THE MAHATMA GANDHI UNIVERSITY

UNDERGRADUATE PROGRAMMES

(HONOURS) SYLLABUS

MGU-UGP (Honours)

(2024 Admission Onwards)

Faculty : **Science**
BoS : **Mathematics**
Programme : **Bachelor of Science (Honours) Mathematics**

Mahatma Gandhi University

Priyadarsini Hills, Kottayam – 686560
Kerala, India

PREFACE

As recommended by the University Grants Commission (UGC) and proposed for implementation by Mahatma Gandhi University, the Board of Studies of Mathematics works to implement the Four Year Under Graduate Program (FYUGP).

The following facts are taken into consideration when designing the basic structure of the Under Graduate (UG) programme:

a) Flexibility to switch between disciplines of study,

b) Opportunity for learners to select the courses of their interest across all disciplines,

c) Flexibility for students to switch between institutions so they can engage in multi- and/or interdisciplinary learning,

d) Flexibility to switch to alternative modes of learning,

e) Knowledge required for self-employment initiatives and entrepreneurship mindset,

f) Ability for complex critical thinking and real-life problem solving,

g) Capability to understand global issues, multicultural competence and digital literacy,

h) Capable on research skills, communication skills, community based engagement, environment awareness, responsibility and accountability.

Board of Studies - Members

1. Sri. Jayaraj T
   Chairperson
   Associate Professor and Head of the Department
   SVR NSS College, Vazhoor, Kottayam.
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   St. Thomas College, Palai, Kottayam.
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   St. Stephen's College, Uzhavoor, Kottayam.
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   Assistant Professor
   Pavanatma College, Murickassery, Idukki.
8. Sri. Sugesh Kumar V
   Assistant Professor
   M.E.S College, Nedumkandam, Idukki.
9. Smt. Anu Ann James
   Assistant Professor
   Mar Thoma College, Tiruvalla, Pathanamthitta.
10. Sri. Liju Alex
    Assistant Professor
    Bishop Chulaparambil Memorial College,Kottayam.
11. Smt. Jayasree A S
    Associate Professor
    Sree Sankara College, Kalady.

List of Members of Scrutiny Committee

1. Sri. Jayaraj T

   Chairperson, UG BoS, Mathematics

   SVR NSS College, Vazhoor, Kottayam.

2. Dr. Madhavan Namboothiri N M

   Chairperson, PG BoS, Mathematics

   Government Arts and Science College, Santhanpara, Idukki.

3. Dr. Vishnu Nampoothiri K

   External Expert

   Baby John Memorial Government College, Chavara, Kollam.

4. Dr. K P Jose

   Internal Expert

   St. Peter's College, Kolenchery.

5. Sri. Tommy Thomas

   Member, UG BoS Mathematics

   St. Thomas College, Palai, Kottayam.

6. Dr. Jaya S

   Member, UG BoS Mathematics

   Maharaja's College Ernakulam.

7. Dr. Tijo James

   Course Parameter Expert

   Pavanatma College, Murickassery , Idukki.

8. Dr. Vinu T P

   Master Trainer

   NSS Hindu College, Changanassery, Kottayam.

Programme Outcomes (PO)

PO 1: Critical thinking and Analytical reasoning

Capability to analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.

PO 2 : Scientific reasoning and Problem solving

Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.

PO 3: Multidisciplinary/interdisciplinary/transdisciplinary Approach

Acquire interdisciplinary/ multidisciplinary/ transdisciplinary knowledge base as a consequence of the learning they engage with their programme of study; develop a collaborative-multidisciplinary/ interdisciplinary/ transdisciplinary - approach for formulate constructive arguments and rational analysis for achieving common goals and objectives.

PO 4: Communication Skills

Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.

PO 5: Leadership Skills

Ability to work effectively and lead respectfully with diverse teams; setting direction, formulating an inspiring vision, building a team that can help achieve the vision, motivating and inspiring team members to engage with

that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.

PO 6: Social Consciousness and Responsibility

Ability to contemplate of the impact of research findings on conventional practices, and a clear understanding of responsibility towards societal needs and reaching the targets for attaining inclusive and sustainable development.

PO 7: Equity, Inclusiveness and Sustainability

Appreciate equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified citizens; able to understand and appreciate diversity (caste, ethnicity, gender and marginalization), managing diversity and use of an inclusive approach to the extent possible.

PO 8: Moral and Ethical Reasoning

Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work, avoid unethical behavior.

PO 9: Networking and Collaboration

Acquire skills to be able to collaborate and network with educational institutions, research organisations and industrial units in India and abroad.

PO 10: Lifelong Learning

Ability to acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

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MG4DSCMAT200	**Matrix Algebra and Number Theory**	**4**
MG4DSCMAT201	**Fundamentals of Analysis**	**4**
MG4DSEMAT200	**Mathematical Modelling**	**4**
MG4DSEMAT201	**Transforms and Fourier Series**	**4**
MG4DSEMAT202	**Operations Research**	**4**
MG4DSCMAT202	**Essential Mathematics for Science**	**4**
MG4DSCMAT203	**Mathematics for Electronics**	**4**
MG4DSCMAT204	**Mathematics for Business and Economics**	**4**
MG4DSCMAT205	**Essential Mathematics for Computing**	**4**
MG4VACMAT200	**Business Mathematics**	**4**
MG4SECMAT200	**Document Preparation using LaTeX**	**4**
MG4INTMAT200	**Internship**	**4**
MG5DSCMAT300	**A First Course in Complex Analysis**	**5**
MG5DSCMAT301	**Limits and Convergence**	**5**
MG5DSCMAT302	**Fundamentals of Groups and Rings**	**5**
MG5DSEMAT300	**Differential Equations and Applications**	**5**
MG5DSEMAT301	**Mathematical Musings beyond Classroom**	**5**
MG5DSEMAT302	**An Invitation to Fuzzy Mathematics**	**5**

MG5DSEMAT303	**Exploring the Harmony of Automata**	**5**
MG5SECMAT300	**Introduction to Python for Mathematical Computation**	**5**
MG6DSCMAT300	**Mathematical Analysis**	**6**
MG6DSCMAT301	**Fundamentals of Linear Algebra**	**6**
MG6DSEMAT300	**Application of Calculus and Linear Algebra in Finance**	**6**
MG6DSEMAT301	**Investment Science**	**6**
MG6DSEMAT302	**Combinatorics**	**6**
MG6DSEMAT303	**Fundamentals of Fluid Dynamics**	**6**
MG6DSEMAT304	**Scilab for Calculations and Visual Presentations**	**6**
MG6VACMAT300	**Mathematical Computation and Visualization with R**	**6**
MG6SECMAT300	**Computations and Graphics using SageMath**	**6**
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MG7DCCMAT401	**Theory of Complex Functions**	**7**
MG7DCCMAT402	**Introduction to Metric Spaces**	**7**
MG7DCEMAT400	**Advanced Theory of Groups and Rings**	**7**
MG7DCEMAT401	**Real Analysis**	**7**

MG7DCEMAT402	**Graph Theory**	**7**
MG8DCCMAT400	**Functional Analysis**	**8**
MG8DCCMAT401	**Measure Theory and Integration**	**8**
MG8DCEMAT400	**Basic Topology**	**8**
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MG8PRJMAT400	**Project (Research /Honours)**	**8**

Syllabus Index

Name of the Major**: Mathematics**

Semester 1

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
MG1DSCMAT100	Ground Roots of Mathematics	DSC A	4	5	3	0	2	0
MG1MDCMAT100	Mathematics for Competitive Examinations	MDC	3	4	2	0	2	0

Semester 2

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
MG2DSCMAT100	A Gateway to Mathematics	DSC A	4	5	3	0	2	0
MG2MDCMAT100	Applicable Mathematics	MDC	3	4	2	0	2	0

Semester 3

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
MG3DSCMAT200	**Perspectives of Mathematics**	**DSC A**	**4**	**5**	**3**	**0**	**2**	**0**
MG3DSCMAT201	**Building Blocks for Higher Mathematics**	**DSC A**	**4**	**5**	**3**	**0**	**2**	**0**
MG3DSEMAT200	**An Invitation to Actuarial Mathematics**	**DSE***	**4**	**4**	**4**	**0**	**0**	**0**
MG3DSEMAT201	**Game Theory and Project Management**		**4**	**4**	**4**	**0**	**0**	**0**
MG3DSEMAT202	**Numerical Methods**		**4**	**4**	**4**	**0**	**0**	**0**
MG3DSCMAT202	**Essential Mathematics for Science**	**DSC B**	**4**	**5**	**3**	**0**	**2**	**0**
MG3DSCMAT203	**Mathematics for Electronics**	**DSC B**	**4**	**5**	**3**	**0**	**2**	**0**
MG3DSCMAT204	**Mathematics for Business and Economics**	**DSC B**	**4**	**5**	**3**	**0**	**2**	**0**
MG3DSCMAT205	**Essential Mathematics for Computing**	**DSC B**	**4**	**5**	**3**	**0**	**2**	**0**
MG3MDCMAT200	**Mathematics of Nature and Art**	**MDC**	**3**	**3**	**3**	**0**	**0**	**0**
MG3VACMAT200	**Mastering Problem Solving through Vedic Mathematics**	**VAC**	**3**	**3**	**3**	**0**	**0**	**0**

* Opt any one from DSE

Semester 4

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
MG4DSCMAT200	Matrix Algebra and Number Theory	DSC A	4	5	3	0	2	0
MG4DSCMAT201	Fundamentals of Analysis	DSC A	4	5	3	0	2	0
MG4DSEMAT200	Mathematical Modelling	DSE*	4	4	4	0	0	0
MG4DSEMAT201	Transforms and Fourier Series		4	4	4	0	0	0
MG4DSEMAT202	Operations Research		4	4	4	0	0	0
MG4DSCMAT202	Essential Mathematics for Science	DSC C	4	5	3	0	2	0
MG4DSCMAT203	Mathematics for Electronics	DSC C	4	5	3	0	2	0
MG4DSCMAT204	Mathematics for Business and Economics	DSC C	4	5	3	0	2	0
MG4DSCMAT205	Essential Mathematics for Computing	DSC C	4	5	3	0	2	0

MG4VACMAT200	**Business Mathematics**	**VAC**	**3**	**3**	**3**	**0**	**0**	**0**
MG4SECMAT200	**Document Preparation using LaTeX**	**SEC**	**3**	**3**	**3**	**0**	**0**	**0**
MG4INTMAT200	**Internship**	**INT**	**2**					

* Opt any one from DSE

Semester 5

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
MG5DSCMAT300	**A First Course in Complex Analysis**	**DSC A**	**4**	**5**	**3**	**0**	**2**	**0**
MG5DSCMAT301	**Limits and Convergence**	**DSC A**	**4**	**4**	**4**	**0**	**0**	**0**
MG5DSCMAT302	**Fundamentals of Groups and Rings**	**DSC A**	**4**	**5**	**3**	**0**	**2**	**0**
MG5DSEMAT300	**Differential Equations and Applications**	**DSE**	**4**	**4**	**4**	**0**	**0**	**0**
MG5DSEMAT301	**Mathematical Musings beyond Classroom**		**4**	**4**	**4**	**0**	**0**	**0**
MG5DSEMAT302	**An Invitation to Fuzzy Mathematics**	**DSE***	**4**	**4**	**4**	**0**	**0**	**0**
MG5DSEMAT303	**Exploring the Harmony of Automata**		**4**	**4**	**4**	**0**	**0**	**0**
MG5SECMAT300	**Introduction to Python for Mathematical Computation**	**SEC**	**3**	**3**	**3**	**0**	**0**	**0**

* Opt any one from DSE

Semester 6

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
MG6DSCMAT300	Mathematical Analysis	DSC A	4	5	3	0	2	0
MG6DSCMAT301	Fundamentals of Linear Algebra	DSC A	4	5	3	0	2	0
MG6DSEMAT300	Application of Calculus and Linear Algebra in Finance	DSE	4	5	3	0	2	0
MG6DSEMAT301	Investment Science		4	4	4	0	0	0
MG6DSEMAT302	Combinatorics		4	4	4	0	0	0
MG6DSEMAT303	Fundamentals of Fluid Dynamics	DSE*	4	4	4	0	0	0
MG6DSEMAT304	Scilab for Calculations and Visual Presentations		4	4	4	0	0	0
MG6VACMAT300	Mathematical Computation and Visualization with R	VAC	3	3	3	0	0	0
MG6SECMAT300	Computations and Graphics using Sage Math	SEC	3	3	3	0	0	0

* Opt any one from DSE

Semester 7

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
MG7DCCMAT400	Advanced Linear Algebra	DCC	4	5	3	0	2	0
MG7DCCMAT401	Theory of Complex Functions	DCC	4	4	4	0	0	0
MG7DCCMAT402	Introduction to Metric Spaces	DCC	4	4	4	0	0	0
MG7DCEMAT400	Advanced Theory of Groups and Rings	DCE	4	4	4	0	0	0
MG7DCEMAT401	Real Analysis	DCE	4	4	4	0	0	0
MG7DCEMAT402	Graph Theory	DCE	4	4	4	0	0	0

Semester 8

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours / Week	Hour Distribution /week			
					L	T	P	O
MG8DCCMAT400	**Functional Analysis**	**DCC**	**4**	**5**	**3**	**0**	**2**	**0**
MG8DCCMAT401	**Measure Theory and Integration**	**DCC**	**4**	**5**	**3**	**0**	**2**	**0**
MG8DCEMAT400	**Basic Topology**	**DCE**	**4**	**5**	**3**	**0**	**2**	**0**
MG8DCEMAT401	**Field Theory**	**DCE**	**4**	**5**	**3**	**0**	**2**	**0**
MG8DCEMAT402	**Optimization Techniques**	**DCE**	**4**	**5**	**3**	**0**	**2**	**0**
MG8PRJMAT400	**Project (Research /Honours)**		**12**					

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester 1

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**
Course Name	**Ground Roots of Mathematics**
Type of Course	**DSC A**
Course Code	**MG1DSCMAT100**
Course Level	**100-199**
Course Summary	This course provides a solid foundation in both mathematical logic and the principles of calculus. Beginning with "Basic Logic", students explore propositional logic, propositional equivalence, predicates, and quantifiers. The course then transitions to "Functions", covering the basics of functions and their graphs, combining functions through shifting and scaling, and introducing inverse functions. The core of the course is dedicated to "Derivatives", where students are introduced to techniques of differentiation without formal proof, higher derivatives, product and quotient rules, derivatives of trigonometric functions using formulas, the chain rule, and implicit differentiation. The focus is on practical applications, preparing students for real-world problem-solving. The course concludes with an exploration of the "Applications of Derivatives", emphasizing the analysis of functions. Topics include determining intervals of increase, decrease, and concavity, identifying relative extrema with geometric implications of multiplicity, applying L'Hôpital's Rule, and addressing indeterminate forms.

Semester	**1**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**

Pre- requisites, If any	Sets, Set operations and Limits

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand the language of Mathematics and communicate in a proper way.	U	1, 2, 3, 4, 10
2	Understand the geometry of basic functions and their properties.	U	1, 2, 3, 10
3	Analyse the conditions for a function to have an inverse.	An	1, 2, 3
4	Understand and apply the process of differentiation.	A	1, 2, 3, 10
5	Characterize increasing/decreasing functions using their derivatives.	U	1, 2, 3, 10
6	Apply L'Hôpital's rule to evaluate indeterminate forms.	A	1, 2
7	Experience graphing tools in doing and enjoying Mathematics	S	1, 2, 3, 4, 9,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Basic Logic**		**15**
	1.1	Propositional Logic	1	
	1.2	Propositional Equivalence	1	
	1.3	Predicates and Quantifiers	1	
		Problems (Practicum)	1	

	Text 2: Chapter 1- Sections: 1.1, 1.3, 1.4			
2		**Functions**		**20**
	2.1	Set, Set operations, Set identities (Review)	1	
	2.2	Functions and their graphs (excluding representing functions numerically)	2	
	2.3	Combining Functions: Shifting and scaling Graphs	2,7	
	2.4	Inverse Functions	3	
		Problems (Practicum)	1, 2, 3, 7	
	Text 3: Chapter 1 - Sections: 1.1, 1.2, Chapter 7 - Section: 7.1 (Inverse functions only)			
3		**Derivatives**		**20**
	3.1	Introduction to Techniques of Differentiation (without proof)	4	
	3.2	Higher derivatives, The product and quotient rules	4	
	3.3	Derivatives of trigonometric functions (Using formulas only)	4	
	3 .4	Chain Rule	4	
	3.5	Implicit Differentiation	4	
		Problems (Practicum)	4	
	Text 1: Chapter 2 - Sections: 2.3 to 2.7			
4		**Applications of derivatives**		**20**
	4.1	Analysis of Functions I: Increase, decrease and concavity	5, 7	
	4.2	Analysis of Functions II: Relative extrema	5, 7	
	4.3	L'Hôpital's Rule	6	
	4.4	Indeterminate forms	6	
		Problems (Practicum)	5, 6, 7	

	Text 1: Chapter 3 - Sections: 3.1, 3.2 (Geometric implications of multiplicity, Analysis of polynomials excluded), Chapter 6 - Section:6.5
5	**Teacher Specific Contents** *(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. **I**t's purpose is to encourage creativity and develop Problem Solving Skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture, Tutorial and Activity oriented		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks
		Module Test- III	5 Marks
		Module Test- IV	5 Marks
		Assignment/Seminar	5 Marks
		Quiz/Viva voce	5 Marks

	B	End Semester Evaluation (ESE) 70 marks			
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]			
		Module	Part A **2 Marks**	Part B **6 Marks**	Part C **10 Marks**	Total
		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. Anton, Howard, Irl Bivens, Stephen Davis. *Calculus*. 10th ed. John Wiley & Sons, Inc., 2012.
2. Rosen, Kenneth H. *Discrete Mathematics and Its Applications* (7th ed.). McGraw Hill Publishing Co. New Delhi, 2013.
3. Thomas, George B., Jr., and Maurice D. Weir. *Thomas' Calculus***.** 12th ed. Pearson, 2009.

SUGGESTED READINGS:

1. Hofstadter, Douglas R. *Gödel, Escher, Bach: An Eternal Golden Braid*. Expanded ed. Basic Books, 2007.
2. Copi, Irving M., Carl Cohen. *Introduction to Logic*. 5th ed. Routledge, 2018.
3. Stewart, James. *Calculus: Early Transcendentals*. 10th ed. Cengage Learning, 2023.
4. Thompson, Silvanus P. *Calculus Made Easy*. 5th ed. Dover Publications, 2014.
5. Thomas, George B., Jr., and Maurice D. Weir. *Thomas' Calculus*. 15th ed. Pearson, 2023.

ADVANCED READINGS:

1. Hurley, Patrick J. *A Concise Introduction to Logic*. 11th ed. Wadsworth Publishing, 2018.
2. Copi, Irving M., Carl Cohen. *Symbolic Logic*. 13th ed. W.W. Norton & Company, 2019.
3. Davis, Philip J. *Advanced Calculus*. 7th ed. Wiley-Interscience, 2002.
4. Tu, Loring W. *Introduction to Manifolds*. 3rd ed. Springer, 2012.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Determine the output of a combinatorial circuit constructed using basic logic gates. Also Build a digital circuit produces the required output. (Eg: Build a digital circuit that produces the output $(p \vee \neg r) \wedge (\neg p \vee (q \vee \neg r))$ with input bits p, q and r .
- Determine whether a given function is injective or surjective using horizontal line test.
- Using a graphing calculator, visualize the effect of stretching and scaling (horizontal &vertical) of functions.
- Using a graphing calculator, plot the inverse of graphs and understand the geometric relationship between a graph and its inverse.
- Match the graphs of functions with the graphs of their derivatives. (Eg: Question 23 of section 2.2 in text 3).
- Use a graphing utility to make rough estimates of the locations of all horizontal tangent lines (Eg: Question 49 & 50 of section 2.3 in text 3).
- Use a graphing utility to make rough estimates of the intervals on which $f\mathrm{r}(x) > 0$ (Eg: Questions 63 & 64 of section 2.3 in text 3).
- Use the implicit plotting capability of a CAS to graph a curve. (Eg: Question 45 of section 2.7 in text 3), Suggested software: Desmos, GeoGebra etc.

Mahatma Gandhi University
Kottayam

Programme						
Course Name	**Mathematics for Competitive Examinations**					
Type of Course	**MDC**					
Course Code	**MG1MDCMAT100**					
Course Level	**100-199**					
Course Summary	This competitive exam-focused mathematics course covers crucial topics like number systems, logical reasoning, data analysis, and mathematical measurements. This course explores concepts such as HCF, LCM, fractions, ratio, percentage, and time-related problem-solving, providing comprehensive preparation for various competitive examinations.					
Semester	**1**	**Credits**			**3**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		2	0	1	0	**60**
Pre- requisites, If any						

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Develop a solid understanding of various types of	K, U, E	1, 2, 10

	numbers. Master techniques for calculating HCF and LCM and gain proficiency in simplifications, squares and square roots.		
2	Acquire logical reasoning skills by exploring concepts such as ratio, proportion, percentage, and solving problems related to profit, loss and age and apply these principles to real world scenarios.	K, U, E	1,2, 3, 4, 10
3	Learn the essentials of data analysis, including concepts of simple interest, compound interest and solving calendar problems. Develop analytical skills to interpret and utilize data effectively.	K, U, A	1, 2, 3, 10
4	Gain expertise in mathematical measurements through topics like time and work, time and distance, and stocks and shares. Apply mathematical concepts to solve practical problems in these areas.	K, A, E	1, 2, 3, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Number System and Numerical Techniques**		**18**
	1.1	Type of Numbers	1	
	1.2	HCF and LCM of Numbers	1	
	1.3	Decimal Fractions, Simplification	1	
	1.4	Square Roots and Cube Roots	1	
		Problems (Practicum)	1	
	Text 1: Relevant Portions			

2		**Logical Reasoning & Data Analysis**		
	2.1	Ratio and Proportion	2	**24**
	2.2	Percentage	2	
	2.3	Profit and Loss	2	
	2.4	Problems on Ages	2	
	2.5	Simple Interest & Compound Interest	3	
	2.6	Calendar	3	
		Problems (Practicum)	2, 3	
	Text 1: **Relevant Portions**			
3		**Mathematical Measurements**		
	3.1	Time and Work	4	**18**
	3.2	Time and Distance	4	
	3.3	Stocks and Shares	4	
		Problems (Practicum)	4	
	Text 1: Relevant Portions			
4	**Teacher Specific Contents** *(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. **I**t's purpose is to encourage creativity and develop Problem solving skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers.

A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

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<tr><td colspan="3">Lecture and Tutorial</td></tr>
<tr><td rowspan="14">Assessment Types</td><td colspan="3">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="2">Continuous Comprehensive Assessment (CCA) 25 Marks</td></tr>
<tr><td rowspan="6"></td><td>Components</td><td>Mark Distribution</td></tr>
<tr><td>Module Test- I</td><td>5 Marks</td></tr>
<tr><td>Module Test- II</td><td>5 Marks</td></tr>
<tr><td>Module Test- III</td><td>5 Marks</td></tr>
<tr><td>Assignment/Seminar</td><td>5 marks</td></tr>
<tr><td>Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td rowspan="8">B</td><td colspan="2">End Semester Evaluation (ESE) 50 marks</td></tr>
<tr><td colspan="2">Question Pattern
(MCQ Examination)
[Maximum Time 75 Minutes, Maximum Marks 50]</td></tr>
<tr><td>Module</td><td>Number of Questions</td></tr>
<tr><td>I</td><td>8</td></tr>
<tr><td>II</td><td>14</td></tr>
<tr><td>III</td><td>8</td></tr>
<tr><td colspan="2">Answer any 25 questions out of 30 Multiple Choice Questions. Each question carries 2 marks.</td></tr>
</table>

REFERENCES:

1. Aggarwal, R.S. *Quantitative Aptitude,* Sultan Chand and company Ltd, New Delhi, 2017.

SUGGESTED READINGS:

1. Abhijit Guha, *Quantitative Aptitude for Competitive Examinations*, McGraw Hill Education 2011.

2. Tyra M., *Magical Book on Quicker Maths*., BSC Publishing Company, 2018.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Discuss different number systems, such as decimal, binary, octal, and hexadecimal, and their conversions.
- Show how number theory concepts apply in various real-life scenarios, like cryptography or data encoding.
- Provide examples where LCM and HCF are used, such as in simplifying fractions, adding and subtracting fractions, or solving equations.
- Incorporate problems where knowledge of roots is essential, such as in Geometry, Physics, or Engineering.
- Provide examples where ratios and proportions are used in real-life situations, such as in finance, cooking, or map scales.
- Provide examples of profit and loss situations in business, trading, and investment scenarios.
- Discuss problem-solving strategies for analyzing profit and loss situations and determining the best course of action.
- Provide examples of interest calculations in banking, investments, loans, and savings accounts.
- Show the difference between simple interest and compound interest and how they affect the total amount over time.
- Provide examples of time and work problems in production scenarios, team projects, or construction projects.

Semester 2

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**A Gateway to Mathematics**					
Type of Course	**DSC A**					
Course Code	**MG2DSCMAT100**					
Course Level	**100-199**					
Course Summary	This course is designed to provide students with a deeper understanding of calculus and linear algebra concepts. The course begins with "Partial Differentiation", covering partial derivatives, the chain rule, and the analysis of extreme values and saddle points. It then progresses into "Integral Calculus," focusing on definite integrals, double integrals, integration methods, and the fundamental theorem of calculus. The course further explores "Matrices", where students delve into linear systems, coefficient matrices, augmented matrices, and matrix operations such as Gauss elimination and back substitution. Elementary row operations, row-equivalent systems, and the various cases of systems in Gauss elimination are covered, leading to the understanding of row echelon form and its implications. The final segment of the course introduces "Graph Theory," covering foundational definitions and examples. Topics include connectedness, adjacency, subgraphs, matrix representations, null graphs, complete graphs, cyclic graphs, path graphs, wheels, regular graphs, bipartite graphs, and the complement of a simple graph					
Semester	**2**	**Credits**			**4**	
		Lecture	Tutorial	Practicum	Others	Total

Course Details	Learning Approach					Hours
		3	0	1	0	**75**
Pre- requisites, If any	Differentiation, Integration and Matrices					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand the concept of partial derivatives and experience its applications	U	1, 2, 3
2	Compute definite integrals of single-variable functions, double integrals and understanding their geometric interpretation.	A	1, 2, 3
3	Apply matrices to solve systems of linear equations using methods of Gaussian elimination and matrix inversion.	A	1, 2, 3, 9, 10
4	Create an insight into the basics of graph theory	C	1, 2, 3, 9, 10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Partial Differentiation**		**20**
	1.1	Partial derivatives	1	
	1.2	The Chain rule	1	
	1.3	Extreme values and saddle points	1	
		Problems (Practicum)	1	

	Text 3: Chapter 14 - Sections: 14.3, 14.4, 14.7			
2		**Integral Calculus: Definite integrals and double integrals**		**20**
	2.1	Integrals and Integration methods (Review)	2	
	2.2	The Definite Integral	2	
	2.3	The Fundamental Theorem of Calculus (Proof of theorems excluded)	2	
	2.4	Double Integrals over rectangular regions	2	
		Problems (Practicum)	2	
	Text 1: Chapter 7 - Section: 7.1; Chapter 4 - Sections: 4.5 (discontinuities and integrability excluded), 4.6(dummy variables, The mean value theorem for integrals and integrating rates of changes excluded); Chapter - 14 - Section:14.1			
3		**Matrices**		**20**
	3.1	Linear System, Coefficient Matrix, Augmented Matrix	3	
	3.2	Gauss Elimination and Back Substitution	3	
	3.3	Elementary Row Operations, Row-Equivalent Systems	3	
	3 .4	Gauss Elimination: The three Cases of systems	3	
	3.5	Row Echelon Form and Information from It	3	
		Problems (Practicum)	3	
	Text 2: Chapter 7 -Section:7.3			
4		**Graph Theory**		**15**
	4.1	Definitions and examples	4	
	4.2	Connectedness, Adjacency	4	
	4.3	Subgraphs	4	

	4.4	Matrix Representations	4	
	4.5	Null graphs, Complete graphs, cyclic graphs, path graphs and wheels	4	
	4.6	Regular graphs, Bipartite graphs, Complement of a simple graph	4	
		Problems (Practicum)	4	
	Text 4: Chapter 2, Sections: 2(Isomorphism excluded), 3 (cubes , platonic graphs and three puzzles are excluded)			
5	**Teacher Specific Contents** *(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. **I**t's purpose is to encourage creativity and develop Problem solving skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.			
Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture, Tutorial and Activity oriented		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks

<table>
<tr><td rowspan="7"></td><td rowspan="5"></td><td colspan="3">Module Test- II</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td>5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td>5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td>B</td><td colspan="4">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td colspan="6">
<table>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>IV</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>5</td><td>3</td><td>13</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>
</td></tr>
</table>

REFERENCES:

1. Anton, Howard, Irl Bivens, Stephen Davis. *Calculus*. 10th ed. John Wiley & Sons, Inc., 2012.
2. Kreyszig, Erwin**.** *Advanced Engineering Mathematics***.** 9th ed. Wiley International, 2011.
3. Thomas, George B., Jr., and Maurice D. Weir. *Thomas' Calculus***.** 12th ed. Pearson, 2009.
4. Wilson, Robin J. *Introduction to Graph Theory***.** 4th ed. Addison Wesley Longman Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, 1996.

SUGGESTED READINGS:

1. Chartrand, Gary, and Ping Zhang. *A First Course in Graph Theory*. 2nd ed. Pearson, 2013.
2. Spivak, Michael. *Calculus and Applications*. 11th ed. Pearson, 2023.
3. Stewart, James. *Calculus: Early Transcendentals*. 10th ed. Cengage Learning, 2023.
4. Thompson, Silvanus P. *Calculus Made Easy*. 5th ed. Dover Publications, 2014.

5. Thomas, George B., Jr., and Maurice D. Weir. *Thomas' Calculus*. 15th ed. Pearson, 2023.

ADVANCED READINGS:

1. Axler, Sheldon. *Linear Algebra Done Right*. 3rd ed. Springer, 2015.
2. Evans, Lawrence C. *Partial Differential Equations: An Introduction*. 2nd ed. American Mathematical Society, 2010.
3. Diestel, Reinhard. *Graph Theory*. 5th ed. Springer, 2017.
4. Fichtenholz, Grisha M. *Integration of Functions of Several variables*. 2nd ed. American Mathematical Society, 2010.
5. Strang, Gilbert. *Introduction to Linear Algebra*. 5th ed. Wellesley-Cambridge Press, 2016.
6. West, Douglas B. *Introduction to Graph Theory*. 6th ed. Pearson, 2017.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Demonstrate how to visualize tangent planes to surfaces at a specific point using partial derivatives.
- Check how to obtain absolute maximum using partial derivatives.
- Use Microsoft excel or spreadsheet to performs basic matrix operations.
- Find the integrals using integration by parts (Problem Solving).
- Integrate rational functions by partial fractions (Problem Solving).
- Finding areas using definite integrals.
- Find the adjacency matrix of some familiar graphs.
- Find the incidence matrix of some familiar graphs.

Mahatma Gandhi University
Kottayam

Programme						
Course Name	**Applicable Mathematics**					
Type of Course	**MDC**					
Course Code	**MG2MDCMAT100**					
Course Level	**100-199**					
Course Summary	Through this course, students are able to investigate the fundamental principles of quantitative techniques, delving into matrices, their algebraic operations, and specialized types. Navigate the world of polynomials, focusing on quadratic and cubic equations and learning their solutions and factorization. Discover the power of permutations and combinations through factorial notation, with practical applications. Finally, grasp the dynamics of variable rates of change by knowing basic functions and differentiation principles. This course provides students with the necessary mathematical tools for real-world problem-solving and analytical thinking.					
Semester	**2**	**Credits**			**3**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		2	0	1	0	**60**
Pre- requisites, If any	Nil					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand and apply matrix algebra	U, A	1, 2, 3, 10
2	Apply quadratic and cubic polynomial techniques, factorization, and solution of quadratic equations to solve problems.	K, U, A	1,2, 4, 10
3	Utilize factorial notation, permutations, combinations, and their applications to solve combinatorial problems.	U, A	1, 2, 7, 10,
4	Apply differentiation principles, standard rules, and elementary functions to interpret and solve problems involving variable rates encountered in competitive exams.	K, U, A	2, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Matrices & Polynomials**		
	1.1	Matrices, Different types of matrices associated with a matrix	1	**24**
	1.2	Some special types of matrices	1	
	1.3	Algebra of matrices	1	
	1.4	Quadratic and cubic polynomials	2	
	1.5	Solution of quadratic polynomials	2	

	1.6	Factorisation of quadratic polynomials	2	
		Problems (Practicum)	1, 2	
	Text 1: Chapter 1– Sections: 1.4 to 1.6; Chapter 2 - Sections: 2.3 to 2.7 **Text 2: Relevant Portions of chapter 10 (Elementary Algebra)**			
2		**Permutation and Combination**		**18**
	2.1	Factorial notation	3	
	2.2	Permutations & its applications	3	
	2.3	Combinations & its applications.	3	
		Problems (Practicum)	3	
	Text 2: Chapter 14 (Permutation & Combination)			
3		**Differentiation**		**18**
	3.1	Introduction to techniques of differentiation	4	
	3.2	The product and quotient rules	4	
	3.3	Derivatives of trigonometric functions (using formulas only)	4	
	3.4	The chain rule	4	
		Problems (Practicum)	4	
	Text 3: Chapter 2 - Sections 2.3 to 2.6 (without proof of rules/ theorems)			
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

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The practicum component is to be done in the classroom under the strict guidance of the teachers.

A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

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<tr><td>II</td><td>8</td></tr>
<tr><td>III</td><td>8</td></tr>
<tr><td colspan="2">Answer any 25 questions out of 30 Multiple Choice Questions. Each question carries 2 marks.</td></tr>
</table>

REFERENCES:

1. Shanti Narayan, Mittal P. K., *Text book of Matrices*, S. Chand.
2. M. Tyra, *Magical Book on Quicker Maths*., BSC Publishing Company, 2018.

