MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous -Affiliated to MG University, Kottayam)

UNDERGRADUATE PROGRAMMES

(HONOURS)SYLLABUS

MCE-UGP (Honours)

(2024AdmissionOnwards)

Faculty : Science

BoS: Mathematics

Programme: B.Sc. Mathematics Honours

Maharaja's College, Ernakulam
(Govt. Autonomous)
Park Avenue Road, Marine Drive
Ernakulam– 682011, Kerala, India

Contents

Preface

Maharaja's College is proud to present its undergraduate Mathematics curriculum, meticulously designed to align with the recommendation of UGC. This program, spanning four years, equips students with a robust foundation in mathematical principles, fosters critical thinking, and ignites a passion for exploration within the fascinating world of Mathematics.

This curriculum reflects the philosophy of a student-centric approach. We've moved away from a purely theoretical approach, incorporating project-based learning, real-world applications, and interdisciplinary connections. Students will not only master core mathematical concepts but also develop the ability to apply them to solve problems relevant to various fields like science, engineering, economics, and computer science.

Our program offers a diverse range of courses, catering to a variety of interests and career aspirations. Students can delve into areas like linear algebra, calculus, differential equations, abstract algebra, discrete Mathematics, and more. They will also gain valuable research experience through projects and elective courses, preparing them for postgraduate studies or careers that leverage quantitative skills. We integrate theoretical aspects with practical applications, helping students see the relevance of Mathematics in the real world. The curriculum offers a variety of electives, allowing students to tailor their learning journey based on their interests and career goals. We encourage students to develop analytical thinking skills through problem-solving exercises and project work. We leverage technology to enhance learning, using simulations, visualization tools, and computational software where appropriate.

This curriculum empowers students to not only excel in Mathematics but also become well-rounded individuals with strong analytical, problem-solving, and critical thinking skills – qualities that are invaluable in today's dynamic world.

Welcome to the exciting world of Mathematics at Maharaja's College. We are confident that this program will equip you with the knowledge, skills, and passion to excel in your chosen field and become a lifelong learner.

Dr. Jaya S.

Chairman

Board of Studies (Mathematics)

Maharaja’s College, Ernakulam

Board of Studies: Mathematics (UG)

1. Dr. Jaya S **(Chairperson)**

   Associate Professor and Head of the Department
2. Mrs. Anusha A. K.,

   Assistant Professor(Mathematics)
3. Dr. Pravas K.

   Assistant Professor(Mathematics)
4. Mrs. Thasneem T. R.

   Assistant Professor(Mathematics)
5. Dr. Sreeja K. U.

   Assistant Professor(Mathematics)
6. Dr. Balakrishnan R.

   Assistant Professor(Mathematics)
7. Mrs. Subha A B

   Assistant Professor(Mathematics)

Expert Committee

8. Dr. Vinod Kumar P. B. **(Expert from outside the university)**

   Professor(Mathematics)
   Rajagiri School of Engineering and Technology(Autonomous), Kochi.
9. Dr. Aparna Lakshmanan S.**(Expert from outside the university**)

   Professor(Mathematics), CUSAT, Kochi.
10. Dr. V. B. Kiran Kumar**(University Nominee**)

    Assistant Professor(Mathematics), CUSAT, Kochi
11. Mr. Sreekanth Raja**(Representative from the field of Industry**)

    Scientist E,
    Naval Physical Oceanographic Laboratory (NPOL), Ministry of Defense
12. Dr. Mary Shalet T. J.**(Meritorious Alumnus)**

    Associate Professor (Mathematics)
    Government College, Chittur

Curricular Structure of the MCE–UG(Honours) Programme

3 Year UG Degree–6Semesters

No.	Course Type	No. of Courses	Total Credits
1	Foundation: Ability Enhancement Courses(AEC)	4	12
2	Foundation: Multi–disciplinary Courses(MDC)	3	9
3	Foundation: Skill Enhancement Courses(SEC)	3	9
4	Foundation: Value Addition Courses(VAC)	3	9
5	Discipline Specific Courses: Major (DSCA/DSE)	17	68
6	Discipline Specific Courses: Minor(DSCB&C)	6	24
7	Internship (INT)		2
	Total	36	133

