1.	
III	1	1	Sections 4.2, 4.4.	
IV	1	2	Sections 1.1	

Suggested Readings:

1. C. Y. Hsuing; Elementary Theory of Numbers; Allied Publishers; 1995.
2. G.E. Andrews; Number Theory; Dover publications Inc.; 1995.
3. William Stallings; Cryptography and Network Security Principles and Practices; Fourth Edition; Prentice Hall.
4. Christof Paar-Jan Pelzl; Understanding Cryptography - A Text for Students and Practitioners; Springer.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

**Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.

SEMESTER - 6

KU6DSCCMT301: COMPUTATIONAL LINEAR ALGEBRA

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSC	300	KU6DSCCMT301	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

This course is one of the mathematical foundations for machine learning. It aims to understand linear transformation, diagonalisation of a square matrix, inner products and orthogonal diagonalisation of symmetric matrices which are essential to learn basic concepts in machine learning.

Course Prerequisite

KU5DSCCMT302: ALGEBRA AND LINEAR ALGEBRA

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Explain what is meant by a linear transformation and be able to prove a given mapping is linear.	Understand
2	Identify the range and null space and determine rank, nullity of a linear transformation.	Understand
3	Find the matrix representation of a transformation with respect to two given bases.	Understand

4	Compute eigenvalues and eigenvectors for a square matrix.	Apply
5	Determine whether or not a matrix can be diagonalised and diagonalise a diagonalisable matrix.	Apply
6	Acquire the concept of inner product on a vector space.	Understand
7	Apply Gram-Schmidt orthonormalisation process	Apply
8	Identify orthogonal diagonalisation	Understand
9	Classify the quadratic form as positive definite, positive semi-definite, negative definite, negative semi- definite and indefinite.	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2	✓			✓			✓
CO 3	✓			✓		✓	
CO 4		✓			✓	✓	
CO 5	✓		✓				✓
CO 6	✓			✓			
CO 7		✓				✓	
CO 8	✓	✓			✓		✓
CO 9			✓		✓		✓

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**1**	**LINEAR TRANSFORMATIONS AND CANGE OF BASIS**	

		a) Linear transformations	**14**
		b) Range and null space	
		c) Coordinate change	
		d) Change of Basis and similarity	
II	**1**	**DIAGONALISATION**	**14**
		a) Eigenvalues and eigenvectors	
		b) Diagonalisation of a square matrix	
		c) When is diagonalisation possible?	
III	**1**	**INNER PRODUCTS AND ORTHOGONALITY**	**14**
		a) Inner products	
		b) Orthogonality	
		c) Orthogonal matrices	
		d) Gram-Schmidt orthonormalisation process	
IV	**1**	**ORTHOGONAL DIAGONALISATION AND ITS APPLICATIONS**	**13**
		a) Orthogonal diagonalisation of symmetric matrices	
		b) Quadratic forms	
V	**Teacher Specific Module**		**5**
	Applications of Diagonalisation and Discussion on activities and comments on activities of modules I to IV		

Essential Readings:

2. M. Anthony and M. Harvey, Linear Algebra- Concepts and Methods, Cambridge University Press, 2012.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections7.1 –7.8	

II	1	1	Section 8.1- 8.7	
III	1	1	Sections 10.1- 10.8	
IV	1	1	Sections 11..1, 11.6	

Suggested Readings:

1. S.H. Friedberg, A. J. Insel and L.E. Spence; Linear Algebra (4th edition); PH Inc
2. Kenneth Hoftnan& Ray Kunze; Linear Algebra (Second Edition); Prentice- Hall of India Pvt. Ltd; 2015
3. R. Larson and D.C. Falvo; Elementary Linear Algebra (6th edition); Houghton Mifflin Harcourt Publishing Company
4. J.R. Kirkwood and B.H. Kirkwood; Elementary Linear Algebra; CRC Press
5. Lee W. Johnson, R. Dean Riess, Jimmy T. Arnold; Introduction toLinear Algebra, Fifth edition; Pearson Education, Inc.; 2002.
6. Gilbert Strang; Introduction to Linear Algebra, 5th Edition;
7. T S Blyth, E F Robertson; Linear Algebra; Springer; Second Edition.
8. Thomas Banchoff, JohnWermer; Linear Algebra Through Geometry; 2nd Edition; Springer

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

KU6DSCCMT302: ADVANCED OPTIMIZATION TECHNIQUES

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSC	300	KU6DSCCMT302	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description:

At the end of the course the student will be able to find a basic feasible solution of Transportation problem and a minimum transportation Schedule. This course also discusses methods to find shortest path in a network and the mathematics required to solve different types of games.

Course Prerequisite:

1. Distribution Function 2. Elementary row operations of Matrices.

.

Course Outcomes :

CO No.	Expected Outcome	Learning Domains

1	Understand, formulate and solve a transportation problem and find the minimum transportation cost.	Understand, Apply
2	Able to find shortest path in a Network	Understand
3	Understand the concept of CPM and PERT	Understand, Apply
4	Understand how optimal strategies are formulated in competitive environment.	Understand
5	Apply various methods to select the optimal strategies to win the game	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓					
CO 2		✓	✓				
CO 3		✓	✓				✓
CO 4	✓	✓	✓				
CO 5	✓	✓					
CO 6	✓	✓					
CO 7	✓			✓	✓		

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Transportation Problem**	**14**
	1	a) Formulating Transportation Problem.	
		b) Finding Basic Feasible Solutions for Transportation Problems	
		c) The Transportation Simplex method	

		d) Sensitivity analysis for Transportation problem	
II	**Networking in Project Planning**		**14**
	1	e) Introduction	
		f) Network	
		g) Numbering the event or labeling	
		h) Algorithm for framing a Network	
		i) Critical Path Method	
		j) Critical Path Analysis	
		k) Project Evaluation and Review Technique	
		l) Distinction between CPM and PERT	
III	**Theory of Games**		**14**
	I	e) Introduction	
		f) Game	
		g) Strategy	
		h) Two-Person zero-sum games	
		i) Payoff Matrix	
		j) The Maxmin and Minimax principles	
		k) Saddle point and value of the game	
		l) Algorithm for determining a saddle point	
		m) Game without a saddle point-mixed strategy	
		n) Technique for mixed strategy	
		o) Saddle point of a function	
IV	**Solving different types of Matrix Games**		**13**
	1	a) Solution of a 2x2 rectangular games without a saddle point	
		b) Dominance property	
		c) General rules for Dominance	

		d) Algebraic method for solving m x n games	
		e) Symmetric game	
		f) Graphical method of solution of 2 x n or m x 2 games	
V	**Teacher Specific Module**		**5**
	Directions		
	Problems of Module 1 from Text 1		

Essential Readings:

1. A. Mukherjee, N. K. Bej; Advanced Linear programming and Gaming Theory; Books and Allied (P) Ltd.
2. Wayne L. Winston; Operations Research Applications and Algorithms (fourth edition); Thomson(Brooks/Cole)

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	2	Section 7.1, 7.2,7.3,7.4	Exclude programming using LINDO, spread sheet etc.
II	1	1	Sections 11.1-11.9	
III	1	1	Section 13.1–13.11	
IV	1	1	Section 13.12–13.17	

Suggested Readings:

1. K. Swarup, P.K.Gupta and M. Mohan; Operations Research (18th edition);Sulthan Chand and Sons
2. J.K. Sharma; Operations Research - Theory and Applications; McMillan
3. H.A. Thaha; Operations Research - An Introduction (8th edition); Prentice Hall
4. G. Hadley; Linear Programming; Oxford & IBH Publishing Company.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** Use of Scientific Calculators below 100 functions (ie up to *fx*99) shall be permitted.

KU6DSCCMT303: NUMERICAL ANALYSIS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSC	300	KU6DSCCMT303	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course is to introduce some numerical methods to solve some concepts in Calculus.

Course Prerequisite

1. Continuity and Derivative of a function.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	To solve the algebraic and transcendental equations numerically.	Understand, Apply

2	Understand the finite differences and the concept of interpolation.	Understand
3	Understand some methods for interpolation.	Understand, Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓		✓		✓	
CO 2						✓	
CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	1	**Solution of Algebraic and Transcendental Equations**	14
		a) Introduction	
		b) Bisection method	
		c) Methods of False position	
		d) Iteration method	
II	1	**Solution of Algebraic and Transcendental Equations**	14
		a) Newton Raphson method	
		b) Ramanujan's method	
		c) The secant method	

III	**1**	**Interpolation**	**14**
		a) Introduction	
		b) Finite Differences	
		c) Differences of a polynomial	
		d) Newton's formulae for interpolation	
IV	**1**	**Interpolation**	13
		a) Guass' Central Difference Formulae: Guass' forward formula and Guass' backward formula only	
		b) Interpolation with unevenly spaced points: Lagrange's interpolation formula	
V	**Teacher Specific Module**		**5**
	Divided differences and their properties, Newton's central difference formula, Inverse interpolation.		

Essential Readings:

1. S.S.Sastry; Introductory Methods of Numerical Analysis(Fifth edition); PHI; 2012.

Reference Distribution:

Module	Unit	Essential Readings No.	Sections	Remarks
I	1	1	Sections 2.1 to 2.4	
II	1	1	Sections 2.5 to 2.7	
III	1	1	Sections 3.1, 3.3, 3.5, 3.6	
IV	1	1	Sections 3.7.1, 3.9.1	

Suggested Readings:

1. S. Sankara Rao; Numerical methods of Scientists and Engineers (Third Edn); PHI; 2007.
2. F.B.Hildebrand; Introduction Numerical Analysis; Dover publications; 2013.
3. J.B. Scarborough; Numerical Mathematical Analysis; Oxford and IBH;2005 .

Assessment Rubrics:

Evaluation Type	Marks

End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

****Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

KU6DSECMT301: COMPLEX ANALYSIS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU6DSECMT301	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course is to introduce Complex Analysis as an extension of Real Analysis by extending the familiar real calculus to complex calculus by introducing complex numbers and functions.