3. Howard Anton, Irl Bivens, Stephens Davis. *Calculus*, 10th ed. John Wiley & Sons, Inc., 2012.

SUGGESTED READINGS:

1. Aggarwal, R.S. *Quantitative Aptitude*, Sultan Chand and company Ltd, New Delhi, 2017.
2. Thomas, George B., Jr., and Maurice D. Weir, *Thomas' Calculus*, 12th ed. Pearson, 2009.
3. Edward, Joseph. *Differential Calculus for beginners*, Nabu Press, 2011.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Discuss different aspects of matrix algebra, including determinant calculation, matrix equations, and solving systems of linear equations using matrices.
- Discuss higher degree polynomials and various methods of polynomial factorization, such as synthetic division, long division and factoring by grouping.
- Illustrate how polynomial equations are represented graphically and how to interpret the behaviour of polynomial functions.
- Include real-life application problems involving permutations and combinations, such as probability, arrangements, and selections.
- Illustrate the applications of derivatives in various fields, such as Physics, Economics, Commerce and Engineering.
- Discuss proofs of differentiation rules or theorems in the sections 2.3, 2.4, 2.5, 2.6 of Text 3

Semester 3

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**
Course Name	**Perspectives of Mathematics**
Type of Course	**DSC A**
Course Code	**MG3DSCMAT200**
Course Level	**200-299**
Course Summary	This course provides a comprehensive exploration of three key areas in advanced mathematics: Analytic Geometry, Theory of Equations, and Multivariable Calculus. Students will delve into the parametrization of plane curves, polar coordinates, conic sections, and conics in polar coordinates. The Theory of Equations section covers roots of equations, relationships between roots and coefficients, transformations of equations, characteristics, and positions of roots, as well as essential theorems and Descartes' rule of signs. The course progresses into the realm of multivariable calculus, introducing double integrals. Students will learn to evaluate double integrals over general regions, compute areas using double integration, and apply double integrals in polar forms. The focus then shifts to triple integrals, exploring rectangular, cylindrical, and spherical coordinates. Substitutions in both double and triple integrals are covered, enhancing students' problem-solving capabilities. This course aims to equip students with advanced mathematical tools and problem-solving skills, preparing them for further studies in mathematics or related fields.

Semester	**3**	**Credits**			**4**
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**

Pre- requisites, If any	Cartesian coordinate system, Division of polynomials using synthetic and usual division

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Demonstrate proficiency in parametrizing plane curves and working with polar coordinates.	A	1,2,3,6,9,10
2	Analyse conic sections and conics in polar coordinates.	An	1,2,3,6,9,10
3	Understand the relationship between roots and coefficients in equations.	U	1,2,3,10
4	Apply transformations to equations and analyse special cases.	A	1,2,3,10
5	Utilize double integrals for area computations and problem-solving in polar forms.	A	1,2,3,6,10
6	Master triple integrals in rectangular, cylindrical, and spherical coordinates.	A	1,2,3,6, 10
7	Apply substitutions effectively in both double and triple integrals.	A	1,2,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO. No:	Hours
1		**Analytic Geometry**		**20**
	1.1	Parametrization of Plane curves	1	
	1.2	Polar Coordinates	1	

	1.3	Conic sections	2	
	1.4	Conics in polar coordinates	2	
		Problems (Practicum)	1, 2	
	Text 2: Chapter 11 - Sections: 11.1 (Brachistochrone and Tautochrone excluded), 11.3, 11.6 & 11.7			
2		**Theory of Equations**		**15**
	2.1	Roots of Equation and Relation connecting the roots and coefficients of equation	3	
	2.2	Transformation of Equations and special cases	4	
	2.3	Character and Position of the roots of an equation	4	
	2.4	Some general theorems (without proof) and Descartes' rule of signs (without proof)	3, 4	
		Problems (Practicum)	3, 4	
	Text 1: Chapter 6 – Sections: 6.1 to 6.4, 6.7 to 6.10			
3		**Double integrals**		**20**
	3.1	Double integrals over general regions	5	
	3.2	Area by double integration	5	
	3.3	Double integrals in Polar Forms	5	
	Text 2: Chapter 15 - Sections: 15.2 to 15.4			
4		**Triple Integrals**		**20**
	4.1	Triple Integrals in Rectangular Coordinates	6	
	4.2	Triple Integrals in Cylindrical and Spherical Coordinates	6	
	4.3	Substitutions in Double Integrals	7	
	4.4	Substitutions in Triple Integrals	7	
		Problems (Double and Triple integrals) (Practicum)	5, 6, 7	
	Text 2: Chapter 15 - Sections: 15.5, 15.7 & 15.8			

5	**Teacher Specific Contents** *(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.

It's 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 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture, Tutorial and Activity oriented		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks
		Module Test- III	5 Marks
		Module Test- IV	5 Marks
		Assignment/Seminar	5 Marks
		Quiz/Viva voce	5 Marks
	B	**End Semester Evaluation (ESE) 70 marks**	
		Question Pattern	

		[Maximum Time 2 Hours, Maximum Marks 70]			
		Module	Part A	Part B	Part C	Total
			2 Marks	**6 Marks**	**10 Marks**	
		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. Bernard, S., J. M. Child. *Higher Algebra*. AITBS Publishers, India
2. Thomas, George B., Jr., Maurice D. Weir. *Thomas' Calculus*, 12th ed. Pearson, 2009.

SUGGESTED READINGS:

1. Berling, William P. *Journey through Genius: The Great Theorems of Algebra and Their Proofs*. Revised ed. Springer, 2016.
2. Spivak, Michael. *Calculus and Applications*. 11th ed. Pearson, 2023.
3. Stewart, James. *Calculus: Early Transcendentals*. 10th ed. Cengage Learning, 2023.
4. Stewart, James. *Multivariable Calculus*. 9th ed. Cengage Learning, 2023.
5. Thompson, Silvanus P. *Calculus Made Easy*. 5th ed. Dover Publications, 2014.
6. Thomas, George B., Jr., and Maurice D. Weir. *Thomas' Calculus*. 15th ed. Pearson, 2023.

ADVANCED READINGS:

1. Artin, Michael. *Algebra: Structures and Applications*. 5th ed. Springer, 2011.
2. Byron, Frederick W., and Robert W. Fuller. *Advanced Analytic Geometry*. 2nd ed Dover Publications, 1970.
3. Evans, Lawrence C. *Algebraic Number Theory*. 2nd ed. Cambridge University Press, 2019.
4. Davis, Philip J. *Advanced Calculus*. 7th ed. Wiley-Interscience, 2002.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Construct a cycloid artwork by tracing the path of a point on a rolling cycle.
- Solve Cubic equations.
- Solve Bi-quadric equation.
- Use double integrals to calculate surface area of three- dimensional object.
- Visualize 3-D surface using any computer software (GeoGebra, Scilab etc).

	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) Mathematics**
Course Name	**Building Blocks for Higher Mathematics**
Type of Course	**DSC A**
Course Code	**MG3DSCMAT201**
Course Level	**200-299**
Course Summary	This course serves as an essential bridge to advanced mathematical concepts, focusing on the development of proof techniques, an in-depth exploration of relations, equivalence relations, partial ordering, vector differentiation, and vector integration. Students will gain proficiency in constructing and understanding mathematical proofs, explore the properties of relations, and delve into the derivatives and integrals of vector functions. The course begins with an "Introduction to Proofs," covering terminologies, theorem statements, and both direct and indirect proof methods. Special attention is given to common mistakes in proofs, enhancing students' ability to critically assess mathematical arguments. The second segment delves into "Relations," examining their properties and methods of representation. Equivalence relations and partially ordered sets are explored, including the construction and interpretation of Hasse Diagrams and Lattices. The latter part of the course transitions into "Vector Calculus," where students will study vector functions, derivatives of vector functions, arc length, unit tangent vectors, curvature, normal vectors of a curve, and directional derivatives. The course concludes with an exploration of vector integration, covering line integrals,

	vector fields, and their applications, including work, circulation, and flux. Fundamental theorems such as path independence, conservative fields, and potential functions are introduced, with the exclusion of detailed proofs. Green's theorem in the plane and the divergence theorem are presented, emphasizing their statements and practical problem-solving.					
Semester	**3**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Vector Algebra					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Develop proficiency in constructing and understanding mathematical proofs.	A	1,2,4,10
2	Analyse and apply properties of relations and represent them effectively.	An	1,2,9
3	Understand the concepts of equivalence relations and partially ordered sets.	U	1,2,9
4	Explore vector functions, derivatives, arc length, and curvature of curves.	A	1,2,3, 9
5	Master line integrals, vector fields, and their applications.	An	1,2,3,9
6	Apply fundamental theorems in vector calculus to problem-solving.	A	1,2,3,9,10
7	Strengthen critical thinking skills through practical applications of mathematical concepts	S	1,2,3,9,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Relations and Proof Techniques**		**15**
	1.1	Terminologies and Understanding How Theorems are Stated	1	
	1.2	Direct Proofs	1, 7	
	1.3	Indirect Proofs	1, 7	
	1.4	Mistakes in Proofs	1, 7	
	1.5	Relations and their properties	2	
	1.6	Representation of Relations	2, 7	
		Problems (Practicum)	2,7	
	Text 1: Chapter 1 - Section: 1.7; Chapter 9 - Sections: 9.1 & 9.3			
2		**Equivalence relations and Partial ordering**		**20**
	2.1	Equivalence Relations	3	
	2.2	Partially Ordered Set	3	
	2.3	Hasse Diagrams	3	
	2.4	Lattices	3	
		Problems (Practicum)	2, 3,7	
	Text 1: Chapter 9 - Sections: 9.5 & 9.6			
3		**Vector Differentiation**		**20**
	3.1	Vector Algebra (Review), Vector functions, Derivatives of vector functions	4	
	3.2	Arc length and unit tangent vector	4	
	3.3	Curvature and normal vectors of a curve	4	
	3.4	Directional derivatives and Gradient vectors	4	
		Problems (Practicum)	4	
	Text 2: Chapter 13 - Sections: 13.1, 13.3, 13.4; Chapter 14 - Section: 14.5			
4		**Vector integration**		**20**

	4.1	Line integrals	5	
	4.2	Vector fields and line integrals: work, circulation and flux	5	
	4.3	Path independence, conservative field and potential function (proofs of theorems excluded)	5	
	4.4	Green's theorem in plane (statement and problems only)	5, 6	
	4.5	Curl, Divergence in three dimensions,	5, 6	
		Problems (Practicum)	5,6	
	Text 2: Chapter 16 - Sections: 16.1 to 16.4,16.7(Curl only) & 16.8 (Divergence in three dimensions only)			
5	**Teacher Specific Contents** *(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. **I**t's purpose to encourage creativity and to develop Problem solving skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and	**Classroom Procedure (Mode of transaction)**

<table>
<tr><td>Learning Approach</td><td colspan="6">Lecture, Tutorial and Activity oriented</td></tr>
<tr><td rowspan="15">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="8"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>IV</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>5</td><td>3</td><td>13</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Rosen, Kenneth H. *Discrete Mathematics and Its Applications* (7th ed.). McGraw Hill Publishing Co. New Delhi, 2013.
2. Thomas, George B., Jr., Maurice D. Weir**.** *Thomas' Calculus***.** 12th ed. Pearson, 2009**.**

SUGGESTED READINGS:

1. Griffiths, David J. *Introduction to Electromagnetism*. 4th ed. Cambridge University Press, 2013.
2. Joyce, David D., and George C. Parker. *Vector Calculus and Its Applications*. 4th ed. Jones & Bartlett Publishers, 2022.
3. Schroeder, Glenn N. *Vector Analysis for Computer Graphics*. 3rd ed. A K Peters/CRC Press, 2017.
4. Tenenbaum, Morris T., and Harry Pollard. *Mathematics for the Nonmathematician: An Intuitive Approach.* 8th ed. Dover Publications, 2013.

ADVANCED READINGS:

1. Borceux, Francis. *Universal Algebra*. 2nd ed. Springer, 2003.
2. Farin, Susan E., and Wayne S. Sayle. *Vector Calculus*. 5th ed. Freeman, 2018.
3. Hayes, Martin H. C. *Introduction to Mathematical Proofs*. 2nd ed. Oxford University Press, 2021.
4. Maddox, Randall. *A Transition to Advanced Mathematics*. 8th ed. American Mathematical Society, 2023.
5. Velleman, Daniel J. *How to Prove It: A Structured Approach*. 4th ed. Pearson, 2015.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Apply vector integration techniques to model projectile motion.
- Plot vector valued functions using graphing calculators and visualise concepts of gradient and directional derivatives.
- Visualize position, velocity and acceleration of a moving object using sci-lab.
- Compute distance travelled and speed for motion along a space curve.
- Experience other commonly used proof methods like exhaustive prof, proof by cases, existence proof etc.
- Study Stoke's theorem and use it for evaluating circulation of vector functions.
- Discuss oriented surface and non-oriented surface with the help of a Mobius band.

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**An invitation to Actuarial Mathematics**					
Type of Course	**DSE**					
Course Code	**MG3DSEMAT200**					
Course Level	**200-299**					
Course Summary	Introduces the students to provide basic grounding in basic financial mathematics like simple interest, compound interest, loan calculation and their simple applications. It familiarises the concepts- annuity, Stocks, dividends bonds, securities etc and the calculation associated with.					
Semester	**3**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any	Probability, Money Math Fundamentals					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	To Provide Basic Grounding in Financial Mathematics	U	1,2,7
2	To Calculate various interests rates and budget.	A	1,2,3,6
3	To develop the skills, select suitable insurances according to the circumstances	S	6,7,8
4	To handle various types of cash flows and rate fluctuations.	I	1,2,6,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Probabilities and Events	1	14
	1.2	Conditional Probabilities	1	
	1.3	Random Variable, Expected values and variance.	1	
2	2.1	Simple Interest, Compound Interest, Continuously compounded interest	2	16
	2.2	Present values of future payments, rate of return	2	
	2.3	Continuously varying interest rates	2	
	2.4	Annuities, Calculating annuity premiums	2	
	2.5	Amortization of a debt, sinking funds, capital budgeting	2	
3	3.1	Risk and Insurance, Long Term and Short term insurance	3	16
	3.2	Life Insurance ,Automobile insurance, property insurance,	3	
	3.3	Indemnity principle, co-insurance principle	3	
	3.4	Stocks, dividends and bonds	3	
4	4.1	Deterministic Cash flows, internal rate of interests, modified internal interest rates, project choice	4	14
	4.2	Fixed income securities(bonds): bond price and yield, duration, convexity	4	

	4.3	Immunisation against interest rate fluctuations, short and forward rates	4	
	4.4	Term structure of interest rates, incorporating term structure into price/duration/convexity/immunization	4	
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**				
	Lecture, Teaching, Interactive instruction, Seminar, Group assignment, Library work and Group discussion.				
Assessment Types	**MODE OF ASSESSMENT**				
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**			
		Components		**Mark Distribution**	
		Module Test- I		5 Marks	
		Module Test- II		5 Marks	
		Module Test- III		5 Marks	
		Module Test- IV		5 Marks	
		Assignment/Seminar		5 Marks	
		Quiz/Viva voce		5 Marks	
	B	**End Semester Evaluation (ESE) 70 marks**			
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**			
		Module	Part A **2 Marks**	Part B **6 Marks**	Part C **10 Marks**	Total
		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**

		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. Sheldon Ross. *An Elementary Introduction to Mathematical Finance*.3rd Edition, Cambridge Advanced Sciences,2011
2. David Promislow. *Fundamentals of Actuarial Mathematics*. Wiley, 3rd Edition, 2015
3. Luenberger. *Investment Science* (Indian Edition), Oxford University Press, 2nd Edition,2013

SUGGESTED READINGS:

1. Robert Buchanan. *An Undergraduate Introduction to Financial Mathematics.*
2. Lerner and Zima. *Business Mathematics (Schaum's Outline Series).*
3. Brealy and Myers. *Corporate Finance*, Mc Graw Hill, 2023.
4. Sharpe, N.J. and Bailey Upper Saddler. River. *Investment* Prentice Hall, 1999.
5. Bodie, Kane and Marcus. *Investments*, McGraw-Hill Irwin, 2005.
6. P Romislow, S. D. *Fundamentals of Actuarial Mathematics.* John Wiley & Sons, 2014.
7. Bower, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A., & Nesbitt, C. J. *Actuarial Mathematics*, 1997.

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Game Theory and Project Management**					
Type of Course	**DSE**					
Course Code	**MG3DSEMAT201**					
Course Level	**200-299**					
Course Summary	This course delves into the fundamental principles of game theory and project management, providing the students with a comprehensive understanding of strategic decision making, methods of solving games, techniques of project management and critical paths analysis. This course aims to equip students with the skills to strategically solve complex decision making scenarios and to successfully manage projects in their future fields.					
Semester	**3**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any						

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand how optimal strategies are formulated in conflict and competitive environment	U	1,2,
2	Apply various methods to select and execute various optimal strategies to win the game	E	1,2,3,4

3	Understand the significance of using PERT and CPM techniques for project management	U	1,2
4	Determine critical path and floats associated with non-critical activities and events along with total project completion time.	E	1,2,3,4

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Game Theory: An Introduction**		**13**
	1.1	Game Theory: Introduction, Two-Person Zero-Sum Games	1	
	1.2	Pure Strategies: Games with Saddle Point	1	
	1.3	Mixed Strategies: Games without Saddle Point, Rules of Dominance	1	
	Text 1: Chapter 12 – Sections: 12.1 to 12.5			
2		**Game Theory: Solution Methods**		**17**
	2.1	Solution Methods: Algebraic Method	2	
	2.2	Arithmetic Method	2	
	2.3	Matrix Method	2	
	2.4	Graphical Method	2	
	2.5	Linear Programming Method	2	
	Text 1: Chapter 12 – Sections: 12.6.1 to 12.6.5			
3		**Fundamentals of Project Management**		**13**
	3.1	Project Management: Introduction, Basic Difference between PERT and CPM	3	

	3.2	Phases of Project Management	3	
	3.3	PERT/CPM Network Components and Precedence Relationships	3	
	Text 1: Chapter 13 – Sections: 13.1 to 13.4			
4		**Critical Path Analysis**		**17**
	4.1	Critical Path Analysis: Forward Pass Method	4	
	4.2	Backward Pass Method	4	
	4.3	Float of an Activity and Event	4	
	4.4	Critical Path	4	
	Text 1: Chapter 13 – Sections: 13.5.1 to 13.5.4			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**	
	Lecture, Teaching, Interactive instruction, Seminar, Assignment, and Group discussion.	
Assessment Types	**MODE OF ASSESSMENT**	
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**
	Components	**Mark Distribution**
	Module Test- I	5 Marks
	Module Test- II	5 Marks
	Module Test- III	5 Marks
	Module Test- IV	5 Marks
	Assignment/Seminar	5 Marks
	Quiz/Viva voce	5 Marks
	B	**End Semester Evaluation (ESE) 70 marks**

		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]			
		Module	Part A **2 Marks**	Part B **6 Marks**	Part C **10 Marks**	Total
		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. Sharma J.K. *Operations Research: Theory and Applications – 6th edition.* Trinity Press an Impint of Laxmi Publications Pvt. 2016.

SUGGESTED READINGS:

1. Frederick S. Hillier., Gerald J Lieberman. *Introduction to Operations Research 10th edition.* McGraw Hill Education, 2015.
2. Taha, Hamdy A. *Operations Research: An Introduction – 8th edition*. Pearson Education, 2007.
3. Kanti Swarup., Gupta ,,P.K., Man Mohan. *Operation Research.* Sultan Chand and Sons, 2010.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Problem solving using the methods discussed in the module 1, 2 3 and 4

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Mathematics**
Course Name	**Numerical Methods**
Type of Course	**DSE**
Course Code	**MG3DSEMAT202**
Course Level	**200-299**
Course Summary	Calculation of error and approximation is a necessity in all real life, industrial and scientific computing. The objective of this course is to acquaint students with various numerical methods of finding solution of different type of problems, which arises in different branches of science such as locating roots of equations, finding solution of systems of linear equations and differential equations, interpolation, differentiation, evaluating integration.

Semester	**3**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any						

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Find the consequences of finite precision and the inherent limits of numerical methods	E	1,2
2	Find appropriate numerical methods to solve algebraic and transcendental equations.	,E	1,2,3
3	Use numerical methods to find missing values of data.	A	1,2,3,6
4	Apply numerical methods to solve real life problems	C	1,2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO NO:	Hours
1	1.1	Numerical Analysis: Mathematical Preliminaries, Errors and Their Computations.	1	15
	1.2	Introduction, Bisection Method, Method of False Position.	2,3	
	1.3	Iteration Method, Newton - Raphson Method	2,3	
	Text 1: Chapter 1 - Sections: 1.2 to 1.3; Chapter 2 – Sections: 2.1 to 2.5.			
2	2.1	Interpolation: Finite Differences, Differences of a polynomial.	4	15
	2.2	Newton's Formulae for Interpolation.	3,4	
	2.3	Central Difference: Gauss's Central difference formulae.	4	
	Text 1: Chapter 3 - Sections: 3.3,3.5,3.6 & 3.7.1			
3	3.1	Interpolation with Unevenly Spaced Points: Lagrange's Interpolation Formula.	3,4	15
	3.2	Divided Differences and Their Properties.	3,4	
	3.3	Inverse Interpolation.	3,4	
	Text 1- Chapter 3 - Sections: 3.9.1, 3.10 & 3.11			
4	4.1	Numerical differentiation and Integration: Numerical differentiation, Errors in Numerical Differentiation.	1,3	15
	4.2	Differentiation Formulae with Function Values.	2,4	
	4.3	Numerical integration: Trapezoidal Rule, Simpson's 1/3- rule, Simpson's 3/8- rule.	4	
	Text 1- Chapter 6 - Sections: 6.2.1,6.2.3, 6.4.1 to 6.4.3			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="6">Lecture, Teaching, Interactive Instruction, Seminar, Group Assignment, Library Work and Group Discussion</td></tr>
<tr><td rowspan="16">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="9"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>IV</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>5</td><td>3</td><td>13</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Sastry, S. S. *Introductory methods of Numerical Analysis,5th edition, PHI Learning Private Limited, 2013.*

SUGGESTED READINGS:

1. Jain, M. K., Iyengar, S. R. K., & Jain R. K. Numerical Methods for *Scientific and Engineering Computation (6th ed.).* New Age International Publishers. Delhi, 2012.
2. Bradie, Brian. *A Friendly Introduction to Numerical Analysis*. Pearson Education India, 2006.
3. Chapra, Steven C. *Applied Numerical Methods with MATLAB for Engineers and Scientists (4th ed.).* McGraw-Hill Education, 2018.
4. Fausett, Laurene V. *Applied Numerical Analysis Using MATLAB*. Pearson. India, 2009.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Problem solving using the methods discussed in the module 1, 2, 3 and 4.
- Extra reading and practice: Stirling's formula, Bessel's formula, Boole's and Weddle's Rules.

Mahatma Gandhi University

Kottayam

Programme						
Course Name	**Essential Mathematics for Science**					
Type of Course	**DSC B**					
Course Code	**MG3DSCMAT202**					
Course Level	**200-299**					
Course Summary	This Mathematics minor course complements and enhances the undergraduate programmes on science disciplines such as Physics, Chemistry etc., by enabling the students to understand the concepts of complex numbers and analytic functions, to solve differential equations of different types, to identify different conic sections and its applications in possible areas and to determine unit tangent vector, principal normal vector, and curvature of different curves.					
Semester	**3**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Basic awareness of coordinate systems, vectors, functions, derivatives, and integrals					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand the concepts of complex functions and vector calculus	K	1
2	Apply C-R equations to check the analyticity of complex functions	A	2
3	Analyse the nature of differential equation	An	1

4	Solve equations in complex variables and differential equations	A	2
5	Distinguish between cartesian and polar co-ordinates	An	1
6	Identify conic sections from its equations and Visualize curves	E	2
7	Find the curvature and directional derivatives of curves	E	2
8	Develop applications of mathematical concepts in scientific/real life problems	C	3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Complex Functions**		20
	1.1	Complex Numbers, Sums and Products, Basic Algebraic Properties, moduli, conjugates, Exponential and Polar Forms, Products and Powers in Exponential form	1	
	1.2	Functions of Complex Variables, Separation into Real and Imaginary parts, Limits and Continuity	1	
	1.3	Derivatives, Analytic Function, Cauchy-Riemann Equations, Laplace Equation, Harmonic Function	2	
		Problems (Practicum)	1, 2	
	Text 1: Chapter 1 – Sections: 1 to 7; Chapter 2 – Sections: 12,15,16,18 to 22, 24 to 26 **Theorems – Statements Only**			
2		**Differential Equations**		**18**
	2.1	Degree, Order, Solution of Differential Equations, Variable Separable method	3, 4	
	2.2	Exact Differential Equations	3, 4	
	2.3	Linear Differential Equations, Bernoulli's Equations	4	
		Problems (Practicum)	3, 4	

	Text 2: Chapter 1 – Sections: 1.1 to 1.5 **Theorems – Statements Only**			
3		**Analytic Geometry**		**17**
	3.1	Polar coordinates	5	
	3.2	Conic sections	6	
	3.3	Conic section in polar coordinates	6	
		Problems (Practicum)	5,6	
	Text 3: Chapter 11 – sections: 11.3,11.6 & 11.7 **Theorems – Statements Only**			
4		**Vector Calculus**		**20**
	4.1	Curves in Space and tangents, Velocity and Acceleration, Arc length in space	1, 8	
	4.2	Curvature and Normal vectors of a curve	1, 7	
	4.3	Directional derivatives and gradient vectors	1, 7	
		Problems (Practicum)	1,7,8	
	Text 3: Chapter 13 – Sections: 13.1,13.3,13.4; Chapter 14 – Section: 14.5 **Theorems – Statements Only**			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
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</table>

REFERENCES:

1. James Ward Brown, Ruel V. Churchill. *Complex Variables and Applications, Eighth Edition,* McGraw Hill, *2009*
2. Simmons, G.F., Krantz, S.G. *Differential Equations*, Tata McGraw Hill-New Delhi, 2007.
3. Thomas, George B Jr. *Thomas' Calculus, Twelfth Edition*, Pearson, 2010

SUGGESTED READINGS:

1. Grewal, B. S., *Higher Engineering Mathematics*, *44th Edition*, Khanna Publishers, 2021.
2. Anton, H., Bivens, Devis. *Calculus, tenth Edition*, Wiley India.
3. Kreyszig,E. *Advanced Engineering Mathematics*, Wiley, India.
4. Siddiqi, A.H., Manchanada, P. *A first course in Differential Equations*, Mc Millan.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Proofs of theorems from module 1, 2, 3 & 4
- Solution of equations in Complex variables, Regions in the Complex plane
- Homogeneous Differential equations, Integrating Factors of Differential Equations
- Visualization of curves and conic section, Obtaining Points of farthest and closest approach of Planets/ Satellites
- Integration in vector fields, Finding Work done, Flow, circulation and flux
- Text 1-Chapter 1 (Roots of complex numbers, Regions in complex plane)
- Text 2 – Chapter 1 (Homogeneous Differential Equations, Integrating factors)
- Text 3 – Chapter 16 (Line integrals, Work, Circulation and Flux)

Mahatma Gandhi University
Kottayam

Programme						
Course Name	**Mathematics for Electronics**					
Type of Course	**DSC B**					
Course Code	**MG3DSCMAT203**					
Course Level	**200-299**					
Course Summary	This course will give an introduction to basic concepts of Vector Algebra and various Mathematical manipulations involved. Students get a good understanding of Partial fractions, Laplace transforms and their properties. Students acquire skills to construct Boolean functions, Logic gates and applications and the capacity to use them in Computer science applications and problems.					
Semester	**3**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Differentiation, Partial differentiation and integration					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Compute dot and cross product by giving algebraic concepts	A	2
2	Apply dot or cross product to determine angle between vectors	A	2
3	Find expansion for powers of Sine and Cosine functions. Also understand the relation between Circular and Hyperbolic function.	E	2

4	Understand the concepts of partial fraction	U	2
5	Determine Laplace transform of Elementary functions and understand its properties	E	2
6	Create Boolean functions and logic gates	C	3
7	Analyse and simplify digital logic circuits using Boolean Algebra	An	3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Vector Analysis**		
	1.1	Basic concepts of dot and cross products, (Definition and simple problems)	1	**22**
	1.2	Gradient of a scalar field, Directional derivative	1	
	1.3	Divergent and Curl of a Vector field, Solenoidal and Irrotational	2	
		Problems (Practicum)	1,2	
	Text 1: Chapter 3 – Sections: 3.4, 3.5 (Definition and geometrical interpretation) 3.6 (Definition and geometrical interpretation); Chapter 8 – Sections: 8.4, 8.5(Exclude geometrical interpretation), 8.6, 8.7 (Solenoidal and irrotational)			
2		**Trigonometry**		
	2.1	De Moiré's Theorem (Statement only), Expansions of $sin^n\theta$, $cos^n\theta$ and $sin^n\theta.cos^m\theta$ Simple problems.	3	**15**
	2.2	Expansions of $\sin n\theta, \cos n\theta$ in powers of $\sin\theta$ and $\cos\theta$. Simple problems.	3	
		Problems (Practicum)	3	
	Text 3: Chapter 2 – Sections: 2.5.3, 2.5.5 & 2.5.6			

3		**Laplace Transform**		
	3. 1	Review of partial fraction	4	**18**
	3. 2	Laplace transform of elementary functions	5	
	3. 3	Properties of Laplace transform	5	
		Problems (Practicum)	4,5	
	Text 1: Chapter 21 – Sections: 21.2, 21.3 & 21.4 (Exclude proof and change of scale property)			
4		**Boolean Algebra**		
	4. 1	Boolean function	6	**20**
	4. 2	Representing Boolean functions, SOP form of Boolean expression	6, 7	
	4.3	Logic Gates and representations	6	
		Problems (Practicum)	6,7	
	Text 2: Chapter 10 – Sections: 10.1,10.2 &10.3(Logic gates and combinations)			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
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REFERENCES:

1. Grewal,B.S. *Higher engineering Mathematics,40thEdition*, Khanna publications, 2021.

2. Rosen, Kenneth. H. *Discrete Mathematics and its applications, 6th edition,* McGraw Hill Publishing Co. New Delhi, 2006.

3. Sastry, S.S. *Engineering Mathematics Volume 1*, 4th edition PHI, 2008.

SUGGESTED READING:

1. Kreyszig, Erwin. *Advanced Engineering Mathematics*, Wiley, India, 2006.

ADVANCED READINGS:

1. Muray R Spiegel. *Advanced Calculus, Schaum's Outline series, 2010.*
2. Ralph P Grimaldi , B V Ramana. *Discrete and Combinatorial Mathematics; Pearson Education, Dorling Kindersley India Pvt. Ltd, 2006.*

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Proof of properties - Scalar and Vector product, Physical Applications of Scalar and Vector product
- Proof of Gradient of a scalar field, Directional derivative
- Circular and hyperbolic functions
- Change of scale property
- Applications of Logic gates
- Text 1- Sections 3.5, 3.6,3.7, 8.5, 21.4
- Text 2 - Section 10.3 (Examples of circuits)
- Text 3 - Section 2.5.7

Mahatma Gandhi University
Kottayam

Programme						
Course Name	**Mathematics for Business and Economics**					
Type of Course	**DSC B**					
Course Code	**MG3DSCMAT204**					
Course Level	**200-299**					
Course Summary	Mathematical methods and theories applicable in economics and business to analyse real life problems are included in the course. First module provides an understanding of the way in which financial calculations are worked out. Second module deals with different methods of solving systems of equations and the many varied applications of such systems to business and economics. Optimization of functions using their derivatives is included in the third module. Linear programming is helpful in business and economics where it is often necessary to optimize a profit or cost function subject to several inequality constraints. The graphic approach for maximization and minimization linear programming problems is also illustrated. Module four deals with the applications of calculus in economics and business.					
Semester	**3**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Graphing functions, Basics of differential and integral Calculus, Multi-variable functions and partial differentiation, Percentage calculation, Basics of logarithmic and exponential functions					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	understand the difference between simple and compound interest	U	1,3
2	calculate the future value of a principal under annual compounding and under continuous compounding	A	2,3
3	recognize a geometric progression	K	2
4	evaluate a geometric series and calculate the total investment obtained from a regular savings plan.	E	2,3,10
5	use net present values to appraise investment projects and calculate the internal rate of return, the present value of an annuity	A	2,3,10
6	use discounting to compare investment projects	U, A	1,3
7	understand functions, classical optimization techniques and marginal concepts in economics	U	1,3
8	analyse the real-life problems in business and economics and to model it mathematically	A, An, C	2,3,6,10
9	apply elementary algebra and calculus in economics and business problems and solve it mathematically	A, C	1,2,3
10	solve linear programming problem using graphical method	C	2

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Mathematics of Finance**		
	1.1	Compound Interest	1,2	**15**
	1.2	Geometric Series	3,4	

	1.3	Investment Appraisal	5,6	
		Problems (Practicum)	1,2,3,4,5,6	
	Text 2: Chapter 3 – Sections: 3.2 to 3.4			
2		**Mathematical Economics**		
	2.1	Introduction to System of Equations	7	
	2.2	Graphical Solutions	7,8	
	2.3	Supply-and-Demand Analysis	8,9	
	2.4	Break-Even Analysis	8,9	**20**
	2.5	Elimination and Substitution Methods	8,9	
	2.6	Income Determination Models	8,9	
	2.7	IS-LM Analysis	8,9	
		Problems (Practicum)	7,8,9	
	Text 1: Chapter 4 – Sections: 4.1 to 4.7			
3		**Optimization Techniques**		
	3.1	Use of Graphs in LPP, Maximization Using Graphs	7,10	
	3.2	The Extreme-Point Theorem, Minimization Using Graphs	7,10	
	3.3	Optimization of Functions, The Successive-Derivative Test	7	**25**
	3.4	Marginal Concepts in Economics	7,8,9	
	3.5	Optimizing Economic Functions for Business	8,9	
	3.6	Relationship Among Total, Marginal, and Average Functions	9	
		Problems (Practicum)	7,8,9,10	
	Text 1: Chapter 7 – Sections: 7.1 to 7.4; Chapter 10 – Sections: 10.6 to 10.10			

4		**Applications of Mathematics in Economics and Business**		
	4.1	Functions of Several Independent Variables	7	**15**
	4.2	Constrained Optimization problems with Lagrange Multipliers	7,8,9	
	4.2	Applications of definite integral in consumers and producers surplus	8,9	
		Problems (Practicum)	7,8,9	
	Text 1: Chapter 12 – Section: 12.11; Chapter 13 – Sections: 13.1 & 13.6			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

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Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Direct Instruction, Brain Storming Approach, Interactive instruction, Group Discussion, Presentation by Individual Student/ Group Representatives		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks

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2. Ian Jacques, *Mathematics for Economics and Business*, 5th Edition, Prentice Hall,2006.