4 Year UG Degree (Honours)–8 semesters

4 Year UG Degree (Honours with Research)–8 Semesters

No.	Course Type	No. of Courses	Total Credits
1	Foundation: Ability Enhancement Courses(AEC)	4	12
2	Foundation: Multi–disciplinary Courses(MDC)	3	9
3	Foundation: Skill Enhancement Courses (SEC)	3	9
4	Foundation: Value Addition Courses (VAC)	3	9
5	Discipline Specific Courses: Major(DSC A/DSE)	17	68
6	Discipline Specific Courses: Minor(DSC B&C)	6	24
7	Discipline Capstone Courses: Major (DCC/DCE)	8	32
8	Research Project(PRJ)		12/8
9	Internship(INT)		2
	Total	44	177

Programme Outcomes(POs)

PO1	Critical Thinking and Analytical Reasoning
PO2	Scientific Reasoning and Problem Solving
PO3	Multidisciplinary/Interdisciplinary/Transdisciplinary Approach
PO4	Communication Skills
PO5	Leadership Skills
PO6	Social Consciousness and Responsibility
PO7	Equity, Inclusiveness and Sustainability
PO8	Moral and Ethical Reasoning
PO9	Networking and Collaborating
PO10	Lifelong Learning

Evaluation Scheme

Components	**Marks (4 Credit)**	**Marks (3 Credit)**
Continuous Internal Assessment (CIA)	30	25
End Semester Examination	70	50
Total	100	75

Syllabus Index

Semester	Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ Week	Hour Distribution/ week			
						L	T	P	O
1	MCE1DSCMAT100	Ground roots of Mathematics with visualization	DSC A/B	4	5	3	0	2	0
1	MCE1DSCMAT101	Mathematics foundation for Quantitative analysis	DSC B	4	5	3	0	2	0
1	MCE1MDCMAT100	Mathematics for Competitive Examinations	MDC	3	4	2	0	2	0
2	MCE2DSCMAT100	Matrix Mastery and Calculus Adventures	DSC A/B	4	5	3	0	2	0
2	MCE2DSCMAT101	Advanced Mathematical tool for Quantitative analysis	DSC B	4	5	3	0	2	0
2	MCE2MDCMAT100	Applicable Mathematics	MDC	3	4	2	0	1	0
3	MCE3DSCMAT200	Mathematical Insights: Equations, Multiple Integrals and Conics	DSC A	4	5	3	0	1	0
3	MCE3DSCMAT201	Unlocking Mathematics: Exploring complex number, vectors and equivalence relations	DSC A	4	5	3	0	2	0
3	MCE3DSCMAT202	Mathematical Tools for Physical Sciences	DSC B/C	4	5	3	0	2	0
3	MCE3DSCMAT203	Applied Mathematics in Quantitative Analysis	DSC B/C	4	5	3	0	2	0
3	MCE3DSEMAT200	Fundamentals of Investment Science	DSE	4	4	4	0	0	0
3	MCE3DSEMAT201	Game Theory and Project Management	DSE	4	4	4	0	0	0
3	MCE3DSEMAT202	Mathematical Musings beyond Classroom	DSE	4	4	4	0	0	0
3	MCE3MDCMAT200	Mathematics of Nature and Art	MDC	3	3	3	0	0	0

3	MCE3VACMAT200	Mastering Problem Solving through Vedic Mathematics	VAC	3	3	3	0	0	0
4	MCE4DSCMAT200	Matrix and Number Theory	DSC A	4	5	3	0	2	0
4	MCE4DSCMAT201	A Journey through the basics of Mathematical Analysis	DSC A	4	5	3	0	2	0
4	MCE4DSCMAT202	Mathematical Tools for Physical Sciences	DSC B/C	4	5	3	0	2	0
4	MCE4DSCMAT203	Applied Mathematics in Quantitative Analysis	DSC B/C	4	5	3	0	2	0
4	MCE4DSEMAT200	The Share Market Basics	DSE	4	4	4	0	0	0
4	MCE4DSEMAT201	Mathematical Modelling	DSE	4	4	4	0	0	0
4	MCE4DSEMAT202	Transforms and Fourier Series	DSE	4	4	4	0	0	0
4	MCE4DSEMAT203	Operations Research	DSE	4	4	4	0	0	0
4	MCE4VACMAT200	Business Mathematics	VAC	3	3	3	0	0	0
4	MCE4SECMAT200	Document Preparation using LaTeX	SEC	3	3	3	0	0	0
4	MCE4INTMAT200	Internship	INT	2					
5	MCE5DSCMAT300	A Voyage into Complex Analysis	DSC A	4	5	3	0	2	0
5	MCE5DSCMAT301	Towards Mathematical Precision: Limits And Convergence	DSC A	4	4	4	0	0	0
5	MCE5DSCMAT302	Fundamentals of Groups and Rings	DSC A	4	5	3	0	2	0
5	MCE5DSCMAT303	Differential Equations and Applications	DSC A	4	4	4	0	0	0
5	MCE5DSEMAT300	Numerical Methods	DSE	4	4	4	0	0	0
5	MCE5DSEMAT301	Exploring the Harmony of Automata	DSE	4	4	4	0	0	0
5	MCE5DSEMAT302	Inventory management and	DSE	4	4	4	0	0	0

