

FYUGP
2024

DEPARTMENT OF MATHEMATICS

Syllabus for
Undergraduate Programmes (Honours)
Under Credit Semester System
Outcome Based Education
with Effect from 2024 Admissions



St Berchmans College

Founded 1992

AUTONOMOUS

College with Potential for Excellence

A+ in the Fifth Cycle of Reaccreditation by NAAC

Changanassery, Kerala, India 686101 | Affiliated to Mahatma Gandhi University, Kottayam

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ACKNOWLEDGEMENT

I express my sincere gratitude for the collaborative efforts invested in crafting the curriculum for the Four Year Undergraduate Programme (FYUGP), aimed at fostering a robust understanding of Mathematics at the undergraduate level. This curriculum embarks students on a captivating journey into the realm of Mathematics and Statistics, providing a solid foundation to appreciate abstract concepts and serving as a gateway to the fields of Data Science and Machine Learning.

The FYUGP embodies a student-centric approach to teaching and learning, meticulously designed to attain the outlined objectives and outcomes. Continuous assessment is emphasized, enabling students to gauge their academic progress and personal growth throughout their undergraduate studies.

I extend heartfelt appreciation to all individuals who contributed significantly to the development of the FYUGP syllabus. Special recognition goes to the college authorities and the curriculum revision committee for organizing various training programs in preparation for the integration of FYUGP into the curriculum. I express my sincere gratitude to the external members of the Board of Studies, including Dr Ramesh Kumar P (Professor, University of Kerala, Thiruvananthapuram), Dr Jayanarayanan C R (Assistant Professor, Department of Mathematics, IIT Palakkad), Prof. Jayaprasad P N (Professor, Department of Mathematics, Rajiv Gandhi Institute of Technology, Kottayam), Dr Reji T (Associate Professor, Department of Mathematics, Government College Chittur,, Palakkad), and Mr Rijo Johny (Manager, Assurance Data Analytics, EY Global Delivery Services India, KINFRA, Thiruvananthapuram) whose expertise and insights have enriched the syllabus.

Additionally, I acknowledge the dedication of my esteemed colleagues within the Department for their invaluable contributions to drafting the FYUGP syllabus.

Fr John J Chavara

Chairman of the Board of Studies



BOARD OF STUDIES

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Name	Official Address
Fr John J Chavara	Assistant Professor, Department of Mathematics, St Berchmans College, Changanassery

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Prof Ramesh Kumar P	Professor, Department of Mathematics, University of Kerala
Dr Jayanarayanan C R	Assistant Professor, Department of Mathematics, Indian Institute of Technology (IIT), Palakkad

EXPERT NOMINATED BY THE VICE-CHANCELLOR

Name	Official Address
Prof Jayaprasad P N	Professor, Department of Mathematics, Rajiv Gandhi Institute of Technology (RIT), Pampady Kottayam

ALUMNI REPRESENTATIVE

Name	Official Address
Dr Reji T	Associate Professor, Department of Mathematics, Government College Chittur, Palakkad

REPRESENTATIVE FROM MEDIA/INDUSTRY AND ALLIED AREAS

Name	Official Address
Mr Rijo Johny	Manager, Assurance Data Analytics, EY Global Delivery Services India, LLP, KINFRA, Trivandrum



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BOARD OF STUDIES**

Teacher's Name
Dr Antony Mathews
Dr Shine C Mathew
Mr Tibin Thomas
Dr Ullas Thomas
Ms Treesa Maria Kuriakose
Ms Jinu Mary Jameson
Ms Devi N



PROGRAMME OUTCOMES

- PO1:** Develop in-depth conceptual knowledge and skills in the discipline for vertical growth and scholarly pursuits
- PO2:** Integrate and apply interdisciplinary knowledge incorporating historical, theoretical, scientific, technological, economic, philosophical, cultural, aesthetic and ethical perspectives to address complex challenges in diverse settings
- PO3:** Demonstrate communication skills promoting adaptability, collaboration and resilience in global and local contexts
- PO4:** Develop problem solving skills to transfer the knowledge of methods and systems of different disciplines for a sustainable and egalitarian world order
- PO5:** Cultivate research skills and innovative and critical thinking to contribute to societal development through the creation of sustainable solutions and advancements in the respective fields

PROGRAMME SPECIFIC OUTCOMES

- PSO1:** Acquire the ability to express ideas rigorously and communicate effectively.
- PSO2:** Recognize Mathematics as a precise language for learning all other disciplines and acquire comprehensive knowledge in the fundamental concepts and theories in Mathematics.
- PSO3:** Develop the skills to think logically and critically and to formulate and analyse real life situations mathematically in order to solve them using tools in Mathematics and Statistics.
- PSO4:** Demonstrate the ability to work independently using various mathematical and physical notions and techniques.
- PSO5:** Appreciate the beauty of abstraction in Mathematics and acquire domain knowledge to pursue higher education and research.



COURSES IN MATHEMATICS

OUTLINE OF DISCIPLINE SPECIFIC COURSES

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU24MA1DSC100	Major/Minor	Invitation to Mathematics	5	75	4
SBU24MA1DSC101	Major/Minor	Introduction to Geometry	5	75	4
Semester II (Course Level: 100 - 199)					
SBU24MA2DSC100	Major/Minor	Foundations of Mathematics	5	75	4
SBU24MA2DSC101	Major/Minor	Pillars of Mathematics	5	75	4
Semester III (Course Level: 200 - 299)					
SBU24MA3DSC200	Major	Sequences and Series of Real Numbers	5	75	4
SBU24MA3DSC201	Major	Introduction to Algebraic Structures	5	75	4
SBU24MA3DSC202	Minor	Mathematics for Science	5	75	4
SBU24MA3DSC203	Minor	Mathematics for Computer Science	5	75	4
SBU24MA3DSC204	Minor	Mathematics for Commerce and Economics	5	75	4
Semester IV (Course Level: 200 - 299)					
SBU24MA4DSC200	Major	Calculus of Real Functions	5	75	4
SBU24MA4DSC201	Major	Topics in Algebra	5	75	4
SBU24MA4DSC202	Minor	Essential Mathematical Methods	5	75	4
SBU24MA4INT200		Internship	-	-	2
Semester V (Course Level: 300 - 399)					
SBU24MA5DSC300	Major/Minor	Qualitative Study of Real Functions	5	75	4
SBU24MA5DSC301	Major/Minor	Rings and Fields	5	75	4
Semester VI (Course Level: 300 - 399)					
SBU24MA6DSC300	Major/Minor	Multivariable Calculus	5	75	4
SBU24MA6DSC301	Major/Minor	Basic Complex Analysis	5	75	4
SBU24MA6DSC302	Major/Minor	Ordinary Differential Equations for Environmental Science	5	75	4
Semester VII (Course Level: 400 - 499)					
SBU24MA7DSC400	Major/Minor	Numerical Analysis	5	75	4
SBU24MA7DSC401	Major/Minor	Basic Topology	4	60	4
SBU24MA7DSC402	Major/Minor	Galois Theory	4	60	4
SBU24MA7DSC403	Major/Minor	Measure Theory and Integration	4	60	4
SBU24MA7DSC404	Major/Minor	Partial Differential Equations	4	60	4
SBU24MA7DSC405	Major/Minor	Research Methodology	4	60	4
Semester VIII (Course Level: 400 - 499)					
SBU24MA8DSC400	Major	Functional Analysis	5	75	4
SBU24MA8DSC401	Major	Advanced Complex Analysis	5	75	4
SBU24MA8PRJ400		Project			12

OUTLINE OF DISCIPLINE SPECIFIC ELECTIVE COURSES

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester III (Course Level: 200 - 299)					
SBU24MA3DSE200	Elective	Graph Theory	4	60	4
SBU24MA3DSE201	Elective	Combinatorics	4	60	4



Semester IV (Course Level: 200 - 299)					
SBU24MA4DSE200	Elective	Theory of Equations	4	60	4
SBU24MA4DSE201	Elective	Discrete Mathematics	4	60	4
Semester V (Course Level: 300 - 399)					
SBU24MA5DSE300	Elective	Linear Algebra and its Applications	4	60	4
SBU24MA5DSE301	Elective	Linear Optimization Techniques	4	60	4
SBU24MA5DSE302	Elective	Integral Transforms	4	60	4
SBU24MA5DSE303	Elective	Geometry of Curves and Surfaces	4	60	4
SBU24MA5DSE304	Elective	Number Theory and Cryptography	4	60	4
Semester VI (Course Level: 300 - 399)					
SBU24MA6DSE300	Elective	Mathematics for Machine Learning	4	60	4
SBU24MA6DSE301	Elective	Dynamical Systems	4	60	4
Semester VIII (Course Level: 400 - 499)					
SBU24MA8DSE400	Elective	Advanced Topology	4	60	4
SBU24MA8DSE401	Elective	Operations Research	4	60	4
SBU24MA8DSE402	Elective	Coding Theory	4	60	4

OUTLINE OF MULTIDISCIPLINARY COURSES (MDC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU24MA1MDC100	MDC	Quantitative Techniques	4	60	3
Semester II (Course Level: 100 - 199)					
SBU24MA2MDC100	MDC	Applicable Mathematics	4	60	3
Semester III (Course Level: 200 - 299)					
SBU24MA3MDC200	MDC	Mathematics and Nature	3	45	3

OUTLINE OF SKILL ENHANCEMENT COURSES (SEC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester IV (Course Level: 200 - 299)					
SBU24MA4SEC200	SEC	Mathematical Reasoning	3	45	3
Semester V (Course Level: 300 - 399)					
SBU24MA5SEC300	SEC	Python Programming for Mathematics	3	45	3
Semester VI (Course Level: 300 - 399)					
SBU24MA6SEC300	SEC	Computational Techniques Using SageMath	3	45	3

OUTLINE OF VALUE ADDITION COURSES (VAC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester III (Course Level: 200 - 299)					
SBU24MA3VAC200	VAC	Contributions of Kerala School of Mathematics	3	45	3
Semester IV (Course Level: 200 - 299)					
SBU24MA4VAC200	VAC	Mathematics for Data Analysis	3	45	3
Semester VI (Course Level: 300 - 399)					
SBU24MA6VAC300	VAC	Artificial Intelligence and Human Rights	3	45	3



COURSES IN STATISTICS

OUTLINE OF DISCIPLINE SPECIFIC COURSES

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU24ST1DSC100	Minor	Descriptive Statistics	5	75	4
SBU24ST1DSC101	Minor	Introduction to Index Numbers and Time Series	5	75	4
Semester II (Course Level: 100 - 199)					
SBU24ST2DSC100	Minor	Probability Theory and Random Variables	5	75	4
SBU24ST2DSC101	Minor	Demography and Vital Statistics	5	75	4
Semester III (Course Level: 200 - 299)					
SBU24ST3DSC200	Minor	Inferential Statistics	5	75	4
Semester IV (Course Level: 200 - 299)					
SBU24ST4DSC200	Minor	Statistical Quality Control	5	75	4
Semester V (Course Level: 300 - 399)					
SBU24ST5DSC300	Minor	Numerical Analysis	5	75	4
Semester VI (Course Level: 300 - 399)					
SBU24ST6DSC300	Minor	Stochastic Process and Queueing Theory	5	75	4

OUTLINE OF MULTIDISCIPLINARY COURSES (MDC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU24ST1MDC100	MDC	Data Visualisation Using R Programming	4	60	3
Semester II (Course Level: 100 - 199)					
SBU24ST2MDC100	MDC	Applied Statistics	4	60	3
Semester III (Course Level: 200 - 299)					
SBU24ST3MDC200	MDC	Statistical Optimisation	3	45	3

OUTLINE OF SKILL ENHANCEMENT COURSES (SEC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester IV (Course Level: 200 - 299)					
SBU24ST4SEC200	SEC	Survey Techniques	3	45	3

OUTLINE OF VALUE ADDITION COURSES (VAC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester III (Course Level: 200 - 299)					
SBU24ST3VAC200	VAC	Environmental Statistics	3	45	3
Semester IV (Course Level: 300 - 399)					
SBU24ST4VAC200	VAC	Statistical Modelling	3	45	3



SEMESTER I

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MA1DSC100	Major/Minor	Invitation to Mathematics	5	75	4
SBU24MA1DSC101	Minor	Introduction to Geometry	5	75	4
SBU24MA1MDC100	MDC	Quantitative Techniques	4	60	3



SBU24MA1DSC100: INVITATION TO MATHEMATICS

Type of Course	Major/Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand various concepts in Propositional Calculus	U
CO2	Acquire a fundamental knowledge in Set Theory	U
CO3	Understand the concept of relations and functions	U
CO4	Analyse the conditions for a function to have an inverse	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	1	-	2	2	1	-	-
CO2	1	2	1	2	2	2	1	2	1	2
CO3	1	2	2	2	2	1	2	2	2	-
CO4	1	-	-	2	2	2	-	2	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x		x	x	x	x
CO3		x			x	x
CO4		x			x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Basic Logic (18 Hrs)				
Propositional Logic	1.1	1	2	Lecture, Class room exercise
Applications of Propositional Logic	1.2	1	2	Lecture, Class room exercise and Assignment
Propositional Equivalence	1.3	1	2	Lecture and Demo
Predicates and Quantifiers	1.4	1	3	Lecture and Class room exercise
Rules of Inference	1.5	1	3	Lecture, Class room exercise
Problems (Practicum)		1	6	
Module 2: Set Operations (18 Hrs)				
Sets, Subsets	2.1	2	1	Lecture, Class room exercise
Power sets, Cartesian Product	2.2	2	1	Lecture, Class room exercise
Quantifiers	2.3	2	3	Lecture



Set Operations- Unions and Intersections	2.4	2	2	Lecture and demo
Computer Representation of Sets	2.5	2	3	Lecture, Class room exercise
Problems (Practicum)		2	8	
Module 3: Relations (20 Hrs)				
Relations definitions and Examples	3.1	3	1	Lecture, Class room exercise
Equivalence Relations	3.2	3	2	Lecture, Class room exercise
Partition of a Set	3.3	3	3	Lecture, Class room exercise
Equivalence Classes	3.4	3	3	Lecture, Class room exercise and Assignment
Partial order Relations	3.5	3	3	Lecture, Class room exercise
Problems (Practicum)		3	8	
Module 4: Functions (19 Hrs)				
Functions, Definitions and Examples	4.1	3	2	Lecture, Class room exercise
Injection, Surjection and Bijection	4.2	3	3	Lecture, Class room exercise
Composition of two functions	4.3	3	2	Lecture, Class room exercise
Left inverse and right inverse	4.4	4	1	Lecture, Class room exercise
Invertible Functions	4.5	4	3	Lecture, Class room exercise and Assignment
Problems (Practicum)		3,4	8	
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				
Practicum Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbooks

1. Kenneth H. Rosen. Discrete Mathematics and Its Applications, 7th ed., McGraw Hill Publishers, 2007.
2. Béla Bajnok. An Invitation to Abstract Mathematics, Springer, 2013.

Reference

1. David L. Johnson. Elements of Logic via Numbers and Sets, Springer, 1998.
2. Ian Chiswell & Wilfrid Hodges. Mathematical Logic, Oxford University Press, 2007.
3. William K. Grassman & Jay P. Trempley. Logic and Discrete Mathematics: A Computer Science Perspective, Pearson, 1996.
4. Ralph P. Grimaldi & B. V. Ramana. Discrete and Computational Mathematics, Pearson, 2004.
5. Irving M. Copi & Carl Cohen. Introduction to Logic, 5th ed., Routledge, 2018.
6. Patrick J. Hurley. A Concise Introduction to Logic, 11th ed., Wadsworth Publishing, 2018.

Course designed by: Dr Ullas Thomas



SBU24MA1DSC101: INTRODUCTION TO GEOMETRY

Type of Course	Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand Euclidean Approach to Geometry	A
CO2	Explain the axiomatic formulation of geometrical concepts	A
CO3	Check whether a system of axioms is consistent and independent and apply axioms to arrive at some theorems	A
CO4	Analyse various models of Neutral Geometry	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	1	2	2	-	2	1	-	1
CO2	1	2		1	2	1	1	2	1	2
CO3	2	1	1	2	-	2	1	-	2	1
CO5	1	2	1	1	2	1	2	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x		x
CO2	x		x	x	x	x
CO3		x			x	x
CO5			x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Euclidean Approach to Geometry (19 Hrs)				
Euclid and Elements	1.1	1	2	Lecture, Class room exercise
After Euclid	1.2	1	2	Lecture, Class room exercise
The Discovery of Non-Euclidean Geometry	1.3	1	2	Lecture, Class room exercise
Gaps in Euclid's Arguments	1.4	1	2	Lecture, Class room exercise
Modern Axiom Systems	1.5	1	3	Lecture, Class room exercise
Problems (Practicum)		1	8	
Module 2: Incidence Geometry (20 Hrs)				
The Axioms of Incidence Geometry	2.1	2	3	Lecture, Class room exercise
Interpretation and Models of Incidence Geometry	2.2	2	3	Lecture, Class room exercise
Consistency and Independence	2.3	2	1	Lecture, Class room exercise
Some Infinite Models	2.4	2	1	Lecture, Class room exercise



Parallel Postulates	2.5	2	2	Lecture, Class room exercise
Theorems in Incidence Geometry	2.6	2	2	Lecture, Class room exercise
Problems (Practicum)		2	8	
Module 3: Axioms for Plane Geometry (22 Hrs)				
Points and Lines	3.1	3	1	Lecture, Class room exercise
Distance	3.2	3	1	Lecture, Class room exercise
Segments	3.3	3	1	Lecture, Class room exercise
Rays	3.4	3	1	Lecture, Class room exercise
Plane separation	3.5	3	1	Lecture, Class room exercise
Convex sets	3.6	3	1	Lecture, Class room exercise
Angles	3.7	3	2	Lecture, Class room exercise
Betweenness of Rays	3.8	3	1	Lecture, Class room exercise
The Interior of an Angle	3.9	3	1	Lecture, Class room exercise
Intersections of Lines and Triangles	3.10	3	1	Lecture, Class room exercise
Congruent Triangles	3.11	3	1	Lecture, Class room exercise
Inequalities	3.12	3	1	Lecture, Class room exercise
Congruence Theorems	3.13	3	1	Lecture, Class room exercise
Problems (Practicum)		3	8	
Module 4: Neutral Geometry (14 Hrs)				
The Cartesian model	4.1	4	4	Lecture, Class room exercise
The Poincare Disk model	4.2	4	3	Lecture, Class room exercise
Independence of Neutral Geometry postulates	4.3	4	4	Lecture, Class room exercise
Problems (Practicum)		4	3	
Module 5: Teacher Specific Content				
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)				
This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbook

1. John M. Lee. Axiomatic Geometry. American Mathematical Society, 2013.

Reference

1. Brannan, D. A., Gray, Jeremy, and Esplen, Matthew F. Geometry. Cambridge University Press, 2012.
2. Cederberg, Judith N. A Course in Modern Geometries. Springer New York, 2013.
3. Lee, Nam-Hoon. Geometry: from Isometries to Special Relativity. Springer International Publishing, 2020.
4. Venema, Gerard A. Foundations of Geometry, 2nd ed., Pearson, 2012.
5. Hartshorne, Robin. Geometry: Euclid and Beyond. Springer New York, 2013.
6. Trudeau, Richard J. The Non-Euclidean Revolution. Birkhäuser, 2008.

Course designed by: Dr Shine C Mathew



SBU24MA1MDC100: QUANTITATIVE TECHNIQUES

Type of Course	MDC		
Course Level	100-199		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	30	30	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Acquire a solid understanding of various types of numbers, master techniques for calculating HCF and LCM, and develop proficiency in simplifications, squares, square roots, cubes and cube roots.	A
CO2	Apply quantitative techniques to solve mathematical problems	A
CO3	Analyse and solve Mathematical models of real-life problems	An
CO4	Apply mathematical language and notation to explain the reasoning underlying their conclusions when solving problems using mathematical or statistical techniques	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	1	2	2	-	2	1	1	2
CO2	1	2	1	1	2	1	1	2	2	2
CO3	2	1	1	2		2	2	1	2	1
CO4	1	2	2	2	1	1	1	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x	x		x	x	x
CO2	x		x	x	x	x
CO3		x	x		x	x
CO4			x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Number System and Trigonometry (20 Hrs)				
Types of numbers	1.1	1	1	Lecture, Class room exercise
Multiplication and division of numbers & simple applications	1.2	1	1	Lecture, Class room exercise
HCF and LCM of numbers	1.3	1	1	Lecture, Class room exercise
Fractions	1.4	1	1	Lecture, Class room exercise
Squares and square roots	1.5	1	1	Lecture, Class room exercise
Cube and cube roots	1.6	1	2	Lecture, Class room exercise



Trigonometry introduction, Values of trigonometric ratios of 0° , 30° , 45° , 60° & 90°	1.7	1,2	1	Lecture, Class room exercise
Heights and distances – Simple cases	1.8	1,2	2	Lecture, Class room exercise
Problems (Practicum)		1,2	10	
Module 2: Logical reasoning, Ratio and Proportion (20 Hrs)				
Number series, Odd man out, Number puzzles	2.1	2	1	Lecture, Class room exercise
Distance and Directions	2.2	2,3	2	Lecture, Class room exercise
Blood Relations	2.3	2,3	1	Lecture, Class room exercise
Logical and Analytical Reasoning	2.4	2,3	1	Lecture, Class room exercise
Clock and calendar	2.5	2,3	1	Lecture, Class room exercise
Percentage	2.6	2,3	1	Lecture, Class room exercise
Ratio and Proportion	2.7	2,3	2	Lecture, Class room exercise
Profit and loss	2.8	2,3	1	Lecture, Class room exercise
Problems (Practicum)		2,3	10	
Module 3: Elementary Mathematical Techniques (20 Hrs)				
Simple interest	3.1	3,4	1	Lecture, Class room exercise
Compound Interest	3.2	3,4	1	Lecture, Class room exercise
Ratio and Proportion	3.3	3,4	1	Lecture, Class room exercise
Simple Average	3.4	3,4	1	Lecture, Class room exercise
Time and work	3.5	3,4	2	Lecture, Class room exercise
Partnership	3.6	3,4	1	Lecture, Class room exercise
Mixture	3.7	3,4	1	Lecture, Class room exercise
Work and wages	3.8	3,4	1	Lecture, Class room exercise
Time and distance	3.9	3,4	1	Lecture, Class room exercise
Problems (Practicum)		3,4	10	
Module 4				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				
Practicum Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbook

1. Tyra, M., and Kundan, K. Concepts of Arithmetic. BSC Publishing Company Pvt. Ltd, 2011.

Reference

1. Aggarwal, R.S. Quantitative Aptitude. Sultan Chand and Company Ltd, New Delhi, 2017.
2. Guha, Abhijit. Quantitative Aptitude for Competitive Examinations. McGraw Hill Education, 2011.
3. Sinha, S. K., Satyanarayan, S., & Rana, J. S. (Retd.). The Complete Reference Manual for CMAT. Arihant Publications Ltd, 2012.
4. Praveen, R.V. Quantitative Aptitude and Reasoning. PHI Learning Pvt. Ltd., 2016.



5. Verma, Rajesh. Fast Track Objective Arithmetic. Arihant Publications, 2020.

Course designed by: Jinu Mary Jameson



SEMESTER II

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MA2DSC100	Major/Minor	Foundations of Mathematics	5	75	4
SBU24MA2DSC101	Minor	Pillars of Mathematics	5	75	4
SBU24MA2MDC100	MDC	Applicable Mathematics	4	60	3



SBU24MA2DSC100: FOUNDATIONS OF MATHEMATICS

Type of Course	Major/Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the concepts of differentiation and integration	U
CO2	Apply differentiation and integration to find slopes and areas.	A
CO3	Apply matrices to solve the systems of linear equations	A
CO4	Apply algebraic equations to differentiate different curves and surfaces	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	1	2	2	-	2	2	1
CO2	2	2	-	2	2	-	2	2	2	2
CO3	2	2	2	2	2	2	2	1	2	2
CO4	2	2	2	2	2	2	2	1	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x			x	x	x
CO2	x		x	x	x	x
CO3	x	x			x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Invitation To Differentiation (20 Hrs)				
Slope Finding	1.1	1	2	Lecture
The use of slope finding- to find the maximum or minimum value	1.2	1	2	Lecture, Class room exercise and Assignment
The language of nature is the language of extreme	1.3	1	2	Lecture
Area Problems	1.4	2	1	Lecture, Class room exercise and Assignment
Volume Problems	1.5	2	1	Lecture, Class room exercise
Problems with distance	1.6	2	2	Lecture, Class room exercise and Assignment
Business Problems	1.7	2	2	Lecture, Class room exercise
Problems (Practicum)		1,2	8	



Module 2: Invitation to Integration (15 Hrs)				
A method for finding area	2.1	2	3	Lecture, Class room exercise
The relationship between slope finding and area finding	2.2	2	2	Lecture, Class room exercise
Some practice problems for integration	2.3	2	2	Lecture and Demo
Applications of Area finding	2.4	2	2	Lecture, Class room exercise and Assignment
Problems (Practicum)		2	6	
Module 3: Matrices (20 Hrs)				
Linear System, Coefficient Matrix, Augmented Matrix	3.1	3	2	Lecture, Class room exercise
Gauss Elimination and Back Substitution	3.2	3	3	Lecture, Class room exercise
Elementary Row Operations. Row-Equivalent Systems	3.3	3	2	Lecture, Class room exercise
Gauss Elimination: The Three Possible Cases of Systems	3.4	3	2	Lecture, Class room exercise
Row Echelon Form	3.5	3	3	Lecture, Class room exercise
Problems (Practicum)		3	8	
Module 4: Curves and Surfaces (20 Hrs)				
Conic Sections and Quadratic Equations	4.1	4	3	Lecture, Class room exercise
Classification of Conic Sections by its eccentricity	4.2	4	1	Lecture, Class room exercise
Quadratic Equations and Rotations	4.3	4	2	Lecture, Class room exercise
Parametrization	4.4	4	1	Lecture
Polar Co-ordinates	4.5	4	3	Lecture, Class room exercise
Cylinders and Quadratic Surfaces	4.6	4	2	Lecture, Class room exercise
Problems (Practicum)		4	8	
Module 5				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbooks

1. Pine, E. S. How to Enjoy Calculus. Universities Press, 2002.
2. Kreyszig, Erwin. Advanced Engineering Mathematics, 10th ed., Wiley International, 2011.
3. Thomas, George B., and Ross L. Finney. Calculus and Analytical Geometry, 9th ed., Pearson, 1995.

Reference

1. Akopyan, A. V., & Zaslavsky, A. A. Geometry of Conics. AMS, 2007.
2. Anton, Howard, Bivens, Irl, & Davis, Stephen. Calculus, 10th ed., John Wiley & Sons, Inc, 2012.



3. Apostol, T. M. Calculus Vol 1. John Wiley & Sons, 1991.
4. Lay, D. C., McDonald, J., & Lay, S. R. Linear Algebra and Its Applications, 6th ed., Pearson, 2021.
5. Thomas, George B. Jr. Thomas' Calculus, 12th ed., Pearson, 2008.

Course designed by: Fr John J Chavara



SBU24MA2DSC101: PILLARS OF MATHEMATICS

Type of Course	Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the historical context and limitations of the rational number system, leading to an appreciation of the completeness of real numbers.	U
CO2	Identify and analyze various types of functions, including continuous and discontinuous functions, and apply the epsilon-delta definition of continuity.	A
CO3	Gain familiarity dihedral groups and symmetry groups of patterns.	A
CO4	Acquire knowledge of different distance notions in Euclidean spaces, particularly in $\mathbb{R}$ and $\mathbb{R}^2$, and comprehend the definition and examples of metrics.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	1	1	2	2	1	3	-
CO2	2		1	1	3		1	2		2
CO3		1	2	2	2	2	2	2	2	2
CO4	2		1	1	1	2	1	2	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x	x		x	x	x
CO2	x	x		x	x	x
CO3		x	x		x	x
CO4			x		x	x

Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Numbers Lines and Holes (20 Hrs)				
Some historical background	1.1	1	3	Lecture, Class room exercise and Assignment
Shortcomings of the rational number system	1.2	1	3	Lecture, Class room exercise and Assignment
Incompleteness of the rationals	1.3	1	3	Lecture and Demo



Completeness of Reals	1.4	1	3	Lecture, Class room exercise
Problems (Practicum)		1	8	
Module 2: Curves - Continuous, Discontinuous and Unimaginable (20 Hrs)				
Various ways in which a function can be discontinuous	2.1	2	4	Lecture, Class room exercise
Usefulness of continuous functions	2.2	2	5	Lecture, Class room exercise
Arriving at the 'official' epsilon delta definition of continuity	2.3	2	5	Lecture
Problems (Practicum)		2	6	
Module 3: Introduction to Groups (16 Hrs)				
Symmetries of a Square	3.1	3	2	Lecture, Class room exercise
The Dihedral Groups	3.2	3	3	Lecture, Class room exercise
Symmetry Group of patterns	3.3	3	3	Lecture, Class room exercise
Problems (Practicum)		3	8	
Module 4: Introduction to Metric (19 Hrs)				
Usual distance in R, R^2	4.1	4	2	Lecture, Class room exercise
Other distance notions in R	4.2	4	2	Lecture, Class room exercise
Distance notions in R^2	4.3	4	2	Lecture, Class room exercise
Definition of metric	4.4	4	2	Lecture, Class room exercise
Examples	4.5	4	3	Lecture, Class room exercise
Problems (Practicum)		4	8	
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				
Practicum Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbooks

1. Baylis, John. What is Mathematical Analysis? Macmillan, 1991.
2. Gallian, Joseph. Contemporary Abstract Algebra. Chapman and Hall/CRC, 2021.
3. O'Searcoid, Mícheál. Metric Spaces. Springer Science & Business Media, 2006.

Reference

1. Terrell, William J. A Passage to Modern Analysis. American Mathematical Society, 2019.
2. Fraleigh, John B. A First Course in Abstract Algebra, 8th ed., Pearson Education India, 2003.
3. Cohen, W., & Ehrlich, G. The Structure of the Real Number System. Van Nostrand, 1962.
4. Stoll, R. Sets, Logic and Axiomatic Theories, 2nd ed., Freeman, 1974.
5. Simmons, G. F. Introduction to Topology and Modern Analysis. Tata McGraw-Hill, 2011.

Course designed by: Ms Jinu Mary Jameson



SBU24MA2MDC100: APPLICABLE MATHEMATICS

Type of Course	MDC		
Course Level	100-199		
Credit	3		
Course Delivery	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
Duration	30	30	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Apply the principles of probability and 2-dimensional geometry to solve real world problems.	A
CO2	Analyse and solve problems involving permutations and combinations, applying these concepts to count arrangements and selection in various contexts	An
CO3	Solve problems related to polynomials, elementary mensuration and algebra, applying these concepts to model real world scenarios and perform mathematical calculations effectively.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	1	2	2	-	2	2	1
CO2	1		-	2	1	-	2	1	1	2
CO3	2	2	1	2	1	2	2	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	I	II	Written Test I	Written Test II	
CO1	x	-	x	x	x
CO2	x	x	x	x	x
CO3	-	x	-	x	x

Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Probability and 2-dimensional geometry (20 Hrs)				
Probability – Introduction	1.1	1	2	Lecture, Class room exercise
Sample spaces and events	1.2	1	1	Lecture, Class room exercise
Simple examples like tossing coin, tossing die etc.,	1.3	1	3	Lecture, Class room exercise
Two-dimensional geometry- Introduction	1.4	1	1	Lecture, Class room exercise
Plotting points and drawing graph of the lines of the form $ax + by + c = 0$	1.5	1	3	Lecture, Class room exercise
Problems (Practicum)		1,3	10	
Module 2: Permutation & Combination (20 Hrs)				
Factorial notation	2.1	2	3	Lecture, Class room exercise



Permutations & its applications	2.2	2	4	Lecture, Class room exercise
Combinations & its applications.	2.3	2	3	Lecture, Class room exercise
Problems (Practicum)		2	10	
Module 3: Polynomials, Elementary Mensuration and Algebra (20 Hrs)				
Quadratic and cubic polynomials	3.1	3	1	Lecture, Class room exercise
Solution of quadratic polynomials	3.2	3	1	Lecture, Class room exercise
Factorisation of quadratic polynomials	3.3	3	1	Lecture, Class room exercise
Elementary mensuration	3.4	3	2	Lecture, Class room exercise
Area and perimeter of polygons	3.5	3	2	Lecture, Class room exercise
Elementary Algebra	3.6	3	1	Lecture, Class room exercise
Simplifications of algebraic expressions	3.7	3	2	Lecture, Class room exercise
Problems (Practicum)		3	10	
Module 4				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbook

1. Tyra, M., & Kundan, K. Concepts of Arithmetic. BSC Publishing Company Pvt. Ltd, 2011.

Reference

1. Aggarwal, R.S. Quantitative Aptitude. Sultan Chand and Company Ltd, New Delhi, 2017.
2. Guha, Abhijit. Quantitative Aptitude for Competitive Examinations. McGraw Hill Education, 2011.
3. Sinha, S.K., Satyanarayan, S., & Rana, Col. J.S. (Retd.). The Complete Reference Manual for CMAT. Arihant Publications Ltd, 2012.
4. Praveen, R.V. Quantitative Aptitude and Reasoning. PHI Learning Pvt. Ltd., 2016.
5. Verma, Rajesh. Fast Track Objective Arithmetic. Arihant Publications, 2020.