SUGGESTED READINGS:

1. Taro Yamne, *Mathematics for Economists-An elementary survey,* Prentice -Hall, Inc.
2. Robert Brechner, *Contemporary Mathematics for Business and Consumers,* Fifth Edition
3. Das, N. G., Das, J K. *Business Mathematics and Statistics*, Tata McGraw-Hill, 2012.
4. Martin Anthony, Norman Biggs, *Mathematics for economics and finance Methods and Modelling,* Cambridge University Press, 2012.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Application mathematics in economics and business using spreadsheets

Mahatma Gandhi University
Kottayam

Programme						
Course Name	**Essential Mathematics for Computing**					
Type of Course	**DSC B**					
Course Code	**MG3DSCMAT205**					
Course Level	**200-299**					
Course Summary	This course provides a comprehensive introduction to discrete mathematics and algorithms, covering topics such as number theory, cryptography, Boolean algebra, logic gates, relations, tree structures and graph theory. Practical implementation involves coding tree traversal, depth-first search and breadth-first search algorithms using a programming language. Students gain both theoretical insights and hands -on experience applicable across computer science domains.					
Semester	**3**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Basic understanding of integers and divisibility, basic algebraic operations, set theory and set operations and basic graph theory concepts.					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand the fundamental concepts of number theory, including prime numbers and divisibility	U	2

2	Apply congruence in various mathematical scenarios and recognize its applications in Hashing and Cryptography.	A	8
3	Analyze the truth tables and logical operations associated with each type of logic gates.	An	1
4	Understand the relations and it's representations	U	2
5	Apply the basic concepts of trees and tree traversal techniques	A	2
6	Apply knowledge of spanning trees and understand their applications in different domains	A	3
7	Analyze the security implications and practical applications of the RSA cryptosystem	An	8
8	Apply tree traversal algorithm, depth-first search algorithm and breadth-first search algorithm to solve real world problems , using any suitable programming language.	C	9

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Number Theory & Cryptography**		
	1.1	Divisibility and modular arithmetic:- Division, Division algorithm, Modular arithmetic, Congruence and Basic properties of congruence.	1,2	**17**
	1.2	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	2	
	1.3	Applications of number theory: a) Solving congruence :- Linear congruence, Chinese remainder theorem and Fermat's theorem (Statement only) b) Application of congruence :-Hashing	2	

		function c) Cryptography :- Caesar cipher, Vignere cipher and Hill cipher		
		Problems (Practicum)	1,2	
	Text 1: Chapter 4 – Sections: 4.1, 4.3 to 4.6 **Text 2: Chapter 10 – Section: 10.1**			
2		**Boolean Algebra**		
	2.1	Boolean functions	3	**13**
	2.2	Representing of Boolean functions Sum Of Products (SOP)	3	
	2.3	Logic gates	3	
		Problems (Practicum)	3	
	Text 1: Chapter 11 – Sections: 11.1 to 11.3			
3		**Relations & Partial orders**		
	3.1	Relations & properties	4	**20**
	3.2	Representing relations	4	
	3.3	Equivalence relation	4	
	3.4	Partial ordering & Hasse Diagrams	4	
		Problems (Practicum)	4	
	Text 1: Chapter 8 – Sections: 8.1, 8.3, 8.5 & 8.6			
4		**Trees**		
	4.1	Introduction to trees:- Trees, Properties of trees, Applications of trees:- Binary search trees, Prefix codes and Huffman coding	5	**25**
	4.2	Tree traversal:- Traversal algorithms, Infix, Prefix and postfix notations	7,8	
	4.3	Spanning trees: - Introduction, Depth-first	5	

		search algorithm (BFS), Breadth--first search algorithms (DFS)		
	4.4	Minimum spanning trees:- Algorithms for minimum spanning trees- Kruskal's algorithm and Prim's algorithm	6	
		Problems (Practicum)	5,6,7,8	
	Text 1: Chapter 10 – Sections: 10.1 to 10.5			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

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Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Direct instruction: Lecture Method, Tutorial ,Brainstorming Lectures, Explicit Teaching Interactive instructions: Active Cooperative Learning, Library Work and Group Discussion, Peer Learning, Authentic Learning		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks
		Module Test- III	5 Marks

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REFERENCES:

1. Kenneth H Rosen, *Discrete Mathematics and its Applications (Eighth Edition).* Tata McGraw- Hill Education (India) private limited, Special Indian Edition 2021.
2. Burton, David M. *Elementary Number theory (Seventh edition),* The McGraw Hill companies, 2009.

SUGGESTED READINGS:

1. Clifford Stien., Robert L Drysdale., Kenneth Bogart. *Discrete Mathematics for computer scientists*; Pearson Education; Dorling Kindersley India Pvt Ltd.
2. Kenneth A Ross., Charles R.B.Wright., *Discrete Mathematics*; Pearson Education; Dorling Kindersley India Pvt Ltd.
3. Richard Johnsonbaugh. *Discrete Mathematics.* Pearson Education; Dorling Kindersley India Pvt Ltd.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- RSA public key cryptosystem
- Implement tree traversal algorithm, depth-first search algorithm and breadth-first search algorithm using any suitable programming language.
- Text 1-4.6, 10.3, 10.4
- Text 2- Section 10.1

Mahatma Gandhi University
Kottayam

Programme						
Course Name	**Mathematics of Nature and Art**					
Type of Course	**MDC**					
Course Code	**MG3MDCMAT200**					
Course Level	**200-299**					
Course Summary	The course explores Fibonacci numbers' diverse applications in nature, arts, science, and the significance of the golden ratio and continued fractions in various contexts. It helps to understand their role in natural phenomena, artistic expressions, mathematical principles, and practical applications across disciplines.					
Semester	**3**	**Credits**			**3**	
Course Details		Lecture	Tutorial	Practicum	Others	Total Hours
	Learning Approach	3	0	0	0	**45**
Pre- requisites, If any	Nil					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		

1	Understand Fibonacci and Lucas numbers, their properties, and applications in natural phenomena and diverse real-world scenarios.	U, A	2, 3
2	Analyze and apply Fibonacci's impact on artistic expressions, scientific realms, and interdisciplinary connections across various fields.	K, U, A	1, 2, 3
3	Comprehend the significance of the golden ratio, its geometric interpretations, applications in human anatomy, arts and mathematical constructions.	K, U, A	2, 3, 10
4	Understand and apply the concepts of finite and infinite continued fractions, convergence, recursive definitions, and their implications in solving problems.	K, U, A	2, 3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Fibonacci Numbers in Nature, Arts & Science**		**16**
	1.1	The rabbit problem, Fibonacci numbers, Recursive definition, Lucas numbers, Fibonacci and Lucas primes.	1	
	1.2	Different types of Fibonacci and Lucas numbers.	1	
	1.3	Fibonacci numbers in nature: Fibonacci and the earth, Fibonacci and flowers, Fibonacci and trees, Fibonacci and sunflowers, Fibonacci - pinecones, artichokes and pineapples, Fibonacci and bees, Fibonacci and subsets.	1	
	1.4	Fibonacci and atoms, Fibonacci and reflections. Fibonacci - paraffins and cycloparaffins,	2	

		Fibonacci and music, Fibonacci and poetry.		
	1.5	Fibonacci and compositions with 1's and 2's, Fibonacci and neurophysiology. (Theorems 3.1,3.2,3.3- statement only)	2	
	Text 1: Chapters 2 & 3 (Relevant sections only)			
2		**Fibonacci Numbers in Arts and Science**		**15**
	2.1	The golden ratio, Mean proportional, A geometric interpretation.	3	
	2.2	Ruler and compass construction, Euler construction. Generation by Newton's method.	3	
	2.3	The golden ratio revisited: Golden ratio and human body, Mexican Pyramids, Differential equations, Golden ratio and centroids of circles.	3	
	Text 1: Chapters 20 & 21 (Relevant sections only)			
3		**Continued Fractions**		**14**
	3.1	Finite continued fractions, Convergents of a continued fraction.	4	
	3.2	Recursive definition, Infinite continued fraction.	4	
	3.3	An infinite continued fraction for $-\beta$, Pell's equation.	4	
	Text 1: Chapter 27			
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**
	Lecture and Tutorial

<table>
<tr><td rowspan="14">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 25 marks</td></tr>
<tr><td rowspan="6"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td rowspan="8">B</td><td colspan="5">End Semester Evaluation (ESE) 50 marks</td></tr>
<tr><td colspan="5">Question Pattern
[Maximum Time 75 Minutes, Maximum Marks 50]</td></tr>
<tr><td>Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td></td><td>2 Marks</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>3</td><td>2</td><td>2</td><td>7</td></tr>
<tr><td>II</td><td>3</td><td>2</td><td>1</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>6</td><td>4</td><td>18</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>4</td><td>2</td><td>11</td></tr>
<tr><td>Total Marks</td><td>10</td><td>20</td><td>20</td><td>50</td></tr>
</table>

REFERENCES:

1. Thomas Koshy. *Fibonacci and Lucas numbers with applications*, John Wiley & Sons, Inc, 2001.

SUGGESTED READINGS:

1. Richard A Dunlap. *The Golden Ratio and Fibonacci Numbers*, World Scientific Publishing Co. Pt. Ltd.
2. Mario Livio. *The Golden Ratio*, Broadway Books, New York.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Fibonacci and male bees.
- Fibonacci and sewage treatment.

- Fibonacci and the Balmer series.
- Proofs of Theorems 3.1, 3.2 and 3.3.
- Fibonacci and electrical networks.
- Violin and golden triangle.
- Golden ratio by origami.
- Gattei's discovery of golden ratio.

Mahatma Gandhi University

Kottayam

rogramme						
Course Name	**Mastering Problem Solving through Vedic Mathematics**					
Type of Course	**VAC**					
Course Code	**MG3VACMAT200**					
Course Level	**200-299**					
Course Summary	This course provides a comprehensive exploration of Vedic Mathematics, a traditional Indian system known for its speed and efficiency in problem-solving. Through a structured four-unit approach, students will understand the importance of Vedic Mathematics, advanced arithmetic techniques, root calculations, and applications in algebra, empowering them with valuable tools for quick and accurate problem-solving.					
Semester	**3**	**Credits**			**3**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	0	0	45
Pre- requisites, If any	Nil					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		

1	Develop a comprehensive understanding of Vedic Mathematics principles, techniques, and their historical context.	U	1,2,3,4,8,10
2	Attain proficiency in mental calculation techniques for addition, subtraction, multiplication, and division, fostering quicker and more accurate problem-solving.	S	1,2,4,8,10
3	Apply Vedic Mathematics to solve a diverse range of mathematical problems, including algebraic expressions and equations, showcasing versatility in problem-solving.	A	1,2,3,4,8,10
4	Develop advanced problem-solving skills through the systematic application of Vedic Mathematics techniques, enabling students to tackle complex scenarios with confidence.	A, An	1,2,3,4,8,10
5	Gain confidence and readiness to tackle competitive exams by mastering quantitative aptitude using Vedic Mathematics techniques, ensuring a competitive edge in various examinations.	A, An	1,2,4,5,8,10
6	Apply Vedic Mathematics skills to real-world scenarios, including ratio and proportions, percentage calculations, profit and loss analysis, and interest calculations.	A	1,2,3,4,8,10
7	Apply Vedic Mathematics principles to algebraic expressions, including efficient multiplication of polynomials and solving systems of linear equations.	A, An	1,2,3,4,8,10
8	Empower students with traditional Indian mathematical wisdom, providing them with valuable tools deeply rooted in cultural and historical contexts.	U, I, Ap	1,3,6,7,8,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Foundations of Vedic Mathematics**		**12**

	1.1	Overview of Vedic Mathematics- History and its importance, Vedic Sutras and sub-sutras	1,8	
	1.2	Addition : Ekadhikena Purvena	1,2	
	1.3	Subtraction :Nikhilam Navatascaramam Dasatah, Digit Separator Method	1,2	
	1.4	Multiplication : Ekanyunena Purvena, Multiplication of numbers having two-digits and three-digits using Urdhva Tiryagbhyam, Multiplication by series of 1's and 9's	1,2	
	1.5	Division : Urdhva – Tiryakgbhyam	1,2,5	
	Text 1: Specified sections from Chapters 1 to 4 & 6			
2		**Advanced Arithmetic Techniques and its Applications**		**19**
	2.1	Squares: Squares of numbers up to three-digits using Ekadhikena Purvena, Dwanda yoga	1,2,5	
	2.2	Square roots : Duplex Method	1, 2, 5	
	2.3	Cubes: Cubes of two-digit numbers using Nikhilam	1,2,5	
	2.4	Cube roots : Cube Root of a number having less than 7 digits using Beejank	1, 2, 5	
	2.5	Divisibility and simple Osculators	1,2,5	
	2.6	Applications: Ratio and proportions, Percentage, Profit and Loss, Simple interest, Compound Interest	3, 4, 5, 6, 8	
	Text 1: Specified sections from Chapter 7, 8, 10 & 11 **Text 2: Chapter 29** **Text 3: Chapter 18, 20, 23, 24 & 25**			
3		**Algebraic Multiplication and Equation Solving**		**14**

	3.1	Multiplication in algebra : Multiplication of polynomials of the form ax+by, ax^2+bx+c	1,3,7	
	3.2	Simple Equations: Solving simple equations in one variable	1,3,7	
	3.3	Simultaneous Simple Equations : Solution of system of linear equations in two variables	1,3,7,8	
	Text 1: Specified sections from Chapter 5 **Text 2: Specified sections from Chapters 11, 12, 13 & 15**			
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**				
	Interactive Lectures, Conduct Regular Practical Workshops Focusing on Mental Calculation Techniques and Vedic Mathematics Applications, Provide Hands-on Exercises with Immediate Feedback to Reinforce Learning.				
Assessment Types	**MODE OF ASSESSMENT**				
	A	**Continuous Comprehensive Assessment (CCA) 25 marks**			
		Components			**Mark Distribution**
		Module Test- I			5 Marks
		Module Test- II			5 Marks
		Module Test- III			5 Marks
		Assignment/Seminar			5 marks
		Quiz/Viva voce			5 Marks
	B	**End Semester Evaluation (ESE) 50 marks**			
		Question Pattern **[Maximum Time 75 Minutes, Maximum Marks 50]**			
		Module	Part A **2 Marks**	Part B **5 Marks**	Part C **10 Marks**	Total
		I	3	2	1	**6**
		II	3	2	2	**7**

		III	2	2	1	**5**
		Total no of questions	**8**	**6**	**4**	**18**
		Number of questions to be answered	**5**	**4**	**2**	**11**
		Total Marks	**10**	**20**	**20**	**50**

REFERENCES:

1. Thakur, Rajesh Kumar. *The Essentials of Vedic Mathematics*, Rupa Publications India Pvt Ltd, 2013.
2. Bharati Krishna Tirthaji. *Vedic Mathematics*: *Sixteen Simple Mathematical formulae from the Vedas*, Motilal Banarsidass, 1981.
3. Tyra, M. *Magical Book On Quicker Maths*, BSC Publishing Co. Pvt. Ltd, 5th Edition, 2018.

SUGGESTED READINGS:

1. Singhal, Vandana. *Vedic Mathematics for all ages: A Beginner's Guide*, Motilal Banarsidass, 2014.
2. Patankar, U. S., S. M. Patankar. *Elements of Vedic Mathematics*, TTU Press, 2018.

ADVANCED READING:

1. Dattoli, Giuseppe, Marcello Artioli, Silvia Licciardi. *Vedic Mathematics: A Mathematical Tale from the Ancient Veda to Modern Times*, World Scientific Publishing Co Pte Ltd, 2021.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Relevant topics can be selected from Textbook 3

Semester 4

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Matrix Algebra and Number Theory**					
Type of Course	**DSC A**					
Course Code	**MG4DSCMAT200**					
Course Level	**200-299**					
Course Summary	This course provides an introduction to the fundamental concepts and techniques of matrix algebra and number theory. The first two modules deal with matrix algebra and solutions of systems of linear equations. Third module starts with basics for theory of numbers which will be followed by the Division algorithm, Euclidean algorithm etc. Fourth Module involves some classical theorems by Fermat, Wilson and Euler.					
Semester	**4**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Basic idea about matrices, integers and primes.					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		

1	Demonstrate a thorough understanding of the basic concepts of matrix algebra	U	1, 2, 3
2	Formulate systems of linear equations into matrices	U	1, 2, 4
3	Solve systems of linear equations using Gaussian elimination	A	1, 2, 3
4	Analyze the properties of systems of linear equations and their solutions	An	1, 2, 3, 4
5	Demonstrate understanding of fundamental concepts in number theory, including congruence, divisibility, GCD etc	U	1, 2
6	Analyze Fermat's Little Theorem, understanding its significance and implications	An	1, 2, 3
7	Comprehend Euler's Phi Function and Euler's Theorem and Wilson's theorem and their applications in determining primality.	U	1, 2, 3
8	Apply computational software and tools in matrix computations and also concepts of number theory.	A	1, 2, 3, 9

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Matrix Operations	1	**20**
	1.2	Properties of matrix operations	1	
	1.3	Different types of matrices	1	

	1.4	Matrix representation of system of linear equations	2	
	1.5	Elementary row transformations and elementary matrices	3	
	1.6	Gaussian Elimination, Row-echelon form, Hermite form	3	
		Problems (Practicum)	1,2,3	
	Text 1: Chapter 1; Chapter 3 [upto Exercise 3.10 -Theorems (Statement only) of all theorems in Chapter 3]			
2	2.1	Linear combination and independence/dependence of rows and columns of matrices	4	**15**
	2.2	Row equivalent matrices	4	
	2.3	Row rank, column rank and rank of a matrix	4	
	2.4	Normal form and equivalent matrices	4	
	2.5	Consistency of system of linear equations	4	
	2.6	Invertible Matrices	4	
		Problems (Practicum)	4	
	Text 1: Remaining portions of Chapter 3 and Chapter 4 [Theorems (Statement only) and their applications]			
3	3.1	The Division Algorithm	5	**20**
	3.2	The Greatest Common Divisor	5	
	3.3	The Euclidean Algorithm	5	
	3.4	The Fundamental Theorem of Arithmetic	5	
	3.5	The Sieve of Eratosthenes	5	
		Problems (Practicum)	5	
	Text 2: Chapter 2 – Sections: 2.2 (Statements and applications only), 2.3 [Theorem 2.3 and 2.4(Statements only)], 2.4 [Theorem 2.7 and 2.8(Statements only and applications)]; Chapter 3 - Sections: 3.1 & 3.2 (Theorem 3.4 only)			

4	4.1	Basic Properties of Congruence	5	**20**
	4.2	Fermat's Theorem and pseudoprimes	6	
	4.3	Wilson's Theorem	7	
	4.4	Euler's Phi Function and Theorem	8	
		Problems (Practicum)	5,6,7,8	
	Text 2: Chapter 4 – section: 4.2; Chapter 5 – Sections: 5.2 (Up to Theorem 5.2), 5.3 (Up to Theorem 5.5); Chapter 7 – Sections: 7.2 (Theorem 7.2-Statement only and applications) & 7.3			
5	**Teacher Specific Contents** *(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. **I**t's purpose is to encourage creativity and develop Problem solving skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**
	Lectures, Tutorials, Interactive Sessions, Blended Learning

<table>
<tr><td rowspan="12">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="11"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>IV</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>5</td><td>3</td><td>13</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Blyth, T. S., and E. F. Robertson. *Basic linear algebra*. Springer, 2007**.**
2. Burton, David M.. *Elementary number theory (7th ed.)*. McGraw-Hill Education, 2017.

SUGGESTED READINGS:

1. Strang, Gilbert. *Introduction to linear algebra (5th ed.)*. Wellesley-Cambridge Press, 2016.

2. Lipschutz, S., Lipson, M.. *Schaum's outline of theory and problems of linear algebra (4th ed*.). McGraw-Hill.

3. Kumaresan, S. *Linear Algebra: A Geometric Approach.* PHI Learning.,2015.

4. Bronston, T. A., Costa, A. C. R. . *Linear algebra*: *An introduction (4th ed*.). Academic Press, 2013.

ADVANCED READINGS:

1. Apostol, T. M. . *An Introduction to Analytic Number Theory* (2nd ed.). Springer, 1976.
2. Niven, I., Zuckerman, H. S., Montgomery, H. L. *An Introduction to Number Theory* (5th ed.). Wiley, 1991.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Proofs of theorems in Chapter 3 (up to exercise 3.10) and Chapter 4
- Use of computational software or tools (like Python, Sage math etc.) to perform the matrix operations in the modules 1 and 2
- Illustrate the technique of Sieve of Eratosthenes for finding all primes below a given integer (Chapter 3-Sec. 3.2 of Textbook 2)
- Apply Congruence relation to encrypt and decrypt a message using Caesar Cipher and Vigenere's approach. (Relevant Sections of Chapter 10 of Textbook 2)
- Proofs of theorems 2.3 and 2.4 of Textbook 2.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Fundamentals of Analysis**					
Type of Course	**DSC A**					
Course Code	**MG4DSCMAT201**					
Course Level	**200-299**					
Course Summary	This course covers elementary properties of real and complex numbers, with a focus on analytic functions and various mathematical functions. Practical applications and problem-solving skills are emphasized throughout. The course provides an in-depth review of complex numbers, exploring their fundamental characteristics, exponential representations, and geometric importance. It delves into functions of complex variables, presenting the Cauchy-Riemann equations as a means of identifying analytic functions. The conclusion includes a comprehensive discussion of special functions of complex variables, such as inverse trigonometric and hyperbolic functions, as well as exponential, logarithmic, trigonometric, and hyperbolic functions.					
Semester	**4**	**Credits**				**4**
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Basic Set theory and Calculus					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:

	Upon the successful completion of the course, the student will be able to		
1	To understand the basic principles of set theory, including definitions of finite and infinite sets, cardinality, and operations on sets.	U	1, 2
2	Demonstrate a comprehensive understanding of the real numbers as a complete ordered field, distinguishing their properties from those of other algebraic structures with similarities to real numbers.	A	1,2,3
3	Analyze the concept of completeness property in real numbers and apply the supremum property in mathematical analysis and problem-solving.	An	1,2,3, 10
4	Identify various numerical representations of real numbers and categorize different types of intervals.	An	1,2,3
5	Understand the basic properties of complex plane, its geometrical dimensions and complex functions	U	1,2,3, 10
6	Identify regions of complex plane and behaviour of continuous and differentiable functions of complex variables	A	1,2,3, 10
7	Analyse analytic and harmonic of functions of complex variables	An	1,2,3, 10
8	Categorise the basic properties of some elementary functions of complex variables.	An	1,2,3, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Graphical visualization of Elementary Functions using *Geogebra/ Desmos*	1	**15**
	1.2	Finite and Infinite Sets.	1	
	1.3	The Algebraic and Order Properties of R.	2	
	1.4	Absolute Value and the Real Line.	2	

	Text 1: Chapter 1 - Section: 1.3 (Concepts, statements of the theorems, informal proofs and problems only); Chapter 2 - Sections: 2.1 & 2.2.			
2	2.1	The Completeness property of R	3	**20**
	2.2	Applications of supremum property	3	
	2.3	Intervals	4	
		Problems (Practicum)	**3, 4**	
	Text 1: Chapter 2 - Sections: 2.3, 2.4 (Theorems 2.4.7 – Statement only), 2.5 (Concepts, statements of the theorems and problems only).			
3	3.1	Basic Properties of Complex Numbers	5	**20**
	3.2	Exponential form of Complex Numbers	5	
	3.3	Roots of Complex Numbers	5	
	3.4	Regions in the complex Plane	6	
	3.5	Functions of the complex Variables	5	
	3.6	Limits and Continuity	5	
	3.7	Differentiation of Complex functions and CR Equations	6	
	3.8	Analytic and Harmonic functions	7	
		Problems (Practicum)	**5, 6, 7**	
	Text 2: Sections: 1 to 12,15,16,18 to 22,24 to 26 (Concepts, statements of the theorems and problems only from sections 16, 21 and 22)			
4	4.1	Exponential functions	8	**20**
	4.2	Logarithmic functions	8	
	4.3	Trigonometric and Hyperbolic functions	8	
	4.4	Inverse Trigonometric and Hyperbolic functions	8	
		Problems (Practicum)	8	
	Text 2: Sections: 29 to 32, 34 to 36			

5	**Teacher Specific Contents** *(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. **I**ts purpose is to encourage creativity and develop Problem solving skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture, Tutorial and Activity oriented		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks
		Module Test- III	5 Marks
		Module Test- IV	5 Marks
		Assignment/Seminar	5 Marks
		Quiz/Viva voce	5 Marks
	B	**End Semester Evaluation (ESE) 70 marks**	
		Question Pattern	

		[Maximum Time 2 Hours, Maximum Marks 70]			
		Module	Part A	Part B	Part C	Total
			2 Marks	**6 Marks**	**10 Marks**	
		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. Bartle, Robert G., Sherbert, Donald R. *Introduction to Real Analysis (4th Edition)*, Wiley Internationals, 2000.
2. Brown, James Ward., Churchil, Ruel V. *Complex Variables and Applications (8th Edition)*, McGraw- Hill Publications, 2009

SUGGESTED READINGS:

1. Denlinger, Charles. *Elements of real analysis*. Jones & Bartlett Learning, 2011.
2. Abbott, Stephen. *Understanding analysis*. springer publication, 2015.
3. Ghorpade, Sudhir R., and Balmohan Vishnu Limaye. *A course in calculus and real analysis*. New York: Springer, 2006.
4. Kumar, Ajit, Kumaresan, S. *A basic course in real analysis*. CRC press, 2014.
5. Ponnusamy, S., Herb Silverman. *Complex variables with applications*. Springer Science & Business Media, 2007.
6. Krantz, Steven G. *Complex Variables: a physical approach with applications and MATLAB*. CRC Press, 2007.
7. Kasana, Harvir Singh. *Complex variables: theory and applications*. PHI Learning Pvt. Ltd., 2005.
8. Zill, Dennis G., and Patrick D. Shanahan. *Complex analysis: A first course with applications*. Jones & Bartlett Publishers, 2013.
9. Choudhary, B. *The elements of complex analysis*. New Age International, 1993.

ADVANCED READINGS:

1. Howie, John M. *Real analysis*. Springer Science & Business Media, 2006.
2. Rudin, Walter. *Principles of mathematical analysis*. Vol. 3. New York: McGraw-hill, 1976.
3. Royden, Halsey Lawrence, and Patrick Fitzpatrick. *Real analysis*. Vol. 2. New York: Macmillan, 1968.
4. Saff, E. B., Snider, A. D. *Fundamentals of Complex Analysis with Applications to Engineering, Science and Mathematics*, (2002).
5. Jeffrey, Alan. *Complex analysis and applications*. CRC Press, 2005.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Principle of strong mathematical induction.
- Well ordering property
- Check whether C satisfies the completeness property.
- Binary representation and decimal representation of real numbers.
- Plot and analyse complex functions using available software.
- Applications of complex numbers and complex functions in different areas.
- Studies on multi valued complex functions
- Formal proofs of theorems in section 1.3
- Proof of theorem 2.4.7
- Proof of theorems in section 2.5

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Mathematical Modelling**					
Type of Course	**DSE**					
Course Code	**MG4DSEMAT200**					
Course Level	**200-299**					
Course Summary	Mathematical modelling is a process that uses math concepts to explain systems, functions and events. Nearly any industry can benefit from mathematical modelling, but it's most commonly used in areas such as engineering, computer science, social science and natural science. Mathematical modelling is described as conversion activity of a real problem in a mathematical form. Modelling involves to formulate the real-life situations or to convert the problems in mathematical explanations to a real or believable situation.					
Semester	**4**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any	**Basic Calculus and Differential Equations**					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Get an insight into different Mathematical techniques that are applied in real life.	U	1,2,10

2	Understand the use First Order Differential equation to create mathematical models of real life.	U	1,2,3,6
3	Solve Mathematical Modelling of geometrical problems using first order differential equation.	A	1,2,10
4	Solve Mathematical Modelling of population problems using first order differential equation.	A	1,2,3
5	Use Second Order Differential equation to create mathematical models of real life.	U, A	2,3,6,10
6	Solve Mathematical Modelling of trajectory related problems using second order differential equation.	A	2,3,6,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Simple Situations Requiring Mathematical Modelling	1	**13**
	1.2	The technique of Mathematical Modelling	1	
	1.3	Classification of Mathematical Models	1	
	1.4	Some Characteristics of Mathematical Models	1	
	1.5	Modelling through Geometry, Algebra, Trigonometry, Calculus	1	
	Text 1: Chapter 1 - Sections: 1.1 to 1.8			
2	2.1	Modelling through Differential Equations	2	**17**
	2.2	Linear Growth and Decay Models	2	
	2.3	Non-linear Growth and Decay Models	2	
	2.4	Compartment Models	2	
	2.5	Mathematical Modelling in Dynamics through Ordinary Differential Equations of the first order.	3	

	Text 1: Chapter 2 -Sections: 2.1 to 2.5			
3	3.1	Mathematical Modelling in Population Dynamics	4	**15**
	3.2	Mathematical Modelling in Epidemics	4	
	3.3	Compartment Models	4	
	3.4	Economics Related Models	4	
	Text 1: Chapter 3 - Sections: 3.1 to 3.4			
4	4.1	Mathematical Modelling of Planetary Motion	5	**15**
	4.2	Mathematical Modelling of Circular motion and Motion of Satellites	5	
	4.3	Mathematical Modelling through Linear Differential Equations of Second Order	6	
	4.4	Miscellaneous Problems	6	
	Text 1: Chapter 4 - Sections: 4.1 to 4.4.			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture, Teaching, Interactive Instruction, Seminar, Group Assignment, Library Work and Group Discussion		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks
		Module Test- III	5 Marks

<table>
<tr><td rowspan="8"></td><td rowspan="3"></td><td>Module Test- IV</td><td>5 Marks</td></tr>
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<tr><td>Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td>B</td><td colspan="2">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="7"></td><td colspan="2">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td colspan="2"><table>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
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<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
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<tr><td>Number of questions to be answered</td><td>5</td><td>5</td><td>3</td><td>13</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table></td></tr>
</table>

REFERENCES:

1. Kapur, J. N. *Mathematical Modelling 2nd Edition New Age International Private Limited*, 2021.

SUGGESTED READINGS:

1. Edward A Bender. *An Introduction to Mathematical Modelling, 1st edition*, Dover Publications Inc, 2003.

2. Rutherford Aris. *Mathematical Modelling Techniques, new edition*, Dover Publications Inc, 2003.

3. Seyed M. Moghadas., Majid Jaberi Douraki. *Mathematical Modelling: A Graduate Textbook, first edition,* Jon Wiley and Sons Inc, 2019.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Mathematical Modelling of Geometrical Problems through Ordinary Differential Equations of the first order. (section 2.6).