Thus, in certain ways, problems that are difficult to solve in real calculus may be much easier to solve in complex analysis. Complex analysis is important in applied mathematics for three main reasons

1. Two-dimensional potential problems can be modelled and solved by methods of analytic functions. This reason is the real and imaginary parts of analytic functions satisfy Laplace's equation in two real variables.

2. Many difficult integrals (real or complex) that appear in applications can be solved quite elegantly by complex integration.

3. Most functions in engineering mathematics are analytic functions, and their study as functions of a complex variable leads to a deeper understanding of their properties and to interrelations in complex that have no analogue in real calculus.

Course Prerequisite

Basic idea of Complex numbers, algebra of complex numbers, powers and roots.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of Analytic Functions, Cauchy–Riemann Equations, Laplace's Equation, Harmonic functions and Harmonic conjugates,	Understand
2	Understand the concept of Exponential Function, Trigonometric Functions,Hyperbolic Functions, Logarithmic functions and General Power of complex numbers	Understand Apply
3	Understand the concept of line integral in the complex plane,Cauchy's integral theorem , Cauchy's integral formula and derivatives of analytic functions	Understand, Apply
4	Understand how to apply convergence of Sequences and Series of complex numbers and functions.	Understand, Apply
5	Understand power series, functions given by power series, Taylor series, Maclaurin's Series and Laurent Series	Understand, Apply
6	Understand singularities and zeros of complex functions	Understand, Apply
7	Understand residue integration method	Understand, Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓		✓		✓	
CO 2						✓	

CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Complex Functions, Complex differentiation**		**14**
	1	Derivative, Analytic Function, Cauchy–Riemann Equations (Proof of the derivation of CR equations excluded)	
		Laplace's Equation, Harmonic functions	
		Exponential Function, Trigonometric and Hyperbolic Functions, Euler's Formula,	
		Logarithm, General Power, Principal Value	
II		**Complex Integration**	**14**
	1	Line Integral in the Complex Plane.	
	2	Cauchy's Integral Theorem, Cauchy's Integral Formula, (Proof of Cauchy's Integral theorem, Existence of Indefinite integrals are excluded)	
	3	Derivatives of Analytic Functions (Proof of derivatives of analytic functions are excluded)	
III	**Power Series, Taylor Series**		**14**
	1	Sequences, Series, Convergence tests	
		Power Series,	
		Functions given by Power Series (without proof)	

		Taylor and Maclaurin's Series (Proof of Taylor's theorem excluded) (Sections 15.1- 15.4)	
IV	**Laurent Series, Residue Integration**		**13**
	1	Laurent Series (Proof of Laurent's Theorem excluded)	
		Singularities	
		Zeros, Infinity	
		Residue	
V	**Teacher Specific Module**		**5**
	1	Methods of finding Analytic functions whose real/imaginary parts are given.	
		Methods of finding Harmonic conjugates	
		Evaluation of line integrals	
		Practical methods for finding Taylor Series	
		Practical methods for finding Laurent's Series	
		Residue Integration Method (Sections 16.3).	

Essential Readings:

Erwin Kreyszig, Advanced Engineering Mathematics (Tenth edition), John Wiley, 2011.

Reference Distribution:

1. J.W. Brown and R.V. Churchil; Complex Variables and Applications (Seventh edition); Mc-Graw-Hill, 2004.
2. L.V. Ahlfors, Complex Analysis (Third edition), McGraw-Hill, 1980.
3. S. Ponnusamy, Foundations of Complex Analysis (Second edition), Alpha Science International Ltd., 2005.

Reference Distribution:

Module	Unit	Reference No.	Sections	Remarks
I	1	1	Sections 13.3- 13.7	Proof of the derivation of CR equations excluded
II	1,2	1	Sections 14.1 - 14.4	Proof of the existence of indefinite integrals, Derivetive of Analytic functions are excluded

III	1	1	Sections 15.1- 15.4	Proof of Taylor's theorem excluded
IV	1	2	Sections 16.1-16.3	

Suggested Readings:

1. Murray Spiegel;Complex Variables;Schaum's Outline Series; Second Edition.
2. S.S. Sastry; Engineering Mathematics; Vol 2 (4th edition), PHI.
3. J.B. Conway; Functions of One Complex Variable (2nd edition); Springer

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

****Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

KU6DSECMT302: REAL ANALYSIS II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours

VI	DSE	300	KU6DSECMT302	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

In this course the student will learn the basic concepts and techniques of Real Analysis. It starts from infinite series, convergence, tests for convergence, Absolute convergence, and conditional convergence. Continuous functions and the fundamental properties of continuous functions on intervals, uniform continuity are also discussed. This course also discuss the Riemann Integrals, properties classes of Riemann Integrable functions and the Fundamental theorem of calculus

Course Prerequisite

Sequences, convergence and test for convergence of sequence.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the Infinite Series, Convergence of the series and tests for the convergence. Also apply it to test the convergence of the given series.	Understand, Apply
2	Understand the concepts of Absolute convergence and conditional convergence and apply these concepts to given series.	Understand, Apply
3	Understand the various tests for Absolute convergence and non absolute convergence apply them to test the convergence of a given series	Understand, Apply
4	Understand the concept of continuous functions and its properties, combinations, uniform continuity and apply the various problems involving continuity.	Understand, Apply
5	Understand the concept of Riemann integration, its properties, Fundamental theorems of calculus and apply them in problems and theorems involving integration	Understand, Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓	✓				✓
CO 2	✓		✓			✓	
CO 3	✓		✓				
CO 4	✓		✓				
CO 5	✓		✓		✓		
CO 6	✓		✓				
CO 7	✓		✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Infinite series**		**14**
	1	Introduction to infinite series	
		a) The n^{th} term test	
		b) Cauchy criterion for series	
		c) The comparison tests	
	2	**Absolute convergence**	
		a)Absolute convergence	
		b)Conditional convergence	
		c)Grouping and Re-arrangement of series	
	3	**Test for absolute convergence**	

		a)Limit comparison test II(with out proof)	
		b) Root and ratio test(with out proof)	
		c) Integral test (with out proof)	
		d) Raabe's test 9 with out proof)	
	4	**Test for non absolute convergence**	
		a) Alternating series test	
		b) The Dirichlet and Abel test	
II	**Continuous Functions**		**14**
	1	**Continuous Functions**	
		a) Continuous Function	
		b) Sequential criteria for continuity	
		c) Discontinuity criteria	
	2	**Combination of continuous functions**	
		a) Combination of continuous functions and examples	
		b) Composition of continuous functions and examples	
	3	**Continuous function on intervals**	
		a) Boundedness theorem (without proof)	
		b) Maximum- Minimum theorem (without proof)	
		c) Location of roots theorem(Without proof)	
		d) Bolzano's intermediate value theorem	
		e) Preservation of intervals theorem	

III	**Uniform Continuity**		**14**
	1	**Uniform continuity**	
		a) Uniform continuity	
		b) Uniform continuity theorem	
	2	**Lipschitz functions**	
		a) Lipschitz function	
		b) Continuous Extension Theorem.	
IV	**The Riemann Integral.**		**13**
	1	**Riemann Integral**	
		a) Definition of Riemann Integral and examples	
		b) Properties of Riemann Integral	
		c) Boundedness Theorem.	
	2	**Riemann Integrable functions**	
		a) Cauchy criteria(without proof)	
		b) The Squeeze theorem (Without proof)	
		c) Classes of Riemann integrable functions	
		d) Additivity theorem (Without proof)	
	3	**The Fundamental theorem**	
		a) The Fundamental theorem of calculus first form	
		b) The Fundamental theorem of calculus second form	
		c) Substitution theorem.	

V	**Additional Topic offered by teacher**	
	Directions	
	a) Illustrations of the tests for convergence series	5
	b) Illustrated Examples and counter examples for the topics in continuous functions	
	c) Illustrated Examples of Riemann Integrable functions	

Essential Readings:

1. Robert G. Bartle and Donald R.Sherbert; Introduction to Real Analysis; Fourth Edn.; Wiley India edn.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Section 3.7	
	2	1	Section 9.1	Excluding the proof of Rearrangement Theorem
	3	1	Section 9.2	Excluding the proof of Integral test and Raabe's Test
	4	1	Section 9.3	Excluding the proof of Abel's lemma, Dirichelet's test and Abel's Test
II	1	1	Section 5.1	
	2	1	Sections 5.2	Excluding the proof of theorems
	3	1	Section5.3	Excluding the proof of boundedness theorem, Maximum-Minimum theorem and the Location of Roots theorem
III	1	1	Sections 5.4.1, 5.4.2 and 5.4.3	

	2	1	Sections 5.4.4, 5.4.5, 5.4.6, 5.4.7 and 5.4.8	Excluding the proof of continuous extension theorem
IV	1	1	Sections 7.1	Excluding the proof of theorems 7.1.2, 7.1.3, 7.1.5 and 7.1.6
		1	Section 7.2	Excluding the proof of theorems 7.2.1, 7.2.3,7.2.4. and 7.2.5,7.2.7, 7.2.8,7.2.8, and7.2.9
		1	Section 7.3	Excluding the proof of theorems 7.3.1, 7.3.4,7.3.5 and 7.3.8

Suggested Readings:

1. J.M. Howie; Real Analysis; Springer; 2007.
2. Ghorpade and Limaye; A Course in Calculus and Real Analysis; Springer; 2006
3. K.A. Ross; Elementary Analysis: The Theory of Calculus; Springer; 2013.
4. J.V. Deshpande; Mathematical Analysis and Applications; Alpha Science International Ltd.; 2004.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

****Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

KU6DSECMT303: METRIC SPACES

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU6DSECMT303	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

This course is to introduce the notion of metric spaces, sequences in metric spaces, continuity in metric spaces and some properties of metric spaces.