		simulation : the basics of business success							
5	MCE5SECMAT300	Introduction to Python for Mathematical Computation	SEC	3	3	3	0	0	0
6	MCE6DSCMAT300	Mathematical Analysis	DSC A	4	5	3	0	2	0
6	MCE6DSCMAT301	Fundamentals of Linear Algebra	DSC A	4	5	3	0	2	0
6	MCE6DSCMAT302	Application of Calculus and Linear Algebra in Finance	DSC A	4	5	3	0	2	0
6	MCE6DSEMAT300	An Invitation to Fuzzy Mathematics	DSE	4	4	4	0	0	0
6	MCE6DSEMAT301	Combinatorics	DSE	4	4	4	0	0	0
6	MCE6DSEMAT302	Computations and Graphics Using Scilab	DSE	4	4	4	0	0	0
6	MCE6VACMAT300	Mathematical Computation and Visualization with R	VAC	3	3	3	0	0	0
6	MCE6SECMAT300	Computations and Graphics using SageMath	SEC	3	3	3	0	0	0
7	MCE7DCCMAT400	Advanced Linear Algebra	DCC	4	5	3	0	2	0
7	MCE7DCCMAT401	Theory of Complex Functions	DCC	4	4	4	0	0	0
7	MCE7DCCMAT402	Introduction to Metric Spaces	DCC	4	4	4	0	0	0
7	MCE7DCEMAT400	Algebraic Structures in Depth : Groups and Rings	DCE	4	4	4	0	0	0
7	MCE7DCEMAT401	Real Analysis	DCE	4	4	4	0	0	0
7	MCE7DCEMAT402	Graph Theory	DCE	4	4	4	0	0	0
7	MCE7DSCMAT400	Principles of Quantitative Analysis	DSC B	4	4	4	0	0	0
7	MCE7DSCMAT401	Dynamic Optimization	DSC B	4	4	4	0	0	0
8	MCE8DCCMAT400	Functional Analysis	DCC	4	5	3	0	1	0

8	MCE8DCCMAT401	Measure Theory and Integration	DCC	4	5	3	0	2	0
8	MCE8DCEMAT400	Basic Topology	DCE	4	5	3	0	2	0
8	MCE8DCEMAT401	Exploring Field Extensions and Galois Theory	DCE	4	5	3	0	2	0
8	MCE8DCEMAT402	Optimization Techniques	DCE	4	5	3	0	2	0
8	MCE8PRJMAT400	Project (Research /Honours)	PRJ	12					

MAHARAJA'S COLLEGE, ERNAKULAM
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Programme	**B.A/ B.Sc./ B.Com(Honours)**
Course Name	**Ground Roots of Mathematics with Visualisation**
Type of Course	**Discipline Specific Course - DSC A/B**
Course Code	MCE1DSCMAT100
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**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		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	Hours	CO No:
1		**Basic Logic**	**15**	
	1.1	Propositional Logic		1
	1.2	Propositional Equivalence		1
	1.3	Predicates and Quantifiers		1
	Text 2: Chapter 1- Sections: 1.1, 1.3, 1.4			
2		**Functions**		

	2.1	Set, Set operations, Set identities (Review)	**20**	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) Include Desmos / Geogebra classroom activities for sections 2.2,2.3,24			1, 2, 3, 7
	Text 3: Chapter 1 - Sections: 1.1, 1.2, Chapter 7 - Section: 7.1 (Inverse functions only)			
3		**Derivatives**		
	3.1	Introduction to Techniques of Differentiation (without proof)	**20**	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) Desmos Classroom activities for section 3.2		
	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) Desmos Classroom activities for section 4.1 and 4.2		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

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 using ICT Tools, 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 -1			5 Marks	
		Module Test -2			5 Marks	
		Module Test -3			5 Marks	
		Module Test -4			5 Marks	
		Assignment/ Seminar			5 Marks	
		Quiz/Viva			5 Marks	
		Total			30 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	**6Marks**	**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**