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Transforms and Fourier series**					
Type of Course	**DSE**					
Course Code	**MG4DSEMAT201**					
Course Level	**200-299**					
Course Summary	The content of the course has wide application in the fields such as application of PDE, Digital Signal Processing, Image Processing, Theory of wave equations, Differential Equations and many others. The aim of the course is to familiarise the students various tools and techniques related to Laplace transform and Fourier series. Also to equip them to solve applied problems.					
Semester	**4**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any						

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand and apply Laplace transform, inverse Laplace transform and to solve ODE	A	1,2,3, 10
2	Apply various operations on transforms	A	2,3
3	Solve problems using Fourier series	C	1,2,10
4	Evaluate Fourier sine and cosine transforms in various Scientific problems	E	1,2,3,6

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Laplace Transform, Inverse Transforms, Linearity, Shifting.	1	15
	1.2	Transforms of Derivatives and Integrals, Differential equations.	1	
	1.3	Unit Step functions. Second shifting theorem, Dirac's delta function	1	
	Text 1: Chapter 5 - Sections: 5.1 to 5.3			
2	2.1	differentiation and integration of transforms,	2	15
	2.2	Convolution, integral equations	2	
	2.3	partial fractions, Differential Equations	2	
	Text 1: Chapter 5 - Sections: 5.4 to 5.6			
3	3.1	Fourier series	3	15
	3.2	Functions of any period p=2L	3	
	3.3	Even and odd functions and half range expansions	3	
	Text 1: Chapter 10 - Sections: 10.2 to 10.4			
4	4.1	Fourier sine and cosine transforms,	4	15
	4.2	Fourier transform, Tables of transform	4	
	Text 1: Chapter 10 - Sections: 10.9 to 10.11			

5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**					
	Lecture, Teaching, Interactive Instruction, Seminar, Group Assignment, Library Work and Group Discussion					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**				
		Components			**Mark Distribution**	
		Module Test- I			5 Marks	
		Module Test- II			5 Marks	
		Module Test- III			5 Marks	
		Module Test- IV			5 Marks	
		Assignment/Seminar			5 Marks	
		Quiz/Viva voce			5 Marks	
	B	**End Semester Evaluation (ESE) 70 marks**				
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**				
		Module	Part A **2 Marks**	Part B **6 Marks**	Part C **10 Marks**	Total
		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. Kreyszig, Erwin. *Advanced Engineering Mathematics, Wiley student edition, 8th edition, 2006.*

SUGGESTED READINGS:

1. Lokenath Debnath, Dambaru Bhatta . *Integral Transforms and Their Applications (3rd ed.).* CRC Press Taylor & Francis Group, 2015.
2. Baidyanath Patra. *An Introduction to Integral Transforms*. CRC Press, 2018, Ist Edition.
3. Joel L. Schiff. *The Laplace Transform-Theory and Applications*. Springer 1999.
4. Rajendra Bhatia. *Fourier Series (2nd ed.) Texts and Readings in Mathematics*. Hindustan Book Agency, Delhi 2003.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Problem solving from module 1, 2 and 3
- Problems relating to Fourier transform

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**				
Course Name	**Operations Research**				
Type of Course	**DSE**				
Course Code	**MG4DSEMAT202**				
Course Level	**200-299**				
Course Summary	The objective of this course is to familiarize industrial problems to students with various methods of solving Linear Programming Problems, Transportation Problems, Assignment Problems and their applications				
Semester	**4**	**Credits**		**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any						

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Express objective function and resource constraints in LP model in terms of decision variables and parameters.	U	1,2,3
2	Solve an LP problem by the graphical method.	A	2
3	Interpret the optimal solution of LP problems.	A	2,6,10
4	Formulate the dual LP problem and understand the relationship between primal and dual LP problems.	U	1,2,3

5	Recognize, formulate, and solve a transportation problem involving a large number of shipping routes.	C	1,2,3,6,10
6	Analyse assignment problem and apply the Hungarian method to solve an assignment problem.	C	1,2,3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO NO:	Hours
1	1.1	Linear Programming: Introduction, Formulation of LPP (Example up to 2.6.10)	1	**12**
	1.2	Graphical Method of Solution (Example up to 2.9.8)	2	
	1.3	**a)** Some Exceptional Cases	2	
	1.4	b) The General LPP, Canonical and Standard Forms of LPP	1	
	Text 1: Chapter 2 - Sections: 2.1, 2.6, 2.9 to 2.12			
2	2.1	Simplex Method: Theory of Simplex Method, Some Important Definitions	3	**18**
	2.2	The Simplex Method (Example up to 2.16.4)	3	
	2.3	Artificial Variable Techniques: Big-M Method only (Example up to 2.17.4)	3	
	2.4	Special Cases in Simplex Method Application	3	
	2.5	Duality in Linear Programming	4	
	Text 1: Chapter 2 - Sections: 2.13, 2.14, 2.16, 2.17, 2.18.1 to 2.18.6; Chapter 6 - Sections: 6.1.1 to 6.1.3(problems, theorems without proof)			
3	3.1	Transportation Problem: Introduction to the Model, Assumptions in the Transportation Model, Definitions of the Transportation Model,	5	**16**

		Matrix Terminology		
	3.2	Formulation and Solution of Transportation Model	5	
	3.3	Variants in Transportation Problem	5	
	Text 1: Chapter 3 - Sections: 3.1 to 3.4, 3.5.1,3.5.2, 3.6.1,3.6.2			
4	4.1	Assignment Problem: Definition of the Assignment Model, Mathematical Representation of Assignment Model, Comparison with the Transportation Model	6	**14**
	4.2	Solution of the Assignment Model	6	
	4.3	Hungarian Method for Solution of the Assignment Problems	6	
	4.4	Formulation and Solution of the Assignment Model	6	
	4.5	Variation of Assignment Problem: Non-square Matrix and Maximization Problem	6	
	Text 1: Chapter 4 - Sections: 4.1 to 4.7			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture, Teaching, Interactive Instruction, Seminar, Group Assignment, Library Work and Group Discussion		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks
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</table>

REFERENCES:

1. Prem Kumar Gupta., Hira, D.S. *Operations Research – 7th Edition,* S Chand & Sons Publications, 2014.

SUGGESTED READINGS:

1. Sharma, J.K. *Operations Research: Theory and Applications – 6th edition*, Macmillian India Ltd-New Delhi Publications
2. Frederick S. Hillier., Gerald J Lieberman. *Introduction to Operations Research* – 10th edition. McGraw Hill Publications.
3. Taha , Hamdy A. *Operations Research: An Introduction – 8th edition.* Pearson Education Publishers.
4. Kanti Swarup., Gupta, P.K., Man Mohan. *Operation Research*. S Chand & Sons Publications
5. Aumann R.J. *Mixed and Behaviour strategies in infinite extensive.* Princeton University.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Problem solving using the methods discussed in the module 1, 2 and 3

Mahatma Gandhi University

Kottayam

Programme						
Course Name	**Essential Mathematics for Science**					
Type of Course	**DSC C**					
Course Code	**MG4DSCMAT202**					
Course Level	**200-299**					
Course Summary	This Mathematics minor course complements and enhances the undergraduate programmes on science disciplines such as Physics, Chemistry etc., by enabling the students to understand the concepts of complex numbers and analytic functions, to solve differential equations of different types, to identify different conic sections and its applications in possible areas and to determine unit tangent vector, principal normal vector, and curvature of different curves.					
Semester	**4**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Basic awareness of coordinate systems, vectors, functions, derivatives, and integrals					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand the concepts of complex functions and vector calculus	K	1
2	Apply C-R equations to check the analyticity of complex functions	A	2
3	Analyse the nature of differential equation	An	1

4	Solve equations in complex variables and differential equations	A	2
5	Distinguish between cartesian and polar co-ordinates	An	1
6	Identify conic sections from its equations and Visualize curves	E	2
7	Find the curvature and directional derivatives of curves	E	2
8	Develop applications of mathematical concepts in scientific/real life problems	C	3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Complex Functions**		20
	1.1	Complex Numbers, Sums and Products, Basic Algebraic Properties, moduli, conjugates, Exponential and Polar Forms, Products and Powers in Exponential form	1	
	1.2	Functions of Complex Variables, Separation into Real and Imaginary parts, Limits and Continuity	1	
	1.3	Derivatives, Analytic Function, Cauchy-Riemann Equations, Laplace Equation, Harmonic Function	2	
		Problems (Practicum)	1, 2	
	Text 1: Chapter 1 – Sections: 1 to 7; Chapter 2 – Sections: 12,15,16,18 to 22, 24 to 26 **Theorems – Statements Only**			
2		**Differential Equations**		**18**
	2.1	Degree, Order, Solution of Differential Equations, Variable Separable method	3, 4	
	2.2	Exact Differential Equations	3, 4	
	2.3	Linear Differential Equations, Bernoulli's Equations	4	
		Problems (Practicum)	3, 4	

	Text 2: Chapter 1 – Sections: 1.1 to 1.5 **Theorems – Statements Only**			
3		**Analytic Geometry**		**17**
	3.1	Polar coordinates	5	
	3.2	Conic sections	6	
	3.3	Conic section in polar coordinates	6	
		Problems (Practicum)	5,6	
	Text 3: Chapter 11 – sections: 11.3,11.6 & 11.7 **Theorems – Statements Only**			
4		**Vector Calculus**		**20**
	4.1	Curves in Space and tangents, Velocity and Acceleration, Arc length in space	1, 8	
	4.2	Curvature and Normal vectors of a curve	1, 7	
	4.3	Directional derivatives and gradient vectors	1, 7	
		Problems (Practicum)	1,7,8	
	Text 3: Chapter 13 – Sections: 13.1,13.3,13.4; Chapter 14 – Section: 14.5 **Theorems – Statements Only**			
5	**Teacher Specific Contents** *(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. **I**t's purpose is to encourage creativity and develop Problem solving skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten

copy of the solutions should be kept in the department.

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="5">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="5">Direct Instruction, Brainstorming Lecture, Explicit Teaching, Active Co-operative Learning,</td></tr>
<tr><td rowspan="15">Assessment Types</td><td colspan="5">MODE OF ASSESSMENT</td></tr>
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</table>

REFERENCES:

4. James Ward Brown, Ruel V. Churchill. *Complex Variables and Applications, Eighth Edition,* McGraw Hill, *2009*

5. Simmons, G.F., Krantz, S.G. *Differential Equations*, Tata McGraw Hill-New Delhi, 2007.
6. Thomas, George B Jr. *Thomas' Calculus, Twelfth Edition*, Pearson, 2010

SUGGESTED READINGS:

5. Grewal, B. S., *Higher Engineering Mathematics*, *44th Edition*, Khanna Publishers, 2021.
6. Anton, H., Bivens, Devis. *Calculus, tenth Edition*, Wiley India.
7. Kreyszig,E. *Advanced Engineering Mathematics*, Wiley, India.
8. Siddiqi, A.H., Manchanada, P. *A first course in Differential Equations*, Mc Millan.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Proofs of theorems from module 1, 2, 3 & 4
- Solution of equations in Complex variables, Regions in the Complex plane
- Homogeneous Differential equations, Integrating Factors of Differential Equations
- Visualization of curves and conic section, Obtaining Points of farthest and closest approach of Planets/ Satellites
- Integration in vector fields, Finding Work done, Flow, circulation and flux
- Text 1-Chapter 1 (Roots of complex numbers, Regions in complex plane)
- Text 2 – Chapter 1 (Homogeneous Differential Equations, Integrating factors)
- Text 3 – Chapter 16 (Line integrals, Work, Circulation and Flux)

Mahatma Gandhi University
Kottayam

Programme						
Course Name	**Mathematics for Electronics**					
Type of Course	**DSC C**					
Course Code	**MG4DSCMAT203**					
Course Level	**200-299**					
Course Summary	This course will give an introduction to basic concepts of Vector Algebra and various Mathematical manipulations involved. Students get a good understanding of Partial fractions, Laplace transforms and their properties. Students acquire skills to construct Boolean functions, Logic gates and applications and the capacity to use them in Computer science applications and problems.					
Semester	**4**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Differentiation, Partial differentiation and integration					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Compute dot and cross product by giving algebraic concepts	A	2
2	Apply dot or cross product to determine angle between vectors	A	2
3	Find expansion for powers of Sine and Cosine functions. Also understand the relation between Circular and Hyperbolic function.	E	2

4	Understand the concepts of partial fraction	U	2
5	Determine Laplace transform of Elementary functions and understand its properties	E	2
6	Create Boolean functions and logic gates	C	3
7	Analyse and simplify digital logic circuits using Boolean Algebra	An	3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Vector Analysis**		
	1.1	Basic concepts of dot and cross products, (Definition and simple problems)	1	**22**
	1.2	Gradient of a scalar field, Directional derivative	1	
	1.3	Divergent and Curl of a Vector field, Solenoidal and Irrotational	2	
		Problems (Practicum)	1,2	
	Text 1: Chapter 3 – Sections: 3.4, 3.5 (Definition and geometrical interpretation) 3.6 (Definition and geometrical interpretation); Chapter 8 – Sections: 8.4, 8.5(Exclude geometrical interpretation), 8.6, 8.7 (Solenoidal and irrotational)			
2		**Trigonometry**		
	2.1	De Moiré's Theorem (Statement only), Expansions of $sin^n\theta$, $cos^n\theta$ and $sin^n\theta.cos^m\theta$ Simple problems.	3	**15**
	2.2	Expansions of $\sin n\theta, \cos n\theta$ in powers of $\sin\theta$ and $\cos\theta$. Simple problems.	3	
		Problems (Practicum)	3	

	Text 3: Chapter 2 – Sections: 2.5.3, 2.5.5 & 2.5.6			
3		**Laplace Transform**		
	3. 1	Review of partial fraction	4	**18**
	3. 2	Laplace transform of elementary functions	5	
	3. 3	Properties of Laplace transform	5	
		Problems (Practicum)	4,5	
	Text 1: Chapter 21 – Sections: 21.2, 21.3 & 21.4 (Exclude proof and change of scale property)			
4		**Boolean Algebra**		
	4. 1	Boolean function	6	**20**
	4. 2	Representing Boolean functions, SOP form of Boolean expression	6, 7	
	4.3	Logic Gates and representations	6	
		Problems (Practicum)	6,7	
	Text 2: Chapter 10 – Sections: 10.1,10.2 &10.3(Logic gates and combinations)			
5	**Teacher Specific Contents** *(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. **I**t's purpose is to encourage creativity and develop Problem solving skills.**T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="5">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="5">Brainstorming Lecture, Explicit Teaching, Active Cooperative Learning</td></tr>
<tr><td rowspan="15">Assessment Types</td><td colspan="5">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="4">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td>Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td>5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td>5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td>B</td><td colspan="4">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="8"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
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<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>IV</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>5</td><td>3</td><td>13</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Grewal,B.S. *Higher engineering Mathematics,40th Edition*, Khanna publications, 2021.

2. Rosen, Kenneth. H. *Discrete Mathematics and its applications, 6th edition,* McGraw Hill Publishing Co. New Delhi, 2006.

3. Sastry, S.S. *Engineering Mathematics Volume 1*, 4th edition PHI, 2008.

SUGGESTED READING:

1. Kreyszig, Erwin. *Advanced Engineering Mathematics*, Wiley, India, 2006.

ADVANCED READINGS:

1. Muray R Spiegel. *Advanced Calculus, Schaum's Outline series, 2010.*
2. Ralph P Grimaldi , B V Ramana. *Discrete and Combinatorial Mathematics; Pearson Education, Dorling Kindersley India Pvt. Ltd, 2006.*

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Proof of properties - Scalar and Vector product, Physical Applications of Scalar and Vector product
- Proof of Gradient of a scalar field, Directional derivative
- Circular and hyperbolic functions
- Change of scale property
- Applications of Logic gates
- Text 1- Sections 3.5, 3.6,3.7, 8.5, 21.4
- Text 2 - Section 10.3 (Examples of circuits)
- Text 3 - Section 2.5.7

Mahatma Gandhi University
Kottayam

Programme						
Course Name	**Mathematics for Business and Economics**					
Type of Course	**DSC C**					
Course Code	**MG4DSCMAT204**					
Course Level	**200-299**					
Course Summary	Mathematical methods and theories applicable in economics and business to analyse real life problems are included in the course. First module provides an understanding of the way in which financial calculations are worked out. Second module deals with different methods of solving systems of equations and the many varied applications of such systems to business and economics. Optimization of functions using their derivatives is included in the third module. Linear programming is helpful in business and economics where it is often necessary to optimize a profit or cost function subject to several inequality constraints. The graphic approach for maximization and minimization linear programming problems is also illustrated. Module four deals with the applications of calculus in economics and business.					
Semester	**4**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Graphing functions, Basics of differential and integral Calculus, Multi-variable functions and partial differentiation, Percentage calculation, Basics of logarithmic and exponential functions					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	understand the difference between simple and compound interest	U	1,3
2	calculate the future value of a principal under annual compounding and under continuous compounding	A	2,3
3	recognize a geometric progression	K	2
4	evaluate a geometric series and calculate the total investment obtained from a regular savings plan.	E	2,3,10
5	use net present values to appraise investment projects and calculate the internal rate of return, the present value of an annuity	A	2,3,10
6	use discounting to compare investment projects	U, A	1,3
7	understand functions, classical optimization techniques and marginal concepts in economics	U	1,3
8	analyse the real-life problems in business and economics and to model it mathematically	A, An, C	2,3,6,10
9	apply elementary algebra and calculus in economics and business problems and solve it mathematically	A, C	1,2,3
10	solve linear programming problem using graphical method	C	2

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Mathematics of Finance**		**15**
	1.1	Compound Interest	1,2	
	1.2	Geometric Series	3,4	

	1.3	Investment Appraisal	5,6	
		Problems (Practicum)	1,2,3,4,5,6	
	Text 2: Chapter 3 – Sections: 3.2 to 3.4			
2		**Mathematical Economics**		
	2.1	Introduction to System of Equations	7	
	2.2	Graphical Solutions	7,8	
	2.3	Supply-and-Demand Analysis	8,9	
	2.4	Break-Even Analysis	8,9	**20**
	2.5	Elimination and Substitution Methods	8,9	
	2.6	Income Determination Models	8,9	
	2.7	IS-LM Analysis	8,9	
		Problems (Practicum)	7,8,9	
	Text 1: Chapter 4 – Sections: 4.1 to 4.7			
3		**Optimization Techniques**		
	3.1	Use of Graphs in LPP, Maximization Using Graphs	7,10	
	3.2	The Extreme-Point Theorem, Minimization Using Graphs	7,10	
	3.3	Optimization of Functions, The Successive-Derivative Test	7	**25**
	3.4	Marginal Concepts in Economics	7,8,9	
	3.5	Optimizing Economic Functions for Business	8,9	
	3.6	Relationship Among Total, Marginal, and Average Functions	9	
		Problems (Practicum)	7,8,9,10	
	Text 1: Chapter 7 – Sections: 7.1 to 7.4; Chapter 10 – Sections: 10.6 to 10.10			

4		**Applications of Mathematics in Economics and Business**		
	4.1	Functions of Several Independent Variables	7	**15**
	4.2	Constrained Optimization problems with Lagrange Multipliers	7,8,9	
	4.2	Applications of definite integral in consumers and producers surplus	8,9	
		Problems (Practicum)	7,8,9	
	Text 1: Chapter 12 – Section: 12.11; Chapter 13 – Sections: 13.1 & 13.6			
5	**Teacher Specific Contents** *(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. **I**t's purpose is to encourage creativity and develop Problem solving skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.			
Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Direct Instruction, Brain Storming Approach, Interactive instruction, Group Discussion, Presentation by Individual Student/ Group Representatives		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks

<table>
<tr><td rowspan="8"></td><td rowspan="5"></td><td colspan="3">Module Test- II</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td>5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td>5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td>B</td><td colspan="4">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="8"></td><td colspan="4">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
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<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
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<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
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<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Edward T Dowling, *Mathematical Methods for Business and Economics*, Schaum's Outline Series, McGraw Hill, 2009.
2. Ian Jacques, *Mathematics for Economics and Business*, 5th Edition, Prentice Hall,2006.

SUGGESTED READINGS:

1. Taro Yamne, *Mathematics for Economists-An elementary survey,* Prentice -Hall, Inc.
2. Robert Brechner, *Contemporary Mathematics for Business and Consumers,* Fifth Edition
3. Das, N. G., Das, J K. *Business Mathematics and Statistics*, Tata McGraw-Hill, 2012.
4. Martin Anthony, Norman Biggs*, Mathematics for economics and finance Methods and Modelling,* Cambridge University Press, 2012.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Application mathematics in economics and business using spreadsheets

Mahatma Gandhi University
Kottayam

Programme						
Course Name	**Essential Mathematics for Computing**					
Type of Course	**DSC C**					
Course Code	**MG4DSCMAT205**					
Course Level	**200-299**					
Course Summary	This course provides a comprehensive introduction to discrete mathematics and algorithms, covering topics such as number theory, cryptography, Boolean algebra, logic gates, relations, tree structures and graph theory. Practical implementation involves coding tree traversal, depth-first search and breadth-first search algorithms using a programming language. Students gain both theoretical insights and hands -on experience applicable across computer science domains.					
Semester	**4**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Basic understanding of integers and divisibility, basic algebraic operations, set theory and set operations and basic graph theory concepts.					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand the fundamental concepts of number theory, including prime numbers and divisibility	U	2

2	Apply congruence in various mathematical scenarios and recognize its applications in Hashing and Cryptography.	A	8
3	Analyze the truth tables and logical operations associated with each type of logic gates.	An	1
4	Understand the relations and it's representations	U	2
5	Apply the basic concepts of trees and tree traversal techniques	A	2
6	Apply knowledge of spanning trees and understand their applications in different domains	A	3
7	Analyze the security implications and practical applications of the RSA cryptosystem	An	8
8	Apply tree traversal algorithm, depth-first search algorithm and breadth-first search algorithm to solve real world problems , using any suitable programming language.	C	9

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Number Theory & Cryptography**		
	1.1	Divisibility and modular arithmetic:- Division, Division algorithm, Modular arithmetic, Congruence and Basic properties of congruence.	1,2	**17**
	1.2	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	2	
	1.3	Applications of number theory: a) Solving congruence :- Linear congruence, Chinese remainder theorem and Fermat's theorem (Statement only) b) Application of congruence :-Hashing function c) Cryptography :- Caesar cipher, Vignere	2	

		cipher and Hill cipher		
		Problems (Practicum)	1,2	
	Text 1: Chapter 4 – Sections: 4.1, 4.3 to 4.6 **Text 2: Chapter 10 – Section: 10.1**			
2		**Boolean Algebra**		
	2.1	Boolean functions	3	**13**
	2.2	Representing of Boolean functions Sum Of Products (SOP)	3	
	2.3	Logic gates	3	
		Problems (Practicum)	3	
	Text 1: Chapter 11 – Sections: 11.1 to 11.3			
3		**Relations & Partial orders**		
	3.1	Relations & properties	4	**20**
	3.2	Representing relations	4	
	3.3	Equivalence relation	4	
	3.4	Partial ordering & Hasse Diagrams	4	
		Problems (Practicum)	4	
	Text 1: Chapter 8 – Sections: 8.1, 8.3, 8.5 & 8.6			
4		**Trees**		
	4.1	Introduction to trees:- Trees, Properties of trees, Applications of trees:- Binary search trees, Prefix codes and Huffman coding	5	**25**
	4.2	Tree traversal:- Traversal algorithms, Infix, Prefix and postfix notations	7,8	
	4.3	Spanning trees: - Introduction, Depth-first search algorithm (BFS), Breadth--first search algorithms (DFS)	5	

	4.4	Minimum spanning trees:- Algorithms for minimum spanning trees- Kruskal's algorithm and Prim's algorithm	6	
		Problems (Practicum)	5,6,7,8	
	Text 1: Chapter 10 – Sections: 10.1 to 10.5			
5	**Teacher Specific Contents** *(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. **I**t's purpose is to encourage creativity and develop Problem solving skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Direct instruction: Lecture Method, Tutorial ,Brainstorming Lectures, Explicit Teaching Interactive instructions: Active Cooperative Learning, Library Work and Group Discussion, Peer Learning, Authentic Learning		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks
		Module Test- III	5 Marks

<table>
<tr><td rowspan="11"></td><td rowspan="3"></td><td colspan="2">Module Test- IV</td><td>5 Marks</td></tr>
<tr><td colspan="2">Assignment/Seminar</td><td>5 Marks</td></tr>
<tr><td colspan="2">Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td>B</td><td colspan="4">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="9"></td><td colspan="4">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
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<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Kenneth H Rosen, *Discrete Mathematics and its Applications (Eighth Edition).* Tata McGraw- Hill Education (India) private limited, Special Indian Edition 2021.
2. Burton, David M. *Elementary Number theory (Seventh edition),* The McGraw Hill companies, 2009.

SUGGESTED READINGS:

1. Clifford Stien., Robert L Drysdale., Kenneth Bogart. *Discrete Mathematics for computer scientists*; Pearson Education; Dorling Kindersley India Pvt Ltd.
2. Kenneth A Ross., Charles R.B.Wright., *Discrete Mathematics*; Pearson Education; Dorling Kindersley India Pvt Ltd.
3. Richard Johnsonbaugh. *Discrete Mathematics.* Pearson Education; Dorling Kindersley India Pvt Ltd.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- RSA public key cryptosystem
- Implement tree traversal algorithm, depth-first search algorithm and breadth-first search algorithm using any suitable programming language.
- Text 1-4.6, 10.3, 10.4
- Text 2- Section 10.1

Mahatma Gandhi University

Kottayam

Programme						
Course Name	**Business Mathematics**					
Type of Course	**VAC**					
Course Code	**MG4VACMAT200**					
Course Level	**200-299**					
Course Summary	This course provides a solid foundation in mathematical concepts relevant to business applications. The inclusion of practical lab sessions using Excel enhances the understanding of these concepts through hands-on experience and real-world problem-solving. Students will gain proficiency in applying mathematical tools to analyse economic scenarios, make informed decisions, and solve business-related problems.					
Semester	**4**	**Credits**			**3**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	0	0	**45**
Pre- requisites, If any						

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Perform various matrix operations	A	2
2	Formulate real life problems into matrix and solve	C	1, 6

3	Sketch graphs of linear equations and solve simultaneous equations using graphical method	A	2
4	Formulate and solve system of linear equations from real life problems	C	2, 6
5	Apply excel spreadsheet functions to perform matrix operations and to solve simultaneous equations and linear programming problems	A, S	3, 6 10
6	Learn Freehand Method, Semi-average method, Moving average method & Method of Least squares to analyse underlying causes of trends or systematic patterns over time.	An, A	1, 2, 3, 6, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Matrix Algebra**		**18**
	1.1	Introduction to matrices and vectors	1	
	1.2	Basic principles of matrix multiplication, Matrix multiplication – the general case (using excel)	1,5	
	1.3	The matrix inverse and the solution of simultaneous equations	1,2	
	1.4	Determinants (using excel)	1, 5	
	1.5	Minors, cofactors and the Laplace expansion	1	
	1.6	The transpose matrix, the cofactor matrix, the adjoint and the matrix inverse formula (Exclude the derivation of the matrix-inverse formula)	1	
	1.7	Application of the matrix inverse to the solution of linear simultaneous equations (using excel)	2, 5	
	1.8	Cramer's rule	2	
	1.9	Input- Output Analysis	2	

	Text 1: Chapter 15 - Sections 15.1 to 15.9 & 15.12			
2		**Linear Programming Problems**		**15**
	2.1	Linear Equations: Straight line graphs, An Economic Application- Supply and Demand	3	
	2.2	Simultaneous Equations	3	
	2.3	Linear Inequalities: Inequalities & Economic Applications	3	
	2.4	Linear Programming - Formulation and Graphic Solution (using excel)	4, 5	
	Text 2: Chapter 1 – Sections: 1.1, 1.2, 1.3(Excluding Complications, Three Equations in Three Unknowns and Gaussian Elimination); Chapter 2 – Sections: 2.1 & 2.2 **Text3: Chapter 2 (excluding section 2.5)**			
3		**Interpolation and Time Series Analysis**		**12**
	3.1	Time Series, Necessity of time series analysis	6	
	3.2	Components of time series, Some adjustments of time series data	6	
	3.3	Measurement of trend: Freehand Method, Semi-average method, Moving average method, Method of Least squares. (Linear Trend only)	6	
	Text 4: Chapter 18 - Sections 18.1 to 18.8			
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**
	Verbal Exposition Case Studies: Applying matrix algebra to business scenarios. In-Class Demonstrations: Visualizing matrix operations in action. Think-Pair-Share Activities: Encouraging peer collaboration in understanding

<table>
<tr><td></td><td colspan="6">concepts.
Flipped Classroom Approach: Pre-learning materials before class discussions.
Scenario-based Learning: Learning through hypothetical business scenarios.
Online Quizzes and Exercises: Reinforcing learning through practice.
Concept Mapping Exercises: Creating visual representations of interrelated concepts.</td></tr>
<tr><td rowspan="14">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td rowspan="6">A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 25 marks</td></tr>
<tr><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 marks</td></tr>
<tr><td rowspan="8">B</td><td colspan="5">Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td colspan="6">End Semester Evaluation (ESE) 50 marks</td></tr>
<tr><td colspan="6">Question Pattern
[[Maximum Time 75 Minutes, Maximum Marks 50]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>3</td><td>2</td><td>1</td><td>6</td></tr>
<tr><td>II</td><td>3</td><td>2</td><td>2</td><td>7</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
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</table>

REFERENCES:

1. Rosser, Mike, and Piotr Lis. *Basic mathematics for economists*. 3rd ed. Routledge, 2016.
2. Pemberton, Malcolm, and Nicholas Rau. *Mathematics for economists: an introductory textbook,4th ed*. Manchester University Press, 2016.

3. ND, Vohra. "Quantitative techniques in management.", 3rd ed. Tata McGraw Hill New Delhi, 2007.
4. Ghosh, Ram Krishna, and Suranjan Saha. *Business Mathematics and Statistics, (Algebra, Geometry, and Business Statistics)*. New Central Book Agency, 2019.
5. Harmon, Mark. "Step-by-step optimization with Excel Solver." *Excel Master Series,* 2011.

SUGGESTED READINGS:

1. Mavron, Vassilis C., and Timothy N. Phillips. *Elements of Mathematics for Economics and Finance*. Classroom Companion: Economics. Springer Cham, 2023.

2. Newbold, Paul, et al. *Statistics for Business and Economics*. Pearson Education Limited, 2023

ADVANCED READINGS:

1. Manna, Asim Kumar. *Business Mathematics and Statistics*, McGraw Hill Education (India) Private Limited, 2018.

2. Bradley, Teresa. *Essential Mathematics for Economics and Business*, 4th edition, John Wiley & Sons, 2013.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS

- Lab sessions using excel spreadsheet to perform matrix multiplication and to evaluate determinants.
- Lab sessions using excel spreadsheet to find the inverse of a matrix and to solve simultaneous equations
- Lab sessions using excel spreadsheet to solve linear programming problems (Refer Text 5)
- Practical sessions can be included

Mahatma Gandhi University

Kottayam

Programme						
Course Name	**Document preparation using LaTeX**					
Type of Course	**SEC**					
Course Code	**MG4SECMAT200**					
Course Level	**200-299**					
Course Summary	This course introduces students to the LaTeX typesetting system, a powerful tool for document preparation widely used in academia and industry. Building on basic LaTeX concepts, students will learn advanced techniques for creating professional-quality documents, including complex formatting, mathematical typesetting, and bibliography management.					
Semester	**4**	**Credits**			**3**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	0	0	**45**
Pre- requisites, If any						

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Explain the fundamental principles of LaTeX typesetting	U,S	1,2

2	Apply advanced LaTeX formatting techniques to create professional-quality documents	A,S	1,2,3
3	Analyse and troubleshoot common errors in LaTeX documents	A,S	2,3,4
4	Create and customize bibliographies using BibTeX in LaTeX	C,S	1,2,3,4
5	Demonstrate effective collaboration using LaTeX for group writing projects	A,S	3,4,9,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Preparing the input file	1	18
	1.2	Sentences and paragraphs, the document, sectioning, displayed material	1	
	1.3	Running LaTeX	1,3	
	1.3	Changing the type style	2	
	1.4	Mathematical Formulas: common structures, Mathematical symbols, Arrays, Delimiters, Multiline formulas, Putting one thing above another, spacing and changing style in math mode.	2	
	Text 1: Chapter 2 – Sections: 2.1 to 2.3; Chapter 3 – Sections: 3.1 & 3.3			
2	2.1	Defining commands and environments	3	12
	2.2	Figures and other floating bodies: Figures and Tables	2	
	Text 1: Chapter 3 – Sections: 3.4 & 3.5.1			

3	3.1	Cross references	3	**15**
	3.2	Bibliography and citation	4	
	3.3	Books	2	
	3.4	Slides: Slides and overlays	5	
	Text 1: Chapter 4 – Sections: 4.2 & 4.3; Chapter 5 – Sections: 5.1 & 5.2.1			
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**	
	1. Interactive Instructions using ICT tools 2. Hands on Training	
Assessment Types	**MODE OF ASSESSMENT**	
	A	**Continuous Comprehensive Assessment (CCA) 25 marks** Practical sessions or exams may be organised for each module and the CCA should be based on these hands on experiences. One of the following Activity should be done during the course. Textbook Content Preparation: As part of CCA student must submit a document of at least 3 pages using a mathematics reference texts of students or faculties choice. This document must be considered for CCA.

Components	**Mark Distribution**
Module Test- I	5 Marks
Module Test- II	5 Marks
Module Test- III	5 Marks
Assignment/Seminar	5 marks

		Quiz/Viva voce			5 Marks	
	B	**End Semester Evaluation (ESE) 50 marks**				
		Question Pattern **[Maximum Time 75 Minutes, Maximum Marks 50]**				
		Module	Part A	Part B	Part C	Total
			2 Marks	**5 Marks**	**10 Marks**	
		I	3	2	2	**7**
		II	2	2	1	**5**
		III	3	2	1	**6**
		Total no of questions	**8**	**6**	**4**	**18**
		Number of questions to be answered	**5**	**4**	**2**	**11**
		Total Marks	**10**	**20**	**20**	**50**

REFERENCES:

1. Lamport, Leslie. *LaTeX: A Document Preparation System*, Addison-Wesley, 2nd edition, 1994.

SUGGESTED READINGS:

1. Goossens, M., Mittelbach, F. F., Samarin, a. *The LaTeX Companion*, Addison-Wesley, 1993.
2. Krishnan, E. *LATEX Tutorials: A Primer*, Indian TEX Users Group, 2004.

Semester 5

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**A First Course in Complex Analysis**					
Type of Course	**DSC A**					
Course Code	**MG5DSCMAT300**					
Course Level	**300-399**					
Course Summary	The objective of this course is the introduction of basic concepts of complex analysis through a problem oriented approach. The course is designed for an understanding of elementary contour integrals, which serves as a powerful means to compute definite integrals and analyze the behaviour of complex functions. The Cauchy-Goursat theorem and Cauchy's integral formula which leads to the construction of Taylor series and Laurent series, the power series expansions that capture the intricate behaviour of analytic functions around specific points are analyzed through the course. The concepts of singularities, poles and resides along with their evaluation are introduced. Improper integrals, definite integrals with one or both limits of integration infinite, are being evaluated using the Cauchy's Residue Theorem.					
Semester	**5**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Complex numbers and operations, Regions of complex plane, Basic properties of functions of complex variables, Elementary functions of complex variables.					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand elementary contour integrals and their upper bounds and acquire a thorough knowledge of contour integration methods.	U	1, 2
2	Demonstrate a comprehensive understanding of the complex plane's domains, singular points, and their classifications including isolated, removable and essential singularities.	U	1, 2, 3, 10
3	Apply Cauchy - Goursat theorem, Cauchy's integral formula, and Cauchy's residue theorem to calculate contour integrals, showcasing expertise in complex integration techniques.	A	1, 2 ,10
4	Elaborate on the consequences of Cauchy's integral formula, highlighting its significance in complex analysis and its applications to derivative calculations.	An	1, 2, 3
5	Effectively categorize poles and zeros of analytic functions, demonstrating a clear understanding of their roles in function behaviour and singularities.	An	1, 2
6	Construct series expansions for analytic functions using appropriate techniques, demonstrating proficiency in representing complex functions using power series.	C	1, 2, 10
7	Evaluate improper integrals using the residue theorem, showcasing the versatility of complex integration methods in solving problems involving improper integrals.	E	1, 2, 3, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Integration of Complex Functions**		**22**
	1.1	Definite integrals of functions	1	
	1.2	Contours and contour integrals, Some examples, Upper bounds for moduli of contour integrals	1	
	1.3	Anti derivatives, Cauchy-Goursat Theorem (statement only), Some consequences of the extension	3	
	1.4	Simply and multiply connected domains	2	
	1.5	Cauchy's integral formula, An extension of Cauchy's integral formula	3	
	1.6	Liouville's theorem and Fundamental theorem of algebra, Maximum modulus principle.	4	
		Problems (Practicum)	1, 3 , 4	
	Text 1: Sections: 38 to 41, 43, 44, 46, 48 to 45			
2		**Series of Complex Functions**		15
	2.1	Convergence of sequences and series	2	
	2.2	Taylor series, Proof of Taylor's Theorem, Examples	6	
	2.3	Laurent Series, Examples	6	
		Problems (Practicum)	2, 6	
	Text 1: Sections: 55 to 60 & 62			
3		**Residues and Poles**		**18**
	3.1	Isolated singular points, residues, Cauchy's Residue Theorem	2	
	3.2	Three types of isolated singular points, Residues at poles, examples.	2	
	3.3	Zeros of analytic functions, Zeros and poles	5	
		Problems (Practicum)	2, 5	
	Text 1: Sections: 68 to 70, 60 to 76			

4		**Evaluation of Improper Integrals**		
	4.1	Evaluation of improper integrals, Example	7	**20**
	4.2	Improper integrals from Fourier analysis. Jordan's Lemma (statement only)	7	
	4.3	Definite integrals involving sines and co-sines	7	
		Problems (Practicum)	7	
	Text 1: Sections: 78 to 81 & 85			
5	**Teacher Specific Contents** *(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. **I**t's purpose is to encourage creativity and develop Problem solving skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture methods, Problem solving Methodologies Activity based Tutorials/ Practical Software based visualisation of concepts		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks

<table>
<tr><td rowspan="11"></td><td rowspan="4"></td><td colspan="3">Module Test- III</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td>5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td>5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td>B</td><td colspan="4">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="7"></td><td colspan="4">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>IV</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>5</td><td>3</td><td>13</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Brown, James Ward, Ruel V. Churchill. *Complex variables and Applications* (8th edition). McGraw-Hill, 2009.