Course Prerequisite

1.Real Sequences, Convergence of real sequences.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of metric spaces	Understand
2	Understand the concept of open sets, closed sets, interior of a set and closure of a set.	Understand
3	Extend the concept of convergence of a sequence and the concept of Cuachysequences in to metric spaces	Understand, Apply
4	Understand the concept of continuity in metric spaces.	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7

CO 1	✓	✓		✓		✓	
CO 2						✓	
CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Basic Concepts**		**14**
	1	Metric Spaces	
II	**Basic Concepts**		**14**
	1	Sequences in Metric Spaces.	
	2	Cauchy Sequences	
III	**Topology of Metric Space**		**14**
	1	Open and Closed Sets	
IV	**Continuity**		13
	1	Continuous Mapping	
V	**Teacher Specific Module**		5
	Inequalities		

Essential Readings:

1. Satish Shirali and Harikrishnan L Vasudeva; Metric Spaces; Springer; 2006.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections1.2	
II	1	1	Sections 1.3	
	2	1	Sections 1.4	
III	1	1	Section 2.1	

IV	1	1	Section 3.1	
V	1	1	Section 1.1	

Suggested Readings:

4. C.G.C.Pitts; Introduction to Metric Spaces; Oliver and Boyd Edingburg.
5. G.F.Simmons; Introduction to Topology and Modern Analysis; Tata Mc Graw Hill;1963

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

**Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.

KU6DSECMT304: MATHEMATICAL ECONOMICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU6DSECMT304	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course is designed to understand the applications of Mathematical tools in Economics

Course Prerequisite

Matrices, Integration, Basic Economics

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of equilibrium analysis in Economics	Understand
2	Understand equilibrium in market and National Income Analysis	Understand
3	Understand Matrix Analysis in Economics	Understand

4	Understand the Applications of Integration in Economics	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓		✓		
CO 2		✓				✓	
CO 3	✓		✓				✓
CO 4	✓			✓			✓

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Equilibrium Analysis in Economics**	14
	1.1	The Meaning of Equilibrium	
	1.2	Partial Market Equilibrium- A linear Model	
	1.3	Partial Market Equilibrium- A non-linear model	
II		**Equilibrium and Income**	**14**
	2.1	General Market Equilibrium	
	2.2	Equilibrium in National Income Analysis	
III		**Matrix Analysis**	**14**
	3.1	Applications to Market and National Income Models	
	3.2	Leontif Input-Output Model	
IV		**Applications of Integration**	**13**
	4.1	Some Economic Applications of Integration	
	4.2	Domar Growth Model	
V		**Teacher Specific Module**	**5**
		Non-linear programming and Kuhn-Tucker conditions	

		The Constraint Qualification	

Essential Readings

1. Alpha C Chiang, Kevin Wainwright; Fundamental Methods of Mathematical Economics; 4th Edition; 2005.

Reference Distribution:

Module	Unit	Essential Reading No.	Chapters	Remarks
I	1.1	1	Chapter 3; Section 3.1	
	1.2	1	Chapter 3; Section 3.2	
	1.3	1	Chapter 3; Section 3.3	
II	2.1	1	Chapter 3; Section 3.4	
	2.2	1	Chapter 3; Section 3.5	
III	3.1	1	Chapter 5; Section 5.6	
	3.2	1	Chapter 5; Section 5.7	
IV	4.1	1	Chapter 14; Section 14.5	
	4.2	1	Chapter 14; Section 14.6	
V		1	13.1-13.2	

Suggested Readings

6. Damodar N Gujarati, Sangeetha; Basic Econometrics(4th Edition); TMH Indian Reprint; 2008
7. S.P.Singh, A.K. Parashar, H.P.Singh; Econometrics and Mathematical Economics; S Chand

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		70
Continuous Evaluation		30
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		100

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Calculators shall not be permitted.**

SEMESTER - 7

KU7DSCCMT401: ABSTRACT ALGEBRA

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCCMT401	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

This course is to provide a first approach to the subject of Algebra and provide some advanced level group theory.

Course Prerequisite

1. Basic idea about group theory

Course Outcomes

CO No.	Expected Outcome	Learning Domains

1	To understand group action on a set.	Understand, Apply
2	Understand and apply the Sylow'sTheorems.	Understand
3	Understand and apply isomorphism theorems.	Understand, Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓		✓		✓	
CO 2		✓				✓	
CO 3	✓				✓		✓
CO 4	✓		✓				
CO 5	✓		✓				✓
CO 6	✓				✓		
CO 7	✓				✓		

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Structure of Groups**		14
	1	Finitely generated Abelian Groups	
II	**Homomorphisms and Factor Groups**		14
	1	Group Action on a Set	
III	**Advanced Group Theory**		14
	1	Sylow Theorems and Applications of Sylow Theorems	
IV	**Constructing Rings and Fields, Advanced Group Theory**		13
	1	The field of Quotients of an Integral Domain	
	2	Isomorphism Theorems	
V	**Teacher Specific Module**		5

	1	Series of Groups	
	2	Free Abelian Groups	

Essential Readings:

1. John B Fraliegh, Neal E Brand; A First Course in Abstract Algebra(Eighth Edition); Pearson; 2021

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Chapter 2: Section 9	
II	1	1	Chapter 3: Section 14	
III	1	1	Chapter 4: Section 17	
IV	1	1	Chapter 6: Section 26	
	2	1	Chapter 4: Section 16	
V	1	1	Chapter 4: Sections 18	
	2	1	Chapter 4: Sections 19	

Suggested Readings:

1. Joseph A Gallian; Contemporary Abstract Algebra;Narosa; 1999.
2. N. Herstein; Topics in Algebra; Wiley India Pvt. Ltd; 2006.
3. M. Artin; Algebra (Second Edition); Addison Wesley; 2010.
4. David S Dummit; Abstract Algebra(Third Edition); Wiley India; 2011.
5. D.S. Malik, John.N. Merdson, M.K. Sen; Fundamentals of Abstract Algebra; McGraw - Hill publishing Co; 1996.

Assessment Rubrics:

Evaluation Type	Marks
End Semester Evaluation	**70**

Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

KU7DSCCMT402: LINEAR ALGEBRA

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCCMT402	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course is to introduce the concept of Linear Transformation and matrix properties of its related matrix.

Course Prerequisites: Matrix Theory, Vector Space , Basis

Course Outcomes

CO NO.	EXPECTED OUTCOME	LEARNING DOMAINS
1	Understand the concept of Linear Transformation.	Understand
2	Apply the concept of Matrix related to Linear transformation.	Understand, Apply
3	Understand the concept of Double Dual and Transpose.	Understand
4	Understand the concept of Diagonalisation.	Understand
5	Understand the concept of Characteristic Values	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓		✓		✓	
CO 2						✓	
CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
	Linear Transformations		**14**

I	1	a) Linear Transformations b) The algebra of Linear Transformations c) Isomorphism d) Representation of Transformation by Matrices	
II	1	Linear Functionals	14
		The Double Dual	
		Transpose of a Linear Transformation.	
III	**Elementary Canonical Forms**		**14**
	1	a) Introductions b) Characteristic values c) Annihilating Polynomials	
IV			**13**
	1	a) Invariant Subspace b) Simultaneous Triangulations & Simultaneous Diagonalisation, c) Direct Sum Decompositions	
V	**Teacher Specific Module**		**5**
	1	a) Invariant Direct Sums (without proof) b) The Primary Decomposition Theorem(without proof)	

Essential Readings:

1:Kenneth Hoffman & Ray Kunze;Linear Algebra(Second Edition); Prentice- Hall of India *Pvt.*Ltd;2015

Reference Distribution:

Module	Unit	Reference No.	Sections	Remarks
I	1	1	Sections 3.1-3.4	
II	1	1	Sections 3.5-3.7	
III	1	1	Sections 6.1-6.3	
IV	1	1	Sections 6.4-6.6	

Suggested Readings:

1. Stephen H Friedberg;Arnold **J** lnseland Lawrence E Spence;*Linear Algebra* (Fourth Edition);Prentice Hall;2015.
2. Sheldon Axler;*Linear Algebra Done Right* (Third Edition); Springer;2015
3. Martin Anthony and Michele Harvey;*Linear Algebra: Concepts and Methods; Cambridge* University Press;2012
4. S. Kumaresan;L*inear Algebra: A Geometric Approach;*PHI Learning Pvt. Ltd.;2000

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

****Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

KU7DSCCMT403: MATHEMATICAL ANALYSIS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
7	DSC	400	KU7DSCCMT403	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	**Practical/ Internship**	**Tutorial**	**CE**	**ESE**	**Total**	
4		1	30	70	100	2

Course Description

This course aims to introduce the concepts of basic topology, limit continuity and differentiation of functions of one and several variables

Course Prerequisite

KU5DSCCMT301: REAL ANALYSIS-I,

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the concepts of basic topology on ***R.***	Understand
2	Apply Cauchy convergence criterion to check uniform convergence	Apply
3	Understand the basic concepts of series of functions	Understand
4	Understand the basic concepts of metric spaces	Understand
5	Apply the known concepts to identify open and closed sets in different metric spaces	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2						✓	
CO 3	✓						

CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Basic Topology**		**14**
	1	a)Finite, Countable and uncountable Sets	
		b) Metric spaces	
		c) Compact Sets	
		d) Perfect Sets, Connected Sets	
II	**Continuity**		**14**
	1	a) Limits of function	
		b) Continuous functions	
		c) Continuity and compactness	
		d) Continuity and connectedness	
		e) Discontinuities	
III	**Monotonic functions and Differentiation**		**14**
	1	a) Monotonic functions	
		b) Infinite limits and Limits at infinity	
		c) Derivative of a real function	
		d) Mean value theorems	
		e) Continuity of derivatives	

IV	**Differentiation**		**13**
	1	a) L Hospital's rule	
		b) Derivatives of higher order	
		c) Taylor's theorem	
		d) Differentiation of vector valued functions	
V	**Teacher Specific Module**		**5**
	Directions		
	Visualize the concepts of neighbourhoods and open balls using CAS		
	Analyse limits, continuity and discontinuity of functions using CAS		

Essential Readings:

1. Walter Rudin, *Principles of Mathematical Analysis* (Third Edition), McGraw Hill, 1976.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Chapter 2	
II	1	1	Chapter 4. Sections 4.1 - 4.27	
III	1	1	Chapter 4. Sections 4.28 - 4.34 Chapter 5. Sections 5.1 – 5.12	
IV	1	2	Chapter 5, Sections 5.13 – 5.19	

Suggested Readings:

1. T. M. Apostol;*Mathematical Analysis* (Second Edition);Narosa; 2002.
2. R. G. Bartle;*The Elements of Real Analysis*(Second Edition); Wiley International; 1975
3. G. F. Simmons; *Introduction to Topology and Modern Analysis;* McGraw Hill; 2017
4. Charles Chapman Pugh; *Real Mathematical Analysis;* Springer; 2010
5. Sudhir R. Ghorpadeand Balmohan V. Limaye; *A Course in Calculus and Real Analysis;* Springer; 2006
6. R. G. Bartle and D. R Sherbert;*Introduction to Real Analysis;* John Wiley Bros; 1982

7. L. M Graves;*The Theory of Functions of a Real Variable;* Tata McGraw- Hill; 1978

8. M. H Protter and C.B Moray;*A First course in Real Analysis;* Springer; 1977

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Scientific Calculators below 100 functions (that is, upto *fx 99*) shall be permitted.**

KU7DSCCMT404: TOPOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCCMT404	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

In this course the student will learn the basic concepts and techniques of Topology. It starts from basic definition of topology, different topologies, basis, sub basis, subspaces, metric spaces, product spaces, continuous functions and homeomorphism. This also helps to understand topology as a general tool for analysis.