Course designed by: Ms Jinu Mary Jameson



SEMESTER III

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MA3DSC200	Major	Sequences and Series of Real Numbers	5	75	4
SBU24MA3DSC201	Major	Introduction to Algebraic Structures	5	75	4
SBU24MA3DSC202	Minor	Mathematics for Science	5	75	4
SBU24MA3DSC203	Minor	Mathematics for Computer Science	5	75	4
SBU24MA3DSC204	Minor	Mathematics for Commerce and Economics	5	75	4
SBU24MA3DSE200	Elective	Graph Theory	4	60	4
SBU24MA3DSE201	Elective	Combinatorics	4	60	4
SBU24MA3MDC200	MDC	Mathematics and Nature	3	45	3
SBU24MA3VAC200	VAC	Contributions of Kerala School of Mathematics	3	45	3



SBU24MA3DSC200: SEQUENCES AND SERIES OF REAL NUMBERS

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Analyse the Real Number System as a complete ordered field	An
CO2	Familiarize sequence and its properties	U
CO3	Analyse the nature a sequence	An
CO4	Analyse the behaviour and convergence of the series using various tests.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1		2	1		2	1	1	2	2
CO2	1	1	1	1	1	1	1	2	1	2
CO3	2	2			2	1	1	1		
CO4	1	2	2	2	2	1			1	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x		x
CO2	x		x	x	x	x
CO3		x		x	x	x
CO4			x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Complete Ordered Field of Real Numbers (17 Hrs)				
Algebra in ordered fields	1.1	1	3	Lecture, Class room exercise
Completeness of Real Numbers	1.2	1	2	Lecture, Class room exercise
Archimedean Property	1.3	1	3	Lecture, Class room exercise and Assignment
Consequences of Archimedean Property	1.4	1	3	Lecture, Class room exercise
Problems (Practicum)		1	6	
Module 2: Sequences (20 Hrs)				
Definition Examples	2.1	2	1	Lecture, Class room exercise
Nested Intervals	2.2	2	1	Lecture, Class room exercise
Decimal Representations	2.3	2	3	Lecture, Class room exercise and Assignment



Bolzano-Weierstrass theorem	2.4	2,3	3	Lecture, Class room exercise and Assignment
Cauchy Sequences	2.5	2,3	2	Lecture, Class room exercise and Assignment
Convergence of Cauchy sequences	2.6	2,3	2	Lecture, Class room exercise
Problems (Practicum)		2, 3	8	
Module 3: Basic Theory of Series (19 Hrs)				
Some special sequences	3.1	4	2	Lecture, Class room exercise and Assignment
Concept of a series	3.2	4	2	Lecture, Class room exercise and Assignment
Geometric series	3.3	4	1	Lecture, Class room exercise
Cantor set	3.4	4	2	Lecture, Class room exercise
A series for the Euler number	3.5	4	1	Lecture, Class room exercise
Alternating series	3.6	4	1	Lecture, Class room exercise
Absolute convergence	3.7	4	2	Lecture, Class room exercise
Problems (Practicum)		4	8	
Module 4: Tests for Convergence (19 Hrs)				
Tests for series with positive terms	4.1	4	2	Lecture, Class room exercise
Geometric comparisons	4.2	4	2	Lecture, Class room exercise
Limit superior and limit inferior	4.3	4	1	Lecture, Class room exercise and Assignment
Tests for absolute convergence	4.4	4	2	Lecture, Class room exercise and Assignment
Abel's test	4.5	4	1	Lecture, Class room exercise and Assignment
Dirichlet's Test	4.6	4	1	Lecture, Class room exercise and Assignment
Rearrangements and Riemann's theorem	4.7	4	2	Lecture
Problems (Practicum)		4	8	
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				
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Textbook

1. Terrell, William J. A Passage to Modern Analysis. American Mathematical Society, 2019

Reference

1. Bartle, R. G., & Sherbert, D. R. Introduction to Real Analysis, 4th ed., Wiley, 2019.
2. Canuto, Claudio, & Tabacco, Anita. Mathematical Analysis - I, 2nd ed., Springer, 2015.



3. Strichartz, Robert S. The Way of Analysis. Jones & Bartlett Learning, 2000.
4. Laczkovich, Miklos, & Vera, T. Real Analysis: Foundations and Functions of One Variable, 2015.
5. Protter, M. H., & Morrey, C. B. A First Course in Real Analysis. Springer-Verlag, New York, 1977.

Course designed by: Dr Shine C Mathew



SBU24MA3DSC201: INTRODUCTION TO ALGEBRAIC STRUCTURES

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Analyse and solve systems of linear equations using row reductions.	An
CO2	Apply Elementary matrices and row operations to the concept of determinants.	A
CO3	Illustrate the Fundamental Concepts and structure of Groups and subgroups and familiarize with abelian and cyclic groups	U
CO4	Analyse algebraic properties of groups using homomorphisms.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	2	1	1	-	2	1	-	1	-
CO2	2	1	2	1	1	2	1	-	2	1
CO3	1	1	2	-	1			-	1	1
CO4	1		2	1	1		1	1	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x			x		x
CO2	x		x	x	x	x
CO3	x	x			x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Systems of Linear Equations (15 Hrs)				
Systems of Linear Equations	1.1	1	2	Lecture, Class room exercise
Solutions of systems of Linear Equations	1.2	1	3	Lecture, Class room exercise
Inverses and Row operations	1.3	1	4	Lecture, Class room exercise and Assignment
Problems (Practicum)		1	6	
Module 2: Determinants and LU Factorization (20 Hrs)				
LU Factorization and its existence	2.1	2	1	Lecture
Computation of LU Factorization	2.2	2	1	Lecture, Class room exercise



Determinant	2.3	2	2	Lecture, Class room exercise and Assignment
Determinants and Row operations	2.4	2	2	Lecture, Class room exercise and Assignment
Determinants and Elementary matrices	2.5	2	3	Lecture, Class room exercise and Assignment
Cramer's Rule	2.6	2	3	Lecture, Class room exercise
Problems (Practicum)		2	8	
Module 3: Groups (24 Hrs)				
Introduction to Groups	3.1	3	1	Lecture
Binary operations	3.2	3	1	Lecture, Class room exercise
Isomorphic Binary Structures	3.3	3	1	Lecture, Class room exercise
Groups	3.4	3	2	Lecture, Class room exercise
Elementary Properties of Groups	3.5	3	1	Lecture, Class room exercise
Group Isomorphism	3.6	3	1	Lecture, Class room exercise
Abelian groups	3.7	3	1	Lecture, Class room exercise
Non abelian groups	3.8	3	1	Lecture, Class room exercise
Subgroups and examples	3.9	3	2	Lecture, Class room exercise
Cyclic subgroups	3.10	3	2	Lecture, Class room exercise
Cyclic Groups and examples	3.11	3	1	Lecture, Class room exercise and Assignment
Structure of cyclic groups	3.12	3	1	Lecture, Class room exercise
Subgroups of finite cyclic groups	3.13	3	1	Lecture, Class room exercise
Problems (Practicum)		3	8	
Module 4: Cosets and Lagrange's Theorem (16 Hrs)				
Group homomorphism and examples	4.1	4	2	Lecture, Class room exercise
Groups of permutations	4.2	4	2	Lecture, Class room exercise
Orbits, cycles and Alternating Groups	4.3	4	2	Lecture, Class room exercise
Cosets and Lagrange's Theorem	4.4	4	2	Lecture, Class room exercise
Problems (Practicum)		4	8	
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				
Practicum Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbooks

1. Fraleigh, John B. A First Course in Abstract Algebra, 8th ed., Pearson Education India, 2003.
2. Saikia, Promode Kumar. Linear Algebra, 2nd ed., Pearson Education India, 2014.

Reference

1. Axler, Sheldon. Linear Algebra Done Right, 3rd ed., Springer, 2015.



2. David S. Dummit and Richard M. Foote. Abstract Algebra, John Wiley & Sons, Inc., 2003.
3. Gallian, Joseph. Contemporary Abstract Algebra, Chapman and Hall/CRC, 2021.
4. Herstein, I. N. Topics in Algebra, 2nd ed., Wiley, 2006.
5. Datta, K. B. Matrix and Linear Algebra, Prentice Hall of India Pvt. Ltd., New Delhi, 2000
6. Hoffman, Kenneth, and Ray Kunze. Linear Algebra, 2nd ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 1992.
7. Halmos, Paul R. Linear Algebra Problem Book, The Mathematical Association of America, 1995.
8. Kumaresan, S. Linear Algebra: A Geometrical Approach, Prentice Hall of India, 2000.
9. Lang, Serge. Algebra, 3rd ed., Springer, 2002.
10. Thamban Nair, M., and Singh, A. Linear Algebra, Springer, 2018.

Course designed by: Ms Jinu Mary Jameson



SBU24MA3DSC202: MATHEMATICS FOR SCIENCE

Type of Course	Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Familiarise with vector differentiation, vector integration, vector and scalar operators	A
CO2	Apply vector calculus to find length, area and volumes	A
CO3	Determine the solutions of first-order ODEs, linear ODEs of second or higher order, and utilizing numerical techniques to assess solutions for first-order ODEs.	A
CO4	Solve the linear system of equations using linear algebra techniques and apply Cayley Hamilton Theorem.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	1	2	2	-	2	1	1	2
CO2	1	2	1	1	2	1	1	2	2	2
CO3	2	1	1	2	-	2	2	1	2	1
CO4	1	2	2	2	1	1	1	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x			x		x
CO2	x			x	x	x
CO3		x	x		x	x
CO4			x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Vector Calculus 1 (18 Hrs)				
Vector Differential Calculus	1.1	1	3	Lecture, Class room exercise
Grad	1.2	1	3	Lecture, Class room exercise
Div	1.3	2	2	Lecture, Class room exercise
Curl	1.4	2	2	Lecture, Class room exercise
Problems (Practicum)		1,2	8	
Module 2: Vector Calculus 2 (18 Hrs)				
Vector Integral Calculus	2.1	2	5	Lecture, Class room exercise
Integral Theorems	2.2	1,2	5	Lecture, Class room exercise



Problems (Practicum)		1,2	8	
Module 3: Differential Equations (20 Hrs)				
First-Order ODEs	3.1	3	7	Lecture, Class room exercise
Second-Order Linear ODEs	3.2	3	5	Lecture, Class room exercise
Problems (Practicum)		3	8	
Module 4: Matrices (19 Hrs)				
Matrices	4.1	3	3	Lecture, Class room exercise
Vectors, Determinants. Linear Systems	4.2	3	3	Lecture, Class room exercise
Linear Algebra:	4.3	3	3	Lecture, Class room exercise
Matrix Eigenvalue Problems	4.4	4	4	Lecture, Class room exercise
Problems (Practicum)		4	6	
Module 5				
Teacher Specific Content				
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)				
This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbook

1. Kreyszig, Erwin. Advanced Engineering Mathematics, 8th ed., Wiley.

Reference

1. Anton, H., Biven, I., & Davis, S. Calculus. Wiley. 10th ed., 2015.
2. Stewart, J. Essential Calculus. Cengage. 2nd ed., 2017.
3. Thomas, G. B., & Finney, R. L. Calculus and Analytic Geometry. Pearson. 9th ed., 2002.
4. O'Neil, P. Advanced Engineering Mathematics. Thomson. 7th ed., 2007.
5. Grewal, B. S. Higher Engineering Mathematics. Khanna Publishers. 36th ed., 2010.
6. Barret, L. C., & Wylie, C. R. Advanced Engineering Mathematics. Tata McGraw Hill. 6th ed., 2003.
7. Veerarajan, T. Engineering Mathematics for First Year. Tata McGraw-Hill. 2008.
8. Jain, R. K., & Iyengar, S. R. K. Advanced Engineering Mathematics. Narosa Publications. 5th ed., 2016.

Course designed by: Dr Ullas Thomas



SBU24MA3DSC203: MATHEMATICS FOR COMPUTER SCIENCE

Type of Course	Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the fundamental concepts of number theory, including prime numbers and divisibility and apply congruence in various mathematical scenarios.	A
CO2	Analyse the truth tables and logical operations associated with each type of logic gates.	A
CO3	Understand the relations and its representations	A
CO4	Discuss the concepts of graphs, trees and Eulerian graphs	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	1	1	1	2	2	2	2	1	1	1
CO3	2	2	2		2	1	1	1	2	2
CO4	1	1	1	1	1	2	2	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		X	x		x
CO2	x			x		x
CO3		x		x	x	x
CO4		x	X		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Number Theory (22 Hrs)				
Divisibility and modular arithmetic: - Division, Division algorithm, Modular arithmetic, Congruence and Basic properties of congruence.	1.1	1	6	Lecture, Class room exercise
Primes and Greatest common divisor: - Primes, Fundamental theorem of arithmetic (statement and problems only), Greatest common divisors and least common multiples, Euclidean algorithm, g.c.d as linear combination	1.2	1	5	Lecture, Class room exercise



Applications of number theory: a) Solving congruence: - Linear congruence, Chinese remainder theorem and Fermat's theorem (Statement only) b) Application of congruence: -Hashing function	1.3	1	5	Lecture, Class room exercise
Problems (Practicum)			6	
Module 2: Boolean Functions (19 Hrs)				
Boolean functions	2.1	2	4	Lecture, Class room exercise
Representing of Boolean functions Sum Of Products (SOP)	2.2	2	4	Lecture, Class room exercise
Logic gates	2.3	2	3	Lecture, Class room exercise
Problems (Practicum)		2	8	Lecture, Class room exercise
Module 3: Combinatorics (16 Hrs)				
Relations & properties	3.1	3	2	Lecture, Class room exercise
Representing relations	3.2	3	2	Lecture, Class room exercise
Equivalence relation	3.3	3	2	Lecture, Class room exercise
Partial ordering & Hasse Diagrams	3.4	3	2	Lecture, Class room exercise
Problems (Practicum)			8	
Module 4: Trees (18 Hrs)				
Introduction to trees: - Trees, Properties of trees, Applications of trees: - Binary search trees, Prefix codes and Huffman coding	4.1	4	2	Lecture, Class room exercise
Tree traversal: - Traversal algorithms, Infix, Prefix and postfix notations	4.2	4	3	Lecture, Class room exercise
Spanning trees: - Introduction, Depth-first search algorithm (BFS), Breadth-first search algorithms (DFS)	4.3	4	3	Lecture, Class room exercise
Minimum spanning trees: - Algorithms for minimum spanning trees- Kruskal's algorithm and Prim's algorithm	4.4	4	2	Lecture, Class room exercise
Problems (Practicum)		4	8	
Module 5				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

**Textbook**

1. Rosen, Kenneth H. Discrete Mathematics and its Applications, 8th ed., McGraw-Hill Education Private Limited, 2021.
2. Burton, David M. Elementary Number Theory, 7th ed., The McGraw Hill Companies, 2009.

Reference

1. Stien, Clifford, et al. Discrete Mathematics for Computer Scientists. Pearson Education; Dorling Kindersley India Pvt Ltd., 2011.
2. Ross, Kenneth A., and Charles R. B. Wright. Discrete Mathematics. Pearson Education; Dorling Kindersley India Pvt Ltd., 1999.
3. Johnsonbaugh, Richard. Discrete Mathematics. Pearson Education; Dorling Kindersley India Pvt Ltd., 2009.



SBU24MA3DSC204: MATHEMATICS FOR COMMERCE AND ECONOMICS

Type of Course	Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Calculate the future value of a principal under annual compounding and under continuous compounding and use net present values to appraise investment projects and calculate the internal rate of return, the present value of an annuity.	A
CO2	Apply elementary algebra and differential calculus in economics and business problems and solve it mathematically	A
CO3	Apply graphical method, optimization techniques and marginal concepts in economics	A
CO4	Apply differential calculus of functions of several variables	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	1				1	
CO2	1	1	1	2	1	1	1	1		
CO3	2	2	2				1		1	1
CO4	1	1	1	1		1		1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x			x	x	x
CO2		x			x	x
CO3		x	x		x	x
CO4	x		x	x		x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Mathematics of Finance (19 Hrs)				
Compound Interest	1.1	1	4	Lecture, Class room exercise
Geometric Series	1.2	1	3	Lecture, Class room exercise
Investment Appraisal	1.3	1	4	Lecture, Class room exercise
Problems (Practicum)		1	8	
Module 2: Mathematical Economics (18 Hrs)				
Introduction to System of Equations	2.1	3	1	Lecture, Class room exercise



Graphical Solutions to Linear System of Equations	2.2	2	2	Lecture, Class room exercise
Supply-and-Demand Analysis	2.2	2	1	Lecture
Break-Even Analysis	2.3	2	1	Lecture, Class room exercise
Elimination and Substitution Methods	2.4	2	2	Lecture, Class room exercise
Income Determination Models	2.5	2	1	Lecture, Class room exercise
IS-LM Analysis	2.6	2	2	Lecture, Class room exercise
Problems (Practicum)		2	8	
Module 3: Optimization Techniques (20 Hrs)				
Use of Graphs in LPP, Maximization Using Graphs	3.1	3	2	Lecture, Class room exercise
The Extreme-Point Theorem, Minimization Using Graphs	3.2	3	2	Lecture, Class room exercise
Optimization of Functions, The Successive-Derivative Test	3.3	3	3	Lecture, Class room exercise
Marginal Concepts in Economics	3.4	3	1	Lecture, Class room exercise
Optimizing Economic Functions for Business	3.5	3	2	Lecture, Class room exercise
Relationship among Total, Marginal, and Average Functions	3.6	3	2	Lecture, Class room exercise
Problems (Practicum)		3	8	
Module 4: Applications of Mathematics in Economics and Business (18 Hrs)				
Functions of Several Independent Variables	4.1	4	4	Lecture, Class room exercise
Constrained Optimization problems with Lagrange Multipliers	4.2	4	4	Lecture, Class room exercise
Applications of definite integral in consumers and producer's surplus	4.3	4	4	Lecture, Class room exercise
Problems (Practicum)		4	6	
Module 5				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				
Practicum Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbooks

1. Dowling, Edward T. Theory and Problems of Mathematical Methods for Business and Economics. Schaum's Outline Series, McGraw Hill, 1993.
2. Jacques, Ian. Mathematics for Economics and Business, 5th ed., Prentice Hall, 2006.

Reference

1. Brechner, Robert, and George Bergeman. Contemporary Mathematics for Business and Consumers. Cengage Learning, 2020.
2. Das, N. G., & Das, J. K. Business Mathematics and Statistics. Tata McGraw-Hill, 2012.



3. Anthony, Martin, and Norman Biggs. Mathematics for Economics and Finance: Methods and Modelling. Cambridge University Press, 2012.
4. Yamane, Taro. Mathematics for Economists: An Elementary Survey. 1968.

Course designed by:



SBU24MA3DSE200: GRAPH THEORY

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain concepts related to Graphs	A
CO2	Apply the concept Trees and Connectivity of graphs	A
CO3	Analyse Euler Tours, Hamiltonian Cycles and Matchings	An
CO4	Analyse Planar Graphs and Coloring	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2			-	2		-		-
CO2	1	2		1	1			-	1	1
CO3	2	2	1	-	2	2	1	-	1	
CO4		1	1		1	1	1	1		1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x			x	x	x
CO2	x			x	x	x
CO3	x	x			x	x
CO4		x	x			x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: An Introduction to Graphs (20 Hrs)				
Definition of Graphs	1.1	1	3	Lecture, Class room exercise
Examples	1.2	1	3	Class room exercise
More Definitions	1.3	1	3	Lecture, Class room exercise
Vertex Degree	1.4	1	4	Lecture, Class room exercise
Paths and cycles	1.5	1	4	Lecture, Class room exercise
Matrix representation of graphs	1.6	1	3	Lecture, Class room exercise
Module 2: Trees and Connectivity (12 Hrs)				
Trees Definition and properties	2.1	2	3	Lecture, Class room exercise
Bridges	2.2	2	3	Lecture, Class room exercise
Spanning Trees	2.3	2	3	Lecture, Class room exercise
Cut vertices and Connectivity	2.4	2	3	Lecture, Class room exercise



Module 3: Euler Tours, Hamiltonian Cycles and Matchings (13 Hrs)				
Euler Tour	3.1	3	4	Lecture, Class room exercise
Hamiltonian Graphs	3.2	3	4	Lecture, Class room exercise
Matchings and Augmenting paths	3.3	3	5	Lecture, Class room exercise
Module 4: Planar Graphs and Coloring (15 Hrs)				
Planar Graphs	4.1	4	5	Lecture, Class room exercise
Vertex Coloring	4.2	4	5	Lecture, Class room exercise
Edge Coloring	4.3	4	5	Lecture, Class room exercise

Textbook

1. Clark, John, and Derek Allan Holton. A First Look at Graph Theory. World Scientific, 1991.

Reference

1. West, Douglas Brent. Introduction to Graph Theory. Pearson, 2018.
2. Wilson, Robin J. Introduction to Graph Theory. Pearson Higher Ed, 2015.
3. Chartrand, Gary, and Ping Zhang. Chromatic Graph Theory. CRC Press, 2019.
4. Rosen, Kenneth H. Discrete Mathematics and Its Applications. McGraw-Hill Higher Education, 2016.
5. Bapat, Ravindra B. Graphs and Matrices. Springer London, 2014.
6. Bondy, John Adrian, and U. S. R. Murty. Graph Theory with Applications. Macmillan, 1976.

Course designed by: Ms Jinu Mary Jameson



SBU24MA3DSE201: COMBINATORICS

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand basic concepts in combinatorics	U
CO2	Apply combinatorial principles and techniques to solve counting problems	A
CO3	Demonstrate a deep understanding of Pigeon Hole Principle	A
CO4	Apply the Principle of Inclusion and Exclusion	

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1		1		1	1			
CO2	1	1			1				1	
CO3	1	1	1			1	1			1
CO4				1	1			2	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x			x	x	x
CO3	x	x			x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Basics (20 Hrs)				
Two basic counting principles	1.1	1	3	Lecture, Class room exercise
Addition Principle	1.2	1	3	Lecture, Class room exercise
Multiplication Principle	1.3	1	3	Lecture, Class room exercise
Permutations	1.4	1	3	Lecture, Class room exercise
Circular Permutations	1.5	1	3	Lecture, Class room exercise
Principle of Complementation	1.6	1	3	Lecture, Class room exercise
Combinations	1.7	1	2	Lecture, Class room exercise
Module 2: Injection and Bijection Principle (12 Hrs)				
Injection Principle	2.1	2	3	Lecture, Class room exercise
Bijection principle	2.2	2	3	Lecture, Class room exercise
Arrangements and Selection with repetitions	2.3	2	3	Lecture, Class room exercise



Distribution Problems	2.4	2	3	Lecture, Class room exercise
Module 3: Pigeonhole Principle and Examples (13 Hrs)				
Introduction to the Pigeonhole principle	3.1	3	6	Lecture, Class room exercise
More Examples	3.2	3	7	Lecture, Class room exercise
Module 4: The Principle of Inclusion and Exclusion (15 Hrs)				
Introduction	4.1	4	1	Lecture, Class room exercise
The Principle of Inclusion and Exclusion	4.2	4	6	Lecture, Class room exercise
Generalization of the principle	4.3	4	4	Lecture, Class room exercise
Integer solutions and shortest routes	4.4	4	4	Lecture, Class room exercise
Module 5:				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Textbook

1. Chen, Chuan Chong, and Koh Khee Meng. Principles and Techniques In Combinatorics. World Scientific Publishing Co Pte Ltd, 1992.

Reference

1. Brualdi, Richard A. Introductory Combinatorics. Pearson Education, Inc, 2004.
2. Grimaldi, R. P., & Ramana, B. V. Discrete and Combinatorial Mathematics: An Applied Introduction. Pearson Education, 2007.
3. Bona, Miklos. A Walk-Through Combinatorics: An Introduction to Enumeration and Graph Theory, Second ed., World Scientific, 2006.
4. Flajolet, Philippe, and Robert Sedgewick. Analytic Combinatorics. Cambridge University Press, 2009.
5. Harris, John M. Combinatorics and Graph Theory. Springer, 2008.

Course designed by: Ms Treasa Maria Kuriakose



SBU24MA3MDC200: MATHEMATICS AND NATURE

Type of Course	MDC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45		45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Identify mathematical patterns in natural phenomena such as symmetry fractals, Fibonacci sequences, and geometric shapes.	A
CO2	Apply basic mathematical operations, including arithmetic, algebra, and geometry, to analyse and describe natural processes.	A
CO3	Understand the simple elegance of the Golden Ratio to the intricate designs of fractals and the unpredictability of chaos theory	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	3	1	2	1		1	1	1
CO2	1		1	2		2	2		1	1
CO3	2	2	2		1	1	1	1	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	I	II	Written Test I	Written Test II	
CO1	x		x	x	x
CO2	x	x	x	x	x
CO3		x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Mathematics and Nature, Fibonacci numbers (15 Hrs)				
Introduction to Mathematics and Nature	1.1	1	2	Lecture, Class room exercise
Symmetry in Nature	1.2	1	3	Lecture, Class room exercise
Fractals	1.3	1	3	Lecture, Class room exercise
Rabbit problem	1.4	1	2	Lecture, Class room exercise
Fibonacci numbers in Nature	1.5	1	2	Lecture, Class room exercise
Fibonacci and Lucas Identity	1.6	1	3	Lecture, Class room exercise
Module 2: Golden Ratio (15 Hrs)				
Golden Ratio	2.1	2	5	Lecture, Class room exercise
Tessellations	2.2	2	5	Lecture, Class room exercise
Honeycomb Patterns	2.3	2	5	Lecture, Class room exercise



Module 3 (15 Hrs)				
Geometry of Nature: Shapes, Structures, and Forms	3.1	3	5	Lecture, Class room exercise
Chaos Theory	3.2	3	5	Lecture, Class room exercise
The Butterfly Effect	3.3	3	5	Lecture, Class room exercise
Module 4				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbooks

1. Koshy, Thomas. Fibonacci and Lucas Numbers with Applications. John Wiley & Sons, Inc, 2001.

Reference

1. Benjamin, Arthur. The Magic of Math: Solving for x and Figuring Out Why. Basic Books, 2015.
2. Dunlap, Richard A. The Golden Ratio and Fibonacci Numbers. World Scientific Publishing Co. Pt. Ltd., 1997.
3. Lesmoir-Gordon, Nigel, and Will Rood. Introducing Fractals: A Graphic Guide. Icon Books Ltd, 2014.
4. Gleick, James. Chaos: Making a New Science. Penguin, 2008.
5. Livio, Mario. The Golden Ratio. Broadway Books, New York, 2005.

Course designed by: Ms Jinu Mary Jameson



SBU24MA3VAC200: CONTRIBUTIONS OF KERALA SCHOOL OF MATHEMATICS

Type of Course	VAC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45		45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the Genesis of the Kerala School and explain the techniques such as Mula-Sankalita and Varga-Sankalita	An
CO2	Evaluate the Contributions of Kerala to Trigonometry and explain Madhava-Gregory Series	E
CO3	Evaluate the sum of powers using Jyesthadeva and derivation of sine series in the Yuktibhasa	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1		2	1	2	1	1	1	1	1
CO2	3	2		1	2		1		2	1
CO3	1		1	1	1	2	2	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	I	II	Written Test I	Written Test II	
CO1	x	x	x	x	x
CO2		x		x	x
CO3		x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Genesis of the Kerala School (15 Hrs)				
Social Origins of the Kerala School	1.1	1	3	Lecture
Influence of Aryabhatiya	1.2	1	3	Lecture
Mula-Sankalita	1.3	1	3	Lecture
Varga-Sankalita	1.4	1	3	Lecture
Katapayadi Number System	1.5	2	3	Lecture
Module 2: Contributions to Trigonometry (15 Hrs)				
Outline of Indian Contributions	2.1	3	5	Lecture
Golasara of Nilakantha	2.2	3	5	Lecture
Madhava-Gregory Series	2.3	3	5	Lecture
Module 3: Power Series (15 Hrs)				
Transformation of Series	3.1	4	5	Lecture



Jyesthadeva on Sums of Powers	3.2	4	5	Lecture
Derivation of the Sine Series in the Yuktibhasa	3.3	4	5	Lecture
Module 4				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbooks

1. Joseph, George Gheverghese. A Passage to Infinity. SAGE Publications, New Delhi, 2009.
2. Roy, Ranjan. Sources in the Development of Mathematics: Infinite Series and Products from the Fifteenth to the Twenty-first Century. Cambridge University Press, 2011.

Reference

1. Sarasvati Amma, T. A. Geometry in Ancient and Medieval India. Motilal Banarsidass Publishers Limited, 2007.
2. Divakaran, P. P. The Mathematics of India: Concepts, Methods, Connections. Springer, 2018.
3. Parameswaran, S. The Golden Age of Indian Mathematics. Swadeshi Science Movement Kerala, 1998.
4. Joseph, George Gheverghese. Indian Mathematics: Engaging with the World from Ancient to Modern Times. World Scientific, 2016.
5. Joseph, George Gheverghese. The Crest of the Peacock: Non-European Roots of Mathematics. Princeton University Press, 1991.