SUGGESTED READINGS:

1. Saff, E. B., Snider A. D., *Fundamentals of Complex Analysis with Applications to Engineering, Science and Mathematics*. Pearson, 2002.
2. Ponnusamy, S., Herb Silverman. *Complex variables with applications.* Springer Science & Business Media, 2007.
3. Krantz, Steven G. *Complex Variables: A physical approach with applications and MATLAB*. CRC Press, 2007.
4. Kasana, Harvir Singh. *Complex variables: theory and applications*. PHI Learning Pvt. Ltd., 2005.

5. Zill, Dennis G., Patrick D. Shanahan. *Complex analysis: A first course with applications*. Jones & Bartlett Publishers, 2013.
6. Choudhary, B. *The elements of complex analysis*. New Age International, 1993.
7. Jeffrey, Alan. *Complex analysis and applications*. CRC Press, 2005.

ADVANCED READINGS:

1. Mathews, John, and Russell Howell. *Complex Analysis for Mathematics and Engineering*. Jones & Bartlett Publishers, 2012.
2. Cartan, Henri. *Elementary Theory of Analytic functions of one or several Complex variables.* Courier Corporation, 1995.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Proof of Cauchy - Goursat Theorem
- Proof of Extension of Cauchy's Integral Formula
- Proof of Laurent's Theorem
- Finding complex integrals, zeros, poles and residues using online software like Wolfram Alpha
- Proof of Jordan's Lemma
- Presenting reports on the applications of complex integrals in other subjects / areas

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Limits And Convergence**					
Type of Course	**DSC A**					
Course Code	**MG5DSCMAT301**					
Course Level	**300-399**					
Course Summary	This course offers a robust foundation in the analysis of sequences, series and the concept of limits of functions and thereby develops a comprehensive understanding of the mathematical structures crucial to calculus. Topics include limits of sequences, monotone sequences, subsequences, proper divergence, Cauchy sequences, and infinite series with a focus on convergence criteria, comparison tests, and special attention to tests like Root and Ratio, Raabe's, Alternating Series, Dirichlet and Abel test. The course also discusses the limit concepts of real functions. By course end, students possess a solid foundation for mathematical analysis.					
Semester	**5**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any	Fundamental of real analysis.					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:

	Upon the successful completion of the course, the student will be able to		
1	Analyse various convergence methods for sequences and determine their limits.	An	1,2,3
2	Investigate properties and analyse behaviour of monotone sequences in mathematical contexts.	A, An	1,2,3,10
3	Examine the concept of sub sequences and demonstrate proficiency in analysing their properties within mathematical contexts.	An, A	1,2,3,10
4	Analysis and application of Cauchy sequences in mathematical contexts, demonstrating proficiency in understanding their convergence properties.	An, A	1,2,3,10
5	Comprehend fundamental concepts of infinite series and apply various tests for establishing their convergence or divergence.	U, A	1,2,3,10
6	Develop the fundamental concepts of absolute convergence and apply relevant tests to determine the convergence properties of series.	C, A	1,2,3,10
7	Apply alternative series tests specifically tailored for non-absolute convergence scenarios, demonstrating a nuanced understanding within mathematical contexts.	A	1,2,3,10
8	Develop the concept of limits of functions at specific points and adeptly apply theories to determine these limits and its properties.	U	1,2,3,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Sequences and Their Limits	1	**15**
	1.2	Limit Theorems	1	
	1.3	Monotone Sequences	2	

	Text 1: Chapter 3 - Sections: 3.1, 3.2 (Theorems 3.2.3 and 3.2.11 – statements only), 3.3 (up to 3.3.3)			
2	2.1	Subsequences and the Bolzano-Weierstrass Theorem.	3	**15**
	2.2	The Cauchy Criterion	4	
	2.3	Properly Divergent Sequences	5	
	Text 1: Chapter 3 - Sections: 3.4 (Theorems 3.4.11 and 3.4.12 – statements only), 3.5 (up to 3.5.8, Theorem 3.5.8 – statement only) & 3.6.			
3	3.1	Infinite Series- n^{th} term test, comparison test, limit comparison test.	5	**15**
	3.2	Absolute Convergence, Grouping and rearrangements of series	6	
	3.3	Tests for Absolute Convergence: Limit comparison Test II, The Root and Ratio Test (Concepts and Problems only)	6	
	3.4	The Raabe's Test (Concepts and Problems only)	6	
	3.5	Test for Nonabsolute Convergence: Alternating Series Test, The Dirichlet and Abel test. (Concepts and Problems only)	7	
	Text 1: Chapter 3 - Sections: 3.7; Chapter 9 - Sections: 9.1 (Theorem 9.1.5 – statement only), 9.2.1 to 9.2.5, 9.2.8 to 9.2.10 & 9.3 (Concepts, statements of the theorems and problems only from sections 9.2 and 9.3)			
4	4.1	Limits of Functions	8	**15**
	4.2	Limit Theorems	8	
	4.3	Some Extensions of the Limit Concept	8	
	Text 1: Chapter 4 - Sections: 4.1 (Theorems 4.1.6 and 4.1.9 – statements only), 4.2 (Theorems 4.2.4 and 4.2.9 – statements only), 4.3 (Concepts, statements of the theorems and problems only)			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="6">Lecture, Tutorial and Activity oriented</td></tr>
<tr><td rowspan="15">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
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<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="9"></td><td colspan="5">Question Pattern
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<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
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</table>

REFERENCES:

1. Robert G Bartle., Donald R Sherbert. *Introduction to Real Analysis (4th Edition)*,Wiley Internationals, 2000

SUGGESTED READINGS:

1. Denlinger, Charles. *Elements of real analysis*. Jones & Bartlett Learning, 2011.

2. Howie, John M. *Real analysis*. Springer Science & Business Media, 2006.
3. Abbott, Stephen. *Understanding analysis*. springer publication, 2015.
4. Ghorpade, Sudhir R., Balmohan Vishnu Limaye. *A course in calculus and real analysis*. New York: Springer, 2006.
5. Kumar, Ajit, Kumaresan, S. *A basic course in real analysis*. CRC press, 2014.

ADVANCED READINGS:

1. Gelbaum, Bernard R., and John MH Olmsted. *Counterexamples in analysis*. Courier Corporation, 2003.
2. Rudin, Walter. *Principles of mathematical analysis*. Vol. 3. New York: McGraw-hill, 1976.
3. Apostol, Tom M. *Mathematical analysis*. 1974.
4. Royden, Halsey Lawrence, and Patrick Fitzpatrick. *Real analysis*. Vol. 2. New York: Macmillan, 1968.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- The $K(\varepsilon)$ Game.
- Corollary 3.5.10 and approximate solutions of equations.
- Calculation of Square roots.
- Euler Number.
- Fibonacci fractions and golden ratio.
- The integral test.
- Proof of theorems 3.2.3 and 3.2.11.
- Proof of theorems 3.4.11, 3.4.12 and 3.5.8.
- Proof of theorem 9.1.5, proof of all theorems of Section 9.2 and Section 9.3.
- Proof of theorems 4.1.6, 4.1.9, 4.2.4 and 4.2.9.
- Proof of all theorems of Section 4.3.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Fundamentals of Groups and Rings**					
Type of Course	**DSC A**					
Course Code	**MG5DSCMAT302**					
Course Level	**300-399**					
Course Summary	The objective of the course is to introduce group and ring theory for a beginner. The basic algebraic structure group, its subgroups, cyclic groups, permutations, cosets, homomorphisms, and normal subgroups are covered in the first three modules. Rings and Fields are introduced in the fourth module.					
Semester	**5**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Basic Set Theory and Mathematical Operations					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		

1	Comprehend binary operations, isomorphic structures, groups, and subgroups.	U	1,2,3,4,5
2	Analyse cyclic groups and permutation groups and apply these concepts to solve problems in group theory.	A	1,2,3,4,5
3	Use cosets to prove Lagrange's theorem, analyse homomorphisms, and understand Cayley's Theorem.	A	1,2,3,4,5
4	Analyse rings, fields, and integral domains, and thus become adept in algebraic structures.	A	1,2,3,4,5
5	Apply the ideas of Groups and Permutation in Practical Situations.	A	1,2,3,4,5
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours:
1	1.1	Binary Operations – Definitions and Examples	1	20
	1.2	Groups – Definition, Examples	1	
	1.3	Groups - Elementary Properties	1	
	1.4	Group Isomorphism, Group Tables and Examples of Abelian Groups	1	
		Problems (Practicum)	1	
	Text 1: Chapter 1 – Sections: 1.1 to 1.30; Chapter 2 – Sections: 2.1 to 2.23; Chapter 3 – Sections: 3.1 to 3.5			
2	2.1	Examples of non-abelian groups and Permutation Group	2,5	20
	2.2	Symmetric Groups and Disjoint Cycles	2	
	2.3	Subgroups, Cyclic Groups and Cyclic Subgroups	2	

		Problems (Practicum)	2,5	
	Text 1: Chapter 4 – Sections: 4.1 to 4.16; Chapter 5 – Sections: 5.1 to 5.26; Chapter 6 – Sections: 6.1 to 6.21			
3	3.1	Generating Sets	**3**	**20**
	3.2	Group Homomorphism and Group of Permutation	3	
	3.3	Kernel, Cayley's Theorem, Even and Odd Permutation	3	
	3.4	Cosets and Theorem of Lagrange	3	
		Problems (Practicum)	**3**	
	Text 1: Chapter 7 – Sections: 7.1 to 7.6; Chapter 8 – Sections: 8.1 to 8.25; Chapter 10 – Sections: 10.1 to 10.20			
4	4.1	Rings and Fields	4	**15**
	4.2	Integral Domain, Characteristic of a Ring	4	
	4.3	Field of Quotients of an Integral Domain (Statement only)	4	
		Problems (Practicum)	4	
	Text 1: Chapter 22 – Sections: 22.1 to 22.18; Chapter 23 – Sections: 23.1 to 23.14; Chapter 26 Examples: 26.1 & 26.6 (Theorem 26.6-Statement only)			
5	**Teacher Specific Contents** *(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. **I**t's purpose is to encourage creativity and develop Problem solving skills. **T**he practicum component is to be done in the classroom under the

strict guidance of the teachers.

A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

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<tr><td></td><td colspan="6">Lectures, Tutorials, Interactive Sessions, Blended Learning</td></tr>
<tr><td rowspan="15">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="8"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
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<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="8"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>IV</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>5</td><td>3</td><td>13</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Fraleigh, John B.;. Brand, Neal E, *A First Course in Abstract Algebra* 8th ed, Pearson Education 2021
2. Gallian, Joseph A. *Contemporary Abstract Algebra*, 10th edition, Cengage, 2021.

SUGGESTED READINGS:

1. Dummit, David S., and Richard M. Foote. *Abstract Algebra. 3rd ed.* Wiley, 2003.
2. Artin, M. *Algebra. 2nd ed., Pearson Education 2017*
3. Herstein, I. N. *Topics in Algebra*, 2nd *Edition, John Wiley and sons, 2010*
4. Musili, C. *Rings and Modules 2nd* revised *Edition, Narosa 1997*

ADVANCED READINGS:

1. Hungerford, Thomas.W., Algebra, 4th Print 2003 Edition.
2. Lang, Serge, Algebra, 4th Print 2005 Edition

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Realisation of the group D_4 as symmetries of a square. (Chapter 1 of Text 2)
- Rotations of a Regular Tetrahedron and Application in Chemistry (Chapter 5 – Example 10 of Text 2)
- Group Theory Puzzle – Rubik's Cube (Chapter 5 of Text 2)

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Differential Equations and Applications**					
Type of Course	**DSE**					
Course Code	**MG5DSEMAT300**					
Course Level	**300-399**					
Course Summary	The course covers basics of ordinary and partial differential equations, various methods for solving them and also include some practical applications.					
Semester	**5**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any	Basic knowledge of functions, differentiation and integration. Basic understanding of ordinary and partial differential equations, including degree and order. Knowledge in constructing ordinary differential equations. Basic understanding of the concept of solutions.					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Develop the idea of solving first order Differential Equations	A	1, 2

2	Apply first order Differential Equations to practical situations and solve	A, An	1, 2, 3
3	Solve higher order Differential Equations	A	1, 2
4	Develop the concept of Partial Differential Equations and solve	U, A	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Exact Differential Equations and Integrating Factors	1	15
	1.2	Separable Equations and Equations Reducible to this form	1	
	1.3	Linear Equations	1	
	1.4	Bernoulli Equations	1	
	Text 1: Chapter 2 – Sections: 2.1 (Theorem 2.1 statement only), 2.2 & 2.3			
2	2.1	Finding Integrating Factors	1	10
	2.2	A Special Transformation	1	
	2.3	Orthogonal Trajectories	2	
	2.4	Geometric Applications	2	
	Text 1: Chapter 2 – Sections: 2.4 A & 2.4 B; Chapter 3 – section: 3.1 A, Text 2: Chapter 12 - section 12.2			
3	3.1	Definition and Basic Existence Theorem	3	25
	3.2	The Homogeneous Equation	3	
	3.3	Reduction of Order	3	
	3.4	The Non-Homogeneous Equation	3	
	3.5	The Homogeneous Linear Equation with Constant Coefficients	3	
	3.6	The Method of Undetermined Coefficients	3	

	3.7	Variation of Parameters	3	
	Text 1: Chapter 4 – Sections: 4.1 A, 4.1 B, 4.1 C, 4.1 D, 4.2, 4.3, 4.4			
4	4.1	Methods of solution of $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$	4	**10**
	4.2	Partial Differential Equations, Origin of First Order Partial Differential Equations	4	
	4.3	Linear Equations of First Order Partial Differential Equations	4	
	Text 3: Chapter 1 – Section: 3; Chapter 2 - sections-1,2,4 (Theorem 2 & 3 statement only)			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**				
	Direct Instruction: Explicit Teaching, Lecture. Interactive Instruction: Active Co-operative Learning, Group Assignments				
Assessment Types	**MODE OF ASSESSMENT**				
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**			
		Components		**Mark Distribution**	
		Module Test- I		5 Marks	
		Module Test- II		5 Marks	
		Module Test- III		5 Marks	
		Module Test- IV		5 Marks	
		Assignment/Seminar		5 Marks	
		Quiz/Viva voce		5 Marks	
	B	**End Semester Evaluation (ESE) 70 marks**			
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**			
		Module	Part A **2 Marks**	Part B **6 Marks**	Part C **10 Marks**	Total
		I	2	2	1	**5**

		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. Ross, Shepley L. *Differential Equations*. 3rd ed. Wiley. 2013.
2. Grewal, B. S.. *Higher Engineering Mathematics*. 42nd ed. Khanna Publications. 2012
3. Sneddon, Ian N.. *Elements of Partial Differential Equations*. 1st ed. McGraw-Hill. 1957

SUGGESTED READINGS:

1. Simmons, George F., Steven G Krantz.. *Differential Equations -Theory, Technique, and Practice*. 1st ed. McGraw-Hill (Walter Rudin Student Series). 2007
2. Amaranath,T.. *An Elementary Course in Partial Differential Equations,* 2nd ed. Jones and Bartlett. 2009

ADVANCED READING:

1. Simmons, George F.. *Differential Equations with Applications andHistorical Notes*. 3rd ed. CRC Press, Taylor & Francis. 2016

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Applications of Ordinary Differential Equations of First Order in SimpleElectricCircuits
- Rate of Decay of Radioactive Materials
- Chemical Reactions and Solutions

(Text 2: Chapter 12-Section 12.5, 12.8, 12.9)

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Mathematical Musings beyond Classroom**					
Type of Course	**DSE**					
Course Code	**MG5DSEMAT301**					
Course Level	**300-399**					
Course Summary	Step beyond the confines of classrooms, where mathematics transforms from a mere subject into a gateway, leading you to infinite possibilities and allowing you to revel in the beauty of mathematics.					
Semester	**5**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any						

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Acquire a solid understanding of fundamental mathematical concepts including algebra, geometry, calculus, and probability.	K	3
2	Understand the evolution of mathematical thought and its role in shaping scientific and technological advancements.	U	6
3	Develop the ability to apply mathematical principles to solve real-world problems.	A	1,2

4	Explore the intersection of mathematics with other fields, as portrayed in films.	An	3,5,7
5	Discuss ethical considerations in mathematical research and applications. Encourage students to critically reflect on their own learning and understanding of mathematical concepts.	E	4,6,8,9
6	Demonstrate how mathematics intersects with various disciplines, including science, arts, and humanities.	C	3,10
7	Encourage independent research on specific mathematical topics, historical developments, or philosophical questions.	I	6,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Exploring Enchanting Texts**		**15**
	1.1	An Introduction to Exploring Enchanting Texts of Mathematics.	1	
	1.2	Reference 1 Chapter- 1: Nothing Doing [The Origin of Zero], Chapter- 3: Nothing Ventured [Zero Goes East]	2,6,7	
	1.3	Reference 2 Part Five: Data (Chapter- 22: The New Normal, Chapter- 23: Chances Are, Chapter- 24: Untangling the Web)	1, 2,3,6	
	1.4	Reference 3 Chapter- 3: Einstein vs. Dostoyevsky	2, 5	
	Text 1, Text 2, and Text 3			
2		**Math Meets the Silver Screen**		**12**
	2.1	Introduction to Mathematics on the Silver Screen.	1	

	2.2	The film *A Beautiful Mind* (2001) directed by Ron Howard.	4,5	
	2.3	The film *The Imitation Game* (2014) directed by Morten Tyldum.	2, 4,7	
	2.4	The film *The Man Who Knew Infinity* (2015) directed by Matthew Brown.	2,3,4	
	2.5	The film *Hidden Figures* (2016) directed by Theodore Melfi.	2,4,5	
3		**Mathematical Prelude: Kerala's Historical Journey**		
	3.1	The Actors, The Social Background.	1,2,7	
	3.2	The Motivation and Method, The Madhava-Gregory Series for the Inverse Tangent, The Madhava- Newton Power Series for the Sine and Cosine.	2,7	
	3.3	Transmission of Kerala Mathematics: Establishing Transmissions: A Digression, The Case for Transmission: Applying the Neugebauer Criteria.	2,7	**15**
	3.4	The Case for Transmission: Applying the Legal Standard of Motivation and Opportunity, A Conjecture on the Mode of Acquisition of Manuscripts by the Jesuits.	2,5	
	Text 4: Chapter- 10: A Passage to Infinity: The Kerala Episode			
4		**Unveiling the Philosophy of Mathematics**		
	4.1	Reference 5 Part One, Chapter- 5: Five Classical Puzzles.	2,7	
	4.2	Reference 6 Chapter- 1: Mathematics and Its Philosophy (Sections 1.1 &1.2).	2,5,7	**18**
	4.3	Reference 6 Chapter- 2: The Limits of Mathematics.	2,5,7	
	Text 5 and Text 6			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="6">Direct Instruction, Brain Storming Approach, Interactive Instruction, Watching Movies, Group Discussion, and Presentation by Individual Student/ Group Representatives</td></tr>
<tr><td rowspan="18">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="10"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>IV</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>5</td><td>3</td><td>13</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Seife, Charles. *Zero*: *The Biography of a Dangerous Idea*. United States, Penguin Publishing Group, 2000.
2. Strogatz, Steven Henry. *The Joy of X: A Guided Tour of Math, from One to Infinity*. United States, Houghton Mifflin Harcourt, 2012.
3. Hoffman, Paul. *The Man Who Loved Only Numbers*: *The Story of Paul Erdos and the*

Search for Mathematical Truth. London, Fourth Estate, 1999.
4. George Gheverghese Joseph. *The Crest of the Peacock - Non-European Roots of Mathematics* (3rd Edition). Princeton University Press, Princeton & Oxford, 2011.
5. Hersh, Reuben. *What is Mathematics, Really?*. United Kingdom, Oxford University Press, 1997.
6. Colyvan, Mark. *An Introduction to the Philosophy of Mathematics*. United Kingdom, Cambridge University Press, 2012.

SUGGESTED READINGS:

1. Singh, Simon. *Fermat's Last Theorem*. United Kingdom, Harper Collins Publishers, 2012.
2. Oakley, Barbara A. *A Mind for Numbers: How to Excel at Math and Science (Even If You Flunked Algebra)*. United Kingdom, Penguin Publishing Group, 2014.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Reading of the related books:
  - Nasar, Sylvia. *A Beautiful Mind*. United Kingdom, Faber &Faber, 2012.
  - Hodges, Andrew, and Hofstadter, Douglas. *Alan Turing: The Enigma: The Book That Inspired the Film The Imitation Game* -Updated Edition. United Kingdom, Princeton University Press, 2014.
  - Kanigel, Robert. *The Man Who Knew Infinity: A Life of the Genius Ramanujan*. India, Washington Square Press, 2016.
  - Shetterly, Margot Lee. *Hidden Figures*. United States, Harper Collins, 2018.
- Visit a place of mathematical importance.
- Book Reviews/Film Reviews/Group Discussions/Debates.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**An Invitation to Fuzzy Mathematics**					
Type of Course	**DSE**					
Course Code	**MG5DSEMAT302**					
Course Level	**300-399**					
Course Summary	This course provides a warm introduction to Fuzzy Mathematics, highlighting its significance and showcasing the academic accomplishments of our undergraduate participants. It also offers an overview of the course by having students present the foundational principles and key theories covered, emphasizing their understanding and application.					
Semester	**5**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any	Text 3					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Comprehensive understanding of fuzzy set theory	U	1,3
2	To acquire proficiency in performing operations on fuzzy sets and fuzzy relations.	A	2,4
3	To develop the skills to use fuzzy tools and techniques in various fields such as graphs.	S	1,2
4	To handle the real-life situations using Fuzzy	I	1,7

	Graphs		
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Crisp Sets: An over view	1	17
	1.2	Fuzzy Sets: Basic Types & Concepts	1	
	1.3	c) Alpha Cuts	1	
	1.4	d) Additional properties of Alpha cuts, Representation of Fuzzy Sets & Extension Principle for fuzzy sets	1	
	Text 1: Chapter 1- Sections: 1.1 to 1.4; Chapter 2- Sections: 2.1 to 2.3			
2	2.1	Types of Operations	2	15
	2.2	Fuzzy Compliments	2	
	2.3	Fuzzy intersection : t -norm	2	
	2.4	Fuzzy union : t co-norm	2	
	Text 1: Chapter 3- Sections: 3.1 to 3.4			
3	3.1	Crisp versus Fuzzy Relations	3	15
	3.2	Binary Fuzzy Relations	3	
	3.3	Binary Relation on a single set	3	
	3.4	Fuzzy Equivalence Relations& Compatibility Relations	3	
	Text 1: Chapter 5- Sections: 5.1, 5.3 to 5.6			
4	4.1	Graph theory Revisited: Definition, Sub graph, connectivity, cut vertex, cut edge.	4	13

	4.2	Fuzzy graph with Example	4	
	4.3	Different types of Fuzzy Graphs with Examples	4	
	4.4	Connectivity in Fuzzy Graphs, Fuzzy Bridge and Fuzzy Cut vertex with examples	4	
	4.5	Complete Fuzzy Graphs with examples	4	
	Text 2: Chapter 2- Sections: 2.1, 2.2, 2.2.1(proof is included)			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**				
	Lecture, Teaching, Interactive Instruction, Seminar, Group Assignment, Library Work and Group Discussion				
Assessment Types	**MODE OF ASSESSMENT**				
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**			
		Components		**Mark Distribution**	
		Module Test- I		5 Marks	
		Module Test- II		5 Marks	
		Module Test- III		5 Marks	
		Module Test- IV		5 Marks	
		Assignment/Seminar		5 Marks	
		Quiz/Viva voce		5 Marks	
	B	**End Semester Evaluation (ESE) 70 marks**			
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**			
		Module	Part A **2 Marks**	Part B **6 Marks**	Part C **10 Marks**	Total
		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**

		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. Klir, George J., Yuan, Bo. *Fuzzy Sets and Fuzzy Logic Theory and Applications*, Pearson India Education services Pvt Ltd, 2015.
2. Sunil Mathew., John N Modeson., Davendar S Malik. ,*Fuzzy Graph Theory*. Springer, 2018.
3. Wilson, Robin J; *Introduction to Graph Theory* 5th ed, Pearson Education Limited, 2010

SUGGESTED READINGS:

1. Hans-Jürgen Zimmermann. Fuzzy Set Theory and Its Applications.
2. Didier Dubois., Henri Prade. Fuzzy Sets and Systems: Theory and Applications.
3. John N. Mordeson, Davender S. Malik. Fuzzy Graphs: Theory and applications.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Theorems 2.8, 2.9, & 2.10
- Lemma 3.1-3.2, Theorem 3.3-3.8, Theorem 3.11-3.13. Theorem 3.16-3.18.
- Problem solving using the methods discussed in the Module 3.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Exploring the Harmony of Automata**					
Type of Course	**DSE**					
Course Code	**MG5DSEMAT303**					
Course Level	**300-399**					
Course Summary	The principles acquired in Automata Theory lay a robust groundwork, imparting the skills to effectively address real-life challenges by cultivating the ability to formulate mathematical models for problem-solving. Additionally, this knowledge serves as a springboard for advanced studies in theoretical computer science, algorithm design, and related disciplines.					
Semester	**5**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any						

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	To Provide Basic Grounding in Discrete Mathematics.	U	1,2
2	To Connect Regular Expression, languages and Automata.	A	2,3,10
3	To develop the skills to categorise the different types of mathematical models of computation.	S	2,3,4
4	To handle real-life problems and develop the skill of solving problems through the application of mathematical models and algorithms.	I	2,4,6

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Automata, Computability and Complexity.	1	12
	1.2	Mathematical Notations and Terminology- Sets, Sequences and Tuples	1	
	1.3	e) Relations, Functions and Graphs.	1	
	1.4	f) Strings, Languages, Boolean Logic.	1	
	Text 1: Sections: 0-0.1 & 0.2.			
2	2.1	Regular Languages: Finite Automata	2	18
	2.2	Non-Determinism	2	
	2.3	Regular Expressions	2	
	2.4	Non-Regular Languages	2	
	Text 1: Sections: 1.1 to 1.4			
3	3.1	Context Free Languages: Context Free Grammars	3	15
	3.2	Pushdown Automata	3	
	3.3	Non-Context free Languages	3	
	Text 1: Sections: 2.1 to 2.3			
4	4.1	Church Turing Thesis: Turing Machine	4	15
	4.2	Variants Of Turing Machine	4	
	4.3	Enumerators	4	
	4.4	Equivalence with Other Models	4	
	Text 1: Sections: 3.1 & 3.2			

5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**					
	Lecture, Teaching, Interactive Instruction, Seminar, Group Assignment, Library Work and Group Discussion					
Assessment Types	**MODE OF ASSESSMENT**					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**				
		Components			**Mark Distribution**	
		Module Test- I			5 Marks	
		Module Test- II			5 Marks	
		Module Test- III			5 Marks	
		Module Test- IV			5 Marks	
		Assignment/Seminar			5 Marks	
		Quiz/Viva voce			5 Marks	
	B	**End Semester Evaluation (ESE) 70 marks**				
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**				
		Module	Part A **2 Marks**	Part B **6 Marks**	Part C **10 Marks**	Total
		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. Michael Sipser.. *Introduction to the Theory of Computation.* Thomson Publishing Co,3rd Edition, 2012.

SUGGESTED READINGS:

1. Hop Croft, J.E., Motwani, R., Ullman, J. D. *Introduction to Automata Theory, Languages and Computation*,3rd Edition Pearson, 2008.
2. Lewis, H. R., Papadimitriou, C. H. *Elements of the Theory of Computation.* 2nd Edition, Prentice Hall, 1998.
3. Kozen, C., *Automata and Computability*, Springer-Verlag, 1997

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Problem discussions of the concepts in module 1, 2 and 3
- Discussion of real life problems related to the topics in module 4

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Introduction to Python for Mathematical Computation**					
Type of Course	**SEC**					
Course Code	**MG5SECMAT300**					
Course Level	**300-399**					
Course Summary	This course provides the skills to utilize Python for Mathematical Computations, modelling and problem solving, Through a hands on approach students will gain proficiency in using Python Libraries for various mathematical Applications					
Semester	**5**	**Credits**			**3**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	0	0	**45**
Pre- requisites, If any						

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Discuss the basics of Python programming language.	U,S	1,2
2	Apply strings and lists, tuples, and packages for computation.	A,S	1,2,3,4
3	Employ NumPy for efficient numerical and mathematical operations in Python.	A,S	1,2,3,10

4	Sketch various types of plots (line plots, scatter plots, histograms) using Matplotlib.	A,S	1,2,9,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Getting started with Python	1	**20**
	1.2	Variables and Data Types	1	
	1.3	Operators and their Precedence	1	
	1.4	Python String	1	
	1.5	Python Lists	1	
	1.6	Mutable and Immutable Types	1	
	1.7	Input from the Keyboard	1	
	1.8	Iteration: while and for loops	1	
	1.9	Conditional Execution: if, elif and else	1	
	1.10	Modify loops : break and continue	1	
	1.11	Functions	2	
	1.12	More on Strings and Lists	2	
	1.13	Python Modules and Packages	2	
	Text 1: Chapter 2 – Sections: 2.1 to 2.10 & 2.13 to 2.15			
2	2.1	The NumPy Module -Creating Arrays and Matrices	3	**12**
	2.2	Copying	3	
	2.3	Arithmetic Operations	3	

	2.4	Cross product	3	
	2.5	Dot product	3	
	2.6	Saving and Restoring	3	
	2.7	Matrix inversion .	3	
	2.8	Vectorized Functions	3	
	Text 1: Chapter 3 – Sections: 3.1 & 3.2.			
3	3.1	The Matplotlib Module	4	**13**
	3.2	Plotting mathematical functions	4	
	3.3	Famous Curves	4	
	3.4	Power Series	4	
	3.5	Fourier Series	4	
	3.6	2D plot using colors	4	
	3.7	Fractals	4	
	3.8	Meshgrids	4	
	3.9	3D Plots .	4	
	3.10	Mayavi, 3D visualization	4	
	Text 1: Chapter 4 – Sections: 4.1 to 4.10.			
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**
	1. Interactive instructions using ICT tools **2.** Hands on training
	MODE OF ASSESSMENT

<table>
<tr><td rowspan="11">Assessment Types</td><td rowspan="6">A</td><td colspan="6">Continuous Comprehensive Assessment (CCA) 25 marks
Practical sessions or exams may be organised for each module and the CCA should be based on these hands on experiences.</td></tr>
<tr><td colspan="4">Components</td><td>Mark Distribution</td></tr>
<tr><td colspan="4">Module Test- I</td><td>5 Marks</td></tr>
<tr><td colspan="4">Module Test- II</td><td>5 Marks</td></tr>
<tr><td colspan="4">Module Test- III</td><td>5 Marks</td></tr>
<tr><td colspan="4">Assignment/Seminar</td><td>5 marks</td></tr>
<tr><td colspan="4">Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td rowspan="5">B</td><td colspan="6">End Semester Evaluation (ESE) 50 marks</td></tr>
<tr><td colspan="6">Question Pattern
[Maximum Time 75 Minutes, Maximum Marks 50]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>3</td><td>1</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>3</td><td>3</td><td>2</td><td>8</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>6</td><td>4</td><td>18</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>4</td><td>2</td><td>11</td></tr>
<tr><td>Total Marks</td><td>10</td><td>20</td><td>20</td><td>50</td></tr>
</table>

REFERENCES:

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

SUGGESTED READINGS:

1. Eric Matthes. *Python Crash Course : A hands-on, project-based introduction to programming – 3rd edition,* no starch press, 2023.
2. Wes McKinney. *Python for Data Analysis,* O'Reilly Media, Inc., 2022.
3. Robert Johansson. *Numerical Python: A Practical Techniques Approach for Industry,* Apress, 2015.
4. Ben Root. *Python Plotting with Matplotlib,* Ben Root: Packt Publishing Ltd,. 2017.
5. *SymPy Documentation* (https://docs.sympy.org/latest/index.html) ,2003.

Semester 6

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Mathematical Analysis**					
Type of Course	**DSC A**					
Course Code	**MG6DSCMAT300**					
Course Level	**300-399**					
Course Summary	This real analysis course covers the fundamental concepts, includes continuity, uniform continuity, monotone and inverse functions, derivatives, the mean value theorem, L'Hôspital's Rules and Tayler's theorem. The course also explores the Riemann integral, Riemann integrable functions, and the Fundamental Theorem of Calculus. This curriculum provides students with a solid foundation in calculus and mathematical analysis, essential for advanced mathematical studies.					
Semester	**6**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Limits and Convergence					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		

1	Comprehend the concept of continuous functions and demonstrate proficiency in understanding their properties.	U, A	1,2,3
2	Understand uniform continuity, comparing and contrasting it with continuity.	U	1,2,3
3	Comprehend the concept of differentiation	U, A	1,2,3,10
4	Develop comprehensive understanding of the Mean Value Theorem, L'Hôpital's Rules and Taylor's theorem.	U, A	1,2,3,10
5	Understand the principles of Riemann integration, demonstrating proficiency in applying these concepts	An	1,2,3,10
6	Comprehend Riemann integrable functions and the fundamental theorem of calculus.	U, An	1,2,3,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Continuous Functions	1	15
	1.2	Combinations of Continuous Functions	1	
	1.3	Continuous Functions on Intervals	1	
	Text 1: Chapter 5 - Sections: 5.1 (Concepts, statements of the theorems and problems only), 5.2 (Theorems 5.2.4 and 5.2.5 – statements only), 5.3 (Theorems 5.3.4 and 5.3.5 – Statements only)			
2	2.1	Uniform Continuity	2	20
	2.2	Monotone and Inverse Functions	2	
		Problems (Practicum)	**2**	

	Text 1: Chapter 5 - Sections: 5.4 (up to 5.4.8) (Theorems 5.4.2 and 5.4.8 – Statements only), 5.6 (up to 5.6.5). (Theorems 5.6.4 and 5.6.5 – Statements only)			
3	3.1	The Derivative	3	**20**
	3.2	The Mean Value Theorem	4	
	3.3	Intermediate Value Property of Derivatives	4	
	3.4	L'Hospital's Rules	4	
	3.5	Taylor's Theorem	4	
		Problems (Practicum)	**3, 4**	
	Text 1: Chapter 6 - Sections: 6.1(up to 6.1.7), 6.2.1 to 6.2.8, 6.2.11 to 6.2.13, 6.3 (Theorems 6.3.3 and 6.3.5- statements only), 6.4.1 to 6.4.3 (Theorem 6.4.1- Statement only)			
4	4.1	Riemann Integral	5	**20**
	4.2	Riemann Integrable Functions	6	
	4.3	The Fundamental Theorem	6	
		Problems (Practicum)	**5, 6**	
	Text 1: Chapter 7 - Sections: 7.1, 7.2 (Theorem 7.2.9 – statement only) & 7.3 (up to 7.3.9)			
5	**Teacher Specific Contents** *(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. **I**t's purpose is to encourage creativity and develop Problem Solving Skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers.