Course Prerequisite

Set theory, functions, order relations and basic concepts of metric spaces.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand topology, compare topologies, and distinguish different topologies.	Understand,Apply
2	Understand basis and sub basis, compare topologies using basis and sub basis.	Understand,Apply
3	Construction of new topologies from existing topologies – product topology, subspace topology, geometry of the product topology.	Understand,Apply
4	Understand and identify closed sets, open sets, limit points and continuous functions.	Understand,Apply
5	Compare and distinguish the product topology and box topology.	Understand,Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓	✓				✓
CO 2	✓		✓	✓		✓	
CO 3	✓		✓				✓
CO 4	✓	✓	✓	✓		✓	
CO 5	✓		✓		✓	✓	
CO 6	✓	✓	✓	✓			✓
CO 7	✓	✓	✓			✓	

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	TOPOLOGICAL SPACES – 1		14
	1	Topological spaces	
	2	Basis for a topology	
	3	The order topology	
II	TOPOLOGICAL SPACES – 2		14
	1	The product topology on X x Y	
	2	The subspace topology	
III	TOPOLOGICAL SPACES – 3		14
	1	Closed sets and limit points	

	2	Continuous functions	
IV	TOPOLOGICAL SPACES – 4		13
	1	The product topology (arbitrary product)	
	2	The metric topology	
V	TEACHER SPECIFIC MODULE		5
		Order relations, Well order relations, Well ordering theorem, Maximum Principle	

Essential Readings:

1. James Munkres; Topology; Second edition; Pearson New International Edition; 2014.

Reference Distribution:

Module	Unit	Essential ReadingNo.	Sections	Remarks
I	1	1	12	
	2	1	13	
	3	1	14	
II	1	1	15	
	2	1	16	
III	1	1	17	
	2	1	18	
IV	1	1	19	
	2	1	20	Proof of theorem 20.5 omitted

V	1	1	10, 11	

Suggested Readings:

1. C. Wayne Patty; Foundations of Topology; Second Edition; Jones & Bartlett India Pvt. Ltd., New Delhi, 2012.
2. K. D. Joshi; Introduction to General Topology; New Age International (P) Ltd.
3. Dugundji; Topology; Prentice Hall of India.
4. G. F. Simmons; Introduction to Topology and Modern Analysis; Mc Graw Hill.
5. S. Willard; General Topology; Addison Wesley Publishing Company.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

KU7DSCCMT405: ADVANCED ORDINARY DIFFERENTIAL EQUATIONS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCCMT405	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

To gain knowledge on the basic differential equations at the heart of analysis which is a dominant branch of mathematics for 300 years. This subject is the natural purpose of the primary calculus and the most important part of mathematics for understanding physics.

Course Prerequisite: Calculus, real analysis and basic differential equations.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand topology, compare topologies, and distinguish different topologies.	Understand, Apply
2	Understand basis and sub basis, compare topologies using basis and sub basis.	Understand, Apply
3	Construction of new topologies from existing topologies – product topology, subspace topology, geometry of the product topology.	Understand, Apply

4	Understand and identify closed sets, open sets, limit points and continuous functions.	Understand, Apply
5	Compare and distinguish the product topology and box topology.	Understand, Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓	✓				✓
CO 2	✓		✓	✓		✓	
CO 3	✓		✓				✓
CO 4	✓	✓	✓	✓		✓	
CO 5	✓		✓		✓	✓	
CO 6	✓	✓	✓	✓			✓
CO 7	✓	✓	✓			✓	

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Power Series Solutions and Special Functions-1**	14
	1	Second Order Linear Equations. Ordinary Points	
	2	Regular Singular Points	
II		**Power Series Solutions and Special Functions-2**	14
	1	Regular Singular Points (Continued)	
	2	Gauss's HypergeometricEquation	
III		**Some Special Functions ofMathematical Physics 1**	14
	1	Legendre Polynomials	
	2	Properties of Legendre Polynomials	
IV		**Some Special Functions ofMathematical Physics2**	13

	1	Bessel Functions. The Gamma Function	
	2	Properties of Bessel Functions	
V	**TEACHER SPECIFIC MODULE**		5
	1	Introduction. A Review of Power Series	
	2	Series Solutions of First Order Equations	

Essential Readings:

1. G.F Simmons; Differential Equations with Historical Notes [Third Edition]; CRCPress-Taylor and Francis Group; 2017.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	28	
	2	1	29	
II	1	1	30	
	2	1	31	
III	1	1	44	
	2	1	45	
IV	1	1	46	
	2	1	47	
V	1	1	26	
	2	1	27	

Suggested Readings:

1. G. Birkoff and G. C Rota;Ordinory Differential Equations; Fourth Edition; Wiley and Sons; 1978.
2. E. A Coddington; An Introduction to Ordinary Differential Equations; Prentice Halt of India; 1974.
3. P. Hartmon; Ordinary Differential Equations; Society for Industrial and applied; 1987
4. Chakraborti; Elements of Ordinary Differential Equations and Special Functions; WileyEastern, 1990
6. L.S Poutrigardian; A Course in Ordinary Differential Equations; Hindustan Publishing Corp.; 1967
7. S.G Deo and V.Raghavendra; Ordinary Differential Equations and Stability Theory; Tata McGraw Hill; 1967
8. V. I. Arnold; Ordinary Differential Equations; MIT Press Cambridge; 1981

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		70
Continuous Evaluation		30
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		100

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

SEMESTER - 8

KU8DSCCMT401: ADVANCED ABSTRACT ALGEBRA

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSC	400	KU8DSCCMT401	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course is to provide some advance concepts in abstract Algebra like Galois theory.

Course Prerequisite

2. A strong base in Group theory and Ring theory

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand ring theory in polynomials	Understand, Apply
2	Understand and applications of different type of factorization domains	Understand, Apply

3	Understand and applications of extension fields and to get some basics about Glois group.	Understand, Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓		✓		✓	
CO 2						✓	
CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**1**	Rings of polynomials, Factorization of polynomials over a field	**14**
II	**1**	Homomorphisms and Factor Rings, prime and maximal Ideals.	**14**
III	**1**	Unique Factorization Domains	**14**
IV	**1**	Euclidean Domains, Gaussian Integers and Multiplicative Norms**.**	**13**
IV	**Teacher Specific Module**		**5**
	1	Sylow Theorems	

Essential Readings:

1:John B Fraliegh, Neal E Brand; A First Course in Abstract Algebra(Eighth Edition); Pearson; 2021

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Chapter 6: Sections 27,28,30,31	
II	1	1	Chapter 7: Sections 34 to 36.	
III	1	1	Chapter 8: Sections 39 to 42	

Suggested Readings:

6. Joseph A Gallian; Contemporary Abstract Algebra;Narosa; 1999.

7. N. Herstein; Topics in Algebra; Wiley India Pvt, Ltd; 2006.
8. M. Artin; Algebra (Second Edition); Addison Wesley; 2010.
9. David S Dummit; Abstract Algebra(Third Edition); Wiley India; 2011.
10. D.S. Malik, John.N. Merdson, M.K. Sen; Fundamentals of Abstract Algebra, McGraw - Hill publishing Co, 1996.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

****Use of Scientific Calculators below 100 functions (that is, up to *fx 99*) shall be permitted.**

KU8DSCCMT402: MEASURE THEORY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSC	400	KU8DSCCMT402	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		1	30	70	100	2

Course Description

This course offers an introduction to measure theory, the field of mathematics that is the mathematical foundation of probability theory. It also has applications in functional analysis and other areas. The following concepts will be introduced: sigma-algebras, measures, measurable functions and Lebesgue integrals. We shall see how a series can be interpreted as an integral! Additionally we will discuss the most important convergence theorems.

Course Prerequisite

KU7DSCCMT403 : MATHEMATICAL ANALYSIS

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of Lebesgue measurable sets and constriction of non measurable sets.	Understand
2	Understand the concepts of measurable functions.	Understand
3	Mastery in the general Lebesgue's integral and its properties	Apply
4	Understand the concepts of abstract measure space	Understand
5	Understand the concept of integration with respect to measure	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2						✓	
CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Measure on the Real Line**		**14**
		a)Lebesgue Outer Measure	
		b) Measurable Sets	
		c) Regularity	
II	**Measure on the Real Lin**		**14**
		b) BorelandLebesgue Measurability	
III	**Integration of Functions of a Real Variable**		**14**
	1	e) Integration of Non-negative Functions	
		f) The General Integral	
		c) Riemann and Lebesgue Integrals	
IV	**Abstract Measure Space**		**13**
		i) Measures and Outer measures	
		j) Extension of measure	
		k) Uniqueness of the extension	
V	**Teacher Specific Module**		**5**
	Directions		
	Measure Spaces		
	Integration with respect to a Measure		

Essential Readings:

G De Barra, *Measure Theory and Integration*. (Second Edition), New Age International Pvt.Ltd., 2003.