Course designed by: Dr Shine C Mathew



SEMESTER IV

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MA4DSC200	Major	Calculus of Real Functions	5	75	4
SBU24MA4DSC201	Major	Topics in Algebra	5	75	4
SBU24MA4DSC202	Minor	Essential Mathematical Methods	5	75	4
SBU24MA4DSE200	Elective	Theory of Equations	4	60	4
SBU24MA4DSE201	Elective	Discrete Mathematics	4	60	4
SBU24MA4SEC200	SEC	Mathematical Reasoning	3	45	3
SBU24MA4VAC200	VAC	Mathematics for Data Analysis	3	45	3



SBU24MA4DSC200: CALCULUS OF REAL FUNCTIONS

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain topology of the real line and analyse continuity of the real functions	A
CO2	Demonstrate concepts in differential calculus	An
CO3	Apply techniques of Reimann integral	A
CO4	Understand improper integrals	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1		2	1		2	1	1	2	2
CO2	1	1	1	1	1	1	1	2	1	2
CO3	2	2			2	1	1	1		
CO4	2	1	1	2	1		1	2	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x	x	x	x	x	x
CO2	x	x		x	x	x
CO3		x	x		x	x
CO4			x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Topology of the Real Line (21 Hrs)				
Open sets and closed sets	1.1	1	1	Lecture, Class room exercise
Compact sets	1.2	1	1	Lecture, Class room exercise and Assignments
Connected sets	1.3	1	1	Lecture, Class room exercise and Assignments
Limit of a function	1.4	1	2	Lecture, Class room exercise and Assignments
Continuity at a point	1.5	1	2	Lecture, Class room exercise
Continuous functions on an interval	1.6	1	2	Lecture, Class room exercise
Uniform continuity	1.7	1	2	Lecture, Class room exercise and Assignments



Continuous image of a compact set	1.8	1	2	Lecture, Class room exercise and Assignments
Classification of discontinuities	1.9	1	2	Lecture, Class room exercise
Problems (Practicum)		1	6	
Module 2: Derivative (19 Hrs)				
Definition and Properties	2.1	2	1	Lecture
Mean Value theorem	2.2	2	1	Lecture, Class room exercise
One dimensional Inverse Function Theorem	2.3	2	1	Lecture, Class room exercise
Darboux's theorem	2.4	2	1	Lecture, Class room exercise
Contraction Mapping theorem	2.5	2	1	Lecture, Class room exercise
Cauchy's Mean Value Theorem	2.6	2	1	Lecture, Class room exercise and Assignment
Limits of indeterminate forms	2.7	2	1	Lecture, Class room exercise
Taylor's theorem	2.8		2	Lecture
Extreme points and extreme values	2.9	2	2	Lecture, Class room exercise and Assignment
Problems (Practicum)		2	8	
Module 3: Riemann Integral (18 Hrs)				
Partitions and Riemann-Darboux sums	3.1	3	1	Lecture, Class room exercise
Integral of a bounded function	3.2	3	1	Lecture, Class room exercise
Continuous and monotone functions	3.3	3	1	Lecture, Class room exercise
Lebesgue measure zero and integrability	3.4	3	1	Lecture, Class room exercise
Properties of the integral	3.5	3	2	Lecture, Class room exercise
Integral Mean Value theorems	3.6	3	2	Lecture, Class room exercise
Fundamental Theorem of Calculus	3.7	3	2	Lecture
Problems (Practicum)		3	8	
Module 4: Improper Integrals (17 Hrs)				
Functions on $[a, \infty)$ or $(-\infty, b]$	4.1	4	2	Lecture, Class room exercise
Functions on $(a, b]$ or $[a, b)$	4.2	4	2	Lecture, Class room exercise
Functions on (a, ∞) , $(-\infty, b)$ or $(-\infty, \infty)$	4.3	4	2	Lecture, Class room exercise
Cauchy Principal Value	4.4	4	3	Lecture, Class room exercise
Problems (Practicum)		4	8	
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				
Practicum Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbook

1. Terrell, William J. A Passage to Modern Analysis. American Mathematical Society, 2019.



Reference

1. Bartle, R. G., & Sherbert, D. R. Introduction to Real Analysis, 4th ed., Wiley, 2019.
2. Canuto, Claudio, and Tabacco, Anita. Mathematical Analysis - I, 2nd ed., Springer, 2015.
3. Strichartz, Robert S. The Way of Analysis. Jones & Bartlett Learning, 2000.
4. Laczkovich, Miklos, & Vera, T. Real Analysis: Foundations and Functions of One Variable, 2015.
5. Protter, M. H., & Marrey, C. B. A First Course in Real Analysis. Springer-Verlag, New York, 1977.

Course designed by:



SBU24MA4DSC201: TOPICS IN ALGEBRA

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Analyse the basic concepts and properties of vector spaces, subspaces	U
CO2	Apply concepts of the Rank of Matrix in computations as well as theory	An
CO3	Apply the properties of homomorphism to different algebraic structures and able to construct factor groups	An
CO4	Understand the isomorphism theorems for groups, particularly the First and Second Isomorphism Theorems, and their applications to factor groups.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	2	1	2	-	1	1	2
CO2		1	2	1	2		1	-	2	1
CO3	1	1			1	1		1		1
CO4	1		1	1		1	2	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x			x		x
CO2	x	x		x	x	x
CO3		x			x	x
CO4			x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1 Vector spaces, Basis and Dimensions (21 Hrs)				
Vector space	1.1	1	2	Lecture, Class room exercise
Examples	1.2	1	2	Lecture, Class room exercise and Assignment
Subspaces	1.3	1	2	Lecture, Class room exercise and Assignment
Linear Independence	1.4	1	3	Lecture, Class room exercise and Assignment



Basis and dimension	1.5	1	3	Lecture, Class room exercise and Assignment
Change of basis matrix	1.6	1	3	Lecture, Class room exercise and Assignment
Problems (Practicum)		1	6	
Module 2 Subspaces (16 Hrs)				
Sum of subspaces	2.1	2	2	Lecture, Class room exercise
Rank of a Matrix	2.2	2	3	Lecture, Class room exercise and Assignment
Quotient Spaces	2.3	2	3	Lecture, Class room exercise and Assignment
Problems (Practicum)		2	8	
Module 3: Homomorphism and Factor Groups (19 Hrs)				
Properties of Homomorphisms and related theorems	3.1	3	3	Lecture
Factor Groups	3.2	3	3	Lecture, Class room exercise and Assignment
Factor Group computation	3.3	3	3	Lecture, Class room exercise and Assignment
Simple groups	3.4	3	2	Lecture, Class room exercise
Problems (Practicum)		3	8	
Module 4: Group Action (19 Hrs)				
Group Action	4.1	4	3	Lecture, Class room exercise
Isomorphism Theorems	4.2	4	3	Lecture, Class room exercise
Sylow Theorems	4.3	4	2	Lecture
Applications	4.4	4	3	Lecture, Class room exercise
Problems (Practicum)		4	8	
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbooks

1. Fraleigh, John B. A First Course in Abstract Algebra, 8th ed., Pearson Education India, 2003.
2. Saikia, Promode Kumar. Linear Algebra, 2nd ed., Pearson Education India, 2014.

Reference

1. Axler, Sheldon. Linear Algebra Done Right, 3rd ed., Springer, 2015.
2. Dummit, David S., and Foote, Richard M. Abstract Algebra. John Wiley & Sons Inc, 2003.
3. Gallian, Joseph. Contemporary Abstract Algebra. Chapman and Hall/CRC, 2021.



4. Herstein, I. N. Topics in Algebra, 2nd ed., Wiley, 2006.
5. Datta, K. B. Matrix and Linear Algebra. Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
6. Hoffman, Kenneth, and Kunze, Ray. Linear Algebra. Prentice-Hall of India Pvt. Ltd., New Delhi, 1992.
7. Halmos, Paul R. Linear Algebra Problem Book. The Mathematical Association of America, 1995.
8. Kumaresan, S. Linear Algebra: A Geometrical Approach. Prentice Hall of India, 2000.
9. Lang, Serge. Algebra, 3rd ed., Springer, 2002.
10. Nair, Thamban, and Singh, A. Linear Algebra. Springer, 2018.

Course designed by: Ms Jinu Mary Jameson



SBU24MA4DSC202: ESSENTIAL MATHEMATICAL METHODS

Type of Course	Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Apply the Cauchy-Riemann relations to analyze and characterize the behaviour of functions of a complex variable and employ techniques such as power series expansions and contour integration to solve problems involving complex functions, singularities, and complex integrals	A
CO2	Analyze and solve problems involving surface and volume integrals using integral forms for gradient, divergence, and curl, along with relevant theorems like the divergence theorem and Stokes theorem.	An
CO3	Understand and solve basic partial differential equations	A
CO4	The power series method and the Frobenius method to solve differential equations,	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	1		1	1			1	1
CO2	1	1		1	2	1	1	2	2	2
CO3	2	1	1	2		2	2	1	2	1
CO4	1	2	2	2	1	1	1	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x			x	x	x
CO3	x	x			x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Complex Analysis (18 Hrs)				
Functions of a complex variable	1.1	1	1	Lecture, Class room exercise
The Cauchy- Riemann relations (without proof)	1.2	1	1	Lecture, Class room exercise
Power series in a complex variable	1.3	1	1	Lecture, Class room exercise



Singularities and zeros of complex function	1.4	1	2	Lecture, Class room exercise
Complex integrals	1.5	1	1	Lecture, Class room exercise
Cauchy's theorem (without proof) and its applications	1.6	1	1	Lecture, Class room exercise
Cauchy's integral formula (without proof) and its applications	1.7	1	2	Lecture, Class room exercise
Residue theorem	1.8	1	1	Lecture, Class room exercise
Problems (Practicum)		1	8	
Module 2: Surface and Volume Integrals (18 Hrs)				
Volume integrals	2.1	2	2	Lecture, Class room exercise
Integral forms for Grad, Div and Curl	2.2	2	2	Lecture, Class room exercise
Divergence theorem and related theorem	2.3	2	3	Lecture, Class room exercise
Stokes theorem and related theorems	2.4	2	3	Lecture, Class room exercise
Problems (Practicum)		2	8	
Module 3: Partial Differential Equations (20 Hrs)				
Introduction to partial differential equations	3.1	3	2	Lecture, Class room exercise
Important partial differential equations – wave equation, Laplace's equation, Poisson's equation, Schrodinger's equation	3.2	3	1	Lecture, Class room exercise
General form of a solution	3.3	3	2	Lecture, Class room exercise
General and particular solutions	3.4	3	1	Lecture, Class room exercise
First order equations	3.5	3	3	Lecture, Class room exercise
Inhomogeneous equations and problems	3.6	3	3	Lecture, Class room exercise
Problems (Practicum)		3	8	Lecture, Class room exercise
Module 4: Special Functions (19 Hrs)				
The power series method	4.1	4	1	Lecture, Class room exercise
The Frobenius method	4.2	4	2	Lecture, Class room exercise
The Legendre equation	4.3	4	1	Lecture, Class room exercise
The Hermite equation	4.4	4	2	Lecture, Class room exercise
The Laguerre equation	4.5	4	4	Lecture, Class room exercise
Bessel's functions	4.6	4	3	Lecture, Class room exercise
Problems (Practicum)		4	6	Lecture, Class room exercise
Module 5				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				
Practicum Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbooks

1. Riley, K. F., & Hobson, M. P. Essential Mathematical Methods For Physical Sciences. Cambridge University Press, 2011.
2. Steiner, Erich. The Chemistry Maths Book, Second ed., Oxford University Press, 2008.



3. Kreyszig, Erwin. Advanced Engineering Mathematics, 8th ed., Wiley, 2007.

Reference

1. Anton, H., Biven, I., & Davis, S. Calculus, 10th ed. Wiley, 2015.
2. Stewart, J. Essential Calculus, 2nd ed. Cengage, 2017.
3. Thomas, G. B., & Finney, R. L. Calculus and Analytic Geometry, 9th ed. (Reprint). Pearson, 2002.
4. O'Neil, P. Advanced Engineering Mathematics, 7th ed. Thomson, 2007.
5. Grewal, B. S. Higher Engineering Mathematics, 36th ed. Khanna Publishers, 2010.
6. Barret, L. C., & Wylie, C. R. Advanced Engineering Mathematics, 6th ed. Tata McGraw Hill, 2003.
7. Veerarajan, T. Engineering Mathematics for First Year. Tata McGraw-Hill, 2008.
8. Jain, R. K., & Iyengar, S. R. K. Advanced Engineering Mathematics, 5th ed. Narosa Publications, 2016.
9. Dass, H. K., & Verma, R. Higher Engineering Mathematics. S Chand and Company Limited, New Delhi .

Course designed by: Ms Jinu Mary Jameson



SBU24MA4DSE200: THEORY OF EQUATIONS

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
Duration	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the nature of the roots of polynomial equations and their symmetries and find the relations between the roots and coefficients of equations.	A
CO2	Solve cubic and quartic polynomial equations with special condition on roots and in general	A
CO3	Find symmetric functions in terms of the elementary symmetric polynomials	A
CO4	Analyse the location and describe the nature of the roots of an equation.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	1	2	1	1	1	1	1
CO2	2	2	2		2	1	1	1	2	2
CO3	1	1	1	1	1	2	2	2	1	1
CO4	2		1	2	2	1	1	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x	x		x	x	x
CO2	x	x		x	x	x
CO3	x	x		x	x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1 - Polynomials and Equations (20 Hrs)				
Theorem relating to polynomials when the variable receives large values.	1.1	1	2	Lecture, Class room exercise
Change of form of a polynomial corresponding to an increase or diminution of the variable	1.2	1	2	Lecture, Class room exercise
Derived functions	1.3	1	2	Lecture, Class room exercise
Tabulation of functions,	1.4	1	2	Lecture, Class room exercise
Graphic representation of a polynomial	1.5	1	2	Lecture, Class room exercise



Maximum and minimum values of polynomials	1.6	1	2	Lecture, Class room exercise
Theorems relating to the real roots of equations,	1.7	1	2	Lecture, Class room exercise
Existence of a root in the general equation Imaginary roots, Theorem determining the number of imaginary roots of an equation ,	1.8	1	2	Lecture, Class room exercise
Imaginary roots enter equations in pairs, Descartes' rule of signs for positive roots, Descartes' rule of signs for negative roots, Use of Descartes' rule in proving the existence of imaginary roots.	1.9	1	2	Lecture, Class room exercise
Theorem relating to the substitution of two given numbers for the variable, Examples.	1.10	1	2	Lecture, Class room exercise
Module 2: Relations Between the Roots and Coefficients (12 Hrs)				
Relations between the roots and coefficients Theorem, Applications of the theorem	2.1	2	3	Lecture, Class room exercise
Depression of an equation when a relation exists between two of its roots, The cube roots of unity.	2.2	2	4	Lecture, Class room exercise
Symmetric functions of the roots, Examples	2.3	2	2	Lecture, Class room exercise
Theorems relating to symmetric functions, Examples.	2.4	2	3	Lecture, Class room exercise
Module 3: Transformation of Equations (13 Hrs)				
Transformation of equations, Roots with signs changed, Roots multiplied by a given quantity	3.1	3	3	Lecture, Class room exercise
Reciprocal roots and reciprocal equations, To increase or diminish the roots by a given quantity, Removal of terms, Binomial coefficients, The cubic.	3.2	3	2	Lecture, Class room exercise
The biquadratic, Homographic transformation, Transformation by symmetric functions	3.3	3	3	Lecture, Class room exercise
Formation of the equation whose roots are any powers of the roots of the proposed equation, Transformation in general, Equation of squared differences of a cubic.	3.4	3	2	Lecture, Class room exercise
Criterion of the nature of the roots of a cubic., Equation of differences in general.	3.5	3	3	Lecture, Class room exercise
Module 4: Reciprocal Equations (15 Hrs)				
Reciprocal equations. Binomial equations.	4.1	4	2	Lecture, Class room exercise
Propositions embracing their leading general properties. The special roots of the equation $z^{n-1} = 0$.	4.2	4	2	Lecture, Class room exercise
Solution of binomial equations by circular functions. The algebraic solution of the cubic equation.	4.3	4	2	Lecture, Class room exercise



Application to numerical equations. Expression of the cubic as the difference of two cubes. Solution of the cubic by symmetric functions of the roots. Examples.	4.4	4	1	Lecture, Class room exercise
Homographic relation between two roots of a cubic. First solution by radicals of the biquadratic, Euler's assumption. Examples.	4.5	4	2	Lecture, Class room exercise
Second solution by radicals of the biquadratic. Resolution of the quartic into its quadratic factors. Ferrari's solution	4.6	4	2	Lecture, Class room exercise
Resolution of the quartic into its quadratic factors. Descartes solution.	4.7	4	2	Lecture, Class room exercise
Transformation of the biquadratic into the reciprocal form. Solution of the biquadratic by symmetric functions of the roots.	4.8	4	2	Lecture, Class room exercise
Module 5:				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Textbooks

1. Burnside, W. S., & Panton, A. W. The Theory of Equations, 11th ed., Vol. 1. Dover Publications, Inc, 1979.

Reference

1. Barnard, Samuel, and James Mark Child. Higher Algebra. Macmillan, 1936.
2. Dickson, Leonard Eugene. First Course in the Theory of Equations. John Wiley & Sons, 2009.
3. Evans, Lawrence C. Algebraic Number Theory, 2nd ed. Cambridge University Press, 2019.
4. Prasad, Chandrika. Text Book of Algebra and Theory of Equations. Pothishala Pvt Ltd, 2017.
5. Thomas, George B., Jr., and Maurice D. Weir. Thomas' Calculus, 12th ed. Pearson, 2009.

Course designed by: Dr Ullas Thomas



SBU24MA4DSE201: DISCRETE MATHEMATICS

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Illustrate various concepts in Propositional Calculus	A
CO2	Analyze Partial Ordering Relation and study Hasse Diagram, Chains and Antichains	An
CO3	Explain Lattices and Algebraic System	A
CO4	Discuss the concepts of Boolean algebra	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1		2	1		2	1	1	2	2
CO2	2	2			2	1	1	1		
CO3	2	1	1	2	1		1	2	2	1
CO4	1	2	2	2	2	1			1	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x			x	x	x
CO3		x			x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Proof techniques (16 Hrs)				
Introduction	1.1	1	2	Lecture, Class room exercise
Understanding How Theorems are Stated	1.2	1	2	Lecture, Class room exercise
Methods of Proving theorems: Direct Proofs	1.3	1	3	Lecture, Class room exercise
Proof by Contraposition	1.4	1	3	Lecture, Class room exercise
Proofs by Contradiction	1.5	1	2	Lecture, Class room exercise
Proofs of equivalence	1.6	1	2	Lecture, Class room exercise
Mistakes in Proofs	1.7	1	2	Lecture, Class room exercise
Module 2: Partial Ordering Relation and Chains (15 Hrs)				
Partial Ordering Relation	2.1	2	3	Lecture, Class room exercise
Hasse Diagram	2.2	2	4	Lecture, Class room exercise
Chains	2.3	2	4	Lecture, Class room exercise



Anti-chains	2.4	2	4	Lecture, Class room exercise
Module 3: Lattices (15 Hrs)				
Lattices and Algebraic System	3.1	3	3	Lecture, Class room exercise
Principle of Duality	3.2	3	3	Lecture, Class room exercise
Basic Properties of Algebraic Systems defined by Lattices	3.3	3	3	Lecture, Class room exercise
Distributive Lattice	3.4	3	3	Lecture, Class room exercise
Complemented Lattices	3.5	3	3	Lecture, Class room exercise
Module 4: Boolean Algebra (14 Hrs)				
Boolean Lattices	4.1	4	2	Lecture, Class room exercise
Boolean Algebras	4.2	4	3	Lecture, Class room exercise
Uniqueness of Finite Boolean Algebras	4.3	4	3	Lecture, Class room exercise
Boolean Functions	4.4	4	3	Lecture, Class room exercise
Boolean Expressions	4.5	4	3	Lecture, Class room exercise
Module 5				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Textbooks

1. Rosen, Kenneth H. Discrete Mathematics and Its Applications, 7th ed., McGraw-Hill Education, 2011.
2. Liu, C. L. Elements of Discrete Mathematics, McGraw-Hill Education, 1985.

Reference

1. Johnson, D. L. Elements of Logic Via Numbers and Sets. Springer, 1998.
2. Chiswell, Ian, & Hodges, Wilfrid. Mathematical Logic. Oxford University Press, 2007.
3. Khanna, Vijay. Lattices And Boolean Algebras - First Concepts. Vikas Publishing House, 2001.
4. Ross, Kenneth A., & Wright, Charles R. B. Discrete Mathematics. Pearson Education; Dorling Kindersley India Pvt Ltd, 1999.
5. Johnsonbaugh, Richard. Discrete Mathematics. Pearson Education; Dorling Kindersley India Pvt Ltd, 2009.

Course designed by: Ms Treesa Maria Kuriakose



SBU24MA4SEC200: MATHEMATICAL REASONING

Type of Course	SEC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45		45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Analyse and evaluate arithmetic reasoning problems	An
CO2	Evaluate logical, verbal and non-verbal reasoning problems	A
CO3	Explain syllogism and puzzle problems	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	2		1	1	1	2	1
CO2	1	1	3	3	1	2	2		1	
CO3	3	2	2		3	1		2	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	I	II	Written Test I	Written Test II	
CO1	x		x	x	x
CO2	x	x	x	x	x
CO3		x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Mathematical reasoning techniques (15 Hrs)				
Arithmetic Reasoning	1.1	1	2	Lecture and exercise
Analogy basing on kinds of relationships	1.2	1	3	Lecture and exercise
Pattern and Series of numbers, Letters & Figures	1.3	1	3	Lecture and exercise
Coding-Decoding of Numbers	1.4	1	3	Lecture and exercise
Blood Relations	1.5	1	4	Lecture and exercise
Module 2: Logical reasonings (15 Hrs)				
Venn diagrams	2.1	2	2	Lecture and exercise
Mirror images	2.2	2	2	Lecture and exercise
Problems on cubes and dices	2.3	2	3	Lecture and exercise
Classification	2.4	2	2	Lecture and exercise
Data Sufficiency	2.5	2	3	Lecture and exercise
Statement and Assumptions	2.6	2	3	Lecture and exercise
Module 3: Puzzles and Inequalities (15 Hrs)				
Syllogism	3.1	3	4	Lecture and exercise



Inequalities	3.2	3	4	Lecture and exercise
Sitting arrangement	3.3	3	4	Lecture and exercise
Puzzles test	3.4	3	3	Lecture and exercise
Module 4				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbook

1. Kundan, K. Concept of Arithmetic. BSC Publishing Co. Pvt. Ltd., 2011.

Reference

1. Praveen, R. V. Quantitative Aptitude And Reasoning. PHI Learning Pvt. Ltd., 2016.
2. Aggarwal, R. S. A Modern Approach To Verbal & Non-Verbal Reasoning. S. Chand Limited, 1994.
3. Verma, Rajesh. Fast Track Objective Arithmetic. Arihant Publications, 2020.
4. Verma, Sarvesh K. Quantitative Aptitude Quantum CAT Common Admission Tests for Admission into IIMs. Arihant Publications, 2019.
5. Sharma, Arun. How to Prepare for Quantitative Aptitude for the CAT. Arun Sharma Publisher, McGraw-Hill Education, 2020.

Course designed by: Ms Treesa Maria Kuriakose



SBU24MA4VAC200: MATHEMATICS FOR DATA ANALYSIS

Type of Course	VAC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45		45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the basic ideas of data collection, analysis and interpretation	U
CO2	Examine data with descriptive statistics tools	An
CO3	Interpret association between two variables by computing correlation and regression	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	2	2	2		2	1	1	1	2	2
CO3	2	1	1	2	1	2	2	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	I	II	Written Test I	Written Test II	
CO1	x	x	x	x	x
CO2		x		x	x
CO3		x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Data Collection, Classification and Representation (15 Hrs)				
Data Collection	1.1	1	1	Lecture, Class room exercise
Classification and Representation	1.2	1	1	Lecture, Class room exercise
Definition of Statistics and its Importance and limitations	1.3	1	1	Lecture, Class room exercise
Population and Sample	1.4	1	1	Lecture, Class room exercise
Primary and Secondary data	1.5	1	2	Lecture, Class room exercise
Geographical, Chronological, Qualitative and Quantitative Classifications of data	1.6	1	2	Lecture, Class room exercise
Frequency distribution and Tabulation	1.7	1	1	Lecture, Class room exercise
Bar diagram and Pie diagram	1.8	1	2	Lecture, Class room exercise
Histogram	1.9	1	1	Lecture, Class room exercise
Frequency polygon, Frequency curve	1.10	1	2	Lecture, Class room exercise
Ogives	1.11	1	1	Lecture, Class room exercise



Module 2: Measures of Central Tendency & Measures of Dispersion (20 Hrs)				
Measures of Central Tendency	2.1	2	2	Lecture, Class room exercise
Central Tendency and its Measures	2.2	2	2	Lecture, Class room exercise
Arithmetic mean, Mode	2.3	2	2	Lecture, Class room exercise
Geometric Mean and Harmonic Mean and their properties	2.4	2	3	Lecture, Class room exercise
Dispersion and its Measures	2.5	2	2	Lecture, Class room exercise
Range, Quartile Deviation	2.6	2	2	Lecture, Class room exercise
Mean Deviation and Standard Deviation	2.7	2	2	Lecture, Class room exercise
Relative Measures of Dispersion	2.8	2	2	Lecture, Class room exercise
Coefficient of variation, Deciles, Percentiles	2.9	2	3	Lecture, Class room exercise
Module 3: Bivariate Data (10 Hrs)				
Correlation	3.1	3	1	Lecture, Class room exercise
Scatter diagram	3.2	3	1	Lecture, Class room exercise
Karl Pearson's Coefficient of Correlation	3.3	3	2	Lecture, Class room exercise
Correlation-Spearman's Rank Correlation Coefficient	3.4	3	2	Lecture, Class room exercise
Linear Regression	3.5	3	1	Lecture, Class room exercise
Regression coefficients and properties	3.6	3	2	Lecture, Class room exercise
Fitting of Regression lines	3.7	3	1	Lecture, Class room exercise
Module 4				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbook

1. Gupta, S. C., & Kapoor, V. K. Fundamentals of Mathematical Statistics, 11th ed., Sultan Chand & Sons, 2017.
2. Gupta, S. P. Statistical Methods, 45th ed., Sultan Chand & Sons, 2019.

Reference

1. Agarwal, B. L. Basic Statistics. New Age International (P) LTD, 2006.
2. Hogg, R. V., & Craig, A. T. Introduction to Mathematical Statistics. Amerind Publishing Co Pvt, 1970.
3. Mood, A. M., Graybill, F. A., & Boes, D. C. Introduction to Theory of Statistics. McGraw Hill, 1973.
4. Rohatgi, V. K. An Introduction to Probability and Mathematical Statistics. Willey Eastern, 1976.

Course designed by: Ms Jinu Mary Jameson



SEMESTER V

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MA5DSC300	Major/Minor	Qualitative Study of Real functions	5	75	4
SBU24MA5DSC301	Major/Minor	Rings and Fields	5	75	4
SBU24MA5DSE300	Elective	Linear Algebra and its Applications	4	60	4
SBU24MA5DSE301	Elective	Linear Optimization Techniques	4	60	4
SBU24MA5DSE302	Elective	Integral Transforms	4	60	4
SBU24MA5DSE303	Elective	Geometry of Curves and Surfaces	4	60	4
SBU24MA5DSE304	Elective	Number Theory and Cryptography	4	60	4
SBU24MA5SEC300	SEC	Python Programming for Mathematics	3	45	3



SBU24MA5DSC300: QUALITATIVE STUDY OF REAL FUNCTIONS

Type of Course	Major/Minor		
Course Level	300- 399		
Credit	4		
Course Delivery	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
Duration	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand and apply the concepts of functions of bounded variation and rectifiable curves	U
CO2	Apply the convergence criteria for sequence and series of functions to analyse the uniform, pointwise and absolute convergence.	An
CO3	Demonstrate proficiency in manipulating power series, including determining convergence, radius of convergence and representing functions as power series	A
CO4	Apply Fourier series techniques to analyse periodic functions and understanding convergence, Parseval's identity	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	1	1	1	2	2	2	2	1	1	1
CO3	2	2	2		2	1	1	1	2	2
CO4	1	1	1	1	1	2	2	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x		x
CO2	x			x		x
CO3	x	x		x	x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Functions of Bounded Variation and Rectifiable Curves (19 Hrs)				
Properties of monotonic functions	1.1	1	1	Lecture, Class room exercise
Functions of Bounded Variation	1.2	1	1	Lecture, Class room exercise
Total Variation	1.3	1	1	Lecture, Class room exercise
Additive property of total Variation	1.4	1	1	Lecture, Class room exercise
Total variation on $[a,x]$ as a function of x	1.5	1	1	Lecture, Class room exercise and Assignment



Functions of bounded variation expressed as the difference of increasing functions	1.6	1	2	Lecture, Class room exercise and Assignment
Continuous functions of bounded variation	1.7	1	2	Lecture, Class room exercise
Curves and Paths	1.8	1	2	Lecture, Class room exercise
Rectifiable Paths and arc length	1.9	1	2	Lecture, Class room exercise
Problems (Practicum)		1	6	
Module 2: Sequence and Series of Functions (18 Hrs)				
Pointwise convergence of sequence of function	2.1	2	1	Lecture
Examples of sequences of real valued functions	2.2	2	1	Lecture, Class room exercise
Definition of Uniform convergence	2.3	2	1	Lecture, Class room exercise
Uniform convergence and continuity	2.4	2	1	Lecture, Class room exercise
The Cauchy condition for uniform convergence	2.5	2	1	Lecture, Class room exercise and Assignment
Uniform convergence and Reimann Stieltjes integration	2.6	2	1	Lecture
Uniform convergence and Differentiation	2.7	2	2	Lecture, Class room exercise
Sufficient condition for uniform convergence of series	2.8	2	2	Lecture, Class room exercise
Problems (Practicum)		2	8	
Module 3: Power Series (19 Hrs)				
Power series	3.1	3	1	Lecture, Class room exercise
Multiplication of power series	3.2	3	1	Lecture, Class room exercise
The Substitution Theorem	3.3	3	1	Lecture, Class room exercise
Reciprocal of a power series	3.4	3	1	Lecture, Class room exercise
Real Power Series	3.5	3	2	Lecture, Class room exercise
The Taylor's series generated by a function	3.6	3	2	Lecture, Class room exercise
Bernstein's theorem	3.7	3	1	Lecture, Class room exercise
The Binomial series	3.8	3	1	Lecture, Class room exercise
Abel's limit theorem	3.9	3	1	Lecture, Class room exercise
Problems (Practicum)		3	8	
Module 4: Fourier Series (19 Hrs)				
Trigonometric polynomial	4.1	4	2	Lecture
Fourier Coefficients and Fourier Series	4.2	4	3	Lecture, Class room exercise
Exponential Forms	4.3	4	1	Lecture, Class room exercise
Differentiation	4.4	4	1	Lecture, Class room exercise
Convergence of Fourier Series (Quadratic, Pointwise, Uniform)	4.5	4	2	Lecture, Class room exercise
Periodic Function with Period $T > 0$	4.6	4	2	Lecture, Class room exercise
Problems (Practicum)		4	8	
Module 5				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				



Practicum

Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills.

The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.

Textbook

1. Apostol, Tom M. Calculus II, 2nd ed. Wiley, 2019.

Reference

1. Beyer, Horst R. Calculus and Analysis: A Combined Approach. Wiley, 2010.
2. Canuto, Claudio, and Tabacco, Anita. Mathematical Analysis II. Springer Publication, 2011.
3. Ghorpade, Sudhir R., and Limaye, Balmohan V. A Course in Multivariable Calculus and Analysis. Springer, 2009.
4. Kantorovitz, Shumuel. Several Real Variables. Springer, 2016.
5. Rudin, W. Principles of Mathematical Analysis, 2nd ed. McGraw-Hill, 1964.

Course designed by: Mr Tibin Thomas



SBU24MA5DSC301: RINGS AND FIELDS

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand basic concepts in ring theory, including definitions of rings, subrings, ideals, quotient rings, homomorphisms, and isomorphisms.	U
CO2	Construct new rings and fields from existing ones using operations such as direct products, polynomial rings, and quotient constructions.	A
CO3	Explain Ring homomorphism and introduce the concept of ideal	A
CO4	Analyse various types of Integral Domains	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	2	2	2		2	1	1	1	2	2
CO3	1	1	1	1	1	2	2	2	1	1
CO4	2		1	2	2	1	1	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x			x		x
CO2	x			x	x	x
CO3		x	x		x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Rings and Homomorphisms (21 Hrs)				
Rings: Definition and Basic properties	1.1	1	4	Lecture, Class room exercise
Ring Homomorphism and Isomorphism	1.2	1	3	Lecture, Class room exercise
Fields: Definition and Basic properties	1.3	1	3	Lecture, Class room exercise
Integral Domains	1.4	1	4	Lecture, Class room exercise
Characteristic of a ring	1.5	1	4	Lecture, Class room exercise
Problems (Practicum)		1	3	
Module 2: Field of Quotients and Rings of Polynomials (19 Hrs)				
Field of Quotients	2.1	2	4	Lecture, Class room exercise



Rings of Polynomials	2.2	2	5	Lecture, Class room exercise
Factorization of polynomials over a Field	2.3	2	5	Lecture, Class room exercise and Assignment
Problems (Practicum)		2	5	
Module 3: Ideals and Factor rings (18 Hrs)				
Homomorphisms and Factor rings	2.4	3	7	Lecture, Class room exercise
Prime and Maximal Ideals	2.5	3	7	Lecture, Class room exercise
Problems (Practicum)		3	4	
Module 4: Factorization (17 Hrs)				
Unique Factorization Domains	3.1	4	7	Lecture, Class room exercise and Assignment
Euclidean Domains	3.2	4	7	Lecture, Class room exercise and Assignment
Problems (Practicum)		4	3	
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbook

1. Fraleigh, John B. A First Course in Abstract Algebra, 8th ed., Pearson Education India, 2003.

Reference

1. Dummit, David S., & Foote, Richard M. Abstract Algebra. John Wiley & Sons Inc, 2003.
2. Gallian, Joseph. Contemporary Abstract Algebra. Chapman and Hall/CRC, 2021.
3. Herstein, I. N. Topics in Algebra, 2nd ed. Wiley, 2006.
4. Lang, Serge. Algebra, 3rd ed. Springer, 2002.