A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="6">Lecture, Tutorial and Activity oriented</td></tr>
<tr><td rowspan="20">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="11"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
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<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>IV</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>5</td><td>3</td><td>13</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERNCES:

1. Bartle, Robert G., Sherbert, Donald R. *Introduction to Real Analysis (4th Edition)*,Wiley Internationals,2002.

SUGGESTED READINGS:

1. Denlinger, Charles. *Elements of real analysis*. Jones & Bartlett Learning, 2011.
2. Howie, John M. *Real analysis*. Springer Science & Business Media, 2006.
3. Abbott, Stephen. *Understanding analysis*. springer publication, 2015.
4. Ghorpade, Sudhir R., and Balmohan Vishnu Limaye. *A course in calculus and real analysis*. New York: Springer, 2006.
5. Kumar, Ajit, Kumaresan, S. *A basic course in real analysis*. CRC press, 2014.

ADVANCED READINGS:

1. Gelbaum, Bernard R., and John MH Olmsted. *Counterexamples in analysis*. Courier Corporation, 2003.
2. Rudin, Walter. *Principles of mathematical analysis*. Vol. 3. New York: McGraw-hill, 1976.
3. Apostol, Tom M. *Mathematical analysis*. 1974.
4. Royden, Halsey Lawrence, and Patrick Fitzpatrick. *Real analysis*. Vol. 2. New York: Macmillan, 1968.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Aproximations
- Piecewise linear functions
- Weierstrass aproximation theorem
- Continuity and gauges
- The nth root function
- Rational powers.
- Further applications of the Mean Value Theorem and inequalities.
- Proofs of L'Hospital's Rules
- Point-wise and uniform convergence
- Proof of all theorems of Section 5.1, theorems 5.2.4, 5.2.5, 5.3.4 and 5.3.5.
- Proof of theorems 5.4.2, 5.4.8, 5.6.4 and 5.6.5.
- Proof of theorems 6.3.3 and 6.3.5.
- Proof of theorem 7.2.9.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Fundamentals of Linear Algebra**					
Type of Course	**DSC A**					
Course Code	**MG6DSCMAT301**					
Course Level	**300-399**					
Course Summary	Linear Algebra is a fundamental tool in many areas of mathematics, science, engineering, economics, and data science. It also has applications in machine learning, providing the mathematical foundation for many algorithms and techniques. This course on Linear Algebra deals with the basic concepts like vector spaces, linear transformations, determinants, Eigen values and Eigen vectors.					
Semester	**6**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Algebra of Matrices, Gaussian Elimination Method, Solution and consistency of system of linear equations.					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Analyse the basic concepts of vector spaces	An	1,2,3,10
2	Illustrate the fundamental properties of linear transformations	A	2,3,10

3	Compute the eigen values and eigen vectors	A	3,10
4	Deduce the connections between determinants and other linear algebra concepts	An	1,2,3,10
5	Apply computational software and tools in linear algebra computations.	A	2,3,9
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Vector Spaces: Definition and examples	1	20
	1.2	Subspaces	1	
	1.3	Linear Combination of Vectors, Spanning Set, Linear Dependence and Independence of Vectors	1	
	1.4	Basis of a Vector Space	1	
	1.5	Dimension of a Vector Space	1	
		Problems (Practicum)	1	
	Text 1: Chapter 5			
2	2.1	Linear Mappings	2	20
	2.2	Kernel and Range of a Linear Mapping	2	
	2.3	Bijective Linear Mappings	2	
	2.4	Dimension Theorem	2	
	2.5	Rank and Nullity	2	
	2.6	Linear Isomorphism	2	
		Problems (Practicum)	2	

	Text 1: Chapter 6.			
3	3.1	Eigen Values and Eigen Vectors	3	**20**
	3.2	Characteristic Polynomial, Characteristic Equation and Algebraic Multiplicity	3	
	3.3	Eigen Space and Geometric Multiplicity	3	
	Text 1: Chapter 9 (up to and including theorem 9.2)			
4	4.1	Determinantal Mapping	4	**15**
	4.2	Determinant of a Matrix as a Determinantal Mapping	4,5	
	4.3	Laplace Expansion	4	
	4.4	Adjoint and Inverse of a Matrix	4,5	
		Problems (Practicum)	4,5	
	Text 1: Chapter 8 [Theorems(Statements only) and applications.]			
5	**Teacher Specific Contents** *(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. **I**t's purpose is to encourage creativity and develop Problem Solving Skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="5">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="5">Lectures, Tutorials, Interactive Sessions, Blended Learning</td></tr>
<tr><td rowspan="15">Assessment Types</td><td colspan="5">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="4">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td>Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td>5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td>5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td>B</td><td colspan="4">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="8"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>IV</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>5</td><td>3</td><td>13</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Blyth, T. S., and E. F. Robertson. *Basic linear algebra*, Second Edition, Springer, 2007**.**

2.

SUGGESTED READINGS:

1. Strang, Gilbert. *Introduction to linear algebra (5th ed.)*. Wellesley-Cambridge Press, 2016.
2. Lay, D. C. *Linear algebra and its applications* (5th ed.). Pearson Education, 2018.
3. Axler, S. *Linear algebra Done Right* (3rd ed.). Springer, 2015.
4. Hoffman, K., & Kunze, R. *Linear algebra* (2nd ed.). Prentice Hall, 2009.
5. Lipschutz, S., Lipson, M. *Schaum's outline of theory and problems of linear algebra* (4th ed.). McGraw-Hill, 2009.
6. Thamban Nair, M., Singh, A. *Linear Algebra*. Springer, 2018.
7. Anton, H. *Elementary linear algebra* (12th ed.). Wiley, 2019.
8. Kumaresan, S. *Linear Algebra: A Geometric Approach*. PHI Learning, 2015.
9. Bronston, T. A., Costa, A. C. R. *Linear algebra: An introduction* (4th ed.),Academic Press, 2013.
10. Video lectures of Gilbert Strang hosted by MIT Open Course Ware available at https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/video_galleries/video-lectures/

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Proofs of theorems in Module 4
- Use of computational software or tools (like Python, Sagemath etc.) to perform computations in the modules 1 to 4 efficiently

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Applications of Calculus and Linear Algebra in Finance**					
Type of Course	**DSE**					
Course Code	**MG6DSEMAT300**					
Course Level	**300-399**					
Course Summary	The goal of this course is to give the students a deeper understanding and working Knowledge of the application of mathematical concepts in Economic Analysis, via more sophisticated, realistic, and interesting models.					
Semester	**6**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	**A deeper understanding of mathematical Analysis and Algebra**					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Apply the concept of single variable and several variable calculus to the problems in Economics.	A	2,3,6
2	Analyse the money market and goods market and understand the trading strategy and use it effectively	An	1,2,6.7
3	Create an optimum solution in terms of productivity and profitability for economic problems	C	2,3,6.10
4	Apply Pareto optimality conditions	A	2,3,7,10

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Application of Calculus in Finance**		**15**
	1.1	Production Functions, Cost Functions, Revenue and Profit Functions, Demand Functions and Elasticity **(Practicum) Exercise problems (Text 1)**	1	
	1.2	Base10 Logarithms, Base e Logarithms, Present Value, Annuities, Optimal Holding Time	1	
	1.3	Economic Interpretation, Marginal Products, Elasticity, Geometric Interpretation, an application of higher derivatives in economics, Exercise problems of section 3.6,14.3,14.8 **(Practicum) Problems on Elasticity Text II (section 7.7 Exercise)**	1	
	1.4	System of implicit function (proof excluded) Comparative statics, Simpson's paradox, Exercise problems **(Practicum) Exercise Problems of section 15.4 text I, Problems related to Comparative statics Text II (section 13.7)**	1	
	Text 1: Chapter 3- Section: 3.6; Chapter 5- Sections: 5.3, 5.6; Chapter 14- Sections: 14.2, 14.3, 14.8(An Economic application); Chapter 15- Sections: 15.3, 15.4 & 15.6			
2		**Linear Algebra in Finance**		**15**
	2.1	**EXAMPLES OF LINEAR MODELS** Example 1: Tax Benefits of Charitable Contributions, Example 2: Linear Models of Production, Example 3: Markov Models of Employment, Example 4: IS-LM Analysis, Example 5: Investment and Arbitrage	2	
	2.2	Application to Portfolio Theory, IS-LM analysis via Cramer'S Rule	2	

		(Practicum) Exercise problems Text1 section 9.3		
	2.3	Budget Sets in Commodity Space, Input Space, Probability Simplex	2	
	2.4	The Investment Model, IS-LM Analysis, Supply demand **(Practicum) Exercise 10.42 Text 1(Section 10.7)**	2	
	Text 1: Chapter 6- Section: 6.2; Chapter 7- Section: 7.4(Application to Portfolio Theory); Chapter 9- Section:9.3; Chapter 10- Section: 10.7; Chapter 26- Section: 26.4			
3		**Optimization in Finance**		
	3.1	Quadratic forms, Definiteness of Quadratic forms, : Second Order Conditions and Convexity, Conic Sections, The Definiteness of Diagonal Matrices The Definiteness of 2 X 2 Matrices	3	
	3.2	Definiteness and Optimality One Constraint, Other Approaches, Profit-Maximizing Firm, Discriminating Monopolist, Least Squares Analysis **(Practicum)** **Exercise of section 16.3 Text 1**	3	**15**
	3.3	Homogeneous Function, Definition and Examples, Homogeneous Functions in Economics, Properties of Homogeneous Functions, A Calculus Criterion for Homogeneity	3	
	3.4	Economic Applications of Euler's Theorem, Homogenizing a Function, Economic Applications of Homogenization, cardinal versus ordinal utility	3	
	Text 1: Chapter 16- Sections: 16.1 to 16.3; Chapter 17- Section: 17.5; Chapter 20- Sections: 20.1 to 20.3			
4		**Advanced Calculus in Finance**		
	4.1	Concave functions in Economics, quasi concave and quasi convex Functions, Calculus Criteria, Pseudo concave functions,	4	**20**

	4.2	Concave programming-Unconstrained Problems, Constrained Problems, Saddle Point Approach **(Practicum) Exercise of section 21.5 Text 1**	4	
	4.3	Utility Maximization, The Demand Function, The Indirect Utility Function, The Expenditure and Compensated Demand Functions, The Slutsky Equation, profit and cost, The Proft-Maximizing Firm, The Cost Function	4	
	4.4	Necessary Conditions for a Pareto Optimum Sufficient Conditions for a Pareto Optimum The Fundamental Welfare Theorems, Competitive Equilibrium,Fundamental Theorem of Welfare Economics	4	
	Text 1: Chapter 21- sections: 21.2(Concave functions in Economics)21.3 to 21.5; Chapter 22- sections: 22.1 to 22.4(proof of theorems from all sections excluded)			
5	**Teacher Specific Contents** *(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.

It's 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 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**
	Lecture, Teaching, Interactive Instruction, Seminar, Group Assignment, Library Work and Group Discussion
	MODE OF ASSESSMENT

<table>
<tr><td rowspan="11">Assessment Types</td><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
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<tr><td rowspan="10"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
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<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
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<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Carl P. Simon and Lawrence, Mathematics for Economists, Blume Viva Books, 2018
2. Knut Sydsaeter, Peter Hammond, Arne Strom, Essential Mathematics for Economic Analysis (4th Edition), Pearson Publication, 2012.

SUGGESTED READINGS:

1. Chiang, C., Fundamental Methods of Mathematical Economics, McGraw Hills, *(Latest Edition).*
2. Budnick, Frank, Applied Mathematics for Business, Economics and Social Sciences, McGraw Hills Education, 2017..
3. Dowling E. T., Mathematics for economists, Schum Series (latest edition)
4. Rosser, Mike, Basic Mathematics for Economists, Routledge, Taylor & Francis Group, 2003.

ADVANCED READING:

1. Weber E. Jean, Mathematical Analysis, Business and Economic Applications (Latest Edition) Harper and Row Publishers, New

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Mathematics**				
Course Name	**Investment Science**				
Type of Course	**DSE**				
Course Code	**MG6DSEMAT301**				
Course Level	**300-399**				
Course Summary	This course is an introduction to the application of mathematics in financial world, that enables the student to understand some computational and quantitative techniques required for working in the financial markets and actuarial mathematics				
Semester	**6**	**Credits**			**4**
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any						

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Calculate simple and compound interest for discrete and continuous cases.	A	1,2,3
2	Learn about time value of money, bond prices and yields	E	1,2,10
3	Describe asset return, short selling, portfolio return etc	S	2,6,10
4	Describe capital market line, security market line etc.	U	6,8,10

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Basic principles: Comparison, arbitrage and risk aversion,	1	**15**
	1.2	Interest (simple and compound, discrete and continuous), Interest rates	1	
	1.3	Present value analysis	1	
	1.4	Rate of return, continuously varying interest rates.	1	
2	2.1	Time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods)	2	**15**
	2.2	Comparison of NPV and IRR. Bonds, bond prices and yields, Macaulay and modified duration	2	
	2.3	Term structure of interest rates: spot and forward rates	2	
	2.4	Explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds	2	
3	3.1	Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation).	3	**15**
	3.2	Random returns, portfolio mean return and variance	3	
	3.3	Diversification, portfolio diagram, feasible set.	3	
	3.4	Markowitz model (review of Lagrange multipliers for 1 and 2 constraints)	3	
4	4.1	Two fund theorem, risk free assets, One fund theorem.	3	**15**

	4.2	Capital market line, Sharpe index. Capital Asset Pricing Model (CAPM).	4	
	4.3	Betas of stocks and portfolios, security market line.	4	
	4.4	use of CAPM in investment analysis and as a pricing formula, Jensen's index	3	
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**				
	Lecture, Teaching, Interactive Instruction, Seminar, Group Assignment, Library Work and Group Discussion				
Assessment Types	**MODE OF ASSESSMENT**				
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**			
		Components		**Mark Distribution**	
		Module Test- I		5 Marks	
		Module Test- II		5 Marks	
		Module Test- III		5 Marks	
		Module Test- IV		5 Marks	
		Assignment/Seminar		5 Marks	
		Quiz/Viva voce		5 Marks	
	B	**End Semester Evaluation (ESE) 70 marks**			
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**			
		Module	Part A **2 Marks**	Part B **6 Marks**	Part C **10 Marks**	Total
		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**

		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. David G. Luenberger. *Investment Science*, Oxford University Press, Delhi, 1998.
2. John C. Hull. *Options, Futures and Other Derivatives (6th Edition*), Prentice-Hall India, Indian reprint, 2006.
3. Sheldon Ross. *An Elementary Introduction to Mathematical Finance (2nd Edition)*, Cambridge University Press, USA, 2003.
4. Kevin J Hastings. *Introduction to Financial Mathematics*, CRC Press, 2015.

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Mathematics**				
Course Name	**Combinatorics**				
Type of Course	**DSE**				
Course Code	**MG6DSEMAT302**				
Course Level	**300-399**				
Course Summary	This course is a dynamic exploration of fundamental combinatorial concepts, focusing more on problems than theory. This approach aims to help students excel in competitive examinations by thoroughly covering exercise problems.				
Semester	**6**	**Credits**			**4**
Course Details		Lecture	Tutorial	Practicum	Others	Total Hours
	Learning Approach	4	0	0	0	**60**
Pre- requisites, If any	Elementary Algebra, Basic Set theory, Basic understanding of Probability theory					

COURSEOUTCOMES(CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Provides a valuable toolkit for students preparing for competitive exams, offering a wealth of problems that sharpen logical reasoning and problem-solving skills	S	1, 2
2	Apply combinatorial methods to model and analyse real-world problems, emphasizing the translation of problems into mathematical language	An	1, 2, 3, 4

3	Demonstrate a deep understanding of basic combinatorial concepts, such as permutations, combinations, and the multiplication principle	U	1, 2,3
4	Develop critical thinking skills by analysing and synthesizing complex combinatorial problems, evaluating different approaches, and selecting the most suitable strategies.	I	1, 2, 3, 4, 10
Remember(K),Understand(U),Apply(A),Analyse(An),Evaluate(E),Create(C),Skill(S), Interest (I) and Appreciation (Ap)			

COURSECONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Two basic counting principles	1,2,4	15
	1.2	Permutations	1,3	
	1.3	Circular permutations	1,3	
	1.4	Combinations	1,3	
	Text 1: Chapter 1- Sections: 1.1 to 1.4			
2	2.1	The injection and bijection principles	1,4	15
	2.2	Arrangements and selections with repetitions	1,3	
	2.3	Distribution Problems	1,3	
	Text 1: Chapter 1- Sections: 1.5 to 1.7			
3	3.1	Introduction	1,2	15
	3.2	The Pigeonhole principle	1,2	
	3.3	More examples	1,2,3	
	3.4	Ramsey Type problems and Ramsey numbers	1,4	
	3.5	Bounds for Ramsey Numbers	1,4	

	Text 1: Chapter 3 - Sections: 3.1 to 3.5 (Theorems 3.5.1 and 3.5.2 – statements only)			
4	4.1	Introduction	1	15
	4.2	The Principle of Inclusion and Exclusion:	1,2	
	4.3	A generalization	1,2,4	
	4.4	Integer solutions and shortest routes	1,2,3	
	4.5	The Sieve of Eratosthenes and Euler ϕ –function	1	
	Text 1: Chapter 4 - Sections: 4.1 to 4.4 & 4.7 (Theorem 4.3.1- statement only)			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**				
	Lecture, Tutorial and Activity oriented				
Assessment Types	**MODE OF ASSESSMENT**				
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**			
		Components			**Mark Distribution**
		Module Test- I			5 Marks
		Module Test- II			5 Marks
		Module Test- III			5 Marks
		Module Test- IV			5 Marks
		Assignment/Seminar			5 Marks
		Quiz/Viva voce			5 Marks
	B	**End Semester Evaluation (ESE) 70 marks**			
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**			
		Module	Part A	Part B	Part C	Total
			2 Marks	**6 Marks**	**10 Marks**	

		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. Chen, Chuan-Chong, Khee Meng Koh, and Koh Khee-Meng. *Principles and techniques in combinatorics*. World Scientific, 1992.

SUGGESTED READINGS:

1. Krishnamoorthy, V., Hoewood, E. *Combinatorics theory and applications*, 1986.
2. Hall, Jr. *Combinatorial Theory*, Wiley-Interscinice,1998.
3. Brualdi, RA. *Introductory Combinatorics*, PrenticeHall,1992
4. Bona Miklos. *A Walk Through Combinatorics – An Introduction to Enumeration and Graph Theory*, Second Edition, World Scientific, 2006.

ADVANCED READINGS:

1. Bóna, Miklós, ed. *Handbook of enumerative combinatorics*. Vol. 87. CRC Press, 2015.
2. Flajolet, Philippe, and Robert Sedgewick. *Analytic combinatorics*. Cambridge University press, 2009.
3. Harris, John M. *Combinatorics and graph theory*. Springer, 2008.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Binomial coefficients and multinomial coefficients.
- Stirling numbers of first kind
- Stirling numbers of second kind
- Surjective mappings and Stirling numbers of second kind
- Derangements and A generalization
- Proof of theorems 3.5.1 and 3.5.2
- Proof of theorems 4.3.1
- Generating functions
- Recurrence relations

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Programme	**BSc (Hons) Mathematics**					
Course Name	**Fundamentals of Fluid Dynamics**					
Type of Course	**DSE**					
Course Code	**MG6DSEMAT303**					
Course Level	**300-399**					
Course Summary	This course aims to pave a strong foundation of fluid dynamics. The course is intended to impart knowledge regarding fluids, conservation laws and hence enable students to model basic fluid flow problems. The course begins with introducing the basics of fluid dynamics. The motion of fluids is described using Lagrangian and Eulerian methods. Then the fluid kinematics and the conservation laws are examined. Dimensional homogeneity and dimensional analysis are learned. This enables students to model basic flow problems. This acquired knowledge is used to model one-dimensional flow problems like the Bernoulli's equation and thereafter enable students to solve laminar flows of viscous incompressible fluids. Some real-life problems are modelled and solved mathematically to arrive at analytical solutions.					
Semester	**6**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No.
Upon the successful completion of the course, the student will be able to:			
1	Know the fundamentals of fluid mechanics	R	1, 2, 3, 10.

2	Understand the methods to describe fluid motion.	U	1, 2, 3, 10.
3	Learn fluid kinematics and the laws of conservation to model fluid flows.	U	1, 2, 3.
4	Apply the acquired knowledge to model one-dimensional fluid flow.	A	1, 2, 3, 7, 10.
5	Analyse the dimensional homogeneity of the physical equations.	An	1, 2, 3.
6	Model laminar flow of viscous incompressible fluids and arrive at analytical solutions.	An	1, 2, 3, 10.
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for classroom transaction (Units)

Module	Units	Course Description	CO No.	Hours
1	**Fluids & Fluid Motion**			**15**
	1.1	Fluid, Isotropy, Fluid Properties.	1	
	1.2	Viscous and Inviscid fluids, Important types of flows.	1	
	1.3	Results of vector analysis.	1	
	1.4	Methods to describe fluid motion: Lagrangian and Eulerian methods.	2	
	1.5	Velocity and acceleration of a fluid particle, Material, local and convective derivatives.	2	
	Text 1: Chapter 1 – Sections: 1.1 to 1.6; Chapter 2 – Sections: 2.1 to 2.6.			
2	**Fluid Kinematics & Conservation Laws**			**15**
	2.1	Stream line, Path line, Streak line, Stream tube.	2, 3	
	2.2	Equation of Continuity (Cartesian form).	3	
	2.3	Equation of Motion (Cartesian form): The Navier-Stokes equations.	3	

	2.4	The Energy equation.	3	
	Text 1: Chapter 2 – Sections: 2.7 to 2.9, 2.20 to 2.25; Chapter 3 – Sections: 3.1 & 3.9.			
3	**One-Dimensional Flow & Dimensional Analysis**			**15**
	3.1	One-Dimensional flow: Bernoulli's equation. Bernoulli's Theorem.	4	
	3.2	Flow from a tank through a small orifice: Torricelli's theorem.	4	
	3.3	Dynamical similarity and Inspection analysis: Reynold's principle of similarity.	5	
	3.4	Dimensional analysis using Rayleigh's Technique.	5	
	Text 1: Chapter 4 – Sections: 4.1, 4.2, 4.4A; Chapter 15 – Sections: 15.1 to 15.5, 15.13 & 15.14.			
4	**Laminar Flows of Viscous Incompressible Fluids**			**15**
	4.1	Flow between parallel flat plates: Plane Couette flow.	6	
	4.2	Couette flow.	6	
	4.3	Plane Poiseuille flow.	6	
	Text 1: Chapter 16 – Sections: 16.1 to16.3D.			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned.)* **This content will be evaluated internally.**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**	
	Lecture and Tutorial Practical Demonstration Using Appropriate Software.	
	MODE OF ASSESSMENT	
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**

<table>
<tr><td rowspan="11">Assessment Types</td><td rowspan="7"></td><td colspan="4">Components</td><td>Mark Distribution</td></tr>
<tr><td colspan="4">Module Test- I</td><td>5 Marks</td></tr>
<tr><td colspan="4">Module Test- II</td><td>5 Marks</td></tr>
<tr><td colspan="4">Module Test- III</td><td>5 Marks</td></tr>
<tr><td colspan="4">Module Test- IV</td><td>5 Marks</td></tr>
<tr><td colspan="4">Assignment/Seminar</td><td>5 Marks</td></tr>
<tr><td colspan="4">Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="10"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
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</table>

REFERENCES:

1. Raisinghania, M.D. *Fluid Dynamics: With Complete Hydrodynamics and Boundary Layer Theory*, Eleventh Revised Edition, S. Chand and Company Ltd, 2013.

SUGGESTED READINGS:

1. Yuan, S.W. *Foundations of Fluid mechanics*, Prentice Hall of India, 2001.
2. Chandrasekharaiah, D. S., Debnath, L. *Continuum Mechanics*, Academic Press, 2014.
3. Batchelor, G.K. *An Introduction to Fluid Dynamics*, Cambridge University Press, 2000.
4. Kundu, P.K., Cohen., I.M., Dowling D.R. *Fluid Mechanics*, Fifth Edition, 2012.

ADVANCED READINGS:

1. White, F.M. *Fluid Mechanics*, Tata Mc Graw Hill, 2011.
2. Schlichting, H. *Boundary Layer Theory*, Tata Mc Graw Hill, 2002.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Classify different types of fluids and draw a graph to differentiate Newtonian and non-Newtonian fluids.
- Visualize the streamline of a fluid flow for an instantaneous velocity using Wolfram Alpha.
- Represent the velocity and acceleration of a moving fluid particle using Sci-lab software.
- Inspect the dimensional homogeneity of some well-known physical equations.
- Visualize the Couette flow using MATLAB software.
- Compare the importance of Boundary layer flows and Viscous laminar flows.

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Programme	**BSc (Hons) Mathematics**				
Course Name	**Scilab for Calculations and Visual Presentations**				
Type of Course	**DSE**				
Course Code	**MG6DSEMAT304**				
Course Level	**300-399**				
Course Summary	The course is designed for doing computations, matrix operations, solving system of linear equations, plotting data, visualisation of curves and solving differential equations using Scilab.				
Semester	**6**	**Credits**		**4**	
Course Details		Lecture	Tutorial	Practicum	Others	Total Hours
	Learning Approach	4	0	0	0	**60**
Pre- requisites, If any	Fundamental knowledge on algebraic equations, mathematical functions, matrices, differential equations.				

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand the basic commands used for fundamental mathematical calculations using Scilab	U,S	2, 10
2	Apply basic programming techniques in Scilab to compute the value of expressions involving mathematical functions.	A,S	1, 2
3	Apply Scilab to do various operations in Matrices and solving system of linear equations.	A,S	1, 2
4	Apply Scilab to plot various mathematical functions, expressions and solving differential equations.	A,S	2

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	The General Environment and Console, Simple Numerical Calculations	1	**12**
	1.2	The Menu bar, The Editor	1,2	
	1.3	The Graphics Window (Graphics for Plotting, Modifying a Plot, Online help), Windows Management and Workspace Customization	4	
	Text 1: Chapter 1 – Become Familiar with Scilab			
2	2.1	Variables Assignment and Display (Variables, Functions)	1	**15**
	2.2	Variables Assignment and Display (Display - Brackets : Vectors and Matrices, Strings)	1,2	
	2.3	Loops – for, while, Tests – if.. then.. else.. Tests	1,3	
	Text 1: Chapter 2 – Programming – sections: Variables Assignments and Display to Tests			
3	3.1	2 D and 3D Plots (Basic Plots - of Mathematical Functions, Plots of Plane Curves)	4	**18**
	3.2	2 D and 3D Plots (Plots of Sequence of Points, Bivariate Statistical Data)	4	
	3.3	2 D and 3D Plots (Plots in 3 dimensions – surfaces and curves)	4	
	3.4	2 D and 3D Plots (Simulations and Statistics, Statistics - Plotting Data using Bar graphs)	4	
	Text 1: Chapter 2 – Programming – sections: 2 D and 3D Plots			
4	4.1	Additional Information on Matrices and Vectors (Accessing Elements, Operations on Matrices)	3	**15**
	4.2	Additional Information on Matrices and Vectors	3	

		(Solving Linear Systems, Some useful Functions - sort, length, sum and product)		
	4.3	Additional Information on Matrices and Vectors (Some useful Functions - unique, find) Accuracy Computation Solving Differential Equations	2, 4	
	Text 1: Chapter 2 Programming – sections: Additional Information on Matrices and Vectors to Solving Differential Equations			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**				
	Interactive Instructions using ICT Tools Hands on Training				
Assessment Types	**MODE OF ASSESSMENT**				
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**			
		Components		**Mark Distribution**	
		Module Test- I		5 Marks	
		Module Test- II		5 Marks	
		Module Test- III		5 Marks	
		Module Test- IV		5 Marks	
		Assignment/Seminar		5 Marks	
		Quiz/Viva voce		5 Marks	
	B	**End Semester Evaluation (ESE) 70 marks**			
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**			
		Module	Part A **2 Marks**	Part B **6 Marks**	Part C **10 Marks**	Total
		I	2	2	1	**5**
		II	2	2	2	**6**

		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. https://www.scilab.org/sites/default/files/Scilab_beginners.pdf

SUGGESTED READINGS:

1. https://scilab.in/textbook_companion/generate_book/845
2. https://www.scilab.org/sites/default/files/progscilab-v.0.10_en.pdf

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

1. Text 1 : Chapter 3 Useful Scilab Functions (Analysis, Probability and Statistics, Display and Plot, Utilities)

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Programme	**BSc (Hons) Mathematics**					
Course Name	**Mathematical Computation and Visualization with R**					
Type of Course	**VAC**					
Course Code	**MG6VACMAT300**					
Course Level	**300-399**					
Course Summary	This course delves into the realm of mathematical computation and visualization using the powerful R programming language. Students will embark on a journey through the fundamentals of R, exploring its functionality and applications in various mathematical domains.					
Semester	**6**	**Credits**			**3**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	0	0	**45**
Pre- requisites, If any	Nil					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Apply R to represent and manipulate sets, including operations like union, intersection, and difference	U	1,2,4,10

2	Apply matrix concepts to represent and solve system of linear equations in R	A	1,2,4,10
3	Solve various matrix operations.	A	1,2,4,10
4	Compute determinants of matrices using R & employ Cramer's rule to solve system of linear equations in R	A	1,2,4,10
5	Apply R to analyse functions	A	1,2,4,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**R FUNCTIONS AND AN OVERVIEW OF SETS USING R**		**15**
	1.1	Functions, Parameter versus Argument, Argument Order and Parameter Names, Environments, Scope	1	
	1.2	Sets, Venn diagram, Cardinality of sets, Implementing the Subset Function in R, Equality of Sets, Empty Set.	1	
	1.3	Operations on Sets – Intersection, Union, Complement, Cross Product of two sets.	1	
	Text 1: Chapter 1 - Sections: 1.2 to 1.6; Chapter 3- Sections: 3.1 to 3.9 & 3.11.			
2		**SYSTEM OF LINEAR EQUATIONS AND MATRICES IN R**		**15**
	2.1	Matrix & Vector in R	2	
	2.2	Solving a System of Linear Equations with R (Gaussian Elimination in R)	2	

	2.3	Matrix Operations in R - Addition, Scalar multiplication, Dot product, Transpose	3	
	2.4	Determinant, function, Cramer's rule in R	4	
	Text 2: Chapter 1 – *S*ections: 1.2.3, 1.2.7, 1.3.3, 1.3.7; Chapter 2 - Sections: 2.1, 2.2(2.2.1-2.2.3 & 2.2.7); Chapter 3 - Sections: 3.3 det( ) function only , 3.3.4 {lab exercises using det( ) function}, 3.5.3 & 3.5.7.			
3		**PLOTTING GRAPHS IN R**		**15**
	3.1	Basic arithmetic, Define and Evaluate a Function, Graph a Function in R, Find Roots of a Function, Store Roots as a Variable and Display the First Root, Evaluate a Function with a Variable, Add a Point to a Graph, Evaluate a Function at Multiple Values, Add Multiple Points to a Graph	5	
	3.2	Define a Function from a Function, Define a Function and Graph It, Identify Intersection Points and Add Them to the Graph, Add a Line Segment to a Graph	5	
	Text 3: Chapter 1 (R codes 1.1 to 1.20),			
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**
	The primary goal of this class is to enhance students' proficiency in mathematical computation and visualization using the R programming language. The course will cover fundamental mathematical concepts and their practical implementation through R. **Class Structure:** 1. **Introduction -** Outline the goals and expectations for the class

<table>
<tr><td></td><td colspan="6">2. Recap and Review - Briefly review the key concepts covered
3. Theory and Conceptual Understanding - Discuss theoretical aspects and provide real-world examples
4. Hands-On Computation with R - Conduct practical exercises using R to reinforce mathematical concepts
5. Group Project - Assign a group project
Homework Assignment - Assign relevant homework to reinforce learning</td></tr>
<tr><td rowspan="13">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td rowspan="6">A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 25 marks</td></tr>
<tr><td colspan="4">Components</td><td>Mark Distribution</td></tr>
<tr><td colspan="4">Module Test- I</td><td>5 Marks</td></tr>
<tr><td colspan="4">Module Test- II</td><td>5 Marks</td></tr>
<tr><td colspan="4">Module Test- III</td><td>5 Marks</td></tr>
<tr><td colspan="4">Assignment/Seminar</td><td>5 marks</td></tr>
<tr><td colspan="4">Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td rowspan="7">B</td><td colspan="5">End Semester Evaluation (ESE) 50 marks</td></tr>
<tr><td colspan="5">Question Pattern
[Maximum Time 75 Minutes, Maximum Marks 50]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>3</td><td>2</td><td>1</td><td>6</td></tr>
<tr><td>II</td><td>3</td><td>2</td><td>2</td><td>7</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>6</td><td>4</td><td>18</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>4</td><td>2</td><td>11</td></tr>
<tr><td>Total Marks</td><td>10</td><td>20</td><td>20</td><td>50</td></tr>
</table>

REFERENCES:

1. Claster, William B. *Mathematics and programming for machine learning with R: from the ground up.* CRC Press, 2021.
2. Yoshida, Ruriko. *Linear algebra and its applications with R*. CRC Press, 2021.
3. Pfaff, Thomas J. *Applied Calculus with R*. Springer International Publishing, 2023.

SUGGESTED READINGS:

1. Zuur, Alain F., Elena N. Ieno, and Erik HWG Meesters. *A Beginner's Guide to R*. New York: Springer, 2009.
2. Matloff, Norman. *The art of R programming: A tour of statistical software design*. No Starch Press, 2011.
3. Strang, Gilbert. *Introduction to linear algebra*. Wellesley-Cambridge Press, 2022.
4. Weir, Maurice D., et al. *Thomas' calculus: early transcendentals: based on the original work by George B. Thomas, Jr*. Addison-Wesley, 2006.