Reference Distribution:

Module	Unit	Reference No.	Sections	Remarks
I	1	1	Chapter 2, Sections 2.1 –2.3	
II	1	1	Chapter 2, Sections 2.4–2.5	
III	1	1	Chapter 3, Sections 3.1 – 3.2,3.4	
IV	1	2	Chapter 5, Sections 5.1 – 5.3	

Suggested Readings:

1. Walter Rudin, *Real and Complex Analysis* (Third Edition), Tata McGraw Hill, 2017
2. H. L Royden, P M Fitzpatrick, *Real Analysis*, Pearson, Fourth Edition, Pearson, 2015
3. R. G. Bartle, *The Elements of Integration and Measure Theory*, John Wiley and Sons, 1995
4. P.R Halmos, *Measure Theory,* Springer, 1976
5. A. E Taylor, *General Theory of Functions and Integrations*, Dover Publications, 2010
6. Inder K. Rana, *An Introduction to Measure and Integration*, Narosa Publishing House, 1997
7. M.ThambanNair,*Measure and Integration: A First Course*, CRC Press, 2019

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

KU8DSCCMT403: ADVANCED MATHEMATICAL ANALYSIS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
8	DSC	400	KU8DSCCMT403	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	

4		1	30	70	100	2

Course Description:

This course aims to learn the real analysis in advanced level. The course provides the basis for further studies within functional analysis, topology and function theory. In this course a detailed study of Riemann-Stieltjes integral, Sequence and series of functions, uniform convergence, and the Stone-Weierstrass Theorem are included.

Course Prerequisite

KU7DSCCMT403 : MATHEMATICAL ANALYSIS

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the Riemann-Stieltjes integral	Understand
2	Understand the concepts of sequence and series of functions and uniform convergence	Understand
3	Apply the concepts in uniform convergence in analysing various properties of sequences of functions	Apply
4	Understand the concepts of equicontinuous families of functions	Understand
5	Understand the Stone-Weierstrass approximation theorem	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2						✓	
CO 3	✓						
CO 4	✓						
CO 5	✓						

CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Reimann – Stieltjes integral**.		**14**
		a)Definition and existence of the integral	
		b) Integration and differentiation	
		c) Integration of vector – valued functions	
II	**Sequence and series of Functions**		**14**
		d) Rectifiable curves	
		e) Sequence and series of Functions: Discussion of Main Problem	
		f) Uniform Convergence	
III	**Sequence and series of Functions**		**14**
	1	g) Uniform Convergence and Continuity.	
		h) Uniform Convergence and Integration	
		c) Uniform Convergence and Differentiation	
IV	**The Stone-Weierstrass Theorem**		**13**
		l) Equicontinuous Families of Functions	
		m) The Stone-Weierstrass Theorem	
V	**Teacher Specific Module**		**5**
	Directions		
	Distinguish Riemann integral and Riemann-Stieltjes integral using CAS		
	Visualize the concepts of point wise and uniform convergence using CAS		

	Visualize Equicontinuous Families of Functions using CAS	

Essential Readings:

1. Walter Rudin;*Principles of Mathematical Analysis* (Third Edition); McGraw Hill; 1986.

Reference Distribution:

Module	Unit	Reference No.	Sections	Remarks
I	1	1	Chapter 6, Sections 6.1 - 6.25	
II	1	1	Chapter 6, Sections 6.26 - 6.27 Chapter 7, Sections 7.1 – 7.10	
III	1	1	Chapter 7, Sections 7.11 – 7.18	
IV	1	2	Chapter 7, Sections 7.19 – 7.33	

Suggested Readings:

11. T.M. Apostol;*Mathematical Analysis* (Second Edition);Narosa, 2002
12. R. G. Bartle;*The Elements of Real Analysis*(Second Edition); Wiley International; 1975
13. G.F. Simmons; *Introduction to Topology and Modern Analysis;* McGraw Hill; 2017
14. Charles Chapman Pugh; *Real Mathematical Analysis* Springer, 2010
15. S. R. Ghorpadeand, B. V. Limaye;*A Course in Calculus and Real Analysis;* Springer; 2006
16. R. G Bartle and D. R Sherbert;*Introduction to Real Analysis;* John Wiley Bros.; 1982
17. L. M Graves, *The Theory of Functions of a Real Variable;* Tata McGraw Hill; 1978
18. M. H Protter and C.B Moray;*A First course in Real Analysis;* Springer; 1977
19. S.L.Ross; Differential Equations (Third Edition); Wiley & Sons; 1984.
20. A.H.Siddiqi&P.Manchanda; A First Course in Differential Equations with Applications; Macmillan; 2006.
21. E.A.Coddington; An ntroduction to Ordinary Differential Equation, PHI; 2009.

1. **Assessment Rubrics:**

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12

b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

KU8DSECMT401: ADVANCED TOPOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSECMT401	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4			30	70	100	2

Course Description

In this course the student will learn the advanced concepts and techniques of Topology. It starts from connected spaces, different types of connectedness, components, connectedness on real line, compactness, and different types of compactness, separation axioms and countability axioms.

Course Prerequisite

KU7DSCCMT404: Topology

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand connected spaces and apply the concept of connectedness. Compare different types of connectedness.	Understand,Apply
2	Understand compactness and compare different types of compactness.	Understand,Apply
3	Understand separation axioms. Compare different separation axioms	Understand,Apply
4	Understand countability axiom and compare different countability axiom.	Understand,Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓	✓				✓
CO 2	✓		✓	✓		✓	
CO 3	✓		✓				✓
CO 4	✓	✓	✓	✓		✓	
CO 5	✓		✓		✓	✓	
CO 6	✓	✓	✓	✓			✓
CO 7	✓	✓	✓			✓	

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	CONNECTED SPACES		14
	1	Connected spaces	
	2	Connected subspaces of the real line	
	3	Components and local connectedness	
II	COMPACT SPACES – 1		14
	1	Compact spaces	
	2	Compact subspaces of the real line	
III	COMPACT SPACES – 2		14
	1	Limit point compactness	

	2	Local compactness	
IV	COUNTABILITY AND SEPERATION AXIOMS		13
	1	Countability axioms	
	2	Separation axiom	
	3	Normal spaces	
V	TEACHER SPECIFIC MODULE		5
		More about metric topology	

Essential Readings:

2. James Munkres; Topology; Second edition; Pearson New International Edition; 2014.

Reference Distribution:

Module	Unit	Essential ReadingNo.	Sections	Remarks
I	1	1	23	
	2	1	24	
	3	1	25	
II	1	1	26	
	2	1	27	
III	1	1	28	
	2	1	29	
IV	1	1	30	
	2	1	31	

	3	1	32	
V	1	1	21	

Suggested Readings:

1. C. Wayne Patty; Foundations of Topology; Second Edition; Jones & Bartlett India Pvt. Ltd., New Delhi, 2012.
2. K. D. Joshi; Introduction to General Topology; New Age International (P) Ltd.
3. Dugundji; Topology; Prentice Hall of India.
4. G. F. Simmons; Introduction to Topology and Modern Analysis; Mc Graw Hill.
5. S. Willard; General Topology; Addison Wesley Publishing Company.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

KU8DSECMT402: PARTIAL DIFFERENTIAL EQUATIONS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSECMT402	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4		0	30	70	100	2

Course Description

This course is designed to learn about partial differential equations and finding solutions using various techniques

Course Prerequisite

Differential Equations, Calculus

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the Concept of First Order Partial Differential Equations	Understand
2	Understand the Concept of Second Order Differential Equations in two independent variables	Understand
3	Understand some special Second Order Differential Equations	Understand
4	Understand the method of Separation of Variables	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7

CO 1	✓						
CO 2			✓				
CO 3			✓				
CO 4			✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**First-order equations**	14
		Introduction	
		Quasilinear equations	
		The method of characteristics	
		Examples of the characteristics method	
		The existence and uniqueness theorem	
		The Lagrange method	
		General Nonlinear equations	
		Exercises	
II		**Second-order linear equations in two independent variables**	14
		Classification	
		Canonical form of hyperbolic equations	
		Canonical form of parabolic equations	
		Canonical form of elliptic equations	
		The one-dimensional wave equation	
		Introduction	

III		Canonical form and general solution	14
		The Cauchy problem and d'Alemberts formula	
		Domain of dependence and region of influence	
		The Cauchy problem for the nonhomogeneous wave equation	
IV		**The method of separation of variables**	13
		Introduction	
		Heat equation: homogeneous boundary condition	
		Separation of variables for the wave equation	
		Separation of variables for nonhomogeneous equations	
		The energy method and uniqueness	
		Further applications of the heat equation	
V		**Teacher Specific Module**	5
		Variational Methods	

Essential Readings

1. YehudhaPinchover and Jacob Rubienstein; *An Introduction to Partial Differential Equations*; Camridge University Press; 2005

Reference Distribution

Module	Unit	Reference No.	Chapters	Remarks
I		1	Chapter 2.1-2.6,2.9,2,10	
II		1	Chapter 3	
III		1	Chapter 4	
IV		1	Chapter 5	
V		1	Chapter 10	

Suggested Readings

1. Amaranath T; *Partial Differential Equations;*Narosa; 1997.
2. A. Chakrabarti; *Elements of ordinary Differential Equations and special functions;* Wiley Eastern Ltd; 1990
3. E.A. Coddington; *An Introduction to Ordinary Differential Eqution*s*;* Printice Hall of India; 1974
4. R. Courant and D. Hilbert; *Methods of Mathematical Physics*-Vol I; Wiley Eastern Reprint; 1975

Rubrics

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	12
c)	Seminar, Viva-Voce	6
Total		**100**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Calculators shall not be permitted.**

MULTIDISCIPLINARY COURSES

SEMESTER - 1

KU1MDCCMT101: LOGIC, LATTICES AND BOOLEAN ALGEBRA

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	MDC	100	KU1MDCCMT101	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3		1	25	50	75	1.5

Course Description

This course is designed to understand the concept of Sets and lattices and its applications in Boolean Algebra.