Course designed by: Ms Jinu Mary Jameson



SBU24MA5DSE300: LINEAR ALGEBRA AND ITS APPLICATIONS

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Analyse linear transformations and its matrices	An
CO2	Compute the characteristic polynomial, minimal polynomial eigenvectors, eigenvalues and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue	An
CO3	Understand the basic theory of Direct sum decompositions and Invariant direct sums.	A
CO4	Familiarize the Jordan forms and Quadratic forms.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	2	2	2		2	1	1	1	2	2
CO3	1	1	1	1	1	2	2	2	1	1
CO4	2		1	2	2	1	1	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x			x		x
CO2	x	x		x	x	x
CO3		x			x	x
CO4			x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Linear Transformations (17 Hrs)				
Linear Transformation and examples	1.1	1	3	Lecture, Class room exercise
Kernel and Image of a linear map	1.2	1	3	Lecture, Class room exercise and Assignment
Algebra of Linear Maps	1.3	1	3	Lecture, Class room exercise
Isomorphism	1.4	1	4	Lecture, Class room exercise
Matrices of Linear Maps	1.5	1	4	Lecture, Class room exercise
Module 2: Eigenvalues and Eigenvectors (14 Hrs)				
Characteristic polynomials and Eigenvalues	2.1	3	3	Lecture, Class room exercise
Computing Eigenvectors	2.2	3	3	Lecture, Class room exercise



Diagonalizable Operators	2.3	2,3	2	Lecture, Class room exercise and Assignment
Eigenspaces	2.4	3	2	Lecture, Class room exercise and Assignment
Eigenvalues and eigenvectors of Real symmetric Matrix	2.5	3	1	Lecture, Class room exercise
Minimal Polynomial and its applications	2.6	2,3	3	Lecture, Class room exercise
Module 3: Decomposition (15 Hrs)				
Invariant Subspaces	3.1	3	4	Lecture, Class room exercise
Cyclic subspaces	3.2	3	3	Lecture, Class room exercise
Primary Decomposition Theorem	3.3	3	4	Lecture
SN Decomposition	3.4	3	4	Lecture, Class room exercise
Module 4: Jordan Form and Quadratic form (14 Hrs)				
Jordan Form	4.1	4	5	Lecture, Class room exercise
Quadratic Form	4.2	4	6	Lecture, Class room exercise
SVD and its applications	4.3	4	3	Lecture, Class room exercise
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbook

1. Saikia, Promode Kumar. Linear Algebra, 2nd ed., Pearson Education India, 2014.

Reference

1. Axler, S. Linear Algebra Done Right, 3rd ed., Springer, 2015.
2. Datta, K. B. Matrix And Linear Algebra. Prentice Hall Of India Pvt. Ltd., New Delhi, 2000.
3. Hoffman, Kenneth, & Kunze, Ray. Linear Algebra, 2nd ed. Prentice-Hall Of India Pvt. Ltd., New Delhi, 1992.
4. Halmos, Paul R. Linear Algebra Problem Book. The Mathematical Association Of America, 1995.
5. Kumaresan, S. Linear Algebra: A Geometrical Approach. Prentice Hall Of India, 2000.
6. Nair, M. Thamban, & Singh, A. Linear Algebra. Springer, 2018.

Course designed by: Ms Jinu Mary Jameson



SBU24MA5DSE301: LINEAR OPTIMIZATION TECHNIQUES

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Introduction to Linear programming problems	U
CO2	Analyse Simplex method in LPP and Analyse Duality in Linear Programming Problems	An
CO3	Understand and Evaluate Transportation and Assignment Problems	A
CO4	Analyse the concept of game theory	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Mapping of CO to Assessment Tools (Theory)

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	1	2	2	-	2	2	1
CO2	2	2	-	2	2	-	2	2	2	2
CO3	2	2	2	1	2	2	2	1	2	2
CO4	2	2	1	2	2	2	2	1	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x	x		x		x
CO2	x	x		x		x
CO3	x	x		x		x
CO4		x	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Linear Programming Problems (20 Hrs)				
Introduction to Linear Programming	1.1	1	3	Lecture, Class room exercise
LPP in two-dimensional space	1.2	1,2	3	Lecture, Class room exercise
general LPP, Feasible solution	1.3	1,2	3	Lecture, Class room exercise
Basic and basic feasible solution, optimal solution.	1.4	1,2	3	Lecture, Class room exercise
Simplex method (numerical example), Simplex tableau,	1.5	1,2	4	Lecture, Class room exercise
Finding the first b.f. s., artificial variables, Degeneracy, simplex multipliers	1.6	1,2	4	Lecture, Class room exercise
Module 2: Duality in Linear Programming (12 Hrs)				
Duality in LPP	2.1	2	2	Lecture, Class room exercise



Duality theorems	2.2	2	2	Lecture, Class room exercise
Application of duality	2.3	2	3	Lecture, Class room exercise
Dual simplex method	2.4	2	3	Lecture, Class room exercise
Jacobi Symbol	2.5	2	2	Lecture, Class room exercise
Module 3: Transportation and Assignment Problems (15 Hrs)				
Transportation problems: transportation model – Mathematical formulation	3.1	3	2	Lecture, Class room exercise
Solution by North West corner method, lowest cost entry method, Vogel's and MODI method	3.2	3	2	Lecture, Class room exercise
Degeneracy and its solution	3.3	3	2	Lecture, Class room exercise
Assignment problems. Assignment model, mathematical formulation	3.4	3	3	Lecture, Class room exercise
Duality theorems, Application of duality	3.5	3	3	Lecture, Class room exercise
Dual simplex method	3.6	3	3	Lecture, Class room exercise
Module 4: Introduction to Game Theory (13 Hrs)				
Two-person Zero sum game	4.1	4	2	Lecture, Class room exercise
pure and mixed strategy with saddle point	4.2	4	2	Lecture, Class room exercise
Solution of pure strategy games, solution of mixed strategy games	4.3	4	3	Lecture, Class room exercise
Problems by arithmetic method, Principle of dominance	4.4	4	3	Lecture, Class room exercise
Solution by graphical method	4.5	4	3	Lecture, Class room exercise
Module 5				
Teacher Specific Content				
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)				
This content will be evaluated internally				

Textbook

1. Mital, K. V., & Mohan, C. Optimization Methods in Operations Research and Systems Analysis, 3rd ed., New Age International, 1996.
2. Swarup, Kanti, Gupta, P. K., & Manmohan. Operation Research. Sultan Chand and Sons, 1997.

Reference

1. Swarup, Kanti, Gupta, P. K., & Mohan, Man. Operations Research. Sultan Chand and Sons, 1997.
2. Gupta, P. K., & Hira, D. S. Problems in Operations Research. S. Chand, 1991.
3. Ravindran, A., Philip, D. T., & Solberg, J. J. Operations Research. John Wiley and Sons, 1987.
4. Bazaraa, Mokhtar S., Jarvis, J. J., & Sherali, H. D. Linear Programming and Network Flows. Wiley India, 2011.

Course designed by: Dr Ullas Thomas



SBU24MA5DSE302: INTEGRAL TRANSFORMS

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the concept and definition of Fourier series, and its application to represent standard functions.	U
CO2	Analyze the properties of Fourier series, including convergence and periodicity, to solve mathematical problems.	An
CO3	Apply Fourier cosine and Fourier sine series to decompose functions into their corresponding trigonometric components.	A
CO4	Analyse Discrete Fourier Transforms and z transforms	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	1	2	2	-	2	2	1
CO2	2	2	-	2	2	-	2	2	2	2
CO3	2	2	2	1	2	2	2	1	2	2
CO4	2	2	1	2	2	2	2	1	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x	x	x	x	x	x
CO2	x	x		x	x	x
CO3	x	x	x		x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Fourier Series (16 Hrs)				
Definition of Fourier series	1.1	1	3	Lecture, Class room exercise
Fourier series for some standard functions	1.2	1	3	Lecture, Class room exercise
Properties of Fourier series	1.3	1	3	Lecture, Class room exercise
Fourier cosine and Fourier sine series	1.4	1	3	Lecture, Class room exercise
The sine integral and Gibbs' phenomenon	1.5	1	4	Lecture, Class room exercise
Module 2: Fourier Transform (16 Hrs)				
Introduction to Fourier transform	2.1	2	2	Lecture, Class room exercise
Some standard Fourier transforms	2.2	2	2	Lecture, Class room exercise
Properties of the Fourier transform	2.3	2	3	Lecture, Class room exercise



Rapidly decreasing functions	2.4	2	3	Lecture, Class room exercise
Convolution	2.5	2	2	Lecture, Class room exercise
The fundamental theorem	2.6	2	2	Lecture, Class room exercise
Consequences of the fundamental theorem	2.7	2	2	Lecture, Class room exercise
Module 3: Laplace Transform (14 Hrs)				
Definition and existence of the Laplace transform	3.1	3	2	Lecture, Class room exercise
Linearity, shifting and scaling	3.2	3	2	Lecture, Class room exercise
Differentiation and integration	3.3	3	3	Lecture, Class room exercise
Convolution	3.4	3	3	Lecture, Class room exercise
Initial and final value theorem	3.5	3	2	Lecture, Class room exercise
The inverse Laplace transform	3.6	3	2	Lecture, Class room exercise
Module 4: Discrete Transforms (14 Hrs)				
Introduction and definition of the discrete Fourier transform	4.1	4	1	Lecture, Class room exercise
Fundamental theorem of the discrete Fourier transform	4.2	4	2	Lecture, Class room exercise
Properties of the discrete Fourier transform	4.3	4	2	Lecture, Class room exercise
Definition and convergence of the z-transform	4.4	4	1	Lecture, Class room exercise
Properties of the z-transform	4.5	4	2	Lecture, Class room exercise
The inverse z-transform of rational functions	4.6	4	3	Lecture, Class room exercise
Convolution	4.7	4	3	Lecture, Class room exercise
Module 5:				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Textbook

1. Beerends, R. J. et al. Fourier and Laplace Transforms. Cambridge University Press, New York, 2003.

Reference

1. Andrews, Larry C., and Shivamoggi, Bhimsen K. Integral Transforms for Engineers. SPIE Press, Washington, 1999.
2. Nair, Sudhakar. Advanced Topics in Applied Mathematics. Cambridge University Press, New York, 2011.
3. Debnath, Lokenath, & Bhatta, Dambaru. Integral Transforms and Their Applications, 3rd ed., CRC Press Taylor & Francis Group, 2015.
4. Patra, Baidyanath. An Introduction to Integral Transforms. CRC Press, 2018.
5. Schiff, Joel L. The Laplace Transform: Theory and Applications. Springer, 1999.
6. Bhatia, Rajendra. Fourier Series. Texts and Readings in Mathematics, Hindustan Book Agency, Delhi, 2003.

Course designed by: Dr Shine C Mathew



SBU24MA5DSE303: GEOMETRY OF CURVES AND SURFACES

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the geometric properties and representations of various types of curves	U
CO2	Evaluate the derivative of a function from R^m to R^n and analyze regular surfaces and tangent planes	A
CO3	Analyze orientable surfaces and understand their properties	An
CO4	Analyze curvature of surfaces, geodesics and parallel transport	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1	2	1	1	2	1
CO2	1	2		2	1	3	1	1	2	1
CO3	3	1		2		2			2	1
CO4	2		2	1		1			2	3

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x		x
CO2	x			x		x
CO3	x	x		x	x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Curves (15 Hrs)				
Parametrized Curves	1.1	2	3	Lecture, Class room exercise
Acceleration	1.2	2	2	Lecture, Class room exercise
Reparameterization	1.3	2	2	Lecture, Class room exercise
Curvature	1.4	2	2	Lecture, Class room exercise
Plane Curves	1.5	2	2	Lecture, Class room exercise
Space Curves	1.6	3	2	Lecture, Class room exercise
Rigid Motions	1.7	2	2	Lecture, Class room exercise
Module 2: Surfaces (15 Hrs)				
Derivative of a function from R^m to R^n	2.1	2	3	Lecture, Class room exercise
Regular Surfaces	2.2	2	2	Lecture, Class room exercise



Tangent Planes	2.3	2	2	Lecture, Class room exercise
Area Distortion and Orientation	2.4	2	2	Lecture, Class room exercise
Orientable Surfaces	2.5	3	2	Lecture, Class room exercise
Surface Area	2.6	2	2	Lecture, Class room exercise
Isometries and First Fundamental Form	2.7	2	2	Lecture, Class room exercise
Module 3: Curvature of Surfaces (15 Hrs)				
Guass Map	3.1	1	3	Lecture, Class room exercise
Self adjoint linear transformation	3.2	2	3	Lecture, Class room exercise
Normal Curvature	3.3	3	3	Lecture, Class room exercise
Gaussian Curvature	3.4	3	3	Lecture, Class room exercise
Second Fundamental Form	3.5	2	3	Lecture, Class room exercise
Module 4: Geodesics (15 Hrs)				
Definition and Examples	4.1	1	1	Lecture, Class room exercise
Exponential Map	4.2	2	2	Lecture, Class room exercise
Gauss's Remarkable Theorem	4.3	3	2	Lecture, Class room exercise
Complete Surfaces	4.4	3	2	Lecture, Class room exercise
Parallel Transport	4.5	2	2	Lecture, Class room exercise
Covariant Derivative	4.6	2	3	Lecture, Class room exercise
Gauss-Bonnet Theorem	4.7	3	3	Lecture, Class room exercise
Module 5				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Textbook

1. Tapp, Kristopher. Differential Geometry of Curves and Surfaces. Springer International Publishing, Switzerland, 2016.

Reference

1. Abate, Marco, & Tovena, Francesca. Curves and Surfaces. Springer-Verlag, Italia, 2012.
2. Thorpe, John A. Elementary Topics in Differential Geometry, 1st ed., Springer, 1979.
3. Lang, Serge. Differential Manifolds, 2nd ed., Springer, 1985.
4. Siger, I. M., & Thorpe, J. A. Lecture Notes on Elementary Topology and Geometry. Springer Verlag, 1967.
5. Sternberg, S. Lectures on Differential Geometry. Prentice-Hall, 1964.
6. Do Carmo, Manfredo P. Differential Geometry of Curves And Surfaces, 1st ed., Pearson, 1976.
7. Goursat, Edouard. A Course In Mathematical Analysis, translated by Earle Raymond Hedrick, vol. 1, 1904.

Course designed by: Dr Shine C Mathew



SBU24MA5DSE304: NUMBER THEORY AND CRYPTOGRAPHY

Type of Course	DSE		
Course Level	300- 399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Express arithmetic operations in different bases	U
CO2	Explain the concepts of big O notation, divisors and divisibility, Euclidean algorithm, congruence, Fermat's theorem, Chinese remainder theorem	A
CO3	Demonstrate the properties of finite fields and quadratic residues	A
CO4	Familiarize classical cryptosystems and Explain public key cryptosystems	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	1	1	1	2	2	2	2	1	1	1
CO3	2	2	2		2	1	1	1	2	2
CO4	1	1	1	1	1	2	2	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x	x		x	x	x
CO2	x	x		x	x	x
CO3	x	x			x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Elementary Number Theory (18 Hrs)				
Number In Different Bases and Arithmetic Operations in Different Bases	1.1	1	1	Lecture, Class room exercise
Number Of Digits	1.2	1	1	Lecture, Class room exercise
Bit Operations	1.3	2	1	Lecture, Class room exercise
Time Estimate For Doing Arithmetic Operations	1.4	1	1	Lecture, Class room exercise
Big O Notations	1.5	2	2	Lecture, Class room exercise
Divisors And Divisibility	1.6	1	2	Lecture, Class room exercise
The Euclidean Algorithm	1.7	2	2	Lecture, Class room exercise



Congruences	1.8	1	2	Lecture, Class room exercise
Fermat's Little Theorem	1.9	1	2	Lecture, Class room exercise
Chinese Remainder Theorem	1.10	2	2	Lecture, Class room exercise
Some Applications Of Factoring	1.11	1	2	Lecture, Class room exercise
Module 2: Finite Field and Quadratic Residues (12 Hrs)				
Fields	2.1	1	1	Lecture, Class room exercise
Finite Fields	2.2	2	1	Lecture, Class room exercise
Multiplicative Generators of Finite Fields	2.3	2	1	Lecture, Class room exercise
Existence And Uniqueness of Finite Fields with Prime Power Number of Elements	2.4	2	1	Lecture, Class room exercise
Roots of Unity & Primitive Nth Root of Unity	2.5	2	1	Lecture, Class room exercise
Quadratic Residues	2.6	2	1	Lecture, Class room exercise
Legendre Symbol	2.7	2	2	Lecture, Class room exercise
Law Of Quadratic Reciprocity	2.8	2	2	Lecture, Class room exercise
Jacobi Symbol	2.9	2	2	Lecture, Class room exercise
Module 3: Classical Cryptography (15 Hrs)				
Some Simple Cryptosystems	3.1	3	2	Lecture, Class room exercise
Basic Notations	3.2	3	2	Lecture, Class room exercise
Encryption Decryption	3.3	3	2	Lecture, Class room exercise
Digraph Transformations	3.4	4	3	Lecture, Class room exercise
Enciphering Matrices	3.5	3	3	Lecture, Class room exercise
Linear Algebra Modulo n (Excluding Affine Enciphering Transformations)	3.6	4	3	Lecture, Class room exercise
Module 4: Public Key Cryptography (15 Hrs)				
The Idea of Public Key Cryptography	4.1	4	1	Lecture, Class room exercise
Difference Between Classical and Public Key Cryptography	4.2	4	1	Lecture, Class room exercise
Authentication	4.3	4	2	Lecture, Class room exercise
Hash Functions, Key Exchange, Probabilistic Encryption, RSA, Discrete Log	4.4	4	2	Lecture, Class room exercise
Diffie Hellman Key Exchange System & Diffie Hellman Assumption	4.5	4	2	Lecture, Class room exercise
Massey Omura Cryptosystem	4.6	4	2	Lecture, Class room exercise
El Gammel Cryptosystem	4.7	4	2	Lecture, Class room exercise
The Digital Signature Standard (Excluding Algorithms for Finding Discrete Log)	4.8	4	3	Lecture, Class room exercise
Module 5:				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Textbook

1. Koblitz, Neal. A Course in Number Theory and Cryptography, 2nd ed., Springer, 1994.

Reference

1. Burton, David. Elementary Number Theory and its Applications. McGraw-Hill Education (India) Pvt. Ltd, 2006.



2. Ireland, K., & Rosen, M. A Classical Introduction to Modern Number Theory, 2nd ed., Springer, 1990.
3. Kraft, James S., & Washington, Lawrence C. An Introduction to Number Theory with Cryptography, 2nd ed., CRC Press, 2018.
4. Menezes, Alfred J., van Oorschot, Paul C., & Vanstone, Scott A. Handbook of Applied Cryptography. CRC Press, 1996.
5. Niven, Ivan, Zuckerman, H. S., & Montgomery, H. L. An Introduction to the Theory of Numbers, 5th ed., John Wiley, 1991.
6. Stinson, Douglas R. Cryptography Theory and Practice, 2nd ed., Chapman & Hall, 2002.

Course designed by: Ms Jinu Mary Jameson



SBU24MA5SEC300: PYTHON PROGRAMMING FOR MATHEMATICS

Type of Course	SEC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45		45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the basics of Python programming	U
CO2	Analyse datatypes, loops and functions	An
CO3	A detailed study of built in functions	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	3	1	1	1		2	2
CO2	2	2	3	1	3	1		2	3	
CO3	2		2		1	2	2	1	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	I	II	Written Test I	Written Test II	
CO1	x		x	x	x
CO2		x	x	x	x
CO3		x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Python Programming and Debugging (15 Hrs)				
Introduction: The Python Programming Language, History, features, Installing Python, Running Python program	1.1	1	4	Lecture and Exercise
Debugging: Syntax Errors, Runtime Errors, Semantic Errors, Experimental Debugging, Formal and Natural Languages	1.2	1	4	Lecture and Exercise
The Difference Between Brackets, Braces, and Parentheses, Variables and Expressions Values and Types, Variables, Variable Names and Keywords, Type conversion, Operators and Operands, Expressions, Interactive Mode and Script Mode, Order of Operations	1.3	1	4	Lecture and Exercise



Conditional Statements: if, if-else, nested if –else Looping: for, while, nested loops Control statements: Terminating loops, skipping specific conditions	1.3	1	3	Lecture and Exercise
Module 2: Functions and strings (15 Hrs)				
Functions: Function Calls, Type Conversion Functions, Math Functions, Composition, Adding New Functions, Definitions and Uses, Flow of Execution	2.1	2	5	Lecture and Exercise
Parameters and Arguments, Variables and Parameters Are Local, Stack Diagrams, Fruitful Functions and Void Functions, Why Functions? Importing with from, Return Values, Incremental Development, Composition, Boolean Functions, More Recursion, Leap of Faith	2.2	2	5	Lecture and Exercise
Checking Types Strings: A String Is a Sequence, Traversal with a for Loop, String Slices, Strings Are Immutable, Searching, Looping and Counting, String Methods, The in Operator, String Comparison, String Operations.	2.3	2	5	Lecture and Exercise
Module 3: List and Dictionary (15 Hrs)				
Lists: Values and Accessing Elements, Lists are mutable, traversing a List, Deleting elements from List, Built-in List Operators, Concatenation, Repetition, In Operator	3.1	3	5	Lecture and Exercise
Built-in List functions and methods Tuples and Dictionaries: Tuples, Accessing values in Tuples, Tuple Assignment, Tuples as return values, Updating Dictionary, Deleting Elements from Dictionary, Properties of Dictionary keys, Operations in Dictionary	3.2	3	5	Lecture and Exercise
Built-In Dictionary Functions, Built-in Dictionary Methods Files: Text Files, The File Object Attributes, Directories Exceptions: Built-in Exceptions, Handling Exceptions, Exception with Arguments, User-defined Exceptions	3.3	3	5	Lecture and Exercise
Module 4				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbook

1. Horstmann, Cay S., & Ncaise, Rance D. Python for Everyone. Wiley, 2021.

Reference

1. DeBarry, Paul A. Head First Python. O'Reilly Media, Inc., 2010.
2. Barry, Paul. Head First Python: A Friendly Guide. O'Reilly Media, 2016.
3. Beazley, David M. Python Essential Reference. Pearson Addison-Wesley, 2009.
4. Matthes, Eric. Python Crash Course. No Starch Press, 2019.
5. Zelle, John. Python Programming: An Introduction to Computer Science. Franklin, Beedle & Associates, 2016.

Course designed by: Ms Treesa Maria Kuriakose



SEMESTER VI

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MA6DSC300	Major/Minor	Multivariable Calculus	5	75	4
SBU24MA6DSC301	Major/Minor	Basic Complex Analysis	5	75	4
SBU24MA6DSC302	Major/Minor	Ordinary Differential Equations for Environmental Science	5	75	4
SBU24MA6DSE300	Elective	Mathematics for Machine Learning	4	60	4
SBU24MA6DSE301	Elective	Dynamical Systems	4	60	4
SBU24MA6SEC300	SEC	Computational techniques using SageMath	3	45	3
SBU24MA6VAC300	VAC	Artificial Intelligence and Human Rights	3	45	3



SBU24MA6DSC300: MULTIVARIABLE CALCULUS

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain Differential calculus for Scalar functions	U
CO2	Explain Differential Calculus for Vector valued functions	A
CO3	Analyze and evaluate the concept of multiple integral	An
CO4	A detailed study of Green's, Stokes and Divergence Theorems	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	1	1	1	2	2	2	2	1	1	1
CO3	1	1	1	1	1	2	2	2	1	1
CO4	2		1	2	2	1	1	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x		x
CO2	x			x		x
CO3		x	x		x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Differential calculus for Scalar functions (20 Hrs)				
Scalar and vector fields	1.1	1	2	Lecture, Class room exercise
Open balls and Open balls	1.2	1	1	Lecture, Class room exercise
Limit and Continuity	1.3	1	2	Lecture, Class room exercise
Derivative of Scalar field	1.4	1	1	Lecture, Class room exercise
Directional Derivative and partial derivatives	1.5	2	2	Lecture, Class room exercise
Partial Derivative of higher order	1.6	2	1	Lecture, Class room exercise
Directional derivative and continuity	1.7	2	2	Lecture, Class room exercise
The total derivative	1.8	2	1	Lecture, Class room exercise
A Sufficient Condition for Differentiability	1.9	2	2	Lecture, Class room exercise
Problems (Practicum)		1,2	6	
Module 2: Differential Calculus for Vector valued functions (18 Hrs)				
Derivatives of vector fields	2.1	2	1	Lecture, Class room exercise



Differentiability implies continuity	2.2	2	1	Lecture, Class room exercise
The Chain Rule	2.3	2	1	Lecture, Class room exercise
Maxima, Minima and saddle points	2.4	2	1	Lecture, Class room exercise
Second Order Taylor formula	2.5	2	2	Lecture, Class room exercise
Nature Stationary points and Eigen values of Hessian matrix	2.6	2	2	Lecture, Class room exercise
Second derivative test for extrema of functions of two variables	2.7	2	2	Lecture, Class room exercise
Problems (Practicum)		2	8	
Module 3: Multiple integral (18 Hrs)				
Partitions of rectangles, step function	3.1	3	1	Lecture, Class room exercise
The Double integral of step functions	3.2	3	1	Lecture, Class room exercise
Double integral of bounded function on rectangles	3.3	3	1	Lecture, Class room exercise
Upper and lower double integrals	3.4	3	1	Lecture, Class room exercise
Evaluation of Double integral by repeated one dimensional integration	3.5	3	1	Lecture, Class room exercise
Geometric interpretation, Volume	3.6	3	1	Lecture, Class room exercise
Integrability of bounded function with discontinuity	3.7	3	1	Lecture, Class room exercise
Double integrals extended over more general region	3.8	3	1	Lecture, Class room exercise
Applications to area and volume	3.9	3	2	Lecture, Class room exercise
Problems (Practicum)		3	8	
Module 4: Green's, Stokes', Divergence Theorems (19 Hrs)				
Greens theorems in the plane and some applications	4.1	4	1	Lecture
A necessary and sufficient condition for a two-dimensional vector field to be a gradient	4.2	4	1	Lecture, Class room exercise
Change of variable in double integral	4.3	4	1	Lecture, Class room exercise
Parametric representation of surfaces	4.4	4	1	Lecture, Class room exercise
The fundamental vector product	4.5	4	1	Lecture, Class room exercise
The fundamental vector product as normal to the surface	4.6	4	1	Lecture, Class room exercise
Area of Parametric surfaces	4.7	4	1	Lecture, Class room exercise
Surface integrals	4.8	4	1	Lecture, Class room exercise and Assignment
Theorem of Stokes'	4.9	4	1	Lecture, Class room exercise
The Curl and divergence of a vector field	4.10	4	1	Lecture, Class room exercise
Further properties of curl and divergence and the divergence theorem	4.11	4	1	Lecture, Class room exercise
Problems (Practicum)		4	8	
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				



Practicum

Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills.

The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.

Textbook

1. Apostol, Tom M. Calculus II, 2nd ed., Wiley.

Reference

1. Apostol, Tom M. Mathematical Analysis. Addison-Wesley, 1974.
2. Ghorpade, Sudhir R., & Limaye, Balmohan V. A Course in Multivariable Calculus and Analysis. Springer, 2009.
3. Kantorovitz, Shumuel. Several Real Variables. Springer, 2016.
4. Canuto, Claudio, & Tabacco, Anita. Mathematical Analysis II. Springer, 2013.
5. Rudin, W. Principles of Mathematical Analysis, 2nd ed., McGraw-Hill, 1964.

Course designed by: Mr Tibin Thomas



SBU24MA6DSC301: BASIC COMPLEX ANALYSIS

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the topology of Complex Plane	An
CO2	A detailed study of Power series, Cauchy Reimann equations, Entire functions and differentiability of functions	A
CO3	Familiarize the exponential function	U
CO4	Apply contour integration techniques	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	1	1	1	2	2	2	2	1	1	1
CO3	2	2	2		2	1	1	1	2	2
CO4	1	1	1	1	1	2	2	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x		x
CO2	x			x		x
CO3	x	x		x	x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Topology of Complex Plane (17 Hrs)				
Construction of Complex Numbers	1.1	1	2	Lecture, Class room exercise
The $x+iy$ notation, geometric interpretation, Real and imaginary parts, Modulus, complex conjugates, Polar coordinates	1.2	1	3	Lecture
The complex numbers cannot be ordered	1.3	1	1	Lecture
Topology of Complex Plane, Open and closed sets	1.3	1	2	Lecture, Class room exercise
Limits and Continuity of Complex Functions	1.4	1	1	Lecture, Class room exercise
Paths and connectedness	1.5	1	2	Lecture, Class room exercise
Problems (Practicum)		1	6	
Module 2: Power series (18 Hrs)				



Sequence and series	2.1	2	1	Lecture, Class room exercise
Power series, manipulating power series	2.2	2	2	Lecture, Class room exercise
Product of series	2.3	2	1	Lecture, Class room exercise
Differentiation	2.4	3	1	Lecture, Class room exercise
C- R equation	2.5	2	1	Lecture, Class room exercise
Connected set and differentiability	2.6	2	2	Lecture, Class room exercise
Hybrid functions	2.7	2	2	Lecture, Class room exercise
Problems (Practicum)		2	8	

Module 3: Exponential Function (18 Hrs)

Exponential function	3.1	3	1	Lecture, Class room exercise
Real Exponentials and Logarithms	3.2	3	1	Lecture, Class room exercise
Trigonometric Functions	3.3	3	1	Lecture, Class room exercise
An analytic function	3.4	3	1	Lecture, Class room exercise
The behaviour of real trigonometric functions	3.5	3	1	Lecture, Class room exercise
Dynamic Explanation of Euler's formula	3.6	3	1	Lecture, Class room exercise
Complex exponential and trigonometric functions are periodic	3.7	3	2	Lecture, Class room exercise
Other trigonometric functions	3.8	3	1	Lecture, Class room exercise
Hyperbolic functions	3.9	3	1	Lecture, Class room exercise
Problems (Practicum)		3	8	

Module 4: Integration (22 Hrs)

Real and complex integrations	4.1	4	1	Lecture, Class room exercise
Complex integration along a smooth path	4.2	4	1	Lecture, Class room exercise
The length of a path	4.3	4	1	Lecture, Class room exercise
Further properties of lengths	4.4	4	2	Lecture, Class room exercise
Regular paths and curves	4.5	4	1	Lecture, Class room exercise
Regular and singular points	4.6	4	1	Lecture, Class room exercise
Contour integration	4.7	4	1	Lecture, Class room exercise
Fundamental theorem of contour integration	4.8	4	1	Lecture, Class room exercise
Integral depend on paths, consequences of fundamental theorem	4.9	4	1	Lecture, Class room exercise
Radian measure of angles and argument of complex number	4.10	4	1	Lecture, Class room exercise
Complex logarithm	4.11	4	1	Lecture, Class room exercise
Winding number	4.12	4	2	Lecture, Class room exercise
Problems (Practicum)		4	8	

Module 5

Teacher Specific Content

(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)

This content will be evaluated internally

Practicum

Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.

Textbook



1. Stewart, Ian, & Tall, David. Complex Analysis, 2nd ed., Cambridge University Press, 2018.

Reference

1. Ahlfors, Lars V. Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable, 3rd ed., McGraw-Hill Education, 1979.
2. Conway, John B. Functions of One Complex Variable. Springer-Verlag, New York, 1973.
3. Palka, Bruce P. An Introduction to Complex Function Theory. Springer-Verlag, New York, 1991.
4. Bak, Joseph, & Newman, Donald J. Complex Analysis, 3rd ed., Springer, 2010.
5. Brown, James, & Churchill, Reel. Complex Variables and Applications, 9th ed., McGraw-Hill Education, 2013.