ADVANCED READINGS:

1. Emmert-Streib, Frank S., Salissou Moutari and Matthias Dehmer. *Mathematical Foundations of Data Science using R,* De Gruyter, 2022.
2. Jones, Owen, Robert Maillardet and Andrew Robinson. *Introduction to Scientific Programming and Simulation Using R,* 2nd edition, Chapman & Hall/CRC, 2014.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Any suitable topic from Textbook 2 can be included.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Computations and Graphics using SageMath**					
Type of Course	**SEC**					
Course Code	**MG6SECMAT300**					
Course Level	**300-399**					
Course Summary	The course is designed for doing Computations, Analysis, Linear Algebra, Plotting Data and Visualisation of curves using SageMath.					
Semester	**6**	**Credits**			**3**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	0	0	**45**
Pre- requisites, If any	Fundamental Knowledge on algebraic equations, trigonometric functions, Sequences, Series, Power Series, Limits, Derivatives, Partial Derivatives, Matrices, Eigenvalues and Eigenvectors.					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Discuss the basic commands used for mathematical calculations using Sage Math	**U, S**	**1,2**

2	Apply basic programming skills in Sage Math to compute the limits and derivatives of various fuctions	**A, S**	**1,2,3,4**
3	Apply Sage Math to do various operations in Matrices.	**A, S**	**1,3,9**
4	Use SageMath to plot various mathematical functions and data structures.	**A, S**	**1,3,9,10**
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	**1.1**	Sage as a Calculator – First Computations Elementary Functions and Usual Constants On-line help and Automatic Completion	**1**	**20**
	1.2	Python Variables Symbolic Variables (Using Variables and Expressions) First Graphics (Graphics - Plotting Functions)	**1**	
	1.3	Symbolic Expressions and Simplification – Symbolic Expressions, Transforming Expressions, Usual Mathematical Functions, Assumptions, Some Pitfalls	**1**	
	1.4	Equations – Explicit Solving, Equations with no Explicit Solution	**2**	
	1.5	Analysis – Sums, Limits, Sequences, Power Series Expansions, Series, Derivatives, Partal Derivatives, Integrals	**2**	
	Text 1: Chapter 1 – Section: 1.2 (1.2.1 to 1.2.6); Chapter 2 – Sections: 2.1 to 2.3			

2	**2.1**	Basic Linear Algebra - Matrix Computations, Reduction of a Square Matrix	**3**	**13**
	2.2	Elementary Constructs and Manipulations – Vector and Matrix Constructions	**3**	
	2.3	Basic Manipulations and Arithmetic on Matrices, Basic Operations on Matrices	**3**	
	Text 1: Chapter 2 – Section: 2.4 (2.4.3 to 2.4.4); Chapter 8 – Section: 8.1 (8.1.2 to 8.1.4))			
3	**3.1**	2 D Graphics - Graphical Representation of Functions	**4**	**12**
	3.2	Parametric Curves, Curve in Polar Co-ordinates, Curve defined by Implicit Equation	**4**	
	3.3	Data Plot, Displaying Solutions of Differential Equations, Evolute of a Curve	**4**	
	3.4	3 D Curves	**4**	
	Text 1: Chapter 4 – Sections: 4.1 & 4.2			
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**	
	Interactive instructions using ICT tools Hands on training	
Assessment Types	**MODE OF ASSESSMENT**	
	A	**Continuous Comprehensive Assessment (CCA) 25 marks** Practical sessions or exams may be organized for each module, and the Continuous Comprehensive Assessment (CCA) should be based on these hands-on experiences.

		Components			**Mark Distribution**	
		Module Test- I			5 Marks	
		Module Test- II			5 Marks	
		Module Test- III			5 Marks	
		Assignment/Seminar			5 marks	
		Quiz/Viva voce			5 Marks	
	B	**End Semester Evaluation (ESE) 50 marks**				
		Question Pattern [Maximum Time 75 Minutes, Maximum Marks 50]				
		Module	Part A	Part B	Part C	Total
			2 Marks	**5 Marks**	**10 Marks**	
		I	4	1	1	**6**
		II	2	3	2	**7**
		III	2	2	1	**5**
		Total no of questions	**8**	**6**	**4**	**18**
		Number of questions to be answered	**5**	**4**	**2**	**11**
		Total Marks	**10**	**20**	**20**	**50**

REFERENCES:

1. Paul Zimmermann, Alexandre Casamayou, Nathann Cohen, Guillaume Connan, Thierry Dumont, Laurent Fousse, François Maltey, Matthias Meulien, Marc Mezzarobba, Clément Pernet, Nicolas M. Thiéry, Erik Bray, John Cremona, Marcelo Forets, Alexandru Ghitza, Hugh Thomas. *Computational Mathematics with SageMath*., SIAM, 2018

SUGGESTED READINGS :

1. Razvan A. Mezei. Introduction to Programming Using SageMath, Wiley, 2020.
2. The Sage Development Team , Tutorial Release 10.2 ,2023, (https://doc.sagemath.org/pdf/en/tutorial/sage_tutorial.pdf).
3. Gregory V. Bard, William Stein, Sage for Undergraduates, American Mathematical Society , 2015)

4. Robert Beezer, A first course in Linear algebra, Congruent Press,2015, (http://linear.ups.edu/)

5. Tom Judson and Robert Beezer, Abstract Algebra Theory and Applications., open source textbook supported by National Science Foundation, 2022 (http://abstract.ups.edu/)

6. Razvan A Mezei , An Introduction to SAGE Programming: With Applications to SAGE Interacts for Numerical Methods by, Springer, 2015

Semester 7

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Advanced Linear Algebra**					
Type of Course	**DCC**					
Course Code	**MG7DCCMAT400**					
Course Level	**400-499**					
Course Summary	This course on linear algebra provides a comprehensive introduction to the fundamental concepts and techniques of linear algebra. The course covers a wide range of topics, including vector spaces, coordinates, linear transformations, linear functionals, matrix of linear transformations, dual spaces, characteristic values, annihilating polynomials, invariant subspaces, simultaneous triangulisation and diagonalisation, direct sum decomposition, and invariant direct sums.					
Semester	**7**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Basic definitions, properties and theorems on Fields, Vector spaces, subspaces, basis and dimension.					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		

1	Analyse finite and infinite dimensional vector spaces and subspaces over a field and their properties including basis structure of vector spaces	An	1,2,3
2	Use the definition and properties of linear transformations and matrices of linear transformations and change of basis, including kernel, range and isomorphism	A, An	2,3,10
3	Compute the characteristic polynomial, eigenvectors, eigenvalues and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result	A, E	2,3
4	Understand the basic theory of Simultaneous triangulations, Direct sum decompositions and Invariant direct sums	U, An	1,2,3,10
5	Utilize Python to perform computations efficiently in linear algebra.	S, A	2,3,8,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Review on Fields, Vector spaces, subspaces, basis and dimension (Theorems-Statements only)	1	**20**
	1.2	Coordinates	1, 2	
	1.3	Linear transformations and Algebra of Linear Transformations	1, 2	
	1.4	Isomorphism	1, 2	
		Problems (Practicum)	1,2	
	Text 1: Chapter 1 – Section: 1.1; Chapter 2 – Sections: 2.1 to 2.4; Chapter 3 – Sections: 3.1 to 3.3.			
2	2.1	Representation of transformations by matrices	1, 2	**20**
	2.2	Linear functionals and dual space	1, 2	
	2.3	Double dual	1, 2	

		Problems (Practicum)	1,2	
	Text 1: Chapter 3 – Sections: 3.4 to 3.6			
3	3.1	Characteristic Values	3	**20**
	3.2	Diagonalizable linear operators	3,4	
	3.3	Annihilating polynomials	2,3,4	
	3.4	Cayley Hamilton Theorem	3,4	
	3.5	Invariant subspaces	3,4	
		Problems (Practicum)	2,3,4	
	Text 1: Chapter 6 – Sections: 6.1 to 6.4.			
4	4.1	Simultaneous triangulation; simultaneous diagonalization	3,4	**15**
	4.2	Direct sum Decompositions	3,4	
	4.3	Invariant Direct Sums	3,4	
		Problems (Practicum)	3,4,5	
	Text 1: Chapter 6 – Sections: 6.5 to 6.7.			
5	**Teacher Specific Contents** *(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. **I**t's purpose is to encourage creativity and develop Problem Solving Skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten

copy of the solutions should be kept in the department.

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="6">Lectures, Tutorials, Interactive Sessions, Blended Learning</td></tr>
<tr><td rowspan="15">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="8"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>IV</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>5</td><td>3</td><td>13</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Hoffman, K., Kunze, R. Linear algebra: Second edition. Prentice-Hall of India Pvt. Ltd, 1992.

SUGGESTED READINGS:

1. Strang, G.. *Linear algebra and its applications*. Cengage Learning, 2016.
2. Lay, D. C., Lay, S. R., & McDonald, J. J. *Linear algebra and its applications* (5th ed.). Pearson, 2023.
3. Lang, S. *Introduction to linear algebra (2nd ed.).* Springer-Verlag New York, Inc, 1997.
4. Kumaresan, S. *Linear algebra: A geometrical appr*oach. Prentice-Hall of India,2000.
5. Axler, S. *Linear algebra done right* (4th ed.). Springer, 2023
6. Jänich, K. *Linear Algebra (Undergraduate Texts in Mathematics).* Springer-Verlag New York, 2014.
7. Banchoff, T. F., & Wermer, J. T. *Linear algebra through geometry (2nd ed.).* Springer,2002.
8. Friedberg, S. H., Insel, A. J., & Spence, L. E. *Linear algebra (4th ed.)*. Pearson, 2013.
9. Horn, R. A., & Johnson, C. R. *Matrix analysis (2nd ed.)*. Cambridge, UK: Cambridge University Press, 2013.
10. Thamban Nair, M., & Singh, A. *Linear Algebra.* Springer, 2018.
11. Video lectures of Gilbert Strang Hosted by MITOpenCourseware available at Video Lectures | Linear Algebra | Mathematics | MIT Open Course Ware.
12. Klein, P. N. *Coding the Matrix Linear Algebra through Applications to Computer Science*, Newtonian Press, 2013.
13. Dan Bader, David Amos, Joanna Jablonski, Fletcher Heister: *Python Basics: A Practical Introduction to Python (1st Edition)* Real Python March 2021

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Use Python to perform computations in the modules 1 to 4 efficiently
- Transpose of a Linear Transformation (Chapter 3 Section 3.7)
- The rational and Jordan forms (Chapter 7-Sections 7.1 to 7.3)

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**
Course Name	**Theory of Complex Functions**
Type of Course	**DCC**
Course Code	**MG7DCCMAT401**
Course Level	**400-499**
Course Summary	This course is designed to develop analytical skills in complex analysis and comprehensive understanding of topics in complex analysis, preparing students for further explorations. It will explore the properties of lines and half planes in the complex plane, investigate power series and their convergence, and uncover the geometric significance of spherical representations. The course will delve into the Mobius transformations, representation of complex analytic functions as power series, providing powerful tools for expanding and analyzing these functions. Cauchy's theorems, a cornerstone of complex analysis, will be studied in its various forms, revealing its profound implications for contour integration. Students will master the theory of complex integration, gaining proficiency in evaluating integrals along contours in the complex plane. The concept of the index of a closed curve, open mapping theorem and argument principle will be discussed and their implications being analyzed. These theorems provide deep insights into the behavior of analytic functions and their relationship with the complex plane.

Semester	**7**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**

Pre- requisites, If any	The field of complex numbers, Powers and roots of complex numbers, Polar form of complex numbers, Elementary functions, Basic concepts on functions of complex variables.

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Demonstrate a comprehensive understanding of the properties of lines and half planes in the complex plane, power series of complex numbers, spherical representation and Mobius transforms	U	1, 2, 3
2	Illustrate complex analytic functions as power series expansions, recognizing the convergence properties and regions of validity of these representations.	A	1, 2
3	Analyze various versions of Cauchy's theorem and applying them to solve complex integration problems.	An	1, 2, 3, 10
4	Explain the fundamental principles of complex integration, including the definition of line integrals, the concept of residues, and the relationship between residues and contour integrals.	E	1, 2, 3
5	Evaluate the index of a closed curve and determine the types of residues (simple, pole, and essential singularities) that can occur within a given contour.	E	1, 2
6	Interpret open mapping theorem and the argument principle to gain insights into the behaviour of holomorphic functions and their mappings.	E	1, 2
7	Develop strong analytical skills in complex analysis, laying the foundation for further exploration of advanced topics in complex analysis and related fields.	S	1, 2, 3, 9, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Lines and half planes in the complex plane	1	15
	1.2	Extended Plane and its Spherical representation	1	
	1.3	Power Series	1	
	1.4	Analytic functions	2	
	1.5	Analytic functions as mappings. Mobius Transformations	1	
	Text 1: Chapter 1 – Sections: 5 & 6; Chapter 3 – Sections: 1 to 3			
2	2.1	Riemann - Stieltjes integrals	4	15
	2.2	Power series representation of analytic functions	2	
	2.3	Zeros of an analytic function	2	
	2.4	The index of a closed curve	5	
	Text 1: Chapter 1 – Sections: 1 to 4 (only statements of theorem 1.4 and lemma 1.19)			
3	3.1	Cauchy's theorem and integral formula	3	15
	3.2	Homotopy version of Cauchy's theorem and simple connectivity	3, 7	
	3.3	Counting zeros, Open mapping theorem	6, 7	
	3.4	Goursat theorem	3, 7	
	Text 1: Chapter 4 – Sections: 5 to 8 (only statement of third version of Cauchy's theorem)			
4	4.1	Classification of singularities	5	15
	4.2	Residues	4, 5	

	4.3	Argument Principle	6, 7	
	Text 1: Chapter 5 – Sections: 1 to 3			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**					
	Lecture methods, Student Lectures on appropriate sections, Activity based Tutorials/Practical, Software based visualisation of concepts					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**				
		Components			**Mark Distribution**	
		Module Test- I			5 Marks	
		Module Test- II			5 Marks	
		Module Test- III			5 Marks	
		Module Test- IV			5 Marks	
		Assignment/Seminar			5 Marks	
		Quiz/Viva voce			5 Marks	
	B	**End Semester Evaluation (ESE) 70 marks**				
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**				
		Module	Part A **2 Marks**	Part B **6 Marks**	Part C **10 Marks**	Total
		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. Conway, John B. *Functions of one complex variable, 2nd Edition.* Springer, 1978.

SUGGESTED READINGS:

3. Lars V. Ahlfors, *Complex Analysis, Third edition*, McGraw Hill Internationals, 1979
4. Gamelin, Theodore. *Complex analysis*. Springer Science & Business Media, 2003.
5. Priestley, H. A. *Introduction to Complex Analysis*. OUP Oxford, 2003.
6. Mathews, John, and Russell Howell. *Complex analysis for mathematics and engineering*. Jones & Bartlett Publishers, 2012.
7. Cartan, Henri. *Elementary theory of analytic functions of one or several complex variables.* Courier Corporation, 1995.
8. Lang, Serge. *Complex analysis*. Vol. 103. Springer Science & Business Media, 2013.

ADVANCED READINGS:

1. Asmar, Nakhlé H., and Loukas Grafakos. *Complex analysis with applications*. Berlin: Springer, 2018.
2. Nevanlinna, Rolf, and Veikko Paatero. *Introduction to complex analysis*. Vol. 310. American Mathematical Society, 2007.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Study the Group structure of Mobius Transformations.
- Proof of Theorem 1.4 and Lemma 1.19 in Chapter 4 of Text 1
- Third version of Cauchy's Theorem
- Problems and applications of residues and Residue Theorem
- Discussion on latest research areas in Complex Analysis

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Introduction to Metric Spaces**					
Type of Course	**DCC**					
Course Code	**MG7DCCMAT402**					
Course Level	**400-499**					
Course Summary	An introduction to fundamental concepts in Metric Space and generalization of continuity , connectedness, smallness conditions to metric spaces					
Semester	7	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours/Hours
		4	0	0	0	**60**
Pre- requisites, If any	Set and Functions, Fundamentals of Analysis					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Visualize the concept of distance as a mathematical function in various spaces	A, S, I, Ap	1 ,2 ,3, 4 , 10
2	Develop their abstract thinking skills.	A, C, S, I, Ap	1, 2, 4,10

3	Define and Illustrate the concept of metric space and its properties	K, U,S,Ap	1,3,4, 10
4	Explain the concept of continuity connectedness and compactness	K, U,S	1,3,4,10
5	Explain the fundamental concepts of modern analysis and generalization to arbitrary sets.	K, A, C	1,2, 3,4, ,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Inequalities	1	15
	1.2	Metric Spaces	1	
	1.3	Sequences in metric spaces	1,2	
	1.4	Cauchy Sequence (Definitions, Examples and Statements only)	2,3	
	1.5	Completion in Metric Spaces (Proof of Theorem 1.5.3 is excluded)	2,3	
	Text 1: Chapter 1 – Sections: 1.1 to 1.5			
2	2.1	Open and Closed Sets	3	15
	2.2	Relativization and subspaces	3,5	
	2.3	Countability Axioms and Separability	3,5	
	Text 1: Chapter 2 – Sections: 2.1 to 2.3			
3	3.1	Continuous Mapping	**4**	15
	3.2	Uniform continuity	2 ,4	
	3.3	Homeomorphism , Equivalent metrics and	2,4	

		Isometry		
	Text 1: Chapter 3 – Sections: 3.1, 3.4 & 3.5			
4	4.1	Connectedness	4,5	**15**
	4.2	Bounded sets and compactness	4,5	
	4.3	Other characterisation of compactness	4,5	
	4.4	Continuous functions on compact spaces	4,5	
	Text 1: Chapter 4 – Sections: 4.1; Chapter 5 - Sections: 5.1 to 5.3			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**				
	Chalk and Talk, Group Discussion, Seminar, Interactive Sessions, Tutorials, Assignment, Quiz				
Assessment Types	**MODE OF ASSESSMENT**				
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**			
		Components			**Mark Distribution**
		Module Test- I			5 Marks
		Module Test- II			5 Marks
		Module Test- III			5 Marks
		Module Test- IV			5 Marks
		Assignment/Seminar			5 Marks
		Quiz/Viva voce			5 Marks
	B	**End Semester Evaluation (ESE) 70 marks**			
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**			
		Module	Part A	Part B	Part C	Total

			2 Marks	6 Marks	10 Marks	
		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. Satish Shirali, Harikrishnan L Vasudeva, Matric Spaces, Springer – Verlag London Limited 2006.

SUGGESTED READINGS:

1. Simmons, George F. *Introduction to Topology and Modern Analysis*, McGraw-Hill Book Company, 1963.
2. Joshi, K.D. *Introduction to General Topology,* Wiley Eastern Ltd, 1984.

ADVANCED READING:

1. Dugundji. Topology, Universal Book Stall, New Delhi, 1989.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Related Exercise problems in 1.6, 2.5, 3.8
- Proofs of all propositions in section 1.4
- Section 4.2: Local connectedness

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Advanced Theory of Groups and Rings**					
Type of Course	**DCE**					
Course Code	**MG7DCEMAT400**					
Course Level	**400-499**					
Course Summary	The objective of the course is to introduce advanced concepts in groups and rings. The first module includes direct products, classification of finitely generated abelian groups, factor groups and homomorphisms, normal subgroups and inner automorphisms. The second module covers computations of factor groups, simple groups, group actions and application of G-sets to finite groups. The third module includes isomorphism theorems, Sylow theorems and its applications. The fourth module contains homomorphism, factor rings and concepts on ideals.					
Semester	**7**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any	Fundamentals of Groups and Rings					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		

1	Understand and construct direct products of groups and analyse the structure of finitely generated abelian groups	E	1,2,3
2	Comprehend the concepts of normal subgroups, factor groups and simple groups, identify and apply the properties of factor groups and homomorphisms, compute factor groups and analyse their properties	A	1,2,3,4
3	Understand group action on a set, construct examples of G-sets and orbits and apply the results on G-sets to the study of finite groups	An	1,2,3,10
4	Comprehending Sylow theorems, students will apply the Sylow theory to classify groups of different orders.	E	1,2,4
5	Analysing homomorphisms, factor rings, prime and maximal ideals.	An	1,2,3

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Direct Products	1	**17**
	1.2	The structure of finitely generated abelian groups	1	
	1.3	Applications	1	
	1.4	Factor groups	2	
	1.5	Homomorphisms and factor groups	2	
	1.6	Normal subgroups and inner automorphisms	2	
	Text 1: Sections: 9 & 12			
2	2.1	Factor group computations and Simple groups	2	**17**
	2.2	Center and Commutator subgroups. Statement of Theorem 13.17.	2	
	2.3	Group action on a set: The notion of a group action	3	

	2.4	Isotropy subgroups, Orbits	3	
	2.5	Application of G-sets to finite groups	3	
	Text 1: Sections: 13 & 14			
3	3.1	Isomorphism theorems	2	**14**
	3.2	Sylow theorems	4	
	3.3	Applications of the Sylow theorems	4	
	Text 1: Sections: 16 & 17			
4	4.1	Factor rings	5	**12**
	4.2	Homomorphisms, Properties of homomorphisms	5	
	4.3	Fundamental homomorphism theorem (for rings)	5	
	4.4	Prime and maximal ideals	5	
	4.5	Prime Fields	5	
	Text 1: Sections: 30 & 31.1 to 31.20			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lectures, Tutorials, Interactive Sessions, Blended Learning		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks

<table>
<tr><td rowspan="10"></td><td rowspan="4"></td><td colspan="2">Module Test- III</td><td>5 Marks</td></tr>
<tr><td colspan="2">Module Test- IV</td><td>5 Marks</td></tr>
<tr><td colspan="2">Assignment/Seminar</td><td>5 Marks</td></tr>
<tr><td colspan="2">Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td>B</td><td colspan="4">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="9"></td><td colspan="4">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>IV</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>5</td><td>3</td><td>13</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Fraleigh, John B., and Neal E. Brand. *A First Course in Abstract Algebra* 8th ed, Pearson Education, 2021

SUGGESTED READINGS:

1. Dummit, David S., and Richard M. Foote. *Abstract Algebra. 3rd ed.* Wiley, 2003.
2. Artin, M. *Algebra. 2nd ed., Pearson Education, 2017.*
3. Herstein, I. N. *Topics in Algebra*, 2nd *Edition, John Wiley and Sons, 2010*
4. Gallian , Joseph A, *Contemporary Abstract Algebra, 10th edition* ,Cengage 2015.
5. Musili , C. *Introduction to Rings and Modules*, 2nd revised Edition, Narosa ,1997.
6. Hungerford, Thomas W, *Algebra*, Springer,2011.

ADVANCED READINGS:

1. Hungerford, Thomas.W., Algebra, 4th Print 2003 Edition.
2. Lang, Serge, Algebra, 4th Print 2005 Edition

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Proving A_n is simple for $n \geq 5$.
- Applications of G-sets to counting. Burnside's Theorem (Section 15 of Text 1)

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Real Analysis**					
Type of Course	**DSE**					
Course Code	**MG7DCEMAT401**					
Course Level	**400-499**					
Course Summary	This course covers essential topics in mathematical analysis, including functions of bounded variation and rectifiable curves, the Riemann-Stieltjes integral, sequence and series of functions. Students will explore the Riemann-Stieltjes integrals. Its applications to vector-valued functions will be addressed, along with discussions on uniform convergence, integration, and differentiation in the context of sequences and series of functions. The course concludes with an examination of equicontinuous families, the Weierstrass theorem, and the power series.					
Semester	**7**	**Credits**			**4**	
Course Details		Lecture	Tutorial	Practicum	Others	Total Hours
	Learning Approach	4	0	0	0	**60**
Pre- requisites, If any	Fundamentals of Mathematical Analysis					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		

1	Understand and analyses functions of bounded variations and its properties.	U, An	1, 2, 3
2	To analyze and parametrize curves, calculate arc lengths, and apply additive and continuity properties and fostering problem-solving skills in practical mathematical scenarios.	An	1, 2, 3, 10
3	To understand the Riemann-Stieltjes integral	U, An	1, 2, 3
4	To analyse the properties of Riemann-Stieltjes integral	An	1,2,3,10
5	To understand and analyse the concept of uniform convergence and its properties.	U, An	1,2,3,10
6	To understand Equicontinuous families of functions	U	1,2,3,10
7	To study Weierstrass theorem.	U, An	1,2,3
8	To understand power series	U	1,2,3,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Introduction, properties of monotonic functions, functions of bounded variation	1	15
	1.2	Total variation, additive property of total variation, total variation on (a, x) as a function of x.	1	
	1.3	Functions of bounded variation expressed as the difference of increasing functions, continuous functions of bounded variation.	1	
	1.4	Curves and paths, rectifiable path and arc length	2	

	1.5	Additive and continuity properties of arc length.	2	
	Text 1: Chapter 6 - Sections: 6.1 to 6.11.			
2	2.1	Definition and existence of the integral	3	**15**
	2.2	Properties of the integral	4	
	2.3	Integration and differentiation.	4	
	2.4	Integration of vector valued functions.	4	
	Text 1: Chapter 6 - Sections: 6.12 to 6.25			
3	3.1	Sequence and series of functions - Discussion of main problem.	5	**15**
	3.2	Uniform convergence.	5	
	3.3	Uniform convergence and Continuity.	5	
	3.4	Uniform convergence and Integration.	5	
	3.5	Uniform convergence and Differentiation.	5	
	Text 2: Chapter 7 - Sections: 7.1 to 7.18.			
4	4.1	Equicontinuous families of functions.	6	**15**
	4.2	The Weierstrass theorem	7	
	4.3	Power series	8	
	Text 2: Chapter 7 - Sections: 7.19 to 7.27; Chapter 8 – sections: 8.1 to 8.5.			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			
Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**			
	Lecture, Tutorial and Activity oriented			

<table>
<tr><td rowspan="11">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="10"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
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<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Apostol, Tom M. *Mathematical analysis*. Narosa, 1974.
2. Rudin, Walter. *Principles of mathematical analysis*. Vol. 3. New York: McGraw-hill, 1976.

SUGGESTED READINGS:

1. Stein, Elias M., and Rami Shakarchi. *Real analysis: measure theory, integration, and Hilbert spaces*. Princeton University Press, 2009.
2. Abbott, Stephen. *Understanding analysis*..springer publication, 2015.

3. Fitzpatrick, Patrick. *Advanced calculus*.Vol. 5. American Mathematical Soc., 2009.
4. Folland, Gerald B. *Real analysis: modern techniques and their applications*. Vol. 40. John Wiley & Sons, 1999.
5. Royden, H.L. *Real Analysis, 2nd edition*, Macmillan, New York.

ADVANCED READINGS:

1. Gelbaum, Bernard R., and John MH Olmsted. *Counterexamples in analysis*. Courier Corporation, 2003.
2. Carothers, Neal L. *Real analysis*. Cambridge University Press, 2000.
3. Rudin, Walter. Real and complex analysis, Mcgraw-hill international editions: Mathematics series, 1987.
4. Axler, Sheldon. *Measure, integration & real analysis*. Springer Nature, 2020.
5. Widder, David V. *Advanced calculus*. Courier Corporation, 2012.
6. Franklin, Philip. *A treatise on advanced calculus*. Courier Dover Publications, 2016.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Equivalence of paths, change of parameter. (*Text 1, Chapter 6 Section 6.12*)
- Linear Space of functions.
- Absolutely continuous functions and Bounded variation.
- Uniform Lipschitz condition and bounded variation.
- Prime numbers and Riemann zeta function.
- Riemann Stieljes integration of Cantor sets
- Weak form of Lebesgue's dominated convergence theorem.
- Helly's Selection Theorem.
- Space Filling Curves.
- The algebraic completeness of complex field.
- The exponential and logarithmic functions.
- The trigonometric functions.
- Algebra and its Uniform closure
- Stone's generalization of the Weierstrass theorem (Theorem)
- Fourier series.
- Gamma Functions.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Graph Theory**					
Type of Course	**DCE**					
Course Code	**MG7DCEMAT402**					
Course Level	**400-499**					
Course Summary	This course provides a comprehensive introduction to graph theory, equipping students with the knowledge and skills to analyse and solve problems in diverse fields like computer science, biology, chemistry, sociology, operations research etc.					
Semester	**7**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any	Definition of a graph					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand basic concepts and properties of graphs.	U	1, 2, 10
2	Analyse real world problems using graph theory	An	1, 2, 3, 10
3	Understand the theoretical approach of graph theory	U	1, 2, 10

4	Identify research problems relating to graph theory	I	1, 2, 3, 4, 6, 9, 10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Introduction, Basic concepts, Sub graphs, Degrees of vertices.	1	15
	1.2	Paths and Connectedness.	3	
	1.3	Operations on graphs.	3	
	1.4	Directed Graphs: Introduction, basic concepts.	3	
	1.5	Tournaments.	3	
	Text 1: Chapter 1 – Sections: 1.1 to 1.5, 1.8; Chapter 2 – Sections: 2.1 to 2.3			
2	2.1	Connectivity: Introduction, Vertex cuts and edge cuts	1, 3	15
	2.2	Connectivity and edge connectivity.	3	
	2.3	Blocks.	1	
	Text 1: Chapter 1 – Sections: 3.1 to 3.3, 3.4.1 & 3.4.2			
3	3.1	Trees: Introduction, Definition, characterization and simple properties.	1, 3	15
	3.2	Centres and Centroids.	1, 3	
	3.3	Independent Sets.	1, 2	
	3.4	Eulerian and Hamiltonian Graphs: Introduction, Eulerian graphs.	1, 2, 3	
	3.5	Hamiltonian Graphs, Closure of graphs.	1, 2, 3	
	Text 1: Chapter 4 – Sections: 4.1 to 4.3; Chapter 5 – Sections: 5.1, 5.2; Chapter 6 – sections: 6.1 to 6.3			

4	4.1	Graph Colorings: Introduction, Vertex Coloring.	1, 2, 3, 4	**15**
	4.2	Planarity: Introduction, Planar and Nonplanar Graphs.	1, 2, 3	
	4.3	Euler Formula and its consequences, K_5 and $K_{3,3}$ are Non-planar Graphs.	2, 3	
	Text 1: Chapter 7 – Sections: 7.1 to 7.2.5; Chapter 8 – Sections: 8.1 to 8.4			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**				
	Direct Instruction, Brain Storming Approach, Interactive instruction, Group Discussion, Presentation by individual student/ group representatives.				
Assessment Types	**MODE OF ASSESSMENT**				
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**			
		Components		**Mark Distribution**	
		Module Test- I		5 Marks	
		Module Test- II		5 Marks	
		Module Test- III		5 Marks	
		Module Test- IV		5 Marks	
		Assignment/Seminar		5 Marks	
		Quiz/Viva voce		5 Marks	
	B	**End Semester Evaluation (ESE) 70 marks**			
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**			
		Module	Part A	Part B	Part C	Total
			2 Marks	**6 Marks**	**10 Marks**	

		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. Balakrishnan, R., Ranganathan, K. A *Textbook of Graph Theory*. Second edition, Springer New York, 2012.

SUGGESTED READINGS:

1. Chartrand, Gary, and Zhang, Ping. *Chromatic Graph Theory*. United States, CRC Press, 2019.
2. Clark, John, and Derek Allan Holton. *A First Look at Graph Theory*. World Scientific Publishing Company, 1991.
3. Rosen, Kenneth H. *Discrete Mathematics and Its Applications*. United States, McGraw-Hill Higher Education -, 2016.
4. West, Douglas Brent. *Introduction to Graph Theory*. United Kingdom, Pearson, 2018.
5. Wilson, Robin J. *Introduction to Graph Theory* UPDF EBook. United Kingdom, Pearson Education, 2015.