TEXT BOOKS:

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.
6. Featured collections in https://teacher.desmos.com/

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

MAHARAJA'S COLLEGE, ERNAKULAM
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Programme	B.A./ B.Sc. / B.Com. Honours					
Course Name	Mathematics Foundation for Quantitative Analysis					
Type of Course	**Discipline Specific Course (DSC B)**					
Course Code	MCE1DSCMAT101					
Course Level	**100-199**					
Course Summary	This is a course designed to equip students with the essential mathematical tools for advanced quantitative studies. It covers fundamental concepts such as sets, relations, functions, and their applications in economic models like market equilibrium and national income analysis. The course delves into differential calculus, including derivatives, limits, continuity, and partial differentiation. Matrix algebra, encompassing operations, properties, and inverses, is also introduced. This foundation is crucial for understanding quantitative techniques used in various fields, providing a solid base for further specialized studies.					
Semester	1	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		3	0	1	0	**75**
Pre-requisites, if any	**Basic Mathematics Knowledge**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, student will be able to:			
1	Get an insight into the concept of the set and functions	U	1, 2, 10
2	Understand the concept of Limit and continuity	U	1, 2, 3, 6
3	Perform ordinary and partial differentiation	**A**	1,2,10

4	Perform of basic operations Matrices	U,A	2, 3,6,16
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	Hrs	CO No.
1	1.1	The real number system, The concepts of sets,	15	1
	1.2	Relation and Functions		1
	1.3	Types Functions, functions of two or more independent variables		1
	1.4	Practical market equilibrium, A nonlinear model, General market equilibrium (Exclude n commodity case)		1
	1.5	Equilibrium in National income analysis		1
		Chapter 2 section 2.2 -2.6, Chapter 3 Section 3.3-3.5		
2	2.1	Rate of change and the derivative	20	2
	2.2	Derivative and the slope of a curve		2
	2.3	Concept of limit, Limit Theorem		2
	2.4	Continuity and differentiability of a function		2
	2.5	**Practicum: Problems**		2
		Section 6.2 - 6.4, 6.6-6.7		
3	3.1	Rules of differentiation for a function of one variable	20	**3**
	3.2	Rules of differentiation involving two or more functions in the same variable		3
	3.3	Rules of differentiation involving functions of different variables		3
	3.4	Partial differentiation		3
	3.5	**Practicum: Problems**		3
		Section 7.1-7.4		
4	**4.1**	Matrices and vectors	20	4
	4.2	Matrix operations, Notes on vector operations		4
	4.3	Commutative associative and distributive		4

		laws		
	4.4	Identity matrices and null matrices, Transpose and inverse		4
	4.5	**Practicum: Problems**		4
		4.1-4.6		

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 **P**racticum 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 hand written 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

Teaching and Learning Approach	***Classroom Procedure (Mode of transaction)***					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**				
		Components			**Mark Distribution**	
		Module Test -1			5 Marks	
		Module Test -2			5 Marks	
		Module Test -3			5 Marks	
		Module Test -4			5 Marks	
		Assignment/ Seminar			5 Marks	
		Quiz/Viva			5 Marks	
		Total			30 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**

Text Book:

1. Chiang, C., Fundamental Methods of Mathematical Economics McGraw Hills, *(Latest Edition).*

SUGGESTED READINGS:

1. Simon, Carl P., and Lawrence Blume. *Mathematics for economists*. Vol. 7. New York: Norton, 1994.
2. Knut Sydsaeter, Peter Hammond, Arne Strom, Essential Mathematics for Economic Analysis (4th Edition), Pearson Publication, 2012.
3. Budnick, Frank, Applied Mathematics for Business, Economics and Social Sciences, McGraw Hills Education, 2017..
4. Dowling E. T., Mathematics for economists, Schum Series (latest edition)
5. Rosser, Mike, Basic Mathematics for Economists, Routledge, Taylor & Francis Group, 2003.