Course designed by: Mr Tibin Thomas



SBU24MA6DSC302: ORDINARY DIFFERENTIAL EQUATIONS FOR ENVIRONMENTAL SCIENCE

Type of Course	Major/Minor		
Course Level	300- 399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain first order differential equation, solve them using various methods and examples in environmental science	A
CO2	Explain Second order differential equation and solve them using various methods	A
CO3	Analyse and study Picard's method and Power Series Solutions	An
CO4	Solve system of first order equations	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2		1	1	1	1
CO2	1	1	1	2		2	2	1		1
CO3	2	2	2		2	1	1		2	2
CO4		1	1	1	1	2	2	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x		x
CO2	x			x		x
CO3		x		x	x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1 First Order Differential Equations (20 Hrs)				
Introduction to Differential equations and its solutions	1.1	1	1	Lecture, Class room exercise
Orthogonal trajectories	1.2	1	1	Lecture, Class room exercise
Separable Differential equations	1.3	1	1	Lecture, Class room exercise
Linear equation and Bernoulli Differential equations	1.4	1	1	Lecture, Class room exercise
Homogeneous Differential Equations	1.5	1	1	Lecture, Class room exercise
Exact Differential Equations	1.6	1	1	Lecture, Class room exercise
Integrating factors	1.7	1	1	Lecture, Class room exercise



Reduction of order	1.8	1	1	Lecture, Class room exercise
Example applications: Models of Biological Systems	1.9	1	2	Lecture, Class room exercise
Population Growth Model	1.10	1	1	Lecture, Class room exercise
An atomic Waste disposal problem	1.11	1	1	Lecture, Class room exercise
Problems (Practicum)		1	8	
Module 2 Second Order Linear ODE (18 Hrs)				
Introduction to second order linear Ordinary differential equations	2.1	2	1	Lecture, Class room exercise and assignment
General solutions of homogeneous second order linear ordinary differential equations	2.2	2	2	Lecture, Class room exercise and assignment
Use of a known solution to find another	2.3	2	2	Lecture, Class room exercise
Homogeneous second order Ordinary Differential Equation with constant coefficients	2.4	2	2	Lecture, Class room exercise and assignment
Method undetermined coefficients	2.5	2	2	Lecture, Class room exercise and assignment
Method of variation of parameters	2.6	2	1	Lecture, Class room exercise and assignment
Operator methods for finding particular solution	2.7	2	1	Lecture, Class room exercise
Example application: ground water hydraulics, groundwater flow and solute transport modelling	2.8	2	1	Lecture, Class room exercise
Problems (Practicum)		2	6	
Module 3 Picard's method and Power Series Solutions (18 Hrs)				
Method of successive approximation, Picard's Theorem	3.1	3	2	Lecture, Class room exercise and Assignment
Series solutions of first order equations	3.2	3	2	Lecture, Class room exercise and Assignment
Ordinary points and singular points	3.3	3	1	Lecture, Class room exercise
Series solutions of second order Ordinary differential equations with respect to ordinary points	3.4	3	2	Lecture, Class room exercise
Frobenius method of second order Ordinary differential equations with respect to regular singular points.	3.5	3	3	Lecture, Class room exercise
Problems (Practicum)		3	8	
Module 4 Systems of differential equations (19 Hrs)				
Systems of First order differential equations, Homogenous Linear systems with constant coefficients	4.1	4	5	Lecture, Class room exercise and Assignment
Volterra's Prey Predator Equations.	4.2	4	6	Lecture, Class room exercise
Problems (Practicum)		4	8	
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				



Practicum

Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills.

The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.

Textbooks

1. Simmons, George F. Differential Equations with Applications and Historical Notes, 2nd ed., McGraw-Hill Education, 2003.
2. Nandakumaran, A. K., Datti, P. S., & George, Raju K. Ordinary Differential Equations: Principles and Applications. Cambridge University Press, 2017.
3. Hritonenko, Natali, & Yatsenko, Yuri. Mathematical Modelling in Economics, Ecology and Environmental Science, 2nd ed., Springer, 2013.

Reference

1. Zeidan, Bakenaz. Mathematical Modeling of Environmental Problems, 2015.
2. Bronson, Richard. Differential Equations, 3rd ed., Schaum's Outline Series, 2009.
3. Coddington, E. A. An Introduction to Ordinary Differential Equations. Dover, 1961.
4. Parkhurst, David F. Introduction to Applied Mathematics for Environmental Science. Springer, 2006.
5. Ross, Shepley L. Differential Equations, 3rd ed., Wiley India, 2007.
6. Sidiqi, A. H., & Manchanda, P. Differential Equations with Applications. Macmillan Publishers India Limited, 2006.
7. Zill, Dennis G. A First Course in Differential Equations with Modeling Applications, 10th ed., Brooks/Cole, Cengage Learning, 2013.

Course designed by: Ms Jinu Mary Jameson



SBU24MA6DSE300: MATHEMATICS FOR MACHINE LEARNING

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the mathematical concepts behind machine learning	U
CO2	Apply fundamentals of matrices and vector spaces to machine learning	A
CO3	Understand the fundamental concepts of supervised and unsupervised learning.	U
CO4	Analyse complex data using algorithms	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	1	1	1	2	2	2	2	1	1	1
CO3	2	2	2		2	1	1	1	2	2
CO4	1	1	1	1	1	2	2	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x		x
CO2	x			x		x
CO3	x	x		x	x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Machine Learning (16 Hrs)				
What is Machine Learning- Data	1.1	1	1	Lecture, Class room exercise
Models and ML Task - Paradigms of Machine Learning	1.2	1	1	Lecture, Class room exercise
Supervised Learning: Regression	1.3	1	1	Lecture, Class room exercise
Supervised Learning: Classification	1.4	1	1	Lecture, Class room exercise
Unsupervised Learning: Dimensionality	1.5	1	1	Lecture, Class room exercise
Reduction- Unsupervised Learning: Density Estimation-	1.6	1	1	Lecture, Class room exercise
Loss functions Classification	1.7	1	2	Lecture, Class room exercise



Loss functions	1.8	1	2	Lecture, Class room exercise
Generative and Discriminative Models	1.9	1	2	Lecture, Class room exercise
Overfitting and underfitting	1.10	1	2	Lecture, Class room exercise
Bagging- Boosting	1.11	1	2	Lecture, Class room exercise
Module 4: Mathematics for Machine Learning (14 Hrs)				
Four Fundamental Subspaces	2.1	2	1	Lecture, Class room exercise
Orthogonal Vectors and Subspaces	2.2	2	1	Lecture, Class room exercise
Projections	2.3	2	1	Lecture, Class room exercise
Least Squares and Projections onto a Subspace	2.4	2	2	Lecture, Class room exercise
Eigenvalues and Eigenvectors	2.5	2	1	Lecture, Class room exercise
Diagonalization of a matrix	2.6	2	1	Lecture, Class room exercise
Complex Matrices- Hermitian Matrices Unitary Matrices	2.7	2	1	Lecture, Class room exercise
Diagonalization of Hermitian Matrices-	2.8	2	2	Lecture, Class room exercise
Singular Value Decomposition- Example of SVD, Real world Application of SVD Positive Definite Functions and Matrices	2.9	2	2	Lecture, Class room exercise
-Introduction to Convexity- Properties of Convex Sets- Convex Functions- Properties of Convex Functions.	2.10	2	2	Lecture, Class room exercise
Module 3: Unsupervised Learning (18 Hrs)				
Representation Learning	3.1	3	1	Lecture, Class room exercise
Principal component analysis	3.2	3	1	Lecture, Class room exercise
PCA as maximizing variance	3.3	3	1	Lecture, Class room exercise
Issues with PCA- Time-complexity issue with PCA, complexity issue with PCA	3.4	3	1	Lecture, Class room exercise
Feature Transformation	3.5	3	1	Lecture, Class room exercise
Kernel Functions- Kernel PCA	3.6	3	1	Lecture, Class room exercise
Introduction to Clustering- K-means Clustering (Lloyd's algorithm)	3.7	3	2	Lecture, Class room exercise
Convergence of K-means algorithm- Nature of clusters produced by K-means-	3.8	3	2	Lecture, Class room exercise
Initialization of centroids, K-means++	3.9	3	2	Lecture, Class room exercise
Choice of K- Maximum Likelihood Estimation- Bayesian estimation	3.10	3	2	Lecture, Class room exercise
Gaussian Mixture Models- Likelihood of GMM-	3.11	3	2	Lecture, Class room exercise
Convex functions and Jensen's inequality- Estimating the parameters- EM algorithm	3.12	3	2	Lecture, Class room exercise
Module 4: Supervised Learning (12 Hrs)				
Linear Regression- Optimizing the error function- Geometric interpretation of linear regression	4.1	4	2	Lecture, Class room exercise
Gradient descent- Kernel regression- Probabilistic view of linear regression- Goodness of Maximum Likelihood Estimator for linear regression-	4.2	4	2	Lecture, Class room exercise



Cross-validation for minimizing MSE- Bayesian Modelling for linear regression- Bayesian Modelling for linear regression	4.3	4	2	Lecture, Class room exercise
Relation between solution of linear regression and ridge regression- Relation between solution of linear regression and Lasso regression Characteristics of Lasso regression	4.4	4	2	Lecture, Class room exercise
Introduction to Binary Classification- K Nearest Neighbours	4.5	4	2	Lecture, Class room exercise
Introduction to Decision Trees- Decision Tree Algorithm- Perceptron Learning Algorithm-Logistic Regression- Support Vector Machine- Neural Networks	4.6	4	2	Lecture, Class room exercise
Module 5				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Textbooks

1. Duda, Richard O., and Peter E. Hart. Pattern Classification. John Wiley & Sons, 2006.
2. Bishop, Christopher M. Pattern Recognition and Machine Learning. Springer Science+ Business Media, LLC, 2006.
3. Hastie, Trevor, et al. The Elements of Statistical Learning: Data Mining, Inference, and Prediction, vol. 2, Springer, 2009.

Reference

1. Murphy, Kevin P. Machine Learning: A Probabilistic Perspective. MIT Press, 2012.
2. Alpaydin, Ethem. Introduction to Machine Learning. MIT Press, 2020.
3. Géron, Aurélien. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow. O'Reilly Media, Inc., 2022.
4. Ng, Andrew. "Machine Learning Yearning." Deeplearning.ai, 2018, URL: <https://www.deeplearning.ai>, <https://github.com/ajaymache/machine-learning-yearning>.

Course Designed by: Fr John J Chavara



SBU24MA6DSE301: DYNAMICAL SYSTEMS

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the linear dynamical system	U
CO2	Characterize the stability theory	U
CO3	Understand Nonlinear system	U
CO4	Evaluate the behaviour of solution set	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	2	2	2		2	1	1	1	2	2
CO3	1	1	1	1	1	2	2	2	1	1
CO4	2		1	2	2	1	1	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x		x
CO2	x	x		x	x	x
CO3		x	x		x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to linear systems (15 Hrs)				
Uncoupled linear systems	1.1	1	3	Lecture, Class room exercise
Diagonalization	1.2	1	3	Lecture, Class room exercise
Exponentials of operators	1.3	1	3	Lecture, Class room exercise
The fundamental theorem for linear systems	1.4	1	3	Lecture, Class room exercise
Linear system in R ²	1.5	1	3	Lecture, Class room exercise
Module 2: Stability theory (12 Hrs)				
Complex Eigenvalues	2.1	2	2	Lecture, Class room exercise
Multiple Eigenvalues	2.2	2	2	Lecture, Class room exercise



Jordan Forms	2.3	2	3	Lecture, Class room exercise
Stability Theory	2.4	2	3	Lecture, Class room exercise
Nonhomogeneous linear systems	2.5	2	2	Lecture, Class room exercise
Module 3: Nonlinear Systems (20 Hrs)				
Local Theory	3.1	3	2	Lecture, Class room exercise
Some preliminary concepts and definitions	3.2	3	3	Lecture, Class room exercise
The fundamental Existence - Uniqueness Theorem	3.3	3	3	Lecture, Class room exercise
Dependence on initial conditions and parameters	3.4	3	3	Lecture, Class room exercise
Maximal interval of existence	3.5	3	3	Lecture, Class room exercise
The flow defined by differential equation	3.6	3	3	Lecture, Class room exercise
Linearization	3.7	3	3	Lecture, Class room exercise
Module 4: Qualitative behaviour of solution set (13 Hrs)				
Stable Manifold theorem	4.1	4	1	Lecture, Class room exercise
The Hartman-Grobman theorem	4.2	4	2	Lecture, Class room exercise
Stability and Liapunov Theorem	4.3	4	2	Lecture, Class room exercise
Saddles, Nodes, Foci and centers	4.4	4	2	Lecture, Class room exercise
Nonhyperbolic Critical points in R^2	4.5	4	2	Lecture, Class room exercise
Center Manifold theory	4.6	4	2	Lecture, Class room exercise
Gradient and Hamiltonian systems	4.7	4	2	Lecture, Class room exercise
Module 5				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Textbook

1. Perko, Lawrence. Differential Equations and Dynamical Systems, 3rd ed., Springer, 2013.

Reference

1. Arnold, V. I. Geometric Methods in Ordinary Differential Equations, 2nd ed., Springer, 2012.



2. Arrowsmith, D. K., & Place, C. M. An Introduction to Dynamical Systems, Cambridge University Press, 1990.
3. Chicone, Carmen. Ordinary Differential Equations and Applications, Springer, 2006.
4. Guckenheimer, J., & Holmes, P. Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields, Springer, 2002.
5. Kotok, A., & Hasselblatt, B. Introduction to the Modern Theory of Dynamical Systems, Cambridge University Press, 1995.

Course designed by: Mr Tibin Thomas



SBU24MA6SEC300: COMPUTATIONAL TECHNIQUES USING SAGEMATH

Type of Course	SEC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45		45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Apply basic programming techniques in SageMath to compute the value of expressions involving mathematical functions.	A
CO2	Apply SageMath to do various operations in Matrices	A
CO3	Apply SageMath to plot various mathematical functions, expressions and solving differential equations.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	3	1	1	1		2	2
CO2	2	2	3	1	3	1		2	3	
CO3	2		2		1	2	2	1	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	I	II	Written Test I	Written Test II	
CO1	x		x	x	x
CO2		x		x	x
CO3		x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hour	Transaction Mechanism
Module 1: Basics of SageMath (15 Hrs)				
Sage as a Calculator – First Computations Elementary Functions and Usual Constants.	1.1	1	3	Lecture, Exercise
Python Variables Symbolic Variables (Using Variables and Expressions) First Graphics (Graphics – Plotting Functions)	1.2	1	3	Lecture, Exercise
Symbolic Expressions and Simplification – Symbolic Expressions, Transforming Expressions, Usual Mathematical Functions, Assumptions, Some Pitfalls.	1.3	1	3	Lecture, Exercise
Equations – Explicit Solving, Equations with no Explicit Solution	1.4	1	3	Lecture, Exercise
Analysis – Sums, Limits, Sequences, Power	1.5	1	3	Lecture, Exercise



Series Expansions, Series, Derivatives, Partial Derivatives, Integrals				
Module 2: Linear Algebra using SageMath (15 Hrs)				
Basic Linear Algebra - Matrix Computations, Reduction of a Square Matrix	2.1	2	5	Lecture, Exercise
Elementary Constructs and Manipulations – Vector and Matrix Constructions	2.2	2	5	Lecture, Exercise
Basic Manipulations and Arithmetic on Matrices, Basic Operations on Matrices	2.3	2	5	Lecture, Exercise
Module 3: Functions using SageMath (15 Hrs)				
2 D Graphics - Graphical Representation of Functions	3.1	3	4	Lecture, Exercise
Parametric Curves, Curve in Polar Coordinates, Curve defined by Implicit Equation	3.2	3	4	Lecture, Exercise
Data Plot, Displaying Solutions of Differential Equations, Evolute of a Curve	3.3	3	4	Lecture, Exercise
3 D Curves	3.4	3	3	Lecture, Exercise
Module 4				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbook

1. Zimmermann, Paul, et al. Computational Mathematics with SageMath. SIAM, 2018.

Reference

1. Mezei, Razvan A. Introduction to Programming Using SageMath. Wiley, 2020.
2. The Sage Development Team. 2023.
https://doc.sagemath.org/pdf/en/tutorial/sage_tutorial.pdf.
3. Bard, Gregory V., and William Stein. Sage for Undergraduates. American Mathematical Society, 2015.
4. Beezer, Robert. A First Course in Linear Algebra. Congruent Press, 2015.
<http://linear.ups.edu/>
5. Judson, Tom, and Robert Beezer. Abstract Algebra Theory and Applications. Open-source textbook supported by National Science Foundation, 2022. <http://abstract.ups.edu/>
6. Mezei, Razvan A. An Introduction to Sage Programming: With Applications to Sage Interacts for Numerical Methods. Springer, 2015.



SBU24MA6VAC300: ARTIFICIAL INTELLIGENCE AND HUMAN RIGHTS

Type of Course	VAC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45		45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Practical implementation and analysis of search algorithms	A
CO2	Analyzing game strategies and heuristics employed in game search algorithms	An
CO3	Demonstrate a comprehensive understanding of national and international perspectives on human rights and the core issues contributing to the deprivation of human rights	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	1	2	2	1	1	1	1
CO2	1		1	1	1	3	2		1	2
CO3	1	1	2	1		2	2	1	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	I	II	Written Test I	Written Test II	
CO1	x	x	x	x	x
CO2		x	x	x	x
CO3		x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Uninformed Search and Informed Search (15 Hrs)				
Overview of Artificial Intelligence	1.1	1	1	Lecture, Class room exercise
State-Space Graphs	1.2	1	1	Lecture, Class room exercise
The False Coin Problem	1.3	1	1	Lecture, Class room exercise
Generate-and-Test Paradigm	1.4	1	1	Lecture, Class room exercise
Backtracking	1.5	1	1	Lecture, Class room exercise
The Greedy Algorithm	1.6	1	1	Lecture, Class room exercise
The Traveling Salesperson Problem	1.7	1	1	Lecture, Class room exercise
Blind Search Algorithms	1.8	1	1	Lecture, Class room exercise
Depth First Search	1.9	1	1	Lecture, Class room exercise
Breadth First Search	1.10	1	1	Lecture, Class room exercise



Implementing and Comparing Blind Search Algorithms	1.11	1	1	Lecture, Class room exercise
Steepest-Ascent Hill Climbing	1.12	1	1	Lecture, Class room exercise
The Best-First Search	1.13	1	1	Lecture, Class room exercise
The Beam Search	1.14	1	1	Lecture, Class room exercise
Additional Metrics for Search Algorithms	1.14	1	2	Lecture, Class room exercise
Module 2: Search Using Games (15 Hrs)				
Branch and Bound	2.1	2	1	Lecture, Class room exercise
Branch and Bound with Underestimates	2.2	2	1	Lecture, Class room exercise
AND/OR Trees	2.3	2	1	Lecture, Class room exercise
The Bidirectional Search	2.4	2	1	Lecture, Class room exercise
Heuristic Evaluation	2.5	2	1	Lecture, Class room exercise
Minimax Evaluation of Game Trees	2.6	2	1	Lecture, Class room exercise
Minimax with Alpha-Beta Pruning	2.7	2	1	Lecture, Class room exercise
Negamax Algorithm	2.8	2	1	Lecture, Class room exercise
Progressive Deepening	2.9	2	1	Lecture, Class room exercise
Heuristic Continuation and the Horizon Effect	2.10	2	2	Lecture, Class room exercise
Games of Chance and the Expectiminimax Algorithm	2.11	2	2	Lecture, Class room exercise
The Iterated Prisoner's Dilemma	2.12	2	2	Lecture, Class room exercise
Module 3: Human Rights (15 Hrs)				
National and International Perspectives: Definitions of Human Right	3.1	3	1	Lecture
Relevance of Human Rights in India-Social Aspects-Economic Aspects-Political Aspects	3.2	3	1	Lecture
Human Rights International Norms	3.3	3	1	Lecture
Human Rights International Norms	3.4	3	1	Lecture
Rights against torture, Discrimination and forced labour	3.5	3	1	Lecture
Rights of the child, Human Rights and duties in India	3.6	3	1	Lecture
Preamble to the Indian Constitution-Human Rights and Duties in Indian constitution	3.7	3	2	Lecture
Deprivation of Human Rights-The core issues: Poverty-Overpopulation-Illiteracy-Unsustainable Development, Disadvantageous Groups	3.8	3	1	Lecture
Redressal Mechanisms against Human Rights Violation	3.9	3	1	Lecture
Judiciary -Government systems for Redressal - NHRC and other Statutory Commissions	3.10	3	2	Lecture
Media advocacy-Creation of Human Rights Literacy and Awareness	3.11	3	1	Lecture
How freedom of expression, right to privacy and the right to equality are impacted using AI.	3.12	3	2	Lecture

**Module 4****Teacher Specific Content**

(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)

This content will be evaluated internally

Textbooks

1. Lucci, Stephen et al. Artificial Intelligence in the 21st Century. 3rd ed., Mercury Learning and Information, New Delhi, 2022.
2. Jain, Rashee. Textbook on Human Rights Law and Practice. 3rd ed., Universal Law Publishing - An imprint of LexisNexis, 2016.

Reference

1. Cruft, Rowan, S. Matthew Liao, and Massimo Renzo. Philosophical Foundations of Human Rights. Oxford University Press, 2015.
2. Aryehneier. The International Human Rights Movement: A History. Princeton University Press, 2012.
3. Poole, David L., and Alan K. Mackworth. Artificial Intelligence: Foundations of Computational Agents. Cambridge University Press, 2010.
4. Wellman, Carl. The Moral Dimensions of Human Rights. Oxford University Press, 2011.
5. Stacy, Helen M. Human Rights for the 21st Century: Sovereignty, Civil Society, Culture. Stanford University Press, 2009.
6. Clapham, Andrew. Human Rights: A Very Short Introduction. Oxford University Press.

Course designed by: Ms Jinu Mary Jameson



SEMESTER VII

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MA7DSC400	Major/Minor	Numerical Analysis	5	75	4
SBU24MA7DSC401	Major/Minor	Basic Topology	4	60	4
SBU24MA7DSC402	Major/Minor	Galois Theory	4	60	4
SBU24MA7DSC403	Major/Minor	Measure Theory and Integration	4	60	4
SBU24MA7DSC404	Major/Minor	Partial Differential Equations	4	60	4
SBU24MA7DSC405	Major/Minor	Research Methodology	4	60	4



SBU24MA7DSC400: NUMERICAL ANALYSIS

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Illustrate various methods of numerical analysis	A
CO2	Understand the concept of interpolation and also learn to apply some well-known interpolation techniques	A
CO3	Apply techniques for numerical differentiation and integration and also realize their merits and demerits	A
CO4	Evaluate numerical approximations to solutions of initial value problems and also to understand the efficiency of various methods.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	1	2	2	-	2	1	1	2
CO2	2	1	1	2		2	2	1	2	1
CO3	1	2	2	2	1	1	1	2	1	1
CO4	1	2	2	1	2	1	2	1		2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x			x	x	x
CO2	x	x			x	x
CO3		x	x		x	x
CO4			x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Errors and Solutions of Equations in One Variable (19 Hrs)				
Numerical Analysis: Mathematical Preliminaries, Errors and Their Computations.	1.1	1	3	Lecture, Class room exercise
Introduction, Bisection Method, Method of False Position.	1.2	1	4	Lecture, Class room exercise
Iteration Method, Newton - Raphson Method	1.3	1	4	Lecture, Class room exercise
Problems (Practicum)		1	8	



Module 2: Interpolation and Polynomial Approximation (19 Hrs)				
Interpolation: Finite Differences, Differences of a polynomial.	2.1	2	3	Lecture, Class room exercise
Newton's Formulae for Interpolation	2.2	2	4	Lecture, Class room exercise
Central Difference: Gauss's Central difference formulae.	2.3	2	4	Lecture, Class room exercise
Problems (Practicum)		2	8	
Module 3: Numerical Differentiation and Integration (19 Hrs)				
Introduction to numerical differentiation	3.1	3	1	Lecture, Class room exercise
Newton's Forward-differences formula to get the derivative	3.2	3	1	Lecture, Class room exercise
Newton Backward-differences formula to get the derivative	3.3	3	1	Lecture, Class room exercise
Introduction to numerical integration	3.4	3	1	Lecture, Class room exercise
Newton-Cotes Formula	3.5	3	1	Lecture, Class room exercise
The Trapezoidal Rule.	3.6	3	1	Lecture, Class room exercise
Romberg's Method	3.7	3	1	Lecture, Class room exercise
Simpson's one third Rule	3.8	3	2	Lecture, Class room exercise
Simpson's three-eighth rule	3.9	3	2	Lecture, Class room exercise
Problems (Practicum)		3	8	
Module 4: Initial-Value Problems for Ordinary Differential Equation (18 Hrs)				
The Elementary Theory of Initial-Value Problems	4.1	4	2	Lecture, Class room exercise
Euler's Method	4.2	4	3	Lecture, Class room exercise
Modified Euler's method	4.3	4	3	Lecture, Class room exercise
Runge-Kutta method of order four	4.4	4	4	Lecture, Class room exercise
Problems (Practicum)		4	6	
Module 5:				
Teacher Specific Content				
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)				
This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbooks

1. Kandasamy, P., Thilagavathy, K., & Gunavathi, K. Numerical Methods. S Chand, 1997.

Reference

1. S.S. Sastry, Introductory Methods of Numerical Analysis, 5th ed., PHI
2. K F Riley and M P Hobson: Essential Mathematical Methods for Physical Sciences, Cambridge University Press, 2011.
3. Erwin Kreyszig, Advanced Engineering Mathematics, 8th ed., Wiley, 2007.
4. George B. Thomas, Jr, Thomas' Calculus 12th ed., Pearson, 2009.
5. Srimanta Pal, Numerical Methods, Oxford University Press, 2009.

Course designed by: Ms Jinu Mary Jameson



SBU24MA7DSC401: BASIC TOPOLOGY

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Familiarize the notion of open sets and closed sets in Metric Spaces	U
CO2	Introduce the concept of Topological spaces and analyse the properties of examples provided	An
CO3	Understand the concept of continuity and analyze equivalence of topological spaces	A
CO4	Understand and analyse connectedness and compactness in Topological space	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	1	1	1	2	2	2	2	1	1	1
CO3	2	2	2		2	1	1	1	2	2
CO4	1	1	1	1	1	2	2	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x	x		x	x	x
CO2	x	x		x	x	x
CO3			x		x	x
CO4		x			x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Metric Spaces (15 Hrs)				
The Definition and Some Examples	1.1	1	2	Lecture, Class room exercise
Open Sets and Closed Sets in Metric Spaces	1.2	1	2	Lecture, Class room exercise
Interior, Closure and Boundary	1.3	1	3	Lecture, Class room exercise
Continuous Functions	1.4	1	2	Lecture, Class room exercise
Equivalence of Metric Space	1.5	1	2	Lecture, Class room exercise
New Spaces from Old	1.6	1	2	Lecture, Class room exercise
Complete Metric Spaces	1.7	1	2	Lecture, Class room exercise



Module 2: Topological Spaces (17 Hrs)				
Definition and some examples	2.1	2	3	Lecture, Class room exercise
Interior	2.2	2	2	Lecture, Class room exercise
Closure	2.3	2	2	Lecture, Class room exercise
Boundary	2.4	2	2	Lecture, Class room exercise
Basis and sub basis	2.5	3	2	Lecture, Class room exercise
Continuity	2.6	3	2	Lecture, Class room exercise
Topological equivalence	2.7	3	2	Lecture, Class room exercise
Arzela- Ascoli theorem	2.8	3	1	Lecture, Class room exercise
Montel theorems	2.9	3	1	Lecture, Class room exercise
Module 3: Connectedness (13 Hrs)				
Connected and disconnected spaces	3.1	4	2	Lecture, Class room exercise
Theorems on connectedness	3.2	4	2	Lecture, Class room exercise
Connected subsets of the real line	3.3	4	2	Lecture, Class room exercise
Applications of Connectedness	3.4	4	2	Lecture, Class room exercise
Path connected spaces	3.5	4	2	Lecture, Class room exercise
Locally connected Spaces	3.6	4	2	Lecture, Class room exercise
Locally path connected spaces	3.7	4	1	Lecture, Class room exercise
Module 4: Compactness (15 Hrs)				
Compact spaces and subspaces	4.1	4	3	Lecture, Class room exercise
Compactness and continuity	4.2	4	4	Lecture, Class room exercise
Properties related to compactness	4.3	4	4	Lecture, Class room exercise
One-point compactification	4.4	4	4	Lecture, Class room exercise
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbook

1. Croom, Fred H. Principles of Topology. Cengage Learning, 2016.

Reference

1. Joshi, K. D. Introduction to General Topology. Wiley Eastern Ltd, 1984.
2. Munkres, James R. Topology - A First Course. Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
3. Mendelson, Bert. Introduction to Topology. Dover Publications, 1990.
4. Patty, C. Wayne. Foundations of Topology. Jones and Bartlett Publishers, 2009.
5. Parthasarathy, K. Topology: An Invitation. Springer, 2022.

Course designed by: Dr Shine C Mathew



SBU24MA7DSC402: GALOIS THEORY

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Introduce Extension fields	U
CO2	Develop the concepts of Galois fields through the splitting fields, concept of finite fields, cyclotomic polynomials, splitting fields, normal fields, separable polynomials,	A
CO3	Compare normal extension and separable extensions	An
CO4	Concreting the concept of Galois extension and Explain Cyclotomic extensions and abelian extensions over Q	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	1	1	1	2	2	2	2	1	1	1
CO3	2	2	2		2	1	1	1	2	2
CO4	1	1	1	1	1	2	2	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x	x		x	x	x
CO3		x			x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: (16 Hrs)				
Introduction to Extension Fields	1.1	1	3	Lecture, Class room exercise
The Irreducible Polynomial	1.2	1	3	Lecture, Class room exercise
Simple Extensions	1.3	1	3	Lecture, Class room exercise
Algebraic Extensions	1.4	1	4	Lecture, Class room exercise
Finite Fields	1.5	1	3	Lecture, Class room exercise
Module 2: (15 Hrs)				
Introduction to Galois Theory	2.1	2	3	Lecture, Class room exercise
Splitting Field	2.2	2	3	Lecture, Class room exercise
Properties of Splitting field	2.3	2,3	3	Lecture, Class room exercise



Normal Extension	2.4	2,3	3	Lecture, Class room exercise
Separable Extensions	2.5	2,3	3	Lecture, Class room exercise
Module 3: (14 Hrs)				
Galois Theorems	3.1	4	7	Lecture, Class room exercise
Illustrations of Galois Theory	3.2	4	7	Lecture, Class room exercise
Module 4: (15 Hrs)				
Cyclotomic Extension	4.1	4	7	Lecture, Class room exercise
Constructible polygons	4.2	4	8	Lecture, Class room exercise
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbook

1. Fraleigh, John B. A First Course in Abstract Algebra. 8th ed., Pearson Education India, 2003.

Reference

1. Dummit, David S., and Richard M. Foote. Abstract Algebra. John Wiley & Sons Inc, 2003.
2. Gallian, Joseph. Contemporary Abstract Algebra. Chapman And Hall/CRC, 2021.
3. Herstein, I. N. Topics in Algebra. 2nd ed., Wiley, 2006.
4. Lang, Serge. Algebra. 3rd ed., Springer, 2002.