ADVANCED READINGS:

1. Bondy, John Adrian, and Murty, U. S. R. *Graph Theory with Applications*. United Kingdom, Macmillan, 1976.
2. Hsu, Lih-Hsing, and Lin, Cheng-Kuan. *Graph Theory and Interconnection Networks.* United States, CRC Press, 2008.
3. Haynes, Teresa W., et al. *Fundamentals of Domination in Graph*s. United States, CRC Press, 2013.
4. Biggs, Norman. *Algebraic Graph Theory*. United Kingdom, Cambridge University Press, 1993.
5. Kottarathil, Jomon, et al. *Graph Theory and Decomposition*. CRC Press, Boca Raton, USA, 2024.
6. Li, Xueliang, et al. *Graph Energy. United States*, Springer New York, 2012.
7. Bapat, Ravindra B. *Graphs and Matrices.* India, Springer London, 2014.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- An application to Chemistry(Section 1.10),
- An application to Social Psychology (Section 1.11),
- Proof of theorem 2.3.2
- Counting the number of Spanning Trees (Section 4.4),
- Cayley's Formula (Section 4.5),
- Applications: The Connector Problem (Section 4.7.1),
- Kruskal's Algorithm
- Edge Coloring (Section 7.6)
- The Four-Color Theorem and the Heawood Five-Color Theorem (Section 8.6)
- Spectral Properties of Graphs: Chapter 11
- Visualize graphs using software like Sage Math, Python, or Wolfram Mathematica

Semester 8

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Functional Analysis**					
Type of Course	**DCC**					
Course Code	**MG8DCCMAT400**					
Course Level	**400-499**					
Course Summary	This is a comprehensive curriculum on vector spaces and related concepts which facilitate between Linear Algebra and Advanced Functional Analysis. It covers various aspects of normed spaces, linear operators, inner product spaces and Hilbert spaces. These chapters delve into the properties of vector spaces equipped with different structures, like norms and inner products. The concepts progress from normed spaces, linear operators and functionals to more specialized spaces like Hilbert spaces, emphasizing their properties, relationships and specific identities related to inner product spaces. The course ends with Hahn- Banach Theorem, the most important theorem connected with bounded linear operators, which is an extension theorem for linear functionals and guarantees that a normed space is richly supplied with linear functionals. The concepts and problems are intended to help the student to develop skill and intuition in Functional Analysis and its applications.					
Semester	**8**	**Credits**			**4**	
Course Details		Lecture	Tutorial	Practicum	Others	Total Hours
	Learning Approach	3	0	1	0	**75**
Pre- requisites, If any	Ordinary Calculus, Metric spaces, Cauchy sequences, Complete spaces, Linear Algebra of finite dimensional vector spaces.					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Analyse the additional characteristics and properties exhibited by normed spaces and comprehend how these properties influence the behaviour of elements within these spaces.	An	1,2,9
2	Evaluate the peculiarities of finite-dimensional normed spaces and explore the properties and behaviour of spaces with a finite dimension.	E	1,2
3	Analyse the behaviour and properties of linear operators and functionals in various spaces.	An	1,2
4	Evaluate the structure and properties of Inner product spaces and Hilbert spaces, emphasizing completeness and orthogonality.	E	1,2,9
5	Understand the concept of the orthogonal complements and direct sum in relation to Inner Product spaces.	U	1,2,10
6	Evaluate orthonormal sets, sequences and the series related to the sequence, and total orthonormal sets and sequences	E	1, 2, 9, 10
7	Analyse the representation of functionals on Hibert Spaces and Hilbert Adjoint Operators	An	1,2,9,10
8	Evaluate the properties of self-adjoint, Unitary and Normal operators	E	1, 2, 9, 10
9	Understand Hahn - Banach Theorem, the most important theorem in connection with bounded linear operators and its generalisation to Complex Vector spaces and normed spaces.	U	1, 2, 9, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Vector space	1	20
	1.2	Normed spaces, Banach spaces	1	
	1.3	Further properties of normed spaces. (Proof of Completion theorem (2.3-2) excluded)	1	
	1.4	Finite dimensional normed spaces and subspaces	2	
	1.5	Compactness and finite dimension.	2	
		Problems of all sections (Practicum)		
	Text 1: Chapter 2 - Sections: 2.1 to 2.5			
2	2.1	Linear operators.	3	18
	2.2	Bounded and continuous linear operators.	2, 3	
	2.3	Linear functionals (Algebraic dual, second algebraic dual and algebraic reflexivity are excluded)	3	
	2.4	Linear operators and functionals on finite dimensional spaces (Proof of theorem 2.9-3 excluded)	3	
	2.5	Normed space of operators, Dual spaces.	3	
		Problems of all Sections (Practicum)		
	Text 1: Chapter 2 - sections: 2.6, 2.7, 2.8.1 to 2.8.8, 2.9 & 2.10			
3	3.1	Inner product spaces, Hilbert spaces.	4	20
	3.2	Further properties of inner product spaces. (Proof of Completion theorem (3.2-3) excluded)	4	
	3.3	Orthogonal complements	5	
	3.4	Direct sums	5	

	3.5	Orthonormal sets and sequences	6	
	3.6	Series related to orthonormal sequences and sets (Example 3.5-1 excluded)	6	
	3.7	Total orthonormal sets and sequences (Proof of theorem 3.6-5 excluded)	6	
		Problems of 3.1, 3.2 & 3.3 (Practicum)		
	Text 1: Chapter 3 - Sections: 3.1 to 3.6			
4	4.1	Representation of Functionals on Hilbert Spaces. (Proof of Riesz representation theorem (3.8-4) excluded)	7	**17**
	4.2	Hilbert-adjoint operator.	7	
	4.3	Self-Adjoint, Unitary and Normal Operators.	8	
	4.4	Zorn's lemma.	9	
	4.5	Hahn-Banach Theorem.	9	
	4.6	Hahn-Banach Theorem for Complex Vector Spaces and Normed Spaces	9	
	Text 1: Chapter 3 - Sections: 3.8 to 3.10; Chapter 4 - Sections: 4.1 to 4.3			
5	**Teacher Specific Contents** *(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. **I**t's purpose is to encourage creativity and to develop Problem solving skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="5">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="5">Lecture methods, Problem Solving Methodologies, Activity Based Tutorials/ Practical, Software Based Visualisation of Concepts</td></tr>
<tr><td rowspan="15">Assessment Types</td><td colspan="5">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="4">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="2">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="2">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="2">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="2">Module Test- III</td><td colspan="2">5 Marks</td></tr>
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<tr><td colspan="2">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="2">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="4">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="8"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>IV</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
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<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Erwin Kreyszig, *Introductory Functional Analysis with Applications*, Wiley International publication. 1978 (Reprint 2007)

SUGGESTED READINGS:

1. Limaye, B V. *Functional Analysis*. New Age International (P) LTD, New Delhi,2004.

2. Simmons, G F. *Introduction to Topology and Modern Analysis*, Mc Graw-Hill, New York,1963.
3. Siddiqi, A H. *Functional Analysis with Applications*, Tata Mc Graw-Hill, New Delhi, 1989.
4. Walter Rudin. *Functional Analysis, Second Edition*, International Series in Pure & Applied Mathematics, Tata Mc Graw Hill, 1973.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Example 2.2-7
- Proof of completion theorem 2.3-2
- Canonical mapping and algebraic reflexivity (2.8)
- Example 3.1-5
- Proof of Completion theorem 3.2-3
- Example 3.5.1
- Proof of theorem 3.6-5
- Legendre, Hermite and Laguerre Polynomials (3.7)
- Proof of Riesz representation theorem 3.8-4
- Application to Bounded Linear Functionals on C[a,b] (4.4)

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**
Course Name	**Measure Theory and Integration**
Type of Course	**DCC**
Course Code	**MG8DCCMAT401**
Course Level	**400-499**
Course Summary	This course provides a comprehensive exploration of measure theory and integration, with a primary focus on the development and applications of the Lebesgue measure and integral. The syllabus covers fundamental concepts such as Lebesgue outer measure, sigma algebra of Lebesgue measurable sets, outer and inner approximation techniques, countable additivity, and the Borel-Cantelli Lemma. Students will delve into non-measurable sets, including the Canter set and Canter Lebesgue function. The second part of the course introduces Lebesgue measurable functions and their integration. Topics include Lebesgue integration for sums, products, and compositions of functions, sequential pointwise limits, and simple approximations. Classical theorems, including Littlewood's three principles, Egoroff's theorem, and Lusin's theorem, are presented without proof to provide a practical understanding of their applications. The Lebesgue integration section covers a comparison between the Riemann and Lebesgue integrals. Students will learn to calculate the Lebesgue integral of bounded measurable functions over sets of finite measure, as well as explore the integral for measurable non-negative functions. The General Lebesgue Integral is introduced along with discussions on countable additivity and continuity of integration. The

	course also addresses the integration of derivatives and the differentiation of indefinite integrals. The latter part of the course extends the study to general measure spaces. Students will explore properties and constructions of measures and measurable sets. Signed measures, Hahn and Jordan decompositions, and the Caratheodory Measure induced by an outer measure are discussed. The construction of outer measures is covered, leading to advanced theorems such as the Radon-Nikodym Theorem, Lebesgue Decomposition Theorem, and Radon-Nikodym Derivative. The course concludes with a generalization of measurability concepts for functions on general measurable spaces. Students will study integration over general measure spaces, utilizing the Caratheodory construction of measure. The construction of product measures is introduced, and classic theorems of Fubini and Tonelli are proven. By the end of the course, students will have a comprehensive understanding of measure theory and integration, with the ability to apply these concepts in both Lebesgue and general measure spaces. The course aims to equip students with the analytical tools necessary for advanced mathematical applications and research.

Semester	**8**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Fundamentals of Mathematical Analysis					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Acquire a deep understanding of the principles behind the Lebesgue measure, including its introduction, outer measure, and the sigma algebra associated with Lebesgue measurable sets	U	1,2,3

2	Develop skills in both outer and inner approximation methods for Lebesgue measurable sets, allowing them to analyze and manipulate these sets effectively	S	1,2, 9
3	Master the principles of countable additivity and continuity, fundamental for Lebesgue measure theory through theoretical understanding and practical applications,	A	1,2, 9
4	Recognize and analyze non-measurable sets, including specific examples like the Cantor set, and comprehend the implications of their existence	E	1,2,9
5	Gain a theoretical understanding of Littlewood's three principles and the theorems of Egoroff and Lusin, allowing them to apply these principles in various scenarios without requiring formal proof.	An	1,2
6	Develop proficiency in integrating functions within the Lebesgue framework, including the Riemann integral, Lebesgue integral of bounded and non-negative measurable functions, and the General Lebesgue Integral.	C	1,2,3, 9
7	Apply integration techniques to differentiate indefinite integrals, showcasing a practical understanding of the interplay between differentiation and integration	A	1,2,3, 9, 10
8	Acquire a comprehensive understanding of general measure spaces, including their properties and construction, enabling them to analyze and work with measures in a broader context.	U	1,2, 10
9	Proficient in utilizing the Caratheodory construction of measure, allowing them to construct product measures and prove classic theorems such as Fubini and Tonelli in the context of general measure spaces.	S	1,2,3, 10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Lebesgue Measure**		**20**
	1.1	Introduction	1	
	1.2	Lebesgue outer measure	1	

	1.3	The σ algebra of Lebesgue measurable sets	1	
	1.4	Outer and inner approximation of Lebesgue measurable sets	2	
	1.5	Countable additivity, continuity and Borel-Cantelli Lemma	2, 3	
		Problems (Practicum)	1,2,3	
	Text 1: Chapter 2 - Sections: 2.1 to 2.5			
2		**Measurable Functions**		**17**
	2.1	Non measurable set	3, 4	
	2.2	The Cantor set and Cantor Lebesgue function	3, 4	
	2.3	Lebesgue Measurable Functions: Sums, products and compositions	5	
	2.4	Sequential pointwise limits and simple approximation	5	
	2.5	Littlewood's three principles, Egoroff's theorem, and Lusin's theorem (All theorems without proof)	5	
		Problems (Practicum)	3,4,5	
	Text 1: Chapter 2 - Sections: 2.6 to 2.7, 3.1 to 3.3			
3		**Lebesgue Integration**		**20**
	3.1	The Riemann Integral	6	
	3.2	The Lebesgue integral of a bounded measurable function over a set of finite measure	6	
	3.3	The Lebesgue integral of a measurable non negative function	6	
	3 .4	The General Lebesgue Integral.	6	
	3.5	Countable Additivity and Continuity of Integration	6	
	3.6	Integrating Derivatives: Differentiating Indefinite Integrals	7	
		Problems (Practicum)	6,7	
	Text 1: Chapter 2 - Sections: 4.1 to 4.5; Chapter 6 - Section: 6.5			

4		**General Measure spaces: Their properties and construction**		
	4.1	Measures and Measurable Sets (Theorems without proof)	8	**18**
	4.2	Signed Measures: The Hahn and Jordan Decompositions	8	
	4.3	The Caratheodory Measure Induced by an Outer Measure (Propositions 5,6 and 7 Statement only)	9	
	4.4	The Construction of Outer Measures	9	
	4.5	The Radon-Nikodym Theorem (without proof), The Lebesgue Decomposition Theorem and Radon-Nikodym Derivative	8, 9	
	Text 2: Chapter 17 - Sections: 17.1 to 17.4; Chapter 18 - Section: 18.4			
5	**Teacher Specific Contents** *(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.

It's 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 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and	**Classroom Procedure (Mode of transaction)**

<table>
<tr><td>Learning Approach</td><td colspan="6">Lecture, Tutorial and Activity oriented</td></tr>
<tr><td rowspan="15">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
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<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="9"></td><td colspan="5">Question Pattern
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<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
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<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Royden, H. L. , Fitzpatrick, P.M. *Real Analysis Fourth Edition, Pearson Education, 2010.*

SUGGESTED READINGS:

1. Barra, G. de. *Measure Theory and integration*, New Age International (P) Ltd., New Delhi, 1981 (Reprint 2003)
2. Halmos, P.R. *Measure Theory*, D. van Nostrand Co., 1974

3. Jain, P.K., and Gupta,V.P. *Lebesgue Measure and Integration*, New Age International (P) Ltd., New Delhi, 1986 (Reprint 2000).
4. Bartle, R.G.,*The Elements of Integration*, John Wiley & Sons, Inc New York, 1966.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Generalize the concepts of measurability of functions on general measurable spaces.
- Study the integration over general measure spaces
- Using Caratheodory construction of measure, construct product measures and prove the classic theorems of Fubini and Tonelli
- Prove the Radon-Nikodym Theorem

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Basic Topology**					
Type of Course	**DCE**					
Course Code	**MG8DCEMAT400**					
Course Level	**400-499**					
Course Summary	Course introduces properties of topological spaces, including Compactness, Connectedness and Separation axioms					
Semester	8	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Fundamentals of Analysis and Basics of Metric spaces.					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Define and illustrate the concept of subspace and closed sets of a topological space	K, U, S, Ap	1, 2, 3,10
2	Describe the concept of neighbourhoods and interior point of a point in a topological space	U, I, Ap	1, 2, 3, 4, 10
3	Prove a selection of theorems concerning topological spaces, continuous functions, and quotient topologies.	U, An, Ap	1,2,4,10

4	Define and illustrate the concepts of compact and Lindeloff Space and their properties	K, U, S, An, S, I, Ap	1,2,4,10
5	Define connectedness, separation axioms, and prove related theorems	K, U, S, An, S, I, Ap	2,3,4,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Definition and related concepts. Examples of topological spaces (Practicum)	1	**20**
	1.2	Bases and subbases	1	
	1.3	Subspaces	1	
	1.4	Closed Sets and Closure	1	
		Problems (Practicum)	1	
	Text 1: Chapter 4 – Sections: 1, 2, 3 (3.1 to 3.9), 4; Chapter 5 – Section: 1			
2	2.1	Neighbourhoods, Interior and Accumulation points	2	**20**
	2.2	Continuity. Related concepts (Practicum)	3	
		Problems (Practicum)	2,3	
	Text 1: Chapter 5 – Sections: 2 (2.1 to 2.10 and 2.13) & 3 (3.1 to 3.10)			
3	3.1	Making functions continuous and Quotient Spaces	3	**15**
	3.2	Smallness condition on a Space	4	
		Problems (Practicum)	3,4	
	Text 1: Chapter 5 – Sections: 4 (4.1 to 4.12); Chapter 6 – Section 1(1.1 to 1.11)			
4	4.1	Connectedness	5	**20**

	4.2	Path Connectedness	5	
	4.3	Separation axioms	5	
		Problems (Practicum)	5	
	Text 1: Chapter 6 – Sections: 2 & 3 (3.6 to 3.8); Chapter 7 – Section: 1			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
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Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture, Tutorial and Activity oriented		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks
		Module Test- III	5 Marks
		Module Test- IV	5 Marks
		Assignment/Seminar	5 Marks

		Quiz/Viva voce		5 Marks	
	B	**End Semester Evaluation (ESE) 70 marks**			
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**			
		Module	Part A **2 Marks**	Part B **6 Marks**	Part C **10 Marks**	Total
		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. K. D. Joshi. *Introduction to General Topology,* Third Edition, New Age International(P) Ltd, 2023.

SUGGESTED READINGS:

1. Munkres J.R, *Topology-A First Course*, Prentice Hall of India (P). Ltd., New Delhi, 2000.
2. Willard, Stephen. *General Topology*, Addison-Wesley, 2004.
3. George F Simmons, *Introduction to Topology and Modern Analysis*, McGraw-Hill Book Company, 1963.

ADVANCED READINGS:

1. Dugundji. *Topology,* Universal Book Stall, New Delhi, 1989.
2. J. Arthur Seebach, Lynn Arthur Steen, *Counter Examples in Topology*, Dover Publications, 1995

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Study the concept of nearness relation on a set and the one-to-one correspondence between set of topologies on a set and the set of nearness relation on that set.
- Study the concept of embedding problem, extension problem and lifting problem.
- Study the concept of identification space and identification maps.
- Study the concept of local connectedness.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Field Theory**					
Type of Course	**DCE**					
Course Code	**MG8DCEMAT401**					
Course Level	**400-499**					
Course Summary	The objective of the course is to learn more about field theory. The first module covers topics on ring of polynomials, factorization of polynomials etc. The second module covers concepts on extension fields, finite fields etc. The third module includes automorphisms of fields, splitting fields etc. Topics on separable extensions, Galois theory etc. are covered in the fourth module.					
Semester	**8**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Concepts from Fundamentals of Groups and Rings and Advanced Theory of Groups and Rings					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		

1	Explain ring of polynomials, master polynomial factorization, and comprehend the ideal structure in F[x].	An	1, 2, 3, 10
2	Comprehend the concept of extension, distinguish the various types of extensions and analyse finite fields.	An	1, 2, 3, 10
3	Examine field automorphisms, categorize splitting fields and apply the isomorphism extension theorem.	A	1, 2, 3, 10
4	Analyse separable extensions and understand the Galois theorems.	E	1, 2, 3, 9, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Rings of polynomials, The evaluation homomorphisms	1	15
	1.2	Factorization of polynomials over a field, The division algorithm in F[x]	1	
	1.3	Irreducible polynomials, Uniqueness of factorization in F[x]	1	
	1.4	Ideal Structure in F[x], Application to unique factorization in F[x]	1	
		Problems (Practicum)	1	
	Text 1: Sections: 27, 28 & 31 (31.21 to 31.27)			
2	2.1	Introduction to Extension fields, Algebraic and transcendental elements, The irreducible polynomial for α over F	2	20
	2.2	Simple extensions	2	
	2.3	Algebraic extensions, Algebraically closed fields and algebraic closures	2	
	2.4	Finite fields, The existence of $GF(p^n)$	2	
		Problems (Practicum)	2	

	Text 1: Sections: 39, 40 (40.1 to 40.18) & 42			
3	3.1	Introduction to Galois theory	3	**20**
	3.2	Conjugation isomorphism	3	
	3.3	Splitting fields, The isomorphism extension theorem	3	
	3.4	Properties of splitting fields	3	
		Problems (Practicum)	3	
	Text 1: Sections: 43, 44 (44.1 to 44.4, 44.5 (Statement only) & 44.6 to 44.15)			
4	4.1	Separable extensions, Characteristic p	4	**20**
	4.2	Counting Automorphisms, The primitive element theorem	**4**	
	4.3	Normal extensions	4	
	4.4	Galois Theory, The Galois theorems	4	
		Problems (Practicum)	4	
	Text 1: Sections 45 & 46			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum

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<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="5">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="5">Direct Instruction: Explicit Teaching, Lecture

Interactive Instruction: Active Co-operative Learning, Seminar Presentation by Individual Student</td></tr>
<tr><td rowspan="15">Assessment Types</td><td colspan="5">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="4">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td>Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td>5 Marks</td></tr>
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<tr><td>B</td><td colspan="4">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="8"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>II</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
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<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

REFERENCES:

1. Fraleigh, John B., and Neal E. Brand. *A First Course in Abstract Algebra* 8th ed, Pearson Education, 2021.

SUGGESTED READINGS:

1. Dummit, David S., and Richard M. Foote. *Abstract Algebra. 3rd ed.* Wiley, 2003.
2. Artin, M. *Algebra. 2nd ed., Pearson Education, 2017*
3. Herstein, I. N. *Topics in Algebra*, 2nd *Edition.,John Wiley and Sons, 2010*
4. Gallian , Joseph A, *Contemporary Abstract Algebra, 10th edition* ,Cengage 2021.
5. Musili , C. *Introduction to Rings and Modules*, 2nd revised Edition, Narosa, 1997.

ADVANCED READINGS:

1. Hungerford, Thomas.W., Algebra, 4th Print 2003 Edition.
2. Lang, Serge, Algebra, 4th Print 2005 Edition

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Unique Factorization Domains, Euclidean Domains ; Understanding the concepts of Unique Factorization Domain, Principal Ideal Domain, Euclidean Domain and analysing the relationships among the three.

  (Text 1: Sections 34, 35)
- Geometric Constructions ; Gaining a basic knowledge of constructible numbers and illustrates the impossibility of certain constructions (Doubling the cube, squaring the circle, trisecting the angle) (Text 1: Sections 41)

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Mathematics**					
Course Name	**Optimization Techniques**					
Type of Course	**DCE**					
Course Code	**MG8DCEMAT402**					
Course Level	**400-499**					
Course Summary	This Mathematics undergraduate course investigates linear programming methods, including simplex techniques and duality theorems. It explores challenges related to Integer Linear Programming (ILP) and Mixed Integer Linear Programming (MILP), utilizing cutting-edge approaches like cutting planes and branch-and-bound methods. The curriculum also includes fundamental concepts in graph theory, such as minimum path and spanning trees, as well as sequential activity scheduling and maximum flow problems. Furthermore, the course provides an introduction to Unconstrained Optimization, utilizing tools like Taylor's series, Fibonacci, and Golden Section searches. Constrained Optimization is also covered, incorporating topics such as gradient projection and Lagrange multipliers.					
Semester	**8**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Linear Programming Problem, Formation of an LPP. Optimal solution					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:

	Upon the successful completion of the course, the student will be able to		
1	Apply graphical method to solve LP problems, mastering simplex tableau and duality principles for solving LP problems.	A	1, 2
2	Students master ILP, MILP problems, cutting plane, and Branch-and-Bound methods, enhancing problem-solving and optimization skills	An	1, 2
3	Analyze graphs, solve minimum path and spanning tree problems, and optimize sequential activities with maximum flow.	An	1, 2
4	Find the solution of unconstrained optimization problems using Taylor's series, Fibonacci, Golden Section, and Hooke-Jeeves methods.	E	1,2, 3
5	Find the solution of constrained optimization problems using gradient projection, Lagrange multipliers, and constrained derivatives techniques.	E	1, 2, 3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO NO:	Hours
1		**Linear Programming**		**20**
	1.1	LP in two-dimensional space and problems, Statement of General LP problems, Definitions of FS, BS, BFS and OS, Simplex tableau and problems.	1	
	1.2	Definition of Artificial Variable and Big-M Method, Meaning of Degeneracy in LP Problems	1	
	1.3	Duality in LP Problems, Duality Theorems (statements only), Dual Simplex Method	1	
		Problems (Practicum)	1	
	Text 1: Chapter 3 – Sections: 3.2, 3.3, Definitions in Sections 3.4 to 3.7, 3.12 to 3.14, 3.17, 3.18 & 3.20			

2		**Integer Programming**		
	2.1	General ILP and MILP Problem	2	**15**
	2.2	Cutting Plane Method	2	
	2.3	Branch and Bound Method	2	
		Problems (Practicum)	2	
	Text 1: Chapter 6 – Sections: 6.3, 6.5, 6.6 & 6.8			
3		**Flow in Networks**		
	3.1	Graphs: Definition and Notations	3	**15**
	3.2	Minimum Path Problem, Spanning Tree of Minimum Length.	3	
	3.3	Scheduling of Sequential Activities, Maximum Flow Problem.	3	
		Problems (Practicum)	3	
	Text 1: Chapter 5 – Sections: 5.2 to 5.7			
4		**Non Linear Programming**		
	4.1	Taylor's Series Expansions Necessary and Sufficient Condition	4	**25**
	4.2	Fibonacci and Golden Section Search	4	
	4.3	Hooke and Jeeves Search	4	
	4.4	Gradient Projection	5	
	4.5	Lagrange Multipliers	5	
	4.6	Equality Constrained Optimization: Constrained Derivatives	5	
		Problems (Practicum)	4, 5	
	Text 1: Chapter 11 – Sections: 11.2 to 11.7			

5	**Teacher Specific Contents** *(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.

It's 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 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**					
	Direct Instruction: Explicit Teaching and E-learning. Interactive instruction: Engage in collaborative learning through active participation, seminars, group assignments, group discussions, and presentations by individual students or group representatives					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**				
		Components			**Mark Distribution**	
		Module Test- I			5 Marks	
		Module Test- II			5 Marks	
		Module Test- III			5 Marks	
		Module Test- IV			5 Marks	
		Assignment/Seminar			5 Marks	
		Quiz/Viva voce			5 Marks	
	B	**End Semester Evaluation (ESE) 70 marks**				
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**				
		Module	Part A	Part B	Part C	Total

			2 Marks	6 Marks	10 Marks	
		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	2	**6**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. Mittal, K. V. and Mohan, C. *Optimization Methods in Operations Research and Systems Analysis*; *5th Edition*, New Age Publishers, 2020.

2. Ravindran, Philips, Solberg. *Operations Research Principles and Practice*; *2nd Edition*, Wiley India Publishers, 2012.

SUGGESTED READINGS:

1. Swarup, K. Gupta , P. K., and Man Mohan, *Operations Research*. S. Chand and Sons Publishers, 2010.
2. Sharma , S. D. *Operations Research Theory, Methods And Applications*;, Kedar Nath Ram Nath Publishers, 2014.

ADVANCED READING:

1. Taha, A. H. Operations Research: An Introduction. Pearson Publishers, 2012.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Organize interactive discussions where students can explore the conceptual foundations of duality in linear programming. Encourage them to discuss real-world applications and implications of duality theorems. Challenge students to delve into the proofs of duality theorems. This can be done individually or in groups. They can present their understanding of the proofs to the class or in a written format.
- Challenge students to implement the Cutting Plane Method or Branch and Bound Method for solving optimization problems. They can use programming languages like Python or MATLAB or others. Encourage them to test their implementations on various problems and analyse the results.
- Demonstrate real-world applications of minimum spanning tree problems and flow in networks. This could include applications in logistics, telecommunications, project management, and network design.

- Assign small optimization problems where students can apply the Hooke and Jeeves Search method and Gradient Projection method. These problems could encompass scenarios in engineering, finance, or operations research.

Internship & Project

Mathematics

A. Internship: Students can earn a maximum of 2 credits (4th Semester)

This internship programme enables students to gain practical experience and academic research skills, preparing them for careers in the mathematics field or further studies.

Duration: 60 Hours, between the fourth and fifth semesters.

Credit Allocation: 2 Credits

Objectives:

- Provide practical experience.
- Enhance skills in experimental techniques, data analysis, and scientific communication.
- Gain practical knowledge.
- Establish connections in the industry or research sector.
- Foster collaboration between academic institutions and industry/research organizations.

Evaluation Criteria: Total 50 marks

1. Internal Evaluation (15 marks):
    I. Feedback from the hosting organization (5 marks).
    II. Supervisor feedback (10 marks).
2. Final Evaluation (35 marks):
    I. Presentation (15 marks).
    II. Internship report (10 marks).
    III. Viva Voce (10 marks).

B. Project and Comprehensive Viva -Voce: Students can earn a maximum of 12 credits (8th Semester)

a) The project work should be done under the supervision of a teacher of the concerned department.

b) There will be an internal assessment and an external assessment for project work.

c) Project work is evaluated based on the presentation of the student and viva voce on the project.

d) External evaluation of the project work will be done by one/two external examiners from different colleges and one internal examiner from the concerned college.

e) The final external mark of the project will be calculated by taking the average of the marks given by the two external examiners and the internal examiner.

Objectives:

- **Application of Knowledge**: Utilize theoretical and practical knowledge gained during coursework to solve real-life situations or complex problems.
- **Independent Research:** Conduct independent research, demonstrating the ability to work autonomously and think critically.
- **Critical Analysis:** Develop skills in critical analysis and synthesis of information, evaluating various sources and data.
- **Professional Preparedness**: Prepare for future academic or professional endeavors by gaining experience in a research-oriented environment.
- **Scientific Communication**: Improve scientific communication skills through the preparation of reports, presentations, and discussions of findings.

Evaluation Criteria: Total 200 marks

1. Internal Evaluation (60 marks):
   I. Synopsis Presentation (20 marks).
   II. Technical Skill (20 marks).
   III. Report & Overall Performance (20 marks).

2. External Evaluation (140 marks):

   I. Relevance of the topic (20 marks).
   II. Review of Literature (20 marks).
   III. Results and Discussion (30 marks).
   IV. Presentation (30 marks).
   V. Viva Voce (40marks).

List of Participants in Workshop

Sl.No.	Name of Teacher	Designation	Name of College
1	Aiswaria Jayan	Assistant Professor	Swamy Saswathikananda College, Poothotta
2	Amal Pavithran	Assistant Professor	The Cochin College, Ernakulam
3	Ancy Mathew	Assistant Professor	MES College Erumely
4	Aneesa. K. B	Assistant Professor	KMM College of Arts and Science, Thrikkakara
5	Anil Kumar P U	Assistant Professor	Government Arts & Science College, Santhanpara
6	Ann Johns	Assistant Professor	Bishop Chulaparambil Memorial College, Kottayam.
7	Anu Ann James	Assistant Professor	Mar Thoma College, Tiruvalla
8	Anu Joy	Assistant Professor	St.Dominic's College, Kanjirapally
9	Anupriya C S	Assistant Professor	SN Trusts Arts and Science College, Pambanar
10	Arun T Kumar	Assistant Professor	Sree Vidyadhiraja NSS College, Vazhoor
11	Aswathy S Nair	Assistant Professor	NSS Hindu College, Changanacherry
12	Athira Ajithkumar.K	Assistant Professor	Cochin Arts and Science College, Kakkanad

13	Babin B	Assistant Professor	Sree Vidyadhiraja NSS College, Vazhoor
14	Bincy Varghese P	Assistant Professor	STAS, Edappally
15	Boby P Mathew	Assistant Professor	St Thomas College, Palai
16	Caroline Simon	Assistant Professor	Aquinas College, Edakochi
17	Deena C Scaria	Assistant Professor	St. Aloysius College, Edathua
18	Dr. Ambily P. Mathew	Assistant Professor	CMS College, Kottayam
19	Dr. Ann Mary Philip	Assistant Professor	Assumption College, Changanassery
20	Dr. Anu Varghese	Assistant Professor	Bishop Chulaparambil Memorial College, Kottayam
21	Dr. Binu M	Assistant Professor	St. Albert’s College, Ernakulam
22	Dr. Divya Mary Daises	Assistant Professor	St Albert's College, Ernakulam
23	Dr. Elizabeth Reshma M T	Assistant Professor	St. Teresa's College, Ernakulam
24	Dr. Fathima Perveen	Assistant Professor	Al Ameen College, Edathala
25	Dr. G N Prakash	Associate Professor	Government College, Kattappana

26	Dr. Geena Joy	Assistant Professor	Union Christian College, Aluva
27	Dr. Jaya Paul	Assistant Professor	St. Peter's College, Kolenchery
28	Dr. Jaya S	Associate Professor	Maharaja's College Ernakulam
29	Dr. Jeet Kurian Mattam	Assistant Professor	Sacred Heart College, Thevara
30	Dr. Jomon K Sebastian	Assistant Professor	St Joseph's College Moolamattom
31	Dr. K.P. Jose	Associate Professor	St. Peters College, Kolenchery
32	Dr. Latha S. Nair	Associate Professor	Mar Athanasius College, Kothamangalam
33	Dr. Pravas K	Assistant Professor	Maharaja’s College, Ernakulam
34	Dr. Rajesh K Thumbakara	Associate Professor	Mar Athanasius College, Kothamangalam
35	Dr. Resmi Varghese	Assistant Professor	St Xavier's College for Women, Aluva
36	Dr. Roshan Sara Philipose	Assistant Professor	Mar Thoma College, Tiruvalla
37	Dr. Salini S Nair	Associate Professor	St.Peter's College, Kolenchery
38	Dr. Sheeja T. K.	Associate Professor	T. M. Jacob Memorial Govt College, Manimalakunnu

39	Dr. Sonia K Thomas	Assistant Professor	Alphonsa college Pala
40	Dr. Susan Mathew Panakkal	Assistant Professor	St. Teresa's College, Ernakulam
41	Dr. Tijo James	Assistant Professor	Pavanatma College, Murickassery
42	Dr. Ursala Paul	Assistant Professor	St. Teresa’s College, Ernakulam
43	Dr. Vinitha. T	Assistant Professor	Al-Ameen College, Edathala
44	Dr. Vivek S	Assistant Professor	CMS College, Kottayam
45	Essy C Cherian	Assistant Professor	Sree Sankara College, Kalady
46	Jaimy Sarah Jacob	Assistant Professor	Baselius College, Kottayam
47	Jais Kurian	Assistant Professor	St Stephen's College Uzhavoor
48	Jayaraj T	Associate Professor	SVR NSS College, Vazhoor
49	Jebin Jacob	Assistant Professor	Sree Sankara Vidyapeetom College
50	Jijo Joy	Assistant Professor	St. Aloysius College, Edathua
51	Jilu Jose	Assistant Professor	St.Mary's College, Manarcaud

52	Jintumol K.U	Assistant Professor	BCM College, Kottayam
53	Jis Mary Jose	Assistant Professor	Government Polytechnic College, Muttom
54	Jyothy Thomas	Assistant Professor	Deva Matha College, Kuravilangad
55	Kumari Suja V R	Assistant Professor	SVR NSS College, Vazhoor
56	Lakshmi C	Assistant Professor	Bharata Mata College, Thrikkakara
57	Liju Alex	Assistant Professor	Bishop Chulaparambil Memorial College, Kottayam
58	Liny Mariam Mathew	Assistant Professor	DB College,Thalayolaparambu
59	Majitha Beegam K.A	Assistant Professor	MES M.K Mackar Pillay College for Advanced Studies, Edathala
60	Manju John	Assistant Professor	Catholicate College, Pathanamthitta
61	Manju K Menon	Associate Professor	St. Paul's College, Kalamassery
62	Manju Mukundan	Associate Professor	Ettumanoorappan College, Ettumanoor
63	Megha Rose Manoj	Assistant Professor	BAM College, Thuruthicadu
64	Ms. Remya C J	Assistant Professor	St Teresa's College, Ernakulam

65	Nisha V M	Assistant Professor	St Paul's College, Kalamassery
66	Parvathy Haridas	Assistant Professor	N S S Hindu College, Changanacherry
67	Pratheesh Mathew	Assistant Professor	Nirmala College, Muvattupuzha
68	Prathish Abraham	Assistant Professor	St. Dominic's College, Kanjirapally
69	Preetha Mathew	Assistant Professor	Baselius College, Kottayam
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71	Remya Harikkuttan	Associate Professor	Swamy Saswathikananda College, Poothotta
72	Retheesh R	Assistant Professor	Mar Thoma College, Thiruvalla
73	Sabu M C	Assistant Professor	St Albert's College, Ernakulam
74	Saira Kurian	Assistant Professor	Catholicate College, Pathanamthitta
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76	Seira Susan Prasad	Assistant Professor	Mar Thoma College for Women, Perumbavoor
77	Sheena Joseph	Assistant Professor	STAS, Edappally

78	Shruthi Mariam David	Assistant Professor	St.Thomas College, Ranni.
79	Sona Jose	Assistant Professor	Newman College, Thodupuzha
80	Sreeja K	Assistant Professor	CMS College, Kottayam
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82	Sreejamol P S	Assistant Professor	STAS, Pularikunnu
83	Sugesh Kumar V	Assistant Professor	MES College, Nedumkandam
84	Susan George	Assistant Professor	St. Thomas College, Kozhencherry
85	Syamli Raj R	Assistant Professor	STAS, Patanamthitta
86	Thomas Mathew	Assistant Professor	St Thomas College, Kozhencherry
87	Tinjumol Mathew	Assistant Professor	St.Thomas College, Palai
88	Tommy Thomas	Associate Professor	St.Thomas College, Palai
89	Unni M S	Assistant Professor	Devaswom Board Pampa College, Parumala
90	Zeta Paul	Assistant Professor	Aquinas College, Edakochi