Course Prerequisite

Sets, Relations, Functions.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the Concept of Logic	Understand
2	Understand the concept of Lattices	Understand
3	Understand the concept of Boolean Algebra	Understand
4	Apply Representation Theorem.	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2			✓				
CO 3			✓				
CO 4			✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Logic and Propositional Calculus**	11
		Introduction	
		Proposition and Compound Statements	
		Basic Logical Operations	
		Propositions and Truth Tables	
		Tautologies and Contradictions	
II		Logical Equivalence	11
		Algebra of Propositions	
		Conditional and Biconditional Statements	
		Arguments	

		Propositional Functions, Quantifiers	
		Negation of Quantified Statements	
III		**Ordered Sets and Lattices**	11
		Introduction	
		Ordered Sets	
		Hasse Diagrams of Partially Ordered Sets	
		Consistent Enumeration	
		Supremum and Infimum	
IV		Isomorphic (Similar) Ordered Sets	12
		Well- Ordered Sets	
		Lattices	
		Bounded Lattices	
		Distributive Lattices	
		Complements, Complemented Lattices	

Essential Readings

1. Seymour Lipschutz, Marc Lars Lipson, Schaum's Outline of Theory and Problems of Discrete Mathematics, Third edition, McGRAW-HILL

Reference Distribution

Module	Unit	Essential Reading No.	Chapters	Remarks
I		1	Chapter 4.1-4.5	
II		1	Chapter 4.6-4.11	
III		1	Chapter 14.1-14.5	

IV		1	Chapter 14.6-14.11	

Suggested Readings

1. Seymour Lipschutz; Schaum's Outlines Set Theory and Related Topics, Second Edition; McGRAW-Hill.
2. Ralph P Grimaldi; Discrete and Combinatorial Mathematics An Applied Introduction, Fifth Edition; Addison-Wesley.
3. V K Balakrishnan; Introductory Discrete Mathematics; Dover Publications, INC

Assessment Rubrics

Evaluation Type		**Marks**
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper *	10
b)	Assignment	10
c)	Seminar, Viva-Voce	5
Total		**75**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

****** Use of Calculators shall not be permitted.

KU1MDCCMT102: THEORY OF MATRICES

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	MDC	100	KU1MDCCMT102	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3		1	25	50	75	1.5

Course Description

This course provides an introduction to matrices. Emphasis is placed on the development of concepts and applications for systems of equations, matrices, determinants, and orthogonality.

Course Prerequisite:

Matrix algebra

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Recognise consistent and inconsistent systems of equations by the row echelon form of the augmented matrix	Understand
2	Able to solve a system of m linear equations in n unknowns using Gaussian elimination	Apply
3	Understand how elementary matrix are used for row operations and find the inverse of a matrix using row operations	Apply
4	Understand the concept 'Rank of a matrix'.	Understand
5	Consistency of a system of linear equations using rank	Apply
6	Understandhow matrices and vectors are used to store data in data science contexts	Understand
7	Understand the role of matrix decomposition in data science	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2	✓		✓			✓	
CO 3	✓	✓					
CO 4	✓						
CO 5	✓						
CO 6	✓			✓			
CO 7	✓		✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Systems of linear equations, Row operations**	**11**
	1	Systems of linear equations	
		a) Systems of linear equations	
	2	Row operations	
		a) Row operations	
II		**Gaussian elimination, Homogeneous systems and null spaces**	11
	1	**Gaussian elimination**	
		a) The algorithm: reduced row echelon form Consistent and inconsistent systems	
		b) Linear systems with free variables	
		c) Solution sets	
	2	**Homogeneous systems and null spaces**	
		a) Homogeneous systems	
		b) Null space	
III		**Matrix inversion**	**11**
	1	**Matrix inversion**	
		a) Matrix inverse using row operations	
		b) Row equivalence	
		c) The main theorem	
		d) Using row operations to find the inverse matrix	
IV		**The rank of a matrix, Rank and systems of linear equations, Range**	12
	1	The rank of a matrix	
	2	Rank and systems of linear equations	

		a) General solution and rank	
		b) General solution in vector notation	
	3	Range	

Essential Readings:

1. Martin Anthony and Michele Harvey Linear Algebra: Concepts and Methods,Cambridge University Press 2012.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Section 2.1	
	2	1	Section 2.2	
II	1	1	Section 2.3	Proof of Theorem 2.17 omitted.
	2	1	Section 2.4	Proof of Theorem 2.21 and Theorem 2.29 omitted.
III	1	1	Section 3.1	Proof of all the theorems in this section omitted
IV	1	1	Section 4.1	Proof of Theorem 4.5 omitted.
	2	1	Section 4.2	
	3	1	Section 4.3	

Suggested Readings:

1) Jeffrey Holt; Linear Algebra with Applications; W.H Freeman & Company; New York
2) T.S Blyth and E F Robertson; Basic Linear Algebra; Springer 2002
3) Charu C Agarwal; Linear Algebra and Optimization for Machine Learning; Springer; 2020
4) Nathen Carter; Data Science for Mathematicians; CRC Press/ Chapman and Hall Handbooks in Mathematics series; 2021.

Assessment Rubrics:

Evaluation Type	Marks
End Semester Evaluation	**50**

Continuous Evaluation		**25**
a)	Test Paper *	10
b)	Assignment	10
c)	Seminar, Viva-Voce	5
Total		**75**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

Use of Scientific Calculators below 100 functions (that is, upto *fx 99*) shall be permitted.

SEMESTER - 2

KU2MDCCMT101**: NUMERICAL ABILITY**

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	MDC	100	KU2MDCCMT101	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3		1	25	50	75	1.5

Course Description

This course is designed to equip students with essential knowledge and skills required to excel in permutation and combination and its applications.

Course Prerequisite

Basic operations in mathematics

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of Permutation and Combination	Understand
2	Understand the concept of principle of inclusion and exclusion	Understand
3	Apply principle of Inclusion and Exclusion	Understand
4	Understand the concept of Generating Functions	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2			✓				
CO 3			✓				
CO 4			✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	1	Permutations	11
	2	Combinations: Binomial Theorem	
	3	Combinations with Repetition	
II	1	The Principle of Inclusion and Exclusion	11
	2	Generalizations of the Principle	
III	1	Introductory Examples	11
	2	Definition and Examples: Calculational Techniques	
IV	3	Partitions of Integers	12
	4	The Exponential Generating Function	

Essential Readings

1. Ralph P. Grimaldi; Discrete and Combinatorial Mathematics (Fourth Edition); Pearson Education.

Reference Distribution

Module	Unit	Essential Readings No.	Chapters	Remarks
I	1	1	Chapter 1.2	
	2	1	Chapter 1.3	
	3	1	Chapter 1.4	
II	1	1	Chapter 8.1	
	2	1	Chapter 8.2	
III	1	1	Chapter 9.1	
	2	1	Chapter 9.2	
IV	1	1	Chapter 9.3	
	2	1	Chapter 9.4	

Suggested Readings

1. Seymour Lipschutz; Marc Lars Lipson; Schaum's Outline of Theory and Problems of Discrete Mathematics; Third edition; Mc. GRAW-HILL
2. V K Balakrishnan; Introductory Discrete Mathematics; Dover Publications, INC

Assessment Rubrics

Evaluation Type		**Marks**
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper *	10
b)	Assignment	10
c)	Seminar, Viva-Voce	5
Total		**75**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Calculators shall not be permitted.**

KU2MDCCMT102: VECTOR ALGEBRA

Semester	Course Type	Course Level	Course Code		Credits	Total Hours
2	MDC	100	KU2MDCCMT102		3	45
Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3		1	25	50	75	1.5

Course Description

This course aims to introduce the concepts of vectors, vector operations, dot product and cross product of two vectors, scalar and vector triple product and applications.

Course Prerequisite

Basic knowledge in Rectangular Cartesian System.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the basics of vectors and vector operations	Understand
2	Comprehend the right- and left-handed systems	Understand
3	Understand dot product, cross product and box product of vectors	Understand
4	Apply the known concepts to illustrate some situations	Understand, Apply
5	Understand miscellaneous applications	Understand, Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2						✓	
CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		a) Fundamental concepts and definitions	11
		b) Vector operations	
		c) Right-handed and Left handed system	
		d) Linear dependence of vectors	
II		a) Dot product of two vectors	11
		b) Projection of a vector on an axis	
III		c) Cross product of two vectors	11
		d) Scalar triple product	
IV	**Miscellaneous applications**		12
		a) Vector triple product	
		b) Vector and Cartesian equation of lines and planes in space	
		c)Example	
		d) Miscellaneous applications	

Essential Readings:

1. DemetriosP.Kanoussis; Vector Algebra for Engineers and Scientists; Amazone Digital Services.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Chapters 1,2,3,4	
II	1	1	Chapters 5,6	
III	1	1	Chapters 7,8,	
IV	1	1	Chapter 9,10,11	

Suggested Readings:

1. James Stewart; Calculus: Early Transcendentals; 9th edition; Cengage learning; 2021.
2. G. B. Thomas Jr, M. D. Weir and Joel R. Hass; Thomas' Calculus; 12th edition; Pearson; 2009.

3. H.Anton, I. Bivens, S. Davis; Calculus; 10th edition; Wiley.

1. **Assessment Rubrics:**

Evaluation Type		Marks
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper *	10
b)	Assignment	10
c)	Seminar, Viva-Voce	5
Total		**75**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

SEMESTER - 3

KU3MDCCMT201: FOUNDATIONS OF HIGHER MATHEMATICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	MDC	200	KU3MDCCMT201	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3		0	25	50	75	1.5

Course Description

This course is to introduce Divisibility property and binary Operations .

Course Prerequisite

1. Basic number theoretic concepts.
2. Sets, relations, Functions.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of Divisibility.	Understand
2	Apply the concept of Division Algorithm to find G.C.D.	Understand, Apply
3	Understand the concept of Binary Operation.	Understand
4	Understand the concept of Isomorphism .	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓		✓		✓	
CO 2						✓	
CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Divisibility Theory in Integers**		**12**
	1	The Division Algorithm	
		The Greatest Common Divisor	
II	1	The Euclidean Algorithm	**11**
III	1	The Diophantine Equation $ax + by = c$.	**11**
	2	The Fundamental Theorem of Arithmetic.	
IV	**Binary Operations**		**11**
	1	a) Binary Operations b) Isomorphic Binary Operations	

Essential Readings:

1. David M. Burton; Elementary Number Theory (Seventh Edition); Mc Graw Hill; 2010.
2. John B Fraleigh; A first Course in Abstract Algebra (Seventh Edition); Pearson Education India.