Course designed by: Ms Jinu Mary Jameson



SBU24MA7DSC403: MEASURE THEORY AND INTEGRATION

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Introduce the concept of Lebesgue Measure	U
CO2	Analyze Measurable functions	An
CO3	Explain Lebesgue Integration of a bounded function	A
CO4	Compare integration and differentiation in the aspect of measure and apply the concept of measure on real line to general spaces and study Radon Nikodym Theorem	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	1	1	1	2	2	2	2	1	1	1
CO3	2	2	2		2	1	1	1	2	2
CO4	1	1	1	1	1	2	2	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x	x		x	x	x
CO3		x	x		x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Lebesgue Measure (15 Hrs)				
Outer Measure	1.1	1	4	Lecture, Class room exercise
Measurable Sets and Lebesgue Measure	1.2	1	3	Lecture, Class room exercise
A Non-Measurable Set	1.3	1	4	Lecture, Class room exercise
Measurable Functions	1.4	2	4	Lecture, Class room exercise
Module 2: The Lebesgue Integral (15 Hrs)				
The Riemann Integral (A Quick Review),	2.1	3	3	Lecture, Class room exercise
The Lebesgue Integral of A Bounded Function Over A Set Of Finite Measures	2.2	3	5	Lecture, Class room exercise
The Integral of A Non-Negative Function	2.3	3	4	Lecture, Class room exercise
The General Lebesgue Integral	2.4	3	3	Lecture, Class room exercise



Module 3: Differentiation and Integration (14 Hrs)				
Differentiation of Monotone Functions	3.1	4	5	Lecture, Class room exercise
Functions of Bounded Variations	3.2	4	2	Lecture, Class room exercise
Differentiation of An Integral	3.3	4	4	Lecture, Class room exercise
Absolute Continuity	3.4	4	3	Lecture, Class room exercise
Module 4: General Measure and Integration (16 Hrs)				
Theory Measurable Spaces	4.1	4	2	Lecture, Class room exercise
Measurable Function	4.2	4	2	Lecture, Class room exercise
Integration	4.3	4	2	Lecture, Class room exercise
Signed Measure	4.4	4	2	Lecture, Class room exercise
The Radon Nikodym Theorem	4.5	4	2	Lecture, Class room exercise
Outer Measure and Measurability	4.6	4	2	Lecture, Class room exercise
The Extension Theorem	4.7	4	2	Lecture, Class room exercise
Product Measures	4.8	4	2	Lecture, Class room exercise
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbook

1. Royden, Halsey, and Patrick Michael Fitzpatrick. Real Analysis. China Machine Press, 2010.

Reference

1. De Barra, G. Measure Theory and Integration. New Age International (P) Linnilect Publishers, 1981.
2. Burk, Frank. Lebesgue Measure and Integration, An Introduction. John Wiley And Sons, 1998.
3. Rana, Inder K. An Introduction to Measure and Integration. Narosa Publishing House, 1997.
4. Jain, P.K., and V.P. Gupta. Lebesgue Measure and Integration. New Age International (P) Ltd., New Delhi, 1986

Course designed by: Dr Ullas Thomas



SBU24MA7DSC404: PARTIAL DIFFERENTIAL EQUATIONS

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Introduction to Partial Differential Equations	U
CO2	Explain the Charpits and Jacobis Method	A
CO3	A detailed study of Linear PDE of second order	A
CO4	Explain Linear PDE with constant coefficients and the solution of linear nonhomogeneous equations	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	1	1	1	2	2	2	2	1	1	1
CO3	2	2	2		2	1	1	1	2	2
CO4	1	1	1	1	1	2	2	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x			x	x	x
CO3			x		x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction (16 Hrs)				
Introduction to PDE	1.1	1	2	Lecture, Class room exercise
Formation of PDE	1.2	2	2	Lecture, Class room exercise
Solution of a first order PDE	1.3	2	2	Lecture, Class room exercise
General integral from complete solution	1.4	2	2	Lecture, Class room exercise
method for solving first order equations	1.5	1	2	Lecture, Class room exercise
Lagrange's method	1.6	1	2	Lecture, Class room exercise
Geometrical interpretation of Lagrange's linear equation	1.7	1	2	Lecture, Class room exercise
particular solution passing through a given curve	1.8	1	2	Lecture, Class room exercise



Module 2: Non-linear first order pde (14 Hrs)				
Nonlinear first order PDE	2.1	2	3	Lecture, Class room exercise
Charpit's method	2.2	2	5	Lecture, Class room exercise
Jacobi's method	2.3	2	6	Lecture, Class room exercise
Module 3: Linear PDE of second order (15 Hrs)				
Linear PDE of second order	3.1	3	3	Lecture, Class room exercise
Solution of second order partial differential equations by direct integration	3.2	3	3	Lecture, Class room exercise
General method for solving second order equations-Monge's method	3.3	3	3	Lecture, Class room exercise
Monge's method for solving	3.4	3	3	Lecture, Class room exercise
Classification of second order PDE	3.5	4	3	Lecture, Class room exercise
Module 4: Linear PDE (15 Hrs)				
Linear PDE with constant coefficients,	4.1	4	4	Lecture, Class room exercise
Solution of linear homogeneous PDE with constant coefficients	4.2	4	4	Lecture, Class room exercise
shorter method for finding particular integral when $g(x, y) = \phi(ax + by)$, $g(x, y) = x^m y^n$, where m, n are non-negative integers, $g(x, y) = V(x, y)$	4.3	4	4	Lecture, Class room exercise
Solution of linear nonhomogeneous equations	4.4	4	3	Lecture, Class room exercise
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbook

1. Amarnath, T. An Elementary Course In Partial Differential Equations. Narosa Publications, 1997.

Reference

1. Sneddon, Ian N. Elements of Partial Differential Equations. Dover Publications, 2006.
2. Grewal, B. S. Higher Engineering Mathematics. 42nd ed., Khanna Publications, 2012.
3. Copson, E. T. Partial Differential Equations. S Chand & Co, 1975.
4. Sankara Rao, K. Introduction to Partial Differential Equations. Prentice-Hall of India, 2010.
5. Sastry, S. S. Engineering Mathematics, Vol. II. 4th ed., PHI.

Course designed by: Dr Ullas Thomas



SBU24MA7DSC405: RESEARCH METHODOLOGY

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the importance and relevance of research in Mathematics	U
CO2	Acquire knowledge in software that supports the Mathematical research.	A
CO3	Develop knowledge in research design and literature review.	An
CO4	Apply LaTeX techniques for documentation	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	1	2	2	-	2	1	1	2
CO2	1	2	1	1	2	1	1	2	2	2
CO3	2	1	1	2		2	2	1	2	1
CO4	1	2	2	2	1	1	1	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x			x	x	x
CO3	x	x			x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Research Methodology (15 Hrs)				
Meaning and importance of Research	1.1	1	2	Lecture
Types of Research	1.2	1	2	Lecture
Selection and formulation of a Research problem	1.3	1	2	Lecture
Research Design – need	1.4	1	2	Lecture
Features- Inductive, Deductive and Development of models	1.5	1	2	Lecture
Developing a Research Plan	1.6	1	2	Lecture
Analysis of Literature Review- Primary and Secondary Sources, Web sources	1.7	1	3	Lecture



Module 2: Research Tools (15 Hrs)				
MathSciNet, ZMATH, Scopus, ISI Web of Science, Impact factor, h-index,	2.3	2	5	Lecture, Class room exercise
Google Scholar, ORCID, JStor, Online and open access journals.	2.4	2	5	Lecture, Class room exercise
Scientific Writing and Presentation: Writing a research paper, survey article, thesis writing;	2.5	2	5	Lecture, Class room exercise
Module 3: How to learn, write, research and present Mathematics (15 Hrs)				
How to Learn Mathematics Why learn mathematics? Studying mathematics Homework assignments and problem solving	3.1	3	4	Lecture, Class room exercise
How to Write Mathematics What is the goal of mathematical writing? General principles of mathematical writing, Writing mathematical sentences Avoiding errors. Writing mathematical solutions and proofs, Writing longer mathematical works	3.2	3	4	Lecture, Class room exercise
How to do Research in Mathematics What is mathematical research? Finding a research topic, General advice, Taking basic steps Fixing common problems, using computer resources Practicing good mathematical judgment	3.3	3	4	Lecture, Class room exercise
How to Present Mathematics, why give a presentation of mathematics? Preparing your talk, DOs and DON'Ts, Using technology Answering questions, Publishing your research	3.4	3	3	Lecture, Class room exercise
Module 4: Documentation using LaTeX (15 Hrs)				
Getting Started with LATEX	4.1	4	3	Lecture, Class room exercise
What is TEX?	4.2	4	3	Lecture, Class room exercise
What is LATEX?	4.3	4	3	Lecture, Class room exercise
How to create LATEX files?	4.4	4	4	Lecture, Class room exercise
How to create and typeset a simple LATEX document?	4.5	4	2	
Module 5:				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Textbooks

1. Kothari, C. R. Research Methodology. 2nd ed., New Age Publishers, 2004.
2. Bindner, Donald, and Martin Erickson. A Student's Guide to the Study, Practice, and Tools of Modern Mathematics. CRC Press, 2011.



Reference

1. Higham, Nicholas J. Handbook of Writing for the Mathematical Sciences. SIAM, 1998.
2. Schiavone, Peter. How to Study Mathematics: Effective Study Strategies for College and University Students. Prentice Hall Canada, 1998.
3. Knuth, Donald E., Tracy Larrabee, and Paul M. Roberts. Mathematical Writing. Mathematical Association of America, 1989.
4. Lamport, Leslie. LaTeX: A Document Preparation System. Pearson, 2008.
5. Mittelbach, Frank, et al. The LaTeX Companion. Pearson, 2004.
6. Steenrod, Norman E., et al. How to Write Mathematics. American Mathematical Society, 1973.

Course designed by: Ms Treesa Maria Kuriakose



SEMESTER VIII

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MA8DSC400	Major	Functional Analysis	5	75	4
SBU24MA8DSC401	Major	Advanced Complex Analysis	5	75	4
SBU24MA8DSE400	Elective	Advanced Topology	4	60	4
SBU24MA8DSE401	Elective	Operations Research	4	60	4
SBU24MA8DSE402	Elective	Coding Theory	4	60	4
SBU24MA8PRJ400		Project (Honours with Research)			12



SBU24MA8DSC400: FUNCTIONAL ANALYSIS

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
Duration	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the fundamentals of normed spaces and inner product spaces	U
CO2	Apply linear maps to normed spaces especially Banach spaces	A
CO3	Analyze dual spaces	An
CO4	Analyze the geometry of Hilbert spaces	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	1	1	1	2	2	2	2	1	1	1
CO3	2	2	2		2	1	1	1	2	2
CO4	1	1	1	1	1	2	2	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x			x	x	x
CO3	x	x			x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Normed Spaces (18 Hrs)				
Normed Spaces – Definition and Examples	1.1	1	1	Lecture, Class room exercise
Reisz's Lemma	1.2	1	2	Lecture, Class room exercise
Finite Dimensional Normed Spaces	1.3	1	1	Lecture, Class room exercise
Continuity of Linear Maps	1.4	1	1	Lecture, Class room exercise
Bounded Linear maps	1.5	1	2	Lecture, Class room exercise
Hahn Banach Separation Theorem	1.6	1	1	Lecture, Class room exercise
Hahn Banach Extension Theorem	1.61	1	2	Lecture, Class room exercise
Unique Hahn Banach Extension	1.62	1	2	Lecture, Class room exercise
Problems (Practicum)		1	6	Lecture, Class room exercise



Module 2: Banach Spaces (19 Hrs)				
Banach Spaces	2.1	2	1	
Uniform Boundedness Principle	2.2	2	2	Lecture, Class room exercise
Banach Steinhaus Theorem	2.3	2	2	Lecture, Class room exercise
Resonance Theorem	2.4	2	2	Lecture, Class room exercise
Closed Graph and Open Mapping Theorem	2.5	2	2	Lecture, Class room exercise
Bounded Inverse Theorem	2.6	2	1	Lecture, Class room exercise
Two Norm Theorem	2.7	2	1	Lecture, Class room exercise
Problems (Practicum)		2	8	
Module 3: Dual Spaces (20 Hrs)				
Dual of Normed Space	3.1	3	2	Lecture, Class room exercise
Transposes	3.2	3	2	Lecture, Class room exercise
Dual Space of l^p , $L^p[a, b]$ and $C[a, b]$	3.3	3	2	Lecture, Class room exercise
Riesz Representation Theorem for L^p	3.4	3	3	Lecture, Class room exercise
Riesz Representation Theorem for $C[a, b]$	3.5	3	3	Lecture, Class room exercise
Problems (Practicum)		3	8	
Module 4: Inner Product Spaces (18 Hrs)				
Inner Product Spaces	4.1	4	2	Lecture, Class room exercise and Assignment
Orthonormal sets	4.2	4	2	Lecture, Class room exercise
Convergence of series in an Inner Product Space	4.3	4	1	Lecture, Class room exercise
Projection Theorem	4.4	4	2	Lecture, Class room exercise
Approximation and Optimization	4.5	4	1	Lecture, Class room exercise
Riesz Representation Theorem	4.6	4	2	Lecture, Class room exercise
Problems (Practicum)		4	8	
Module 5				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbook

1. Limaye, B. V. Functional Analysis. New Age International, 1996.

Reference

1. Kreyszig, Erwin. Introductory Functional Analysis with Applications. Vol. 17. John Wiley & Sons, 1991.
2. Simmons, George F. Introduction to Topology and Modern Analysis. McGraw Hill, 1963.
3. Siddiqi, A. H. Functional Analysis with Applications. Tata McGraw Hill, 1989.
4. Somasundaram, D. Functional Analysis. S. Viswanathan Pvt. Ltd., 1994.
5. Vasistha, A. R., & Sharma, I. N. Functional Analysis. Krishnan Prakasan Media (P) Ltd, 1995-1996.



6. Thamban Nair, M. Functional Analysis: A First Course. Prentice Hall of India Pvt. Ltd., 2008.
7. Rudin, Walter. Functional Analysis. 10th ed., 1974.

Course designed by: Fr John J Chavara



SBU24MA8DSC401: ADVANCED COMPLEX ANALYSIS

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Detailed study on Cauchy Theorem	A
CO2	Familiarize Taylor Series	A
CO3	Study Laurent Series	A
CO4	Identify and analyze the singularities of analytic functions and apply residue theorem to compute contour integrals	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	1	1	1	2	2	2	2	1	1	1
CO3	2	2	2		2	1	1	1	2	2
CO4	1	1	1	1	1	2	2	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x			x	x	x
CO3	x	x			x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Cauchy's Theorem (15 Hrs)				
Cauchy theorem for triangles	1.1	1	2	Lecture, Class room exercise
Existence of an antiderivative in a star domain	1.2	1	1	Lecture, Class room exercise
Logarithms	1.3	1	1	Lecture, Class room exercise
Local existence of an antiderivative	1.4	1	1	Lecture, Class room exercise
Cauchy's Theorem	1.5	1	1	Lecture, Class room exercise
Simply connected domain	1.6	1	1	Lecture, Class room exercise
Problems (Practicum)		1	8	
Module 2: Taylor series (19 Hrs)				
Cauchy's integral formula	2.1	2	1	Lecture, Class room exercise
Taylor's series	2.2	2	1	Lecture, Class room exercise



Morera's theorem	2.3	2	1	Lecture, Class room exercise
Cauchy's estimate	2.4	2	1	Lecture, Class room exercise
Zeros	2.5	2	2	Lecture, Class room exercise
Extension functions	2.6	2	1	Lecture, Class room exercise
Local maxima and minima	2.7	2	2	Lecture, Class room exercise
Maximum Modulus theorem	2.8	2	2	Lecture, Class room exercise
Problems (Practicum)		2	8	
Module 3: Laurent Series (17 Hrs)				
Series involving negative powers	3.1	3	2	Lecture, Class room exercise
Isolated singularities	3.2	3	2	Lecture, Class room exercise
Behaviour near an isolated singularities	3.3	3	1	Lecture, Class room exercise
Extended complex plane	3.4	3	1	Lecture, Class room exercise
Behaviour of a differentiable function at infinity	3.5	3	2	Lecture, Class room exercise
Meromorphic functions	3.6	3	1	Lecture, Class room exercise
Problems (Practicum)		3	8	
Module 4: Residues and Conformal Mappings (24 Hrs)				
Cauchy residue theorem	4.1	4	1	Lecture, Class room exercise
Calculating residue	4.2	4	1	Lecture, Class room exercise
Evaluation of definite integral	4.3	4	2	Lecture, Class room exercise
Summation of series	4.4	4	2	Lecture, Class room exercise
Counting zeros	4.5	4	2	Lecture, Class room exercise
Conformal Transformations	4.6	4	3	Lecture, Class room exercise
Critical points	4.7	4	2	Lecture, Class room exercise
Mobius transformation	4.8	4	1	Lecture, Class room exercise
Mobius transformation preserves circles	4.9	4	2	Lecture, Class room exercise
Classification of Mobius maps	4.10	4	2	Lecture, Class room exercise
Problems (Practicum)		4	6	
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbook

1. Stewart, Ian, and David Tall. Complex Analysis. 2nd ed., Cambridge University Press, 2018.

Reference

1. Ahlfors, Lars V. Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable. 3rd ed., McGraw-Hill Education, 1979.
2. Conway, John B. Functions of One Complex Variable. Springer-Verlag, New York, 1973.
3. Palka, Bruce P. An Introduction to Complex Function Theory. Springer-Verlag, New York, 1991.
4. Bak, Joseph, and Donald J. Newman. Complex Analysis. 3rd ed., Springer, 2010.
5. Brown, James, and Reel Churchill. Complex Variables and Applications. 9th ed., McGraw-Hill Education, 2013.

Course designed by: Mr Tibin Thomas



SBU24MA8DSE400: ADVANCED TOPOLOGY

Type of Course	DSE		
Course Level	400-499		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Analyze the topological properties of product space and quotient space	U
CO2	Analyse and compare various separation axioms	A
CO3	Explain the concept Metrization	A
CO4	Analyze Fundamental groups and define homotopy	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	2	2	2		2	1	1	1	2	2
CO3	1	1	1	1	1	2	2	2	1	1
CO4	2		1	2	2	1	1	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x			x	x	x
CO3		x	x		x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Product and Quotient Spaces (16 Hrs)				
Finite Products	1.1	1	3	Lecture, Class room exercise
Arbitrary products	1.2	1	3	Lecture, Class room exercise
Comparison of topologies	1.3	1	3	Lecture, Class room exercise
Quotient spaces	1.4	1	3	Lecture, Class room exercise
Surfaces and Manifolds	1.5	1	4	Lecture, Class room exercise
Module 2: Separation Axioms (15 Hrs)				
T_0 spaces	2.1	2	3	Lecture, Class room exercise
T_1 spaces	2.2	2	3	Lecture, Class room exercise
T_2 spaces	2.3	2	3	Lecture, Class room exercise
Regular spaces	2.4	2	3	Lecture, Class room exercise
Normal Spaces	2.5	2	3	Lecture, Class room exercise



Module 3: Metrization (14 Hrs)				
Separation by continuous functions	3.1	3	3	Lecture, Class room exercise
Urysohn's Lemma	3.2	3	3	Lecture, Class room exercise
Tietze Extension Theorem	3.3	3	4	Lecture, Class room exercise
Metrization	3.4	3	4	Lecture, Class room exercise
Module 4: Fundamental Group (15 Hrs)				
Homotopy	4.1	4	3	Lecture, Class room exercise
Fundamental Group	4.2	4	3	Lecture, Class room exercise
Fundamental Group of S^1	4.3	4	3	Lecture, Class room exercise
Additional Examples of Fundamental Groups	4.4	4	3	Lecture, Class room exercise
Brouwer fixed point theorem and related results	4.5	4	3	Lecture, Class room exercise
Module 5				
Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a workbook of the solutions should be kept in hand.				

Textbook

1. Croom, Fred H. Principles of Topology. Cengage Learning, 2016.

Reference

1. Croom, Fred H. Basic Concepts of Algebraic Topology. Springer-Verlag, 1978.
2. Joshi, K. D. Introduction to General Topology. Wiley Eastern Ltd, 1984.
3. Munkres, James R. Topology - A First Course. Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
4. Parthasarathy, K. Topology: An Invitation. Springer, 2022.
5. Hocking, John G., and Gail S. Young. Topology. Dover Publications, New York, 1988.
6. Weintraub, Steven H. Fundamentals of Algebraic Topology. Springer, 2014.

Course designed by: Dr Shine C Mathew



SBU24MA8DSE401: OPERATIONS RESEARCH

Type of Course	DSE		
Course Level	400-499		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Apply techniques to solve network programming problems, including minimum path, spanning trees, and maximum flow	A
CO2	Solve optimization problems in 2-dimensional and general spaces using ILP and MILP techniques such as cutting plane and branch and bound.	A
CO3	Demonstrate a deep understanding of nonlinear programming principles, applying Lagrangian functions, Kuhn-Tucker conditions, and quadratic programming to solve complex optimization problems.	A
CO4	Apply direct search and gradient methods such as Fibonacci search, golden section plans, and steepest descent to optimize unimodal and n-dimensional functions effectively.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1		1	2	1	1	1	1	1
CO2	1	1	1	2	2	2	2	1	1	1
CO3	2	2	2		2	1	1	1	2	2
CO4	1	1	1	1	1	2	2	2	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x			x	x	x
CO3	x	x			x	x
CO4		x	x		x	x

Course content and Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Network Programming (17 Hrs)				
Introduction to Network Programming problems	1.1	1	1	Lecture, Class room exercise
Definitions and notations	1.2	1	2	Lecture, Class room exercise
Minimum Path problem	1.3	1	2	Lecture, Class room exercise



Spanning tree of minimum length	1.4	1	3	Lecture, Class room exercise
Problems of Potential Difference	1.5	1	2	Lecture, Class room exercise
Scheduling of Sequential Activities	1.6	1	2	Lecture, Class room exercise
Maximum Flow Problem	1.7	1	2	Lecture, Class room exercise
Duality in Maximum Flow Problem	1.8	1	3	Lecture, Class room exercise
Module 2: Integer Programming Problems (14 Hrs)				
Introduction to ILP and MILP	2.1	2	1	Lecture, Class room exercise
ILP in 2-dimensional space	2.2	2	2	Lecture, Class room exercise
General ILP and MILP Problems	2.3	2	3	Lecture, Class room exercise
Examples	2.4	2	2	Lecture, Class room exercise
Cutting plane method	2.5	2	3	Lecture, Class room exercise
Branch and Bound method	2.6	2	3	Lecture, Class room exercise
Module 3: Non-Linear programming (15 Hrs)				
Introduction to NLPP	3.1	3	1	Lecture, Class room exercise
Lagrangian function and Saddle point	3.2	3	2	Lecture, Class room exercise
Relation between saddle point of $F(X, Y)$ and minimal point of $f(x)$	3.3	3	2	Lecture, Class room exercise
Kuhn-Tucker conditions	3.4	3	4	Lecture, Class room exercise
Primal and Dual problems	3.5	3	3	Lecture, Class room exercise
Quadratic Programming	3.6	3	3	Lecture, Class room exercise
Module 4: Direct Search and Gradient methods (14 Hrs)				
Unimodal functions	4.1	4	1	Lecture, Class room exercise
Search plans for one variable	4.2	4	1	Lecture, Class room exercise
Fibonacci search plan	4.3	4	2	Lecture, Class room exercise
Golden section plan	4.4	4	1	Lecture, Class room exercise
n-dimensional problem	4.5	4	2	Lecture, Class room exercise
Line search methods	4.6	4	3	Lecture, Class room exercise
Method of axial directions	4.7	4	2	Lecture, Class room exercise
Method of steepest descent	4.8	4	2	Lecture, Class room exercise
Module 5				
Teacher Specific Content				
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)				
This content will be evaluated internally				

Textbook

1. Mittal, K. V., & Mohan, C. Optimization Methods in Operations Research and System Analysis. 3rd ed., New Age International, 1996.

Reference

1. Winston, Wayne L. Operations Research: Applications and Algorithms. Cengage Learning, 2003.
2. Taha, Hamdy A. Operations Research: An Introduction. Pearson Education, 2016.
3. Hillier, Frederick S., and Lieberman, Gerald J. Introduction to Operations Research. McGraw-Hill Education, 2020.
4. Gupta, P. K., and Hira, D. S. Operations Research: Problems and Solutions. S. Chand Publishing, 2005.
5. Ravindran, A., Phillips, D. T., and Solberg, J. J. Operations Research: Principles and Practice. Springer, 2006.

Course designed by: Ms Jinu Mary Jameson



SBU24MA8DSE402: CODING THEORY

Type of Course	DSE		
Course Level	400-499		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	60		60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand and Apply Fundamentals of Coding Theory	A
CO2	Analyze Self Dual Codes and BCH Codes.	A
CO3	Apply Polynomials for constructing codes like the BCH code for double error correction.	A
CO4	Apply the theory of finite fields for understanding and constructing various types of error-correcting codes and implement error-correcting codes in practical scenarios using generator polynomials and the properties of binary cyclic codes	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	2	1	2	1	1	1	1	3
CO2	1	1		3	3	2	2	1	2	1
CO3	2	2	2	1	2	1	1	1	2	2
CO4	1	1	1	2	1	2	3	2	1	

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x			x	x	x
CO3	x	x			x	x
CO4		x	x		x	x

Course content and Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction To Coding Theory (15 Hrs)				
Introduction and Basic Definitions	1.1	1	1	Lecture, Class room exercise
Weight, Minimum weight and Maximum Likelihood decoding	1.2	1	1	Lecture, Class room exercise
Syndrome decoding	1.3	1,4	2	Lecture, Class room exercise
Perfect Codes	1.4	1,4	3	Lecture, Class room exercise
Hamming codes	1.5	1,4	2	Lecture, Class room exercise
Sphere packing bound	1.6	1	2	Lecture, Class room exercise
Packing radius and Covering Radius	1.7	1,4	2	Lecture, Class room exercise



MDS Code and Some Bounds	1.8	1,4	2	Lecture, Class room exercise
Module 2: Self Dual Codes and Polynomials (18 Hrs)				
Self-dual codes	2.1	2	2	Lecture, Class room exercise
The Golay codes	2.2	2	3	Lecture, Class room exercise
The problem	2.3	2,4	4	Lecture, Class room exercise
Polynomials	2.4	2,4	2	Lecture, Class room exercise
Finite field of 16 elements	2.5	2	3	Lecture, Class room exercise
Double error correction BCH code	2.6	2	4	Lecture, Class room exercise
Module 3: Finite Fields (12 Hrs)				
Finite fields	3.1	3	3	Lecture, Class room exercise
Groups, structure of a finite field	3.2	3	3	Lecture, Class room exercise
minimal polynomials	3.3	3	3	Lecture, Class room exercise
Factoring $x^n - 1$	3.4	3	3	Lecture, Class room exercise
Module 4: Cyclic Codes (15 Hrs)				
Origin and definition of cyclic codes	4.1	4	2	Lecture, Class room exercise
How to find cyclic codes	4.2	4	3	Lecture, Class room exercise
The generator polynomial	4.3	4	2	Lecture, Class room exercise
Generator polynomial of the dual code	4.4	4	4	Lecture, Class room exercise
Idempotent and minimal ideals for binary cyclic code.	4.5	4	4	Lecture, Class room exercise
Module 5				
Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Textbook

1. Pless, Vera. Introduction to the Theory of Error-Correcting Codes. 3rd ed., Wiley-Interscience, 1998.

Reference

1. R-Lidi, G. Pliz. Applied Abstract Algebra. Springer Verlag, 1997.
2. Van Lint, J.H. Introduction to Coding Theory. Springer Verlag, 1998.
3. Blahut, R.E. Error-Control Codes. Addison Wesley, 1983.
4. Lin, Shu. Error Control Coding. Pearson Education India, 2011.
5. Richardson, Tom, and Ruediger Urbanke. Modern Coding Theory. Cambridge University Press, 2008.

Course designed by: Ms Treesa Maria Kuriakose



SBU24MA8PRJ400: PROJECT

Type of Course	Major		
Course Level	400-499		
Credit	12		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Demonstrate proficiency in advanced mathematical concepts	A
CO2	Systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, and draw appropriate conclusions.	An
CO3	Explore the interconnections between different areas of pure mathematics, recognizing common themes and structures.	An
CO4	Contribute original insights to the advancement of knowledge in pure mathematics through independent research and inquiry.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2		3	1	2	1		2	3
CO2	2	1	2		1		1	2	2	1
CO3	3	2	3	1		1		2		2
CO4	1			2	3		2	3		2



Rubrics for the Assessment of Theory Courses

The rubrics provided below serve as general guidelines and may require adjustments based on the specific requirements and focus areas of different theory courses in Mathematics. Adjustments may include placing more emphasis on certain criteria, adding specific requirements, or modifying the scoring scale to better reflect the expectations of the course.

1. ASSIGNMENT

Rubrics for the Assessment

Criteria	Level 4	Level 3	Level 2	Level 1
Level of Content	All aspects regarding the topic are covered	Some aspects are missing	Many relevant aspects regarding the topic are missing	Essential aspects related to the topic are largely absent, leading to substantial deficiencies in coverage.
Organization	Writing is coherent and logically organized. Overall unity of ideas is present.	Writing is impartially coherent and medium level of logical organization.	Writing lacks logical organization. It shows some coherence but ideas lack unity.	The writing lacks coherence and organization, making it challenging to follow the flow of ideas.
Reference	Enough reference and all the sources are authentic	Sources are listed properly but many are unauthentic	Lack clarity of sources and are unauthentic	Sources are unclear, and authenticity is severely compromised due to a complete absence of verification.

Penalty for Late submission:

If submitted within one week after the stipulated time 75% of the marks calculated as per the above rubrics will be awarded to the student. If submission is after one week of deadline but within the extended time fixed by the course in charge, only 50% of the marks determined as per rubrics will be awarded.

2. SEMINAR PRESENTATION

Rubrics for the Assessment

Criteria	Level 4	Level 3	Level 2	Level 1
Content	Comprehensive, well-researched, relevant, and insightful.	Solid coverage of main points, well-researched, mostly relevant.	Adequate coverage of main points, lacking depth or relevance.	Minimal, inaccurate, or irrelevant content.
Organization	Clear structure, logical flow, seamless transitions.	Logical structure, clear sections, some transitions.	Basic structure, unclear transitions, some sections underdeveloped.	Disorganized, random structure, unclear sections.
Delivery	Confident, engaging, dynamic, clear articulation.	Mostly confident, engaging, occasional lack of clarity.	Hesitant, inconsistent, lacks enthusiasm.	Unclear, hesitant, monotone, lacks engagement.



Knowledge/ Understanding about the subject	Sound understanding about the subject and communicated it well.	Knowledge about the subject is good and tried to exhibit it to a certain extent.	Knowledge about the subject is fairly good but not exhibited through presentation.	Knowledge about the subject of presentation is not up to the mark.
Answering Questions	Answered all questions convincingly.	Answered majority of the questions.	Tried to answer some questions but not so successful.	Not able to answer any question.

3. VIVA-VOCE Rubrics for the Assessment

Criteria	Level 4	Level 3	Level 2	Level 1
Knowledge	Deep and comprehensive understanding, clear, accurate, and insightful responses.	Solid understanding, mostly clear and accurate responses, occasional lack of depth.	Some understanding, responses lack depth or clarity.	Little understanding, struggles with clear or accurate responses.
Critical Thinking	Applies critical thinking effectively, analyzes and evaluates concepts, draws connections.	Demonstrates critical thinking skills but may need prompting, limited depth.	Limited critical thinking, responses lack depth or insight.	Little to no critical thinking, simplistic or superficial responses.
Communication	Clear, confident, and persuasive communication, appropriate language.	Effective communication, occasional lack of confidence or clarity, occasional language issues.	Communication is unclear or hesitant, inconsistent language use.	Unclear or hesitant communication, inappropriate language.
Engagement	Actively engages with enthusiasm, asks insightful questions, and contributes to the conversation.	Engages but may need encouragement, shows some enthusiasm.	Engagement is limited, minimal participation, lacks enthusiasm.	Little to no engagement, minimal participation, demonstrates disinterest.