Reference Distribution:

Module	Unit	Reference No.	Sections	Remarks
I	1	1	Sections 2.2, 2.3, 2.4	
II	1	1	Section 2.4	
III	1	1	Sections 2.5, 3.1.	
IV	1	2	Sections 1.2,1.3	

Suggested Readings:

1. C. Y Hsuing; Elementary Theory of Numbers; Allied Publishers; 1995.
2. G.E. Andrews; Number Theory; Dover publications Inc.; 1995.
3. I. N. Herstein; Abstract Algebra(Third Edition); Wiley student edition.
4. Joseph A Gallian; Contemporary Abstract Algebra (Seventh Edition); Brooks/Cole Cengage Learning.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper *	10
b)	Assignment	10
c)	Seminar, Viva-Voce	5
Total		**75**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

****Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

VALUE ADDED COURSES

SEMESTER - 3

KU3VACCMT201: PROBABILTY THEORY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
3	VAC	200	KU3VACCMT201	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3		1	25	50	75	1.5

Course Description

This course is to introduce Sampling, Null Hypothesis, Level of Significance, critical region, Standard Error and Chi-square distribution and also testing Hypothesis using Normal and Chi-square distribution

Course Prerequisite

Set Theory, Integration, Probability/Statistics course of level 100-199.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand Sampling and Types of Sampling	Understand
2	Understand Null Hypothesis	Understand
3	Understand Error in statistic	Understand
4	Understand Critical region	Understand
5	Understand level of significance	Understand
6	Testing of Hypothesis	Understand, Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓		✓				
CO 3	✓		✓				
CO 4	✓		✓				
CO 5	✓		✓				
CO 6	✓		✓				
CO 7	✓		✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Sampling and Testing of Hypothesis for large samples**	**11**

	1	a) Sampling and Types of Sampling	
	2	a) Testing of Hypothesis for Large samples	
		b)Test for Single Proportion	
II	**Unbiased estimate**, **Standard Error and Testing of Mean**		**11**
	1	a) Unbiased estimate for population Mean	
		b) Unbiased estimate for population Variance	
III	1	a)Standard Error of Sample Mean	**11**
		b)Test of Significance for Mean	
		c)Test of Significance for difference of Means	
IV	**Test of significance for Difference of Standard deviation, Chi-Square Distribution**		**12**
	1	**a)** Test of significance for Difference of Standard deviation	
	2	a) Chi-Square Distribution	
		b) Applications of Chi-Square Distribution	
		c) Yate's Correction	

Essential Readings:

1. S C Gupta & V K Kapoor; Fundamentals of Mathematical Statistics; (10^{th} revised edition);S Chand & Sons

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections 12.1, 12.2	
	2	1	Sections 12.3 to 12.9	Section 12.9.1 omitted
II	1	1	Section 12.10, 12.11	
III	1	1	Sections 12.12 to 12.14	
III	1	1	sections 12.15	
	2	1	sections 13.1, 13.2, 13.3, 13.7 and 13.8	Sections 13.3.3, 13.3.4 are omitted

Suggested Readings:

1. Dennis Wackerly, William Mendenhall Ill and Richard S; Mathematical Statistics with Application (Seventh Edition); Duxbury Press;2007.
2. Robert. V. Hogg and Allen T. Craig; Introduction to Mathematical Statistics (Fifth Edition); Higher education press; 1978.
3. G Shankar Rao;Probability and Statistics for Science and Engineering; University press; 2011.
4. Maria Dolores Ugarte,AnaF.Militino, Alan T.Amholt; Probability and Statistics with R; CRC Press, A Chapman & Hall Book.
5. Frank S Emmert-Streib,SalissouMoutari, Matthias Dehmer; Mathematical Foundations of Data Science Using R; De Gruyter (2022).
6. Meatloaf, Norman S; Probability and Statistics for Data Science-math+R+data; CRC press(2020).

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper *	10
b)	Assignment	10
c)	Seminar, Viva-Voce	5
Total		**75**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

SEMESTER - 4

KU4VACCMT201: CODING THEORY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	VAC	200	KU4VACCMT201	3	45

Learning Approach (Hours/ Week)	Marks Distribution	Duration of

Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	ESE (Hours)
3			25	50	75	1.5

Course Description:

This course discuss construction of efficient codes using algebraic techniques .Also discuss the theory of linear codes, their encoding and decoding techniques. Cyclic codes are special types of linear codes**.**

Course Pre-requisite:

Basics of Linear Algebra, Abstract algebra and number theory.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To understand error detection in coding theory	Understand
2	Able to construct linear codes	Analyse Apply
3	Able to design cyclic codes	Understand Apply, Create
4	Compare different types of linear and cyclic codes.	Analyze, Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓					
CO 2		✓	✓				
CO 3		✓	✓				✓
CO 4	✓	✓	✓				
CO 5							
CO 6							
CO 7	✓			✓	✓		

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	**Introduction,Error detection, correction and decoding**		**11**

	1	a) Communication channels	
		b) Maximum likelihood decoding	
		c) Hamming distance	
		d) Minimum distance decoding	
		e) Distance of a code	
		f) Basics of finite fields and vector space.	
II	**Linear Codes**		**11**
	1	a) Vector spaces over finite fields	
		b) Linear codes	
		c) Hamming Weight	
111	1	a) Bases for linear codes	**11**
		b) Generator matrix and parity check matrix	
		c) Equivalence of linear codes	
IV	**Cyclic Codes**		**12**
	1	a) Definitions	
		b) Generator polynomials	
		c) Generator and parity check matrices	
		d) Decoding of cyclic codes	

Essential reading:

1. San Ling and Chaoping Xing; Coding Theory - A first Course; Cambridge University Press;1983.

Reference Distribution:

Module	Unit	Reference No.	Sections	Remarks
I	1	1	Chapter 1, Chapter 2, Sections 3.1- 3.3	
II	1	1	Sections 4.1- 4.4	

III	1	1	Sections 4.5- 4.7	
IV	1	1	Sections 7.1-7.4	

Suggested reading:

1. R.Lidl and H. Neiderreiter, Introduction to Finite Fields and their Applications, Cambridge University Press,1983
2. F.J Mac Williams and N.J.A Sloane, The theory of error correcting codes, North Holland, Amsterdam, 1998
3. Shu Lin and Daniel J. Costello, Error Control Coding – Fundamentals and Applications, Pearson Education India,2011

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper *	**10**
b)	Assignment	**10**
c)	Seminar, Viva-Voce	**5**
Total		**75**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** Use of Scientific Calculators below 100 functions (ie up to *fx*99) shall be permitted.

KU4VACCMT202: COMPLEX NUMBERS AND THEORY OF EQUATIONS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	VAC	200	KU4VACCMT202	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3		1	25	50	75	1.5

Course Description

This course is to introduce Complex Numbers and to understand the nature of roots of an equation.

Course Prerequisite

1. Complex numbers 2. Solving equation.

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of Complex Numbers.	Understand
2	Understand the nature of roots of an equation	Understand
3	Understand the relationship between roots and coefficients of equations	Understand
4	Understand how to find the roots of equations	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓		✓		✓	
CO 2						✓	
CO 3	✓						
CO 4	✓						
CO 5	✓						
CO 6	✓						
CO 7	✓						

COURSE CONTENTS

- **Contents for Classroom Transaction**

MODULE	UNIT	DESCRIPTION	HOURS
I	1	Complex Numbers and their Geometric Representation. Polar Form of Complex Numbers. Powers,Roots.	11
II	1	a) Basic Concepts b) Relation between roots and coefficients c) Symmetric Functions of roots d) Sum of the powers of roots Newton's Theorem on Sum of the powers of roots,	11
III	1	a) Transformations of equations b) Reciprocal equations c) Descartes rule of signs	11
IV	1	a) Multiple Roots b) Sturm's theorem c) Cardon's Method	12

Essential Readings:

1: Erwin Kreyszig; Advanced Engineering Mathematics (Tenth edition); John Wiley; 2011.
2: K. ManicavachagomPillay, T. Natarajan and K. S. Ganapathy; Algebra;SV Publications.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections 13.1,13.2.	
II	1	2	Sections 6.1-6.14	
III	1	2	Sections 6.15,6.16,6.21, 6.24	
IV	1	2	6.26,6.27,6.34	

Suggested Readings

1. S.S. Sastry; Engineering Mathematics, Vol 2 (4th edition); PHI.
2. J.B. Conway; Functions of One Complex Varible (2nd edition); Springer.
3. M.D.Raisinghnia, R.SAggarwal; Algebra;
4. K. H. Rosen; Discrete Mathematics and its Applications (Sixth edition); Tata McGraw Hill publishing company; New Delhi.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper *	10
b)	Assignment	10
c)	Seminar, Viva-Voce	5
Total		**75**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

****Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

KU4VACCMT203: LINEAR PROGRAMMING

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	VAC	200	KU4VACCMT203	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3			25	50	75	1.5

Course Description

This course is to introduce the notion of Linear Programming problem, solution of Linear Programming problems by Graphical method and Simplex methods, the Transportation models and its solutions .