4. GROUP TUTORIAL

Rubrics for the Assessment

Criteria	Level 4	Level 3	Level 2	Level 1
Preparation	All members well-prepared, and demonstrate familiarity with the topic or assignment.	Most members prepared, demonstrate familiarity with the topic	Some members prepared, but lack depth with familiarity the topic.	Few members prepared, with minimal or irrelevant familiarity with the topic.
Participation	Active engagement, fostering a supportive environment.	Engagement present, but some may dominate or not actively listen.	Limited engagement, with minimal interaction.	Little to no engagement, each speaking independently.
Problem Solving	Demonstrates mastery in solving the given problems accurately and efficiently. Articulates solutions clearly and concisely, demonstrating excellent communication skills.	Effectively solves the given problems with minimal errors. Articulates solutions clearly to others, demonstrating understanding of concepts.	Shows some ability to solve the given problems, but with errors or inconsistencies. Attempts to articulate solutions to others, but with some difficulty in clarity.	Demonstrates little to no ability to solve the given problems. Struggles to articulate solutions clearly to others.
Critical Thinking	Strong critical thinking, analyzing and offering insightful perspectives.	Adequate critical thinking, though some lack depth.	Limited critical thinking, with few challenging assumptions.	Lacks critical thinking, contributions lack analysis.
Contribution	Consistently valuable contributions, enriching the group activity.	Generally contributes, with occasional passivity.	Minimal contribution, with limited participation.	Rarely contributes, remaining passive or silent.
Writing Clarity	Writing is clear, concise, and well-organized, with appropriate use of language and terminology.	Writing is generally clear and organized, but may have some minor issues.	Writing is somewhat unclear or disorganized, hindering understanding.	Writing is unclear, disorganized, or uses inappropriate language/terminology.



5. WORKBOOK

Rubrics for the Assessment

Criteria	Level 4	Level 3	Level 2	Level 1
Accuracy	All solutions are accurate, demonstrating a high level of mathematical understanding and proficiency.	Most solutions are correct, with only minor errors present in a few.	Some solutions are correct, but there are frequent errors or inconsistencies.	Many solutions contain significant errors or are completely incorrect.
Completeness	All solutions are fully complete, including all necessary steps, explanations, and diagrams where applicable.	Most solutions are complete, with all necessary steps and explanations provided.	Some solutions are incomplete, missing important steps or explanations.	Many solutions are incomplete or lack essential steps or explanations.
Clarity	Solutions are exceptionally clear, with concise and coherent explanations that make the solving process easy to understand for readers of varying levels of mathematical proficiency.	Solutions are clear and easy to follow, with explanations that are generally well-written and understandable.	Basic plan, lacks organization or realism. Solutions are generally clear, but some explanations may be confusing or unclear.	Solutions are difficult to follow or understand due to unclear explanations or notation.
Organization	Solutions are impeccably organized, with a clear and logical flow that guides the reader through the problem-solving process effortlessly.	Adequate execution, may encounter challenges. Solutions are well-organized, with a clear structure and logical progression from one step to the next.	Solutions are somewhat organized, but the structure could be improved for better clarity and coherence.	Solutions are disorganized, with no clear structure or logical progression.
Neatness and Presentation	Solutions are impeccably neat and well-presented, with consistently legible handwriting and professionally drawn diagrams that enhance understanding.	Solutions are neatly presented, with consistent handwriting and clear, well-drawn diagrams.	Solutions are generally neat, but handwriting may be inconsistent, or diagrams may be somewhat unclear.	Solutions are messy, with illegible handwriting or poorly drawn diagrams.



6. ONLINE or OFFLINE QUIZ (MCQ)

It will be an online or offline test comprising 10 or 20 multiple choice questions of 15 or 30 minutes duration. Maximum marks will be 10 or 20. Each question will carry 1 mark. Online test will conduct via platform like Linways LMS, Google form, Quizizz etc.



COURSES IN STATISTICS



SEMESTER I

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24ST1DSC100	Minor	Descriptive Statistics	5	75	4
SBU24ST1DSC101	Minor	Introduction to Index Numbers and Time Series	5	75	4
SBU24ST1MDC100	MDC	Data Visualisation Using R Programming	4	60	3



SBU24ST1DSC100: DESCRIPTIVE STATISTICS

Type of Course	Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	-		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the principles of data collection, types of data and analysis	U
CO2	Compute the measures of central tendency and dispersion of various data sets	A
CO3	Determine skewness and kurtosis of distributions	A
CO4	Determine the relationship between two variables using correlation coefficients and regression analysis	A
CO5	Analyze the statistical concepts using R, enriching practical skills	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1						1	1	-	1	-
CO2						2	1	1	1	-
CO3						2	1	1	1	-
CO4						1	1	1	1	-
CO5						1	1	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x			x		x
CO2	x	x	x	x	x	x
CO3	x	x	x		x	x
CO4		x	x		x	x
CO5		x		x	x	

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Statistics (13 Hrs)				
Introduction to statistics, Population and sample	1.1	1	2	Lecture
Types of data, classification and tabulation	1.2	1	2	Lecture and class room exercise
Sampling techniques	1.3	1	1	Lecture and class room exercise
Introduction to R, Graphs and Diagrams using R Programming (Practicum)		5	8	Demo and Class room exercise
Module 2: Measures of Central Tendency (14 Hrs)				
Measures of central tendency - Arithmetic Mean – Properties, Merits and Demerits	2.1	2	3	Lecture, Class room exercise and Assignment



Median and Mode – Properties, Merits and Demerits	2.2	2	2	Lecture, Class room exercise and Assignment
Geometric Mean and Harmonic Mean – Properties	2.3	2	2	Lecture, Class room exercise and Assignment
Compute Measures of Central Tendency and Dispersion Using R (Practicum)		5	7	Demo, Class room exercise and Assignment
Module 3: Measures of Dispersion (26 Hrs)				
Measures of dispersion – Range, Quartile Deviation, Mean Deviation and Standard Deviation– Properties	3.1	2	4	Lecture and Class room exercise
Relative Measures of dispersion – Coefficient of range, Coefficient of Quartile Deviation, Coefficient of Mean Deviation, Coefficient of Variation	3.2	2	4	Lecture, Class room exercise and Assignment
Partition values-Deciles and Percentiles	3.3	2	3	Lecture, Class room exercise and Assignment
Skewness – Types of skewness, Measures-Pearson, Bowley and moment measure - Examples	3.4	3	3	Lecture, Class room exercise and Assignment
Kurtosis – Types, measure of kurtosis based on moments - Examples	3.5	3	4	Lecture, Class room exercise and Assignment
Computing Measures of Dispersion, Skewness and Kurtosis Using R (Practicum)		5	8	Lecture, Class room exercise and Assignment
Module 4: Correlation and Regression (22 Hrs)				
Scatter diagram, Karl Pearson’s coefficient of correlation, Spearman’s rank correlation coefficient (with tied ranks)	4.1	4	6	Lecture, Class room exercise and Assignment
Linear regression, regression coefficients and properties, fitting of straight lines	4.2	4	6	Lecture and Class room exercise
Identification of regression lines	4.4	4	3	Lecture, Class room exercise and Assignment
Correlation and regression Using R (Practicum)	4.5	5	7	Class room exercise and Assignment
Module 5: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills using R programming. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a record of the solutions should be kept in hand.				

Textbooks

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2. Gupta, S. P. Statistical Methods, 45th ed., Sultan Chand & Sons, 2019.



Reference

1. Agarwal, B. L. Basic Statistics. New Age International (P) LTD, 2006.
2. Goon, A. M., Gupta, N. K., & Das Gupta, B. Fundamentals of Statistics- Vol.2. World Press, Calcutta, 1999.
3. Mukhopadhaya, P. Mathematical Statistics. New Central Book Agency (P) Ltd., Calcutta, 1996.
4. Rohatgi, V. K., & Saleh, A. M. E. An Introduction to Probability and Statistics, 2nd ed., John Wiley & Sons, Inc, New York, 2001.
5. Wilks, S. S. Mathematical Statistics. John Wiley, New York, 1964.
6. Purohit, Sudha G., Gore, Sharad D., & Deshmukh, Shailaja. Statistics using R, 2nd ed., Narosa Publishing House, 2019.

Course designed by: Ms Devi N



SBU24ST1DSC101: INTRODUCTION TO INDEX NUMBERS AND TIME SERIES

Type of Course	Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	-		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the concept of Index Numbers	U
CO2	Apply Index numbers to various economic data	A
CO3	Discuss the concepts and components of Time Series	U
CO4	Analyze time series to address problems in various fields	An
CO5	Construction of Index numbers and data forecasting using R programming	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1						1	1	-	-	-
CO2						-	1	1	2	1
CO3						1	1	1	-	-
CO4						1	1	1	2	1
CO5						1	1	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x	x	x	x		x
CO2	x	x	x	x	x	x
CO3		x	x		x	x
CO4			x		x	x
CO5			x	x	x	

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Concept of Index Numbers (16 Hrs)				
Definition, role and limitations of Index numbers	1.1	1	2	Lecture
Construction of Index numbers	1.2	1	1	Lecture and class room exercise
Simple and Weighted Index Numbers	1.3	2	5	Lecture and class room exercise
Simple and Weighted Index Numbers using R (Practicum)		5	8	Demo and Class room exercise



Module 2: Tests for Index Numbers (15 Hrs)				
The Commodity Reversal Test, Unit test, Time Reversal Test	2.1	2	4	Lecture, Class room exercise and Assignment
Circular Test and Factor Reversal Test	2.2	2	4	Lecture, Class room exercise and Assignment
Problems (Practicum)	2.3	2	7	Lecture, Class room exercise and Assignment
Module 3: Introduction to Time Series (25 Hrs)				
Definition, Components and Applications	3.1	3	6	Lecture and Class room exercise
Additive and Multiplicative Models, Decomposition of a Time Series	3.2	3	4	Lecture, Class room exercise and Assignment
Estimation of Trend - Free Hand Curve method	3.3	3,4	2	Lecture, Class room exercise and Assignment
Method of Semi Average, Method of Semi Average	3.4	4	3	Lecture, Class room exercise and Assignment
Least Square Method for Straight Line	3.5	4	2	Lecture, Class room exercise and Assignment
Estimation of Trend using R (Practicum)		5	8	Lecture, Class room exercise and Assignment
Module 4: Method of Seasonal variation (19 Hrs)				
Method of Moving Averages	4.1	3,4	4	Lecture, Class room exercise and Assignment
Ratio to Moving Averages and Link Relative method, Deseasonalization	4.2	4	8	Lecture and Class room exercise
Problems (Practicum)		5	7	Class room exercise and Assignment
Module 5: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills using R programming. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a record of the solutions should be kept in hand.				

Textbooks

1. Gupta, S. C., and V. K. Kapoor. Fundamentals of Mathematical Statistics, 11th ed., Sultan Chand & Sons, 2017.
2. Chatfield, C. The Analysis of Time Series – An Introduction, 6th ed., Chapman and Hall, 2004.

Reference

1. Gupta, S. P. Statistical Methods, 45th ed., Sultan Chand & Sons, 2019.
2. Brockwell, P. J., and Davis, R. A. Introduction to Time Series and Forecasting, 2nd ed., Springer-Verlag, New York, 2013.



3. Agarwal, B. L. Basic Statistics, New Age International (P) LTD, 2006.
4. Goon, A. M., Gupta, N. K., & Das Gupta, B. Fundamentals of Statistics-Vol.2, World Press, Calcutta, 1999.
5. Purohit, Sudha G., Gore, Sharad D., & Deshmukh, Shailaja. Statistics using R, 2nd ed., Narosa Publishing House, 2019.

Course designed by: Ms Devi N



SBU24ST1MDC100: DATA VISUALISATION USING R PROGRAMMING

Type of Course	MDC		
Course Level	100-199		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	30	30	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Construction and interpretation of data using graphs and diagrams	A
CO2	Compute measures of central tendency and dispersion	A
CO3	Apply curve fitting to various data sets	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1						2	1	1	1	-
CO2						1	1	1	1	-
CO3						1	1	1	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x	x	x		x	x
CO3		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Graphs and Diagrams (21 Hrs)				
Data presentation using Graphs and Diagrams	1.1	1	1	Lecture and Class room exercise
Bar diagram, Pie diagram	1.2	1	5	Lecture, Class room exercise and Assignments
Histogram, Frequency Polygon, Ogives	1.3	1	5	Lecture, Class room exercise and Assignments
Illustrate these concepts using R (Practicum)		1	10	Lecture, Class room exercise
Module 2: Measures of Central tendency and Dispersion (21 Hrs)				
Measures of central tendency- Mean, Median and Mode	2.1	2	5	Lecture, Class room exercise
Measures of Dispersion-Range, Quartile Deviation, Mean Deviation, Standard Deviation	2.2	2	6	Lecture, Class room exercise and Assignments
Illustrate these concepts using R (Practicum)		2	10	Lecture and Class room exercise



Module 3: Curve Fitting and Forecasting of data (18 Hrs)				
Scatter diagram, Curve Fitting	3.1	3	3	Lecture and Class room exercise
Second degree equation, exponential curve, power curve	3.2	3	5	Lecture, Class room exercise and Assignments
Illustrate these concepts using R/Excel (Practicum)		3	10	Lecture and Class room exercise
Module 4: Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills using R programming. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a record of the solutions should be kept in hand.				

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3. Mukhopadhyaya, P. Mathematical Statistics. New Central Book Agency (P) Ltd., Calcutta, 1996.
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5. Wilks, S. S. Mathematical Statistics. John Wiley, New York, 1964.
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Course designed by: Ms Devi N



SEMESTER II

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24ST2DSC100	Minor	Probability Theory and Random Variables	5	75	4
SBU24ST2DSC101	Minor	Demography and Vital Statistics	5	75	4
SBU24ST2MDC100	MDC	Applied Statistics	4	60	3



SBU24ST2DSC100: PROBABILITY THEORY AND RANDOM VARIABLES

Type of Course	Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	-		

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the basic concepts and properties of probability and compute the events of random experiments	A
CO2	Describe the basic concepts of random variable	U
CO3	Identify different discrete and continuous probability distributions and properties	A
CO4	Apply different probability distributions to solve real life problems	A
CO5	Compute the probabilities of distributions using R programming	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1						2	1	1	1	-
CO2						1	-	1	-	-
CO3						1	-	1	-	-
CO4						1	1	1	2	1
CO5						1	1	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x	x	x	x		x
CO2	x				x	x
CO3	x	x	x		x	x
CO4	x	x	x		x	x
CO5			x	x	x	

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Probability (15 Hrs)				
Random experiment, Sample space, Events	1.1	1	2	Lecture, Class room exercise
Statistical Probability, Mathematical probability, Axiomatic approach to probability	1.2	1	3	Lecture, Class room exercise



Addition theorem for two, three and n events (with proof)	1.3	1	2	Lecture, Class room exercise
Boole's inequality, Conditional probability, Multiplication theorem, independent events, Bayes' theorem - Examples	1.4	1	3	Lecture, Class room exercise and Assignments
Computing Probabilities of events using R (Practicum)		5	5	Lecture, Class room exercise and Assignment
Module 2: Random Variables (23 Hrs)				
Random variables- Discrete and Continuous type	2.1	2	2	Lecture
Probability Mass Functions, Probability Density Function, Distribution Function and their properties, Change of variable (Univariate only)	2.2	2	3	Lecture, Class room exercise and Assignments
Mathematical Expectation, Moments, Properties of Expectation, Moment Generating Function and its properties,	2.3	2	5	Lecture, Class room exercise
Conditional Expectation and Conditional Variance	2.4	2	2	Lecture, Class room exercise and Assignments
Bivariate random variables- Discrete and Continuous type	2.5	2	2	Lecture, Class room exercise
Joint Probability Mass Function, Marginal Probability Function	2.6	2	2	Lecture, Class room exercise
Conditional Probability Function, Independent random variables	2.7	2	2	Lecture, Class room exercise
Mean and Variance of random variables using R (Practicum)		5	5	Demo, Class room exercise
Module 3: Discrete Distributions (20 Hrs)				
Discrete Uniform Distribution, Binomial Distribution – Properties	3.1	3,4	4	Lecture, Class room exercise and Assignments
Poisson Distribution – Properties	3.2	3,4	3	Lecture, Class room exercise and Assignments
Geometric Distribution and its Lack of memory property	3.3	3,4	3	Lecture, Class room exercise and Assignments
Probabilities and plotting of discrete distributions using R (Practicum)	3.4	5	10	Demo, Class room exercise and Assignment
Module 4: Continuous Distributions (17 Hrs)				
Exponential distribution - Properties	4.1	3,4	2	Lecture, Class room exercise and Assignments
Gamma distribution - Properties	4.1	3,4	2	Lecture, Class room exercise and Assignments
Normal distribution properties, area related curve problems	4.3	3,4	3	Lecture, Class room exercise and assignment
Probabilities and plotting of continuous distributions using R (Practicum)	4.4	5	10	Demo, Class room exercise and Assignment
Module 5: Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				



Practicum

Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills using R programming.

The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a record of the solutions should be kept in hand.

Textbooks

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2. Gupta, S. P. Statistical Methods, 45th ed., Sultan Chand & Sons, 2019.

Reference

1. Bhat, B. R., Sri. Venkata Ramana T., and Rao Madhava K. S. Statistics: A Beginners Text Vol-2. New Age International(P) Ltd, New Delhi, 1977.
2. Goon, A. M., Gupta, N. K., & Das Gupta, B. Fundamentals of Statistics- Vol.2. World Press, Calcutta, 1999.
3. Agarwal, B. L. Basic Statistics. New Age International(P) Ltd, 2006.
4. Mukhopadhaya, P. Mathematical Statistics. New Central Book Agency (P) Ltd., Calcutta, 1996.
5. Rohatgi, V. K., & Saleh, A. M. E. An Introduction to Probability and Statistics, 2nd ed., John Wiley & Sons, Inc, New York, 2001.
6. Wilks, S. S. Mathematical Statistics. John Wiley, New York, 1964.
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Course designed by: Ms Devi N



SBU24ST2DSC101: DEMOGRAPHY AND VITAL STATISTICS

Type of Course	Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	-		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand and explain fundamental concepts and terminology in demography and vital statistics.	U
CO2	Understand the concept of vital statistics	U
CO3	Apply quantitative methods to analyze demographic data, including calculation of rates, ratios, and indices	A
CO4	Understand present official statistical system in India	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1						1	1	1	1	1
CO2						1	1	1	1	1
CO3						1	-	1	-	1
CO4						-	1	2	2	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x		x
CO2	x				x	x
CO3		x	x		x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Population Theories (13 Hrs)				
Coverage and content errors in demographic data	1.1	1	3	Lecture, Class room exercise
Use of balancing equations and Chandrasekaran-Deming formula to check completeness of registration data.	1.2	1	2	Lecture, Class room exercise
Adjustment of age data, use of Myer and UN indices, Population composition, dependency ratio	1.3	1	2	Lecture, Class room exercise
Problems (Practicum)		1	6	Lecture, Class room exercise and Assignment



Module 2: Introduction to Vital Statistics (25 Hrs)				
Introduction and sources of collecting data on vital statistics, errors in census and registration data, Measurement of population, rate and ratio of vital events.	2.1	2	2	Lecture
Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Comparative mortality index, Cause of Death Rate	2.2	2	2	Lecture
Maternal Mortality Rate (MMR), Infant Mortality Rate (IMR), Case Fatality Rate	2.3	2	3	Lecture, Class room exercise
Life table-description, construction of a life table, abridged life table, King's method, Greville's method and method of Reed and Merrell, Use of Life table	2.4	2	3	Lecture, Class room exercise and Assignments
Measurement of fertility -Crude Birth Rate (CBR), General Fertility Rate (GFR), Age-Specific Fertility Rate, Total Fertility Rate (TFR)	2.6	2	3	Lecture, Class room exercise and Assignments
Problems (Practicum)		2	12	Lecture, Class room exercise and Assignments
Module 3: Measurement of Population Growth (22 Hrs)				
Measurement of population growth-crude rate of natural increase and vital index, Gross Reproduction Rate (GRR), Net Reproduction Rate (NRR).	3.1	3	4	Lecture, Class room exercise and Assignments
Measurement of morbidity- morbidity incidence rate, morbidity prevalence rate, Graduation formulae used in vital statistics- graduation of population data, logistic curve, fitting a logistic curve	3.2	3	3	Lecture, Class room exercise and Assignments
Graduation of mortality rates, Makeham's graduation formula, Fitting Makeham's formula, Population Projection.	3.3	3	3	Lecture, Class room exercise and Assignments
Problems (Practicum)	3.4	3	12	Class room exercise and Assignment
Module 4: Indian Official Statistics (15 Hrs)				
Population Statistics, Agricultural statistics, Price statistics, Industrial statistics, Trade statistics, Labour statistics, Transport and communication statistics, Miscellaneous statistics	4.1	4	6	Lecture
Ministry of Statistics & Program Implementation (MoSPI), Responsibilities of NSO, Programme implementation wing and administration division	4.1	4	6	Lecture, Class room exercise and Assignments
National Sample Survey (NSS), Central Statistics office (CSO), National Statistical commission, Indian Statistical Institute	4.3	4	3	Lecture, Class room exercise and assignment

**Module 5: Teacher Specific Content**

(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)

This content will be evaluated internally

Practicum

Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills using R programming.

The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a record of the solutions should be kept in hand.

Textbooks

1. Goon, A. M., Gupta, N. K., & Das Gupta, B. Fundamentals of Statistics- Vol.2. World Press, Calcutta, 2008
2. Gupta, S. P. Statistical Methods, 45th ed., Sultan Chand & Sons, 2019.

Reference

1. Mukhopadhaya, P. Applied Statistics. New Central Book Agency (P) Ltd., Calcutta, 1999.
2. Cox, P.R., Demography, Cambridge University Press, 1976
3. Poston D. L. and Bouvier L. F., Population and Society – An Introduction to Demography, Cambridge University Press, 2010
4. Keyfitz N., Caswell H., Applied Mathematical Demography, Springer, 2005

Course designed by: Ms Devi N



SBU24ST2MDC100: APPLIED STATISTICS

Type of Course	MDC		
Course Level	100-199		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	30	30	60
Pre-requisite (if any)	-		

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the basic concepts of probability	U
CO2	Compute the probability of events of random experiments.	A
CO3	Analyse the two sets of data using correlation and regression	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1						1	-	1	1	-
CO2						2	1	1	1	-
CO3						1	1	1	2	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	I	II	Written Test I	Written Test II	
CO1		x	x	x	x
CO2	x	x	x	x	x
CO3	x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Probability (17 Hrs)				
Random Experiment, Sample Space, Events	1.1	1	2	Lecture and Class room exercise
Classical Definition	1.2	1	2	Lecture, Class room exercise and Assignments
Empirical Definition	1.3	1	1	Lecture and Class room exercise
Axiomatic Definition	1.4	1	2	Lecture and Class room exercise
Computing Probabilities Using R (Practicum)		1	10	Lecture and Class room exercise
Module 2: Conditional Probability and Baye's Theorem (21 Hrs)				
Conditional Probability	2.1	2	4	Lecture, Class room exercise and Assignments
Baye's Theorem	2.2	2	4	Lecture, Class room exercise and Assignments



Geometric Probability	2.3	2	3	Lecture and Class room exercise
Computing Conditional Probabilities Using R (Practicum)		2	10	Lecture and Class room exercise
Module 3: Correlation and Regression (22 Hrs)				
Introduction to bivariate data, Scatter Plot	3.1	3	4	Lecture and Class room exercise
Correlation Analysis	3.2	3	4	Lecture, Class room exercise and Assignments
Regression Analysis	3.3	3	4	Lecture, Class room exercise and Assignments
Computing Correlation and Regression Using R (Practicum)		3	10	Lecture and Class room exercise
Module 4: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills using R programming. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a record of the solutions should be kept in hand.				

Textbook

1. Gupta, S. C., and V. K. Kapoor. Fundamentals of Mathematical Statistics, 11th ed., Sultan Chand & Sons, 2017.

Reference

1. Gupta, S. P. Statistical Methods, 45th ed., Sultan Chand & Sons, 2019.
2. Agarwal, B. L. Basic Statistics, New Age International(P) LTD, 2006.
3. Goon, A. M., Gupta, N. K., & Das Gupta, B. Fundamentals of Statistics-Vol.2, World Press, Calcutta, 1999.
4. Feller, William. An Introduction to Probability Theory and Its Applications, 3rd ed., Wiley, 1968.

Course designed by: Ms Devi N



SEMESTER III

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24ST3DSC200	Minor	Inferential Statistics	5	75	4
SBU24ST3MDC200	MDC	Statistical Optimisation	3	45	3
SBU24ST3VAC200	VAC	Environmental Statistics	3	45	3



SBU24ST3DSC200: INFERENTIAL STATISTICS

Type of Course	Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	-		

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss different sampling distributions and their applications	U
CO2	Describe theory of estimation and methods	A
CO3	Explain the concept of hypothesis testing, apply large and small sample tests for testing various statistical hypothesis.	A
CO4	Apply different non-parametric tests in testing the hypothesis.	A
CO5	Conduct estimation and testing of hypothesis for data using R	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1						1	-	1	-	-
CO2						1	1	1	-	-
CO3						1	1	1	2	1
CO4						1	1	2	1	1
CO5						-	1	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x			x		x
CO2	x		x	x		x
CO3		x	x		x	x
CO4		x	x		x	x
CO5		x	x	x	x	

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Sampling Distributions (13 Hrs)				
Parameter and Statistic, Sampling distribution, Standard error	1.1	1	2	Lecture
Sampling distribution of Mean and Variance	1.2	1	1	Lecture, Class room exercise
t-distribution, F- distribution with their applications, Chi-square distribution and its properties	1.3	1	2	Lecture, Class room exercise
Inter relationships between t, F and Chi square distributions	1.4	1	2	Lecture, Class room exercise



Illustrate these concepts using R (Practicum)	1.5	5	6	Lecture, Class room exercise
Module 2: Theory of Estimation (22 Hrs)				
Parameter space, Estimator, Characteristics of Estimators	2.1	2	2	Lecture
Point estimation, Minimum Variance Unbiased Estimators (definition only), Cramer-Rao inequality (statement only)	2.2	2	4	Lecture
Methods of estimation- Methods of Maximum Likelihood Estimation and its properties (statement), Method of Moments, Method of Minimum Variance(statement)	2.3	2	4	Lecture, Class room exercise
Interval Estimation- concepts, Confidence Interval, confidence coefficient	2.4	2	2	Lecture, Class room exercise and Assignments
Construction of confidence interval for mean, variance and proportion	2.5	2	3	Lecture, Class room exercise and Assignments
Illustrate these concepts using R (Practicum)		5	7	Lecture, Class room exercise
Module 3: Testing of Hypothesis (22 Hrs)				
Statistical hypothesis-Null and Alternative hypothesis, Simple and Composite hypothesis	3.1	3	2	Lecture
Type1 and Type 2 error, Critical Region, Level of significance, Power of the test	3.2	3	2	Lecture, Classroom exercise
Steps involving testing of hypothesis, P-Value, Neyman -Pearson Lemma (without proof)	3.3	3	2	Lecture
Large Sample Tests- Test for population mean, Difference of two means, Population Proportion, Difference of Proportion	3.4	3	4	Lecture, Class room exercise and Assignments
Small Sample Tests- t-test for single mean, t-test for difference of means, Paired t- test for means	3.5	3	3	Lecture, Class room exercise and Assignments
Illustrate these concepts using R (Practicum)	3.6	5	9	Lecture, Class room exercise
Module 4: Non-Parametric Tests (18 Hrs)				
Introduction to Non-parametric tests	4.1	3,4	1	Lecture
Chi-square test for Goodness of Fit, Test of Independence of Attributes	4.2	3,4	2	Lecture, Class room exercise and Assignments
Sign test, sign test for paired data	4.3	4	2	Lecture, Class room exercise
Run test, Test for Randomness	4.4	4	3	Lecture and Class room exercise
Kruskal Walli's H test	4.5	4	2	Lecture, Class room exercise
Illustrate these concepts using R (Practicum)	4.6	5	8	Lecture, Class room exercise
Module 5: Teacher Specific Content				
<i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i>				
This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills using R programming.				



The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a record of the solutions should be kept in hand.

Textbooks

1. Gupta, S. C., and V. K. Kapoor. Fundamentals of Mathematical Statistics, 11th ed., Sultan Chand & Sons, 2017.
2. Gupta, S. P. Statistical Methods, 45th ed., Sultan Chand & Sons, 2019.

Reference

1. Mood, A. M., Graybill, F. A., & Boes, D. C. Introduction to The Theory of Statistics, 3rd ed. (Reprint), Tata McGraw-Hill Pub. Co. Ltd, 2007.
2. Rohatgi, V. K., & Saleh, A. M. E. An Introduction to Probability and Statistics, 2nd ed., John Wiley & Sons, Inc, New York, 2001.
3. Freund, John E. Mathematical Statistics, Pearson Edn, New Delhi, 2002.
4. Purohit, Sudha G., Gore, Sharad D., & Deshmukh, Shailaja. Statistics using R, 2nd ed., Narosa Publishing House, 2019.

Course designed by: Ms Devi N



SBU24ST3MDC200: STATISTICAL OPTIMISATION

Type of Course	MDC		
Course Level	200-299		
Credit	3		
Course Delivery	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
Duration	45		45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the concept of optimization	U
CO2	Apply transportation and assignment problem in various situations	A
CO3	Identify strategic situations, represent it as games and solving	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1						1	1	1	-	1
CO2						1	1	1	2	1
CO3						1	1	1	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	I	II	Written Test I	Written Test II	
CO1		x	x	x	x
CO2	x	x		x	x
CO3	x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to LPP (15 Hrs)				
Linear Programming Problem- Definition, Assumptions, Importance	1.1	1	4	Lecture and Class room exercise
Mathematical Formulation, General Linear Programming Problems	1.2	1	4	Lecture and Class room exercise
Solution of a Linear Programming Problem	1.3	1	3	Lecture and Class room exercise
Graphical Method	1.4	1	4	Lecture, Class room exercise and assignment
Module 2: Transportation and Assignment Problem (15 Hrs)				
Transportation Problem – Definition, Methods for Finding Initial Basic Feasible Solutions by North West Corner Rule, Least Cost method	2.1	1	5	Lecture and Class room exercise
Vogel's Approximation Method, MODI Method for Optimal Solution	2.2	1,2	6	Lecture, Class room exercise



Assignment Problem	2.3	1,2	4	Lecture, Class room exercise and Assignments
Module 3: Introduction to Game Theory (15 Hrs)				
Game Theory- Introduction, Two-Person Zero Sum Game	3.1	3	4	Lecture and Class room exercise
Pure and Mixed Strategy, Maximin-Minimax Principle	3.2	3	4	Lecture, Class room exercise and Assignments
Games with and without saddle point	3.3	3	4	Lecture, Class room exercise and Assignments
Principle of Dominance	3.4	3	3	Lecture and Class room exercise
Module 4: Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbook

1. Kanti Swarup, P. K. Gupta, and Man Mohan. Operation Research. Sultan Chand and Sons, 1997.

Reference

1. Taha, Hamdy A. Operations Research. Pearson Education Publication, 2014.
2. Gupta, R. K. Operations Research. Krishna Prakashan Media (P) Ltd., Meerut, 2010.
3. Bronson, Richard, and Naadimuthu, G. Operation Research. Schaum's Outline Series, McGraw-Hill Education, 1997.
4. Mittal, S. K., and Goel, B. S. Operations Research. Pragati Prakashan, Meerut, 1990.

Course designed by: Ms Devi N



SBU24ST3VAC200: ENVIRONMENTAL STATISTICS

Type of Course	VAC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45		45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the statistical concepts to environmental data	U
CO2	Develop skills in data collection, organization and presentation in environmental studies	A
CO3	Apply statistical methods to assess environmental quality and evaluate environmental impacts.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1						1	1	-	1	-
CO2						1	1	1	2	1
CO3						1	1	1	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2		x	x		x	x
CO3		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Environmental Statistics (15 Hrs)				
Introduction to environmental statistics	1.1	1	5	Lecture
Importance of statistical methods in environmental data	1.2	1	5	Lecture and Class room exercise
Probability distributions applicable to environmental variables	1.3	1	5	Lecture, Class room exercise and Assignments
Module 2: Introduction Environmental Modelling (15 Hrs)				
Environmental modelling using statistics	2.1	2	8	Lecture, Class room exercise and Assignments
Environmental impact assessment	2.2	2	7	Lecture, Class room exercise and Assignments
Module 3: Applications of Environmental Statistics (15 Hrs)				
Climate change statistics	3.1	3	7	Lecture and Demo



Applications and case studies	3.2	3	8	Lecture, Class room exercise and Assignments
Module 4: Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbook

1. Barnett, Vic. Environmental Statistics: Methods and Applications. John Wiley & Sons, Ltd, 2004.

Reference

1. Manly, Bryan F. J. Statistics for Environmental Science and Management, 2nd ed., CRC Press, 2008.
2. Wheater, C. Philip, and Penny A. Cook. Using Statistics to Understand The Environment, 1st ed., Routledge, 2000.