Course Prerequisite

Elementary Linear Algebra

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand a Linear Programming Problem	Understand
2	Formulate A Linear Programming Problem	Understand

3	Apply Graphical method to solve an LPP	Apply
4	Understand Simplex Method	Understand
5	Apply Simplex Algorithm to solve an LPP	Apply
6	Understand the Transportation model	Understand
7	Apply different methods to find an initial solution for Transportation Problem	Apply
8	Understand the Assignment model	Understand
9	Apply Hungarian method to find solution of an Assignment Problem	Understand, Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2	✓						
CO 3			✓				✓
CO 4	✓						
CO 5			✓			✓	
CO 6	✓						
CO 7	✓						✓
CO 8	✓						
CO 9	✓		✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS

I		**Introduction to Linear Programming**	11
	1	Introduction ,Structure of linear programming	
		Advantages ,limitations and applications of LPP	
		General mathematical Model of LPP	
	2	Graphical Solution of LPP	
II		**The Simplex Algorithm**	**11**
	1	Introduction	
		Standard Form of an LP problem	
		Simplex Algorithm (Maximization case)	
III		**Transportation Problem**	**11**
	1	Introduction	
		Mathematical Model of Transportation	
		Transportation Algorithm	
		Methods of finding initial solution	
IV			**12**
	1	**Assignment Problem**	
		Introduction12	
		Mathematical model of Assignment Problem	
		Hungarian method for solving Assignment Problem	

Essential Readings:

1. Operations Research, Theory and Applications, J K Sharma,6th edition, Trinity

Reference Distribution:

Module	Unit	Reference No.	Sections	Remarks
I	1	1	Section 2.1, 2.2, 2.3, 2.4, 2.5, 2.6.	Sections 3.3.5 is omitted
	2	1	Section 3.1,3.2,3.3	

II	1	1	Section 4.1,4.2,4.3	
III	1	1	Sections 9.1,9.2,9.3,9.4	
IV	1	1	Section 10.1, 10.2,10.3.1	

Suggested Readings:

1. H.A. Thaha; Operations Research - An Introduction (10th edition); Pearson
2. G. Hadley; Linear Programming; Oxford & IBH Publishing Company.
3. Richard J. Boucherie, Aleida Braaksma, Henk Tijms; Operation Research - Introduction to Model and Methods; World Scientific.
4. G. Srinivasan; Operations Research - Principles and Applications (Third edition); PHI
5. Michael W. Carter, Camille C Price; Operation Research - A Practical Introduction; CRC Press

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper *	10
b)	Assignment	10
c)	Seminar, Viva-Voce	5
Total		**75**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

** **Use of Scientific Calculators below 100 functions (that is, upto *fx 99*) shall be permitted.**

SKILL ENHANCEMENT COURSES

SEMESTER - 4

KU4SECCMT201: LINEAR PROGRAMMING PROBLEMS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	SEC	200	KU4SECCMT201	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3			25	50	75	1.5

Course Description:

This course is to introduce the mathematical modeling of industrial problems using the concept of Linear Programming, and different methods to solve them, Assignment problem.

Course Prerequisite:

Elementary Linear Algebra

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand a Linear Programming Problem	Understand
2	Formulate a Linear Programming Problem	Understand
3	Apply Graphical method to solve an LPP	Apply
4	Understand Simplex Method, Big M method and Two phase method algorithms	Understand
5	Apply Simplex Algorithm, Big M Method and Two Phase methods to solve an LPP	Apply
6	Understand the various parameters that determine the basic Feasible solution of an LPP	Understand
7	Understand Dual of a primal	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2	✓						
CO 3			✓				✓
CO 4	✓						
CO 5			✓			✓	
CO 6	✓						
CO 7	✓						
CO 8	✓						

CO 9	✓		✓				

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I		**Introduction to Linear Programming**	11
	1	What is a Linear Programming Problem?	
	2	The Graphical Solution of two variable Linear Programming problems	
	3	Special cases	
II		**The Simplex Algorithm**	11
	1	a) How to convert an LP to standard form	
	2	a) Preview of the Simplex Algorithm	
		b) Direction of unboundedness	
		c) Why does an LP have an optimal bfs	
		d) Simplex Algorithm	
		e) Use Simplex Algorithm to solve minimization problems	
III		**Special cases in Simplex method**	11
	1	a) Alternative Optimal solutions	
		b) Unbounded LPs	
		c) Degeneracy and the convergence of the Simplex Algorithm	
IV		**The Big M Method and The Two- Phase Method and Duality**	12
	1	a) The Big M Method	
		b) The Two- Phase Simplex Method	
		c) Unrestricted-in-Sign	
	2	Finding the dual of an LP	

Essential Readings:

1. Wayne L. Winston; Operations Research; Applications and Algorithms (fourth edition); Thomson(Brooks/Cole).

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Section 3.1	
	2	1	Section 3.2	
	3	1	Section 3.3	
II	1	1	Section 4.1	
	2	1	Sections 4.2,4.3,4.4,4.5,4.6	
III	1	1	Sections 4.7,4.8,4.11	
IV	1	1	Section 4.12,4.13,4.14	
	2	1	Sections 6.5	

Suggested Readings:

1. H.A. Thaha; Operations Research - An Introduction (10^{th} edition); Pearson
2. J.K. Sharma; Operations Research - Theory and Applications; McMillan.
3. G. Hadley; Linear Programming; Oxford & IBH Publishing Company.
4. Richard J. Boucherie, AleidaBraaksma, HenkTijms; Operation Research - Introduction to Model and Methods; World Scientific.
5. G. Srinivasan; Operations Research - Principles and Applications (Third edition); PHI
6. Michael W. Carter, Camille C Price; Operation Research - A Practical Introduction, CRC Press.

Assessment Rubrics:

Evaluation Type	Marks

End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper *	10
b)	Assignment	10
c)	Seminar, Viva-Voce	5
Total		**75**

* A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.

**** Use of Scientific Calculators below 100 functions (that is, upto*fx 99*) shall be permitted.**

SEMESTER - 5

KU5SECCMT301: MATHEMATICAL TRANSFORMS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	SEC	300	KU5SECCMT301	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3			25	50	75	1.5

Course Description

This course aims to introduce the Fourier transform, Hankel Transform and, Z transform, its operational properties and applications.

Course Prerequisite

Integral Calculus, Fourier series

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Identify Fourier Integrals	Knowledge
2	Understand Fourier Cosine and Sine Transforms	Understand
3	Apply Fourier transforms techniques in signal analysis	Apply
4	Understand Hankel transform and its properties	Understand
5	Understand Z its inverse transforms and properties	Understand
6	Solve discrete-time signal problems using Z transforms	Apply

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓			✓	
CO 2	✓				✓	✓	

CO 3	✓	✓					
CO 4	✓			✓			
CO 5	✓	✓				✓	
CO 6	✓						✓

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	1	**FOURIER INTEGRALAND TRANSFORMS**	11
		a) Fourier Integrals	
II	1	b) Fourier Cosine and Sine Transforms	11
		c) Fourier Transform (exclude Discrete and Fast Fourier Transforms)	
III	1	**HANKEL TRANSFORMS**	11
		a) Introduction	
		b) The Hankel transform and Examples	
		c) Operational Properties of Hankel Transform	
IV	1	**Z TRANSFORMS**	12
		a) Definition of the Z transform and Examples	
		b) Basic Operational Properties of Z transforms	
		c) The inverse Z transform and Examples	
		d) Application of Z transforms to Finite Difference equations	

Essential Readings:

1. Erwin Kreyzig; Advanced Engineering Mathematics; 9th Edition; John Wiley; 2006.

2. Lokenath Debnath, Dambaru Bhatta; Integral Transform and Their Applications; Second Edition; Chapman & Hall/CRC 2007.

Reference Distribution:

Module	Unit	Essential ReadingNo.	Sections	Remarks
I	1	1	Section 11.7	
II	1	1	Sections 11.8 , 11.9	
III	1	2	Section 7.1- 7.3	
IV	1	2	Sections 12.3- 12.6	

Suggested Readings:

1. Veerarajan T.; Transforms and Partial Differential Equations; 3rd Edition; Tata McGraw-Hill; New Delhi,2012.
2. Ramana B.V.; Higher Engineering Mathematics; 3rd Edition; Tata Mc-Graw Hill; New Delhi; 2010.
3. Larry C. Andrews,Bhimsen K. Shivamoggi; Integral Transforms for Engineers; SPIE Optical Engineering Press

.**Assessment Rubrics:**

Evaluation Type		Marks
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper *	10
b)	Assignment	10
c)	Seminar, Viva-Voce	15
Total		**75**

*** A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.**

SEMESTER - 6

KU6SECCMT301: FUZZY SET THEORY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	SEC	300	KU6SECCMT301	3	45

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3			25	50	75	1.5

Course Description

This course aims to introduce the theory of fuzzy sets and discuss theoretical differences between fuzzy sets and classical sets.

Course Prerequisite

Set Theory

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Interpret fuzzy set theory and uncertainty concepts	Knowledge
2	Understand basic concepts of fuzzy sets	Understand
3	Identify properties of α cuts	Understand
4	Apply decomposition theorems for representing fuzzy sets	Apply

5	Understand different operations on fuzzy sets.	Understand

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2	✓					✓	
CO 3	✓			✓			
CO 4		✓				✓	
CO 5	✓		✓				✓

COURSE CONTENTS

Contents for Classroom Transaction

MODULE	UNIT	DESCRIPTION	HOURS
I	1	**FUZZY SETS** a) Fuzzy Sets-Basic Types b) Fuzzy Sets-Basic Concepts	**11**
II	1	**FUZYY SETS VERSUS CRISP SETS** a) Additional Properties of alpha-Cuts b) Representations of Fuzzy Sets c) Extension Principle for Fuzzy Sets	11
III	1	**OPERATIONS ON FUZZY SETS** a) Types of operations b) Fuzzy Complements	11

IV	1	a) Fuzzy Intersections: t-Norms	12
		b) Fuzzy Unions: t-Conorms	

Essential Readings:

1. George J. Klir and B.O. Yuan; Fuzzy Sets and Fuzzy Logic - Theory and Applications; Prentice Hall; 1995.

Reference Distribution:

Module	Unit	Essential Reading No.	Sections	Remarks
I	1	1	Sections 1.3 – 1.4	
II	1	1	Section 2.1- 2.3	
III	1	1	Section 3.1-3.2	
IV	1	1	Sections 3.3- 3.4	

Suggested Readings:

4. H. J. Zimmerman; Fuzzy Set theory and its Applications; 4th Edition; Kluwer Academic Publishers; 2001.
5. Timothy J Ross; Fuzzy Logic with Engineering Applications; McGraw Hill International Editions.

.**Assessment Rubrics:**

Evaluation Type		Marks
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	Test Paper *	10
b)	Assignment	10
c)	Seminar, Viva-Voce	5
Total		**75**

*** A student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.**