Course designed by: Ms Devi N



SEMESTER IV

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24ST4DSC200	Minor	Statistical Quality Control	5	75	4
SBU24ST4VAC200	VAC	Statistical Modelling	3	45	3
SBU24ST4SEC200	SEC	Survey Techniques	3	45	3



SBU24ST4DSC200: STATISTICAL QUALITY CONTROL

Type of Course	Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	-		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the basic concepts of statistical quality control	U
CO2	Identify the role of quality control in various industries	A
CO3	Apply statistical methods for quality improvement	A
CO4	Interpretation and analysis of control charts	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1						1	-	1	1	-
CO2						1	1	1	1	1
CO3						1	1	1	2	1
CO4						1	1	-	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x		x
CO2	x		x	x		x
CO3		x	x		x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Statistical Quality Control (19 Hrs)				
Process Control and product control, Assignable and Chances causes	1.1	1	2	Lecture
Definition of Quality Control and Statistical Quality Control, Importance of Statistical Quality Control Techniques in Industry, Causes of Quality Variation	1.2	1	3	Lecture, Class room exercise
Control charts, Operation and Uses of Control Charts	1.3	1	3	Lecture, Class room exercise
Probability Limits, Specification Limits, Tolerance Limits, 3 Sigma Limits and Warning Limits	1.4	1	4	Lecture, Class room exercise



Illustrate these concepts using R/Excel (Practicum)		1	7	Lecture, Class room exercise
Module 2: Control Charts for Variables (18 Hrs)				
$\bar{X}$ - Chart, R-Chart, Purpose of The Charts	2.1	2	3	Lecture, Class room exercise
Rational of Sub Grouping, Plotting of $\bar{X}$ And R Charts	2.2	2	4	Lecture, Class room exercise
Standard Out of Control Pattern on Control Charts, Interpretation of Control Charts.	2.3	2	4	Lecture, Class room exercise
Illustrate these concepts using R/Excel (Practicum)		2	7	Lecture, Class room exercise and Assignments
Module 3: Control Charts for Attributes (17 Hrs)				
Construction and Operation of P-Chart, Np-Chart, C - Chart and U- Chart	3.1	3	5	Lecture, Class room exercise
Choices Between Various Attribute Charts	3.2	3	1	Lecture, Class room exercise
Comparison Between Variable and Attribute Charts	3.3	3	3	Lecture
Illustrate these concepts using R/Excel (Practicum)		3	8	Lecture, Class room exercise and Assignments
Module 4: Product Control (21 Hrs)				
Principles of Acceptance Sampling, Stipulation of Good and Bad Lots, Producers and Consumers Risks	4.1	3,4	4	Lecture
Concepts of AQL and LTPD	4.2	3,4	3	Lecture, Class room exercise and Assignments
Simple and Double Sampling Plans, Their O.C and ASN Functions	4.3	4	3	Lecture, Class room exercise
Design of Single and Double Sampling Plans for Attributes using Binomial Distribution	4.4	4	3	Lecture, Class room exercise and Assignments
Illustrate these concepts using R/Excel (Practicum)		4	8	Lecture, Class room exercise
Module 5: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills using R programming/Excel. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a record of the solutions should be kept in hand.				

Textbook

1. Montgomery, D.C. Statistical Quality Control: A Modern Introduction, 6th ed., Wiley India Pvt. Ltd, 2010.
2. Gupta, S.C., and Kapoor, V.K. Fundamentals of Applied Statistics, Sultan Chand & Co., New Delhi, 2014.



Reference

1. Grant, E.L., and Leavenworth, R.S. Statistical Quality Control, 7th ed., Tata McGraw-Hill, 2008.
2. Duncan, A.J. Quality Control and Industrial Statistics, R. D. Irwin, 1986.
3. Levin, Richard I., David S. Rubin, Masood H. Siddiqui, and Sanjay Rastogi. Statistics for Management, 8th ed., Pearson Education, 2017.
4. Purohit, Sudha G., Gore, Sharad D., & Deshmukh, Shailaja. Statistics using R, 2nd ed., Narosa Publishing House, 2019.

Course designed by: Ms Devi N



SBU24ST4VAC200: STATISTICAL MODELLING

Type of Course	VAC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45		45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the concepts of statistical modelling and their relevance in various fields.	U
CO2	Develop skills in model building, model validation and interpretation of results.	A
CO3	Apply statistical modelling techniques to real world data	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1						1	1	-	1	1
CO2						1	2	1	1	-
CO3						1	2	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2		x	x	x	x	x
CO3		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Statistical Modelling (13 Hrs)				
Introduction to statistical modelling	1.1	1	4	Lecture
Basic Concepts	1.2	1	4	Lecture
Importance and Applications	1.3	1	5	Lecture, Class room exercise
Module 2: Linear Regression Models (17 Hrs)				
Simple linear regression models	2.1	2	6	Lecture, Class room exercise and Assignments
Multiple linear regression models	2.2	2	6	Lecture, Class room exercise and Assignments
Interpretation of regression coefficients	2.3	2	5	Lecture, Class room exercise
Module 3: Non-Linear Regression Models (15 Hrs)				
Non-linear regression models	3.1	3	5	Lecture, Class room exercise and Assignments



Interpretation of Non-linear regression models	3.2	3	5	Lecture, Class room exercise and Assignments
Applications of Non-linear regression models	3.3	3	5	Lecture, Class room exercise
Module 4: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Textbook

1. Freedman, David A. Statistical Models: Theory and Practice, Revised Edition, Cambridge University Press, 2009.

Reference

1. Gujarati, Damodar. Basic Econometrics, 4th ed., McGraw Hill, New York, 2003.
2. Maddala, G. S. Introduction to Econometrics, 3rd ed., John Wiley and Sons, New York, 2002.

Course designed by: Ms Devi N



SBU24ST4SEC200: SURVEY TECHNIQUES

Type of Course	SEC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45		45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the types of data and concepts of survey	U
CO2	Construct questionnaire for survey	A
CO3	Identifying and handling data entry errors	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1						1	1	1	-	1
CO2						1	2	2	1	2
CO3						1	2	1	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x	x	x
CO2	x	x	x		x	x
CO3		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Survey and Sampling (15 Hrs)				
Data-Types, Organisation, Classification and Presentation	1.1	1	5	Lecture, Class room exercise
Introduction to survey, Purpose of survey	1.2	1	3	Lecture
Inference and Error in surveys	1.3	1	2	Lecture
Different types of Sampling- Simple Random Sampling, CRLuster Sampling, Stratified and Systematic Sampling	1.4	1	5	Lecture, Class room exercise and Assignments
Module 2: Modes of Survey Administration (15 Hrs)				
Modes of Survey Administration and Problems in answering survey questions	2.1	2	5	Lecture and Class room exercise
Questionnaire preparation- Guidelines for writing good questions	2.2	2	5	Lecture, Demo, Class room exercise and Assignments
Data collection and field work	2.3	2	5	Lecture, Demo, Class room exercise and Assignments
Module 3: Procedures for Entering Data (15 Hrs)				
Procedures for entering data	3.1	3	5	Lecture, Demo



Identifying and handling data entry errors	3.2	3	5	Lecture, Class room exercise
Data cleaning and validation	3.3	3	5	Lecture, Class room and exercise
Module 4: Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbook

1. Bethlehem, Jelke. Applied Survey Methods: A Statistical Perspective. John Wiley & Sons, Inc., 2009.

Reference

1. Rea, Louis M., and Richard A. Parker. Designing & Conducting Survey Research: A Comprehensive Guide, 3rd ed., John Wiley & Sons, 2005.
2. Johnson, Robert L., and Grant B. Morgan. Survey Scales: A Guide to Development, Analysis and Reporting, Guilford Press, 2016.
3. Robinson, Sheila B., and Kimberly Firth Leonard. Designing Quality Survey Questions, 1st ed., SAGE Publications, 2018.
4. Fowler, Jr., Floyd J. Survey Research Methods, 5th ed., SAGE Publications, 2013.

Course designed by: Ms Devi N



SEMESTER V

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24ST5DSC300	Minor	Numerical Analysis	5	75	4



SBU24ST5DSC300: NUMERICAL ANALYSIS

Type of Course	Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	-		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the numerical methods for solving mathematical problems in statistics	A
CO2	Understand the concept of Interpolation	U
CO3	Evaluate the accuracy and efficiency of polynomial interpolation methods	E
CO4	Understand the fundamental concepts of Fourier series and their importance in numerical analysis and apply numerical integration and differentiation methods	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1						1	1	-	1	2
CO2						1	1	1	1	1
CO3						1	1	-	1	1
CO4						1	1	-	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x			x		x
CO2	x		x	x		x
CO3		x	x		x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Solution of Equations (19 Hrs)				
Bisection Method	1.1	1	3	Lecture, Class room exercise
Method of False Position	1.2	1	3	Lecture, Class room exercise
Iteration Method, Aitken's Δ process	1.3	1	3	Lecture, Class room exercise
Newton – Raphson Method, Generalised Newton's Method	1.4	1	3	Lecture, Class room exercise
Problems (Practicum)		1	7	Class room exercise
Module 2: Introduction to Interpolation (18 Hrs)				
Errors in Polynomial Interpolation	2.1	2	3	Lecture, Class room exercise



Finite Differences - Forward Differences, Backward Differences, Central Differences	2.2	2	4	Lecture, Class room exercise
Symbolic Relations	2.3	2	2	Lecture, Class room exercise
Difference of a Polynomial and Newton's Formulae for Interpolation	2.4	2	2	Lecture, Class room exercise
Problems (Practicum)		2	7	Lecture, Class room exercise and Assignments
Module 3: Fourier Approximations (17 Hrs)				
Fourier series, Fourier transform	3.1	3	3	Lecture, Class room exercise
Discrete Fourier transform (DFT)	3.2	3	3	Lecture, Class room exercise
Inverse Discrete Fourier transform (IDFT).	3.3	3	3	Lecture
Problems (Practicum)		3	8	Lecture, Class room exercise and Assignments
Module 4: Numerical Differentiation and Integration (21 Hrs)				
Introduction to numerical differentiation and errors in numerical differentiation.	4.1	4	3	Lecture
Numerical Integration- Trapezoidal Rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule	4.2	4	6	Lecture, Class room exercise and Assignments
Boole's and Weddle's Rules.	4.3	4	4	Lecture, Class room exercise
Problems (Practicum)		4	8	Lecture, Class room exercise
Module 5: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills using R programming/Excel. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a record of the solutions should be kept in hand.				

Textbook

1. S. S. Sastry, Introductory Methods of Numerical Analysis, 5th ed., PHI Learning Private Limited, New Delhi

Reference

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th ed., Wiley, New Delhi, 2015
2. James B., Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing, 2017
3. Francis Shield, Numerical Analysis, McGraw-Hill Education, 1988
4. F. B. Hildebrand, Introduction to Numerical Analysis, McGraw-Hill, 1956

Course designed by: Ms Devi N



SEMESTER VI

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24ST6DSC300	Minor	Stochastic Process and Queueing Theory	5	75	4



SBU24ST6DSC300: STOCHASTIC PROCESS AND QUEUEING THEORY

Type of Course	Minor		
Course Level	300-399		
Credit	4		
Course Delivery	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
Duration	45	30	75
Pre-requisite (if any)	-		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the concept of stochastic processes and its properties	U
CO2	Understand various types of stochastic processes	U
CO3	Describe the properties and applications of Poisson processes	A
CO4	Analyze and solve problems involving standard queueing models	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1						1	-	1	1	1
CO2						1	-	1	1	1
CO3						1	1	1	2	1
CO4						1	1	1	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	I	II	III	Written Test I	Written Test II	
CO1	x		x	x		x
CO2	x		x	x	x	x
CO3	x		x		x	x
CO4		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Stochastic Processes (19 Hrs)				
Classification of stochastic processes, Wide sense and Strict sense stationary processes	1.1	1	2	Lecture, Class room exercise
Processes with stationary independent increments	1.2	1	3	Lecture, Class room exercise
Markov process, Markov chains- transition probability matrices	1.3	1	3	Lecture, Class room exercise
Chapman-Kolmogorov equation, Computation of higher step transition probabilities	1.4	1	4	Lecture, Class room exercise
Problems (Practicum)		1	7	Lecture, Class room exercise
Module 2: Classification of States (18 Hrs)				
First passage probabilities, criteria for recurrent and transient states, Communication of states	2.1	2	3	Lecture, Class room exercise



Reducible and irreducible Markov chains, mean recurrence time	2.2	2	4	Lecture, Class room exercise
Classification of States Stationary distribution and limiting probabilities	2.3	2	4	Lecture, Class room exercise
Problems (Practicum)		2	7	Class room exercise and Assignments
Module 3: Poisson Processes (17 Hrs)				
Poisson processes - derivation and properties	3.1	3	2	Lecture, Class room exercise
Inter-arrival time distribution and waiting times	3.2	3	2	Lecture, Class room exercise
Birth and Death processes	3.3	3	2	Lecture, Class room exercise
Kolmogorov differential equations, linear growth process with immigration	3.4	3	3	Lecture, Class room exercise
Problems (Practicum)		3	8	Class room exercise and Assignments
Module 4: Queueing Theory (21 Hrs)				
Steady-State solutions of Markovian queues - M/M/1, M/M/s, M/M/ ∞ models	4.1	4	4	Lecture, Class room exercise and Assignments
Queue length, System length, Mean Waiting time, Little's Formula, M/M/1/k queues	4.2	4	5	Lecture, Class room exercise and Assignments
M/G/1 and G/M/1 queues and their interarrival, waiting time distribution	4.3	4	4	Lecture, Class room exercise
Problems (Practicum)		4	8	Lecture, Class room exercise
Module 5: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				
Practicum				
Practicum is designed to provide supervised practical application of theoretical knowledge and skills and its purpose is to encourage creativity and develop Problem solving skills using R programming/Excel. The practicum component is to be done in the classroom under the strict guidance of the teachers. A minimum of 15 problems is to be solved, and a record of the solutions should be kept in hand.				

Textbook

1. Karlin S. and Taylor H.M., A First Course in Stochastic Processes, 2nd ed., Academic Press, New-York, 1975
2. Donald Gross, John F. Shortle, James M. Thompson, Carl M. Harris, Fundamentals of Queueing Theory, 4th ed., Wiley Asia, 2012

Reference

1. J. Medhi, Stochastic Processes, 2nd ed., Wiley Eastern, New Delhi, 2017
2. Ross S.M., Stochastic Processes., 2nd ed., Wiley Eastern, New Delhi, 2007
3. Peter W. Jones, peter Smith, Stochastic Processes An Introduction, 3rd ed., CRC Press, 2017



4. U. Narayan Bhat, An Introduction to Queueing Theory Modeling and Analysis in Applications, 2nd ed., Birkhäuser, 2015

Course designed by: Ms Devi N



Rubrics for the Assessment of Theory Courses

The rubrics provided below serve as general guidelines and may require adjustments based on the specific requirements and focus areas of different theory courses in Statistics. Adjustments may include placing more emphasis on certain criteria, adding specific requirements, or modifying the scoring scale to better reflect the expectations of the course.

1. ASSIGNMENT

Rubrics for the Assessment

Criteria	Level 4	Level 3	Level 2	Level 1
Level of Content	All aspects regarding the topic are covered	Some aspects are missing	Many relevant aspects regarding the topic are missing	Essential aspects related to the topic are largely absent, leading to substantial deficiencies in coverage.
Organization	Writing is coherent and logically organized. Overall unity of ideas is present.	Writing is impartially coherent and medium level of logical organization.	Writing lacks logical organization. It shows some coherence but ideas lack unity.	The writing lacks coherence and organization, making it challenging to follow the flow of ideas.
Reference	Enough reference and all the sources are authentic	Sources are listed properly but many are unauthentic	Lack clarity of sources and are unauthentic	Sources are unclear, and authenticity is severely compromised due to a complete absence of verification.

Penalty for Late submission:

If submitted within one week after the stipulated time 75% of the marks calculated as per the above rubrics will be awarded to the student. If submission is after one week of deadline but within the extended time fixed by the course in charge, only 50% of the marks determined as per rubrics will be awarded.

2. SEMINAR PRESENTATION

Rubrics for the Assessment

Criteria	Level 4	Level 3	Level 2	Level 1
Content	Comprehensive, well-researched, relevant, and insightful.	Solid coverage of main points, well-researched, mostly relevant.	Adequate coverage of main points, lacking depth or relevance.	Minimal, inaccurate, or irrelevant content.
Organization	Clear structure, logical flow, seamless transitions.	Logical structure, clear sections, some transitions.	Basic structure, unclear transitions, some sections underdeveloped.	Disorganized, random structure, unclear sections.



Delivery	Confident, engaging, dynamic, clear articulation.	Mostly confident, engaging, occasional lack of clarity.	Hesitant, inconsistent, lacks enthusiasm.	Unclear, hesitant, monotone, lacks engagement.
Knowledge/ Understanding about the subject	Sound understanding about the subject and communicated it well.	Knowledge about the subject is good and tried to exhibit it to a certain extent.	Knowledge about the subject is fairly good but not exhibited through presentation.	Knowledge about the subject of presentation is not up to the mark.
Answering Questions	Answered all questions convincingly.	Answered majority of the questions.	Tried to answer some questions but not so successful.	Not able to answer any question.

3. VIVA-VOCE Rubrics for the Assessment

Criteria	Level 4	Level 3	Level 2	Level 1
Knowledge	Deep and comprehensive understanding, clear, accurate, and insightful responses.	Solid understanding, mostly clear and accurate responses, occasional lack of depth.	Some understanding, responses lack depth or clarity.	Little understanding, struggles with clear or accurate responses.
Critical Thinking	Applies critical thinking effectively, analyzes and evaluates concepts, draws connections.	Demonstrates critical thinking skills but may need prompting, limited depth.	Limited critical thinking, responses lack depth or insight.	Little to no critical thinking, simplistic or superficial responses.
Communication	Clear, confident, and persuasive communication, appropriate language.	Effective communication, occasional lack of confidence or clarity, occasional language issues.	Communication is unclear or hesitant, inconsistent language use.	Unclear or hesitant communication, inappropriate language.
Engagement	Actively engages with enthusiasm, asks insightful questions, and contributes to the conversation.	Engages but may need encouragement, shows some enthusiasm.	Engagement is limited, minimal participation, lacks enthusiasm.	Little to no engagement, minimal participation, demonstrates disinterest.



4. WORKBOOK

Rubrics for the Assessment

Criteria	Level 4	Level 3	Level 2	Level 1
Accuracy	All solutions are accurate, demonstrating a high level of statistical understanding concepts and proficiency.	Most solutions are correct, with only minor errors present in a few.	Some solutions are correct, but there are frequent errors or inconsistencies.	Many solutions contain significant errors or are completely incorrect.
Completeness	All solutions are fully complete, including all necessary steps, explanations, and diagrams where applicable.	Most solutions are complete, with all necessary steps and explanations provided.	Some solutions are incomplete, missing important steps or explanations.	Many solutions are incomplete or lack essential steps or explanations.
Clarity	Solutions are exceptionally clear, with concise and coherent explanations that make the solving process easy to understand for readers of varying levels of statistical proficiency.	Solutions are clear and easy to follow, with explanations that are generally well-written and understandable.	Basic plan, lacks organization or realism. Solutions are generally clear, but some explanations may be confusing or unclear.	Solutions are difficult to follow or understand due to unclear explanations or notation.
Organization	Solutions are impeccably organized, with a clear and logical flow that guides the reader through the problem-solving process effortlessly.	Adequate execution, may encounter challenges. Solutions are well-organized, with a clear structure and logical progression from one step to the next.	Solutions are somewhat organized, but the structure could be improved for better clarity and coherence.	Solutions are disorganized, with no clear structure or logical progression.
Neatness and Presentation	Solutions are impeccably neat and well-presented, with consistently legible handwriting and professionally drawn diagrams that enhance understanding.	Solutions are neatly presented, with consistent handwriting and clear, well-drawn diagrams.	Solutions are generally neat, but handwriting may be inconsistent, or diagrams may be somewhat unclear.	Solutions are messy, with illegible handwriting or poorly drawn diagrams.



5. RECORD

Rubrics for the Assessment

Criteria	Level 4	Level 3	Level 2	Level 1
Completeness	All experiments are fully complete, including all necessary steps, explanations, and diagrams where applicable.	Most experiments are complete, with all necessary steps and explanations provided.	Some experiments are incomplete, missing important steps or explanations.	Many experiments are incomplete or lack essential steps or explanations.
Neatness and Presentation	Solutions are impeccably neat and well-presented, with consistently legible handwriting and professionally drawn diagrams that enhance understanding.	Solutions are neatly presented, with consistent handwriting and clear, well-drawn diagrams.	Solutions are generally neat, but handwriting may be inconsistent, or diagrams may be somewhat unclear.	Solutions are messy, with illegible handwriting or poorly drawn diagrams.
Punctuality	Submission of completed experiments with output on the ensuring day	Submission of record with some experiments	Submission of record having some experiments without outputs.	Delay in timely submission of record sheets

6. ONLINE or OFFLINE QUIZ (MCQ)

It will be an online or offline test comprising 10 or 20 multiple choice questions of 15 or 30 minutes duration. Maximum marks will be 10 or 20. Each question will carry 1 mark. Online test will conduct via platform like Linways LMS, Google form, Quizizz etc.



SHORT TERM COURSES

The main objective of the short term courses offered by the college is to supplement the students with various skills and technical know-how outside the structured academic curriculum, to produce quality citizens who are academically proficient, self-reliant and socially committed. The courses have compulsory components and optional components that equip the students to attain various programme objectives envisaged by the Vision and Mission statements of the college.

All Short-Term Courses (STCs) are coordinated by the Department of Short Term Courses, headed by a Director and is supervised by a Vice Principal nominated by the Principal. Each component of the STC is coordinated and managed by a Faculty Convener. The Advisory Board of the Department consists of the Vice-Principals, Director of the Short Term Courses and the various Conveners.

In case of any grievances, students can approach the Grievance Redressal Cell of the STC which consists of the Vice-Principal in Charge, Director and the concerned Convener. If the student feels that the issue was not adequately addressed, he/she can approach the Grievance Redressal Cell of the college. The grading pattern for all courses will be the same as in the UG regulations 2024. The courses offered by the department are given in the following table.

	Name	Semesters	Type	Credit
1	Value Education	I to VI	Compulsory	3
2	Basic Life Support System and Disaster Management (BLS & DM)	I	Compulsory	1
3	Social Awareness Course (SAC)	I and II	Compulsory	2
4	Skill Development Courses (SDC)	II and III	Optional	2
5	Finishing School	III and IV	Compulsory	1
6	Virtual Lab Experiments	V	Optional	1



REGULATIONS FOR SHORT TERM COURSES

VALUE EDUCATION

Value Education is a compulsory extra credit course with three (3) credits for all the students admitted to the undergraduate programmes.

Duration

The duration of the course shall be three academic years (six semesters). There shall be minimum 60 Hrs spread over three years with 20 Hrs every academic year.

Evaluation

The evaluation of each course shall contain two parts.

- i. Continuous evaluation (every year)
- ii. Final evaluation (every year)

There shall be a maximum of 50 marks comprising of forty (40) marks for final evaluation and ten (10) marks for continuous evaluation.

Continuous Evaluation

Component	Marks
Assignment	5
Attendance	5
Total	10

1. Assignment

The students shall submit at least one assignment in every year. The marks for assignment is five (5).

2. Attendance

The minimum requirement of aggregate attendance during a year for appearing the final examination shall be 75%.

Marks for attendance

Maximum of five (5) marks will be given for attendance as follows.

% of Attendance	Marks
90 and above	5
85-89	4
80-84	3
76-79	2
75	1

(Decimals shall be rounded off to the next higher whole number)

Final evaluation

Final evaluation shall be conducted by the course coordinator at the end of every year.

There shall be an annual written examination of one and a half Hrs (1½) duration with a maximum forty marks (40), every year.

The question paper shall be strictly on the basis of model question paper set by the Expert Committee.

A question paper consists of short answer type, short essay type and long essay type questions.

The total marks of the course (three years combined) shall be one hundred and fifty (150).

Award of certificate

A separate minimum 30% mark each for continuous evaluation and final evaluation and an aggregate minimum of 35% are required for a pass in the course.

If a student does not acquire minimum marks in first and second years, he/she can continue the course.



The student shall be eligible to get certificate only after completing the course with D Grade. On successful completion of the course, the grade awarded will be indicated in the Mark cum Grade Card.

The grading pattern will be the same as in UG Regulations 2024.

The course shall be completed during the tenure of the programme.

BASIC LIFE SUPPORT SYSTEM AND DISASTER MANAGEMENT (BLS & DM)

- The main objective of this course is to provide intensive training on Basic Life Support System and Disaster Management with the help of professional trainers and adequate numbers of mannequins and kits for imparting the training to students.
- This course is compulsory for all the undergraduate students of this college and has one (1) credit.
- The course on BLS & DM shall be conducted by a nodal centre created in the College.
- Each student shall undergo five (5) Hrs of hands-on training in BLS & DM organised by the Centre for BLS & DM.
- After the completion of the training, the skills acquired shall be evaluated using an offline/online test and grades shall be awarded.
- Nodal Centre for BLS & DM shall conduct an online test and publish the results.
- Students who could not complete the requirements of the BLS & DM training shall appear for the same along with the next batch.
- The grading of the course is as per the grading pattern in UG Regulations 2024.



SOCIAL AWARENESS COURSE (SAC)

- The aim of SAC is to make students aware of the problems that different societies and communities face on a day-to-day basis and to be conscious of the difficulties and hardships of society.
- This is a compulsory course with two (2) credits.
- Social Awareness Course shall be conducted by a nodal centre consisting of the convenor, other faculty members nominated by the Principal.
- The centre shall identify the areas where the students can serve the society through the course.
- During the first semester itself, the centre shall organise activities to sensitize the students about the significance and relevance of Social Awareness and publish a list of different areas where they can work as volunteers.
- The centre shall allot students to various areas based on their preference.
- Students shall carry out the voluntary work allotted to them after the regular class Hrs/weekends/holidays falling in the first and second semesters and the summer vacation following the second semester.
- Evaluation of the SAC activity shall be based on the Hrs of work put in by a student. A minimum of 50 Hrs of social work (corresponding to 50 marks) is required for the successful completion of the course. Every additional work beyond the minimum 50 Hrs shall fetch five (5) marks per hour. Maximum marks shall be 100.
- Students who donate blood during the first year shall be given 10 marks on production of the certificate from the medical officer. However, marks earned through blood donation shall not be counted for a pass in the course. Mark for blood donation shall be awarded only once during the SAC.
- Two credits shall be awarded to students who complete the requirements of SAC.
- The grading will be as per the grading pattern in the UG Regulations 2024.
- Students who could not complete the requirements of the SAC shall appear for the same with the next batch.
- The Director of Short-Term Courses and Convenor of SAC has the right to exclude students who are physically challenged from SAC, if requested.



SKILL DEVELOPMENT COURSES (SDC)

- This is a compulsory component of STC with two (2) credits.
- SDC's shall be completed within the first four semesters of the programme.
- Depending on the nature of the course, there will be a theory component and a skill development component.
- The credit will be awarded only if the student gets a D grade (35% marks) and above.
- A student can do a maximum of three skill Development Courses according to his/her choice, but pass in at least one course is compulsory.
- The Convenor of SDC will coordinate the course.
- The Head of the Department concerned in consultation with the faculty members may prepare a syllabus for the SDC, which will be approved by the Board of Studies concerned.

Evaluation of SDC

The evaluation the course shall be done internally and contain two parts.

- Continuous evaluation
- Final evaluation

Both continuous evaluation and final evaluation shall be carried out using indirect grading. The marks for continuous evaluation is twenty (20) and that of the final evaluation is eighty (80).

Continuous evaluation

The components of the continuous evaluation and their marks are as below.

For all courses, without practical

There are two components for continuous evaluation, which include attendance and assignment. All the components of the continuous evaluation are mandatory.

Component	Marks
Attendance	5
Assignments	15
Total	20

Marks for attendance

Minimum 75% attendance is compulsory for attending the final examination.

% of Attendance	Marks
90 and above	5
85 - 89	4
80 – 84	3
76 – 79	2
75	1

(Decimals shall be rounded mathematically to the nearest whole number)

For all courses with practical

The components for continuous evaluation of courses with practical are given below.

Component	Marks
Attendance	5
Lab/skill work involvement	15
Total	20

Assignments

At least one assignment shall be submitted for the course.



Final evaluation

The final evaluation of theory and practical courses shall be conducted by the office of the Controller of Examinations. It can be in the form of 80 marks written examination or 80 marks project/practical examination or 80 marks written and project/practical examination combined, as decided by the Board of Studies concerned.

FINISHING SCHOOL

- It is a compulsory course with one (1) credit.
- The course provides compulsory training for all under graduate students of this college.
- The training is to help students develop their soft skills and interview skills.
- The training shall impart soft skills comprising of language skills, personal presentation and grooming, table manners, resume preparation, group discussion techniques, and interview skills among the undergraduate students.
- This course shall be conducted during the third and fourth semesters for all the undergraduate students.
- There will be a total of 20 contact Hrs which shall be handled by a team of professional members/faculty. In addition, a one-day outbound training session by a team of professional trainers that touches on the aspects of creativity, problem solving and team building shall also be organized.
- The students shall be assessed on the basis of the components given below.

Component	Marks
Attendance	5
Aptitude Test	10
Assignments	10
Group discussion	10
Interview	15
Total	50

Marks for attendance

Maximum of five (5) marks will be given for attendance as follows.

% of Attendance	Marks
90 and above	5
85-89	4
80-84	3
76-79	2
75	1

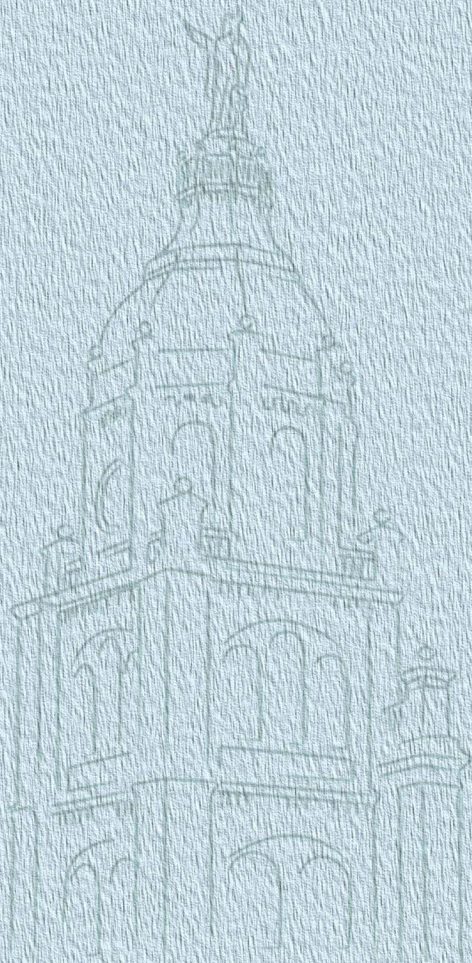
(Decimals shall be rounded off to the next higher whole number)

Grades will be awarded as per grading pattern in UG Regulations 2024.



VIRTUAL LAB EXPERIMENTS

- This is an optional course with one (1) credit.
- The main aim of the Virtual Lab Experiments is to provide remote-access to simulation-based Labs in various disciplines of Sciences which enthuse students to conduct experiments by arousing their curiosity.
- The Convenor will coordinate the Virtual Lab component and he may use the services available in different virtual lab platforms after the approval of the advisory body.
- Students have to do at least 36 Hrs of experiments and they get a maximum of one credit for this.
- Convenor and the mentor of the student shall oversee the progress and assign grades as per the grading pattern in UG Regulations 2024 after the completion of the programme.



St Berchmans College

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