MAHARAJA'S COLLEGE, ERNAKULAM
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Programme	**B.A./ B. Com / B.Sc. Mathematics Honours**					
Course Name	**Mathematics for Competitive Examinations**					
Type of Course	**Multi–disciplinary Course - MDC**					
Course Code	MCE1MDCMAT100					
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, ratios, percentages, and time-related problem- solving, providing comprehensive preparation for various competitive examinations.					
Semester	1	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		2	0	1	0	**60**
Pre-requisites, if any	**Nil**					

COURSE OUTCOMES (CO)

CONo:	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 numbers. Master techniques for calculating HCF and LCM and gain proficiency in simplifications, squares and square roots.	K, U, E	1, 2, 10
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	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)

Units	Course Description	Hours	CO. NO:
1	**Number System and Numerical Technique**	**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)			
Text 1: Relevant portions			

2	**Logical Reasoning & Data Analysis**		
2.1	Ratio and Proportion	**24**	**2**
2.2	Percentage		**2**
2.3	Profit and Loss		**2**
2.4	Problems on Age		**2**
2.5	Simple Interest & Compound Interest		**2**
2.6	Calendar		**2**
	Problems (Practicum)		
Text 1: Relevant Portions			
3	**Mathematical Measurements**		
3.1	Time and Work	**18**	**3**
3.2	Time and Distance		**3**
3.3	Stocks and Shares		**3**
	Problems (Practicum)		
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**		
Teaching and Learning Approach	**Classroom Procedure(Mode of transaction): Lecture, Tutorial**		

	MODE OF ASSESSMENT		
Assessment Types	**A**	**Continuous Comprehensive Assessment (CCA) 25 Marks**	
		Components	**Mark Distribution**
		Module Test -1	**5 Marks**
		Module Test -2	**5 Marks**

		Module Test -3	**5 Marks**
		Assignment/ Seminar	**5 Marks**
		Quiz/Viva voce	**5 Marks**
		Total	**25 Marks**
	B	**End Semester Evaluation(ESE) 50 Marks**	
		Question Pattern (MCQ Examination)	
		Maximum Time 75 Minutes, Maximum Marks 50	
		Module	**Number of Questions**
		I	**8**
		II	**14**
		III	**8**
		Answer any 25 questions out of 30 Multiple Choice Questions.	
		Each question carries 2 marks.	

TEXT BOOK:

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.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**
Course Name	**Matrix Mastery and Calculus Adventures**
Type of Course	**Discipline Specific Course (DSC A)**
Course Code	**MCE2DSCMAT100**
Course Level	**100-199**
Course Summary	This course provides a solid foundation in matrix theory and applications.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. Integral calculus along with applications are included.

Semester	2	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		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 completion of the course, student will be able to:			
1	Understand the concept of partial derivatives and experience its applications	U	1, 2, 3, 4, 10
2	Compute definite integrals of single-variable functions, double integrals and understanding their geometric	A	1, 2, 3, 10

	interpretation.		
3	Apply matrices to solve systems of linear equations using methods of Gaussian elimination and matrix inversion.	A	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	Hrs	CO No.
1		**Partial Differentiation**		
	1.1	Partial derivatives	20	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**		
	2.1	**Integrals and Integration methods (Review)**	20	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)		
		Text 1: Chapter 7 - Section: 7.1; Chapter 4 - Sections: 4.5 (discontinuities and integrability excluded), 4.6(dummy variables, The mean valuetheorem for integrals and integrating rates of changes excluded); Chapter 14 section 14.1		
3		**Matrices**		
	3.1	Linear System, Coefficient Matrix, Augmented Matrix	20	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		**Matrices (continued)**		
	4.1	Linear combination and independence/dependence of rows and columns of matrices	15	3
	4.2	Row equivalent matrices		3
	4.3	Row rank, column rank and rank of a matrix		3
	4.4	Normal form and equivalent matrices		3
	4.5	Consistency of system of linear equations		3
	4.6	Invertible Matrices		3
		Problems (Practicum)		
		Text 4: Relevant portions of Chapter 3 and Chapter 4 [Theorems (Statement only) and their applications]		
5	Teacher Specific Content			
	This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure** Lecture, Tutorial, Activity oriented		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA)**	
		Components	**Mark Distribution**
		Module Test -1	5 Marks
		Module Test -2	5 Marks

		Module Test -3			5 Marks	
		Module Test -4			5 Marks	
		Assignment			5 Marks	
		Quiz/Viva			5 Marks	
		Total			30 Marks	
	B	**End Semester Examination (Written)**				
		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**

TEXT BOOKS:

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

SUGGESTED READINGS:

1. Spivak, Michael. *Calculus and Applications*. 11th ed. Pearson, 2023
2. Stewart, James. *Calculus: Early Transcendentals*. 10th ed. Cengage Learning, 2023.

3. Thompson, Silvanus P. *Calculus Made Easy*. 5th ed. Dover Publications, 2014.
4. Thomas, George B., Jr., and Maurice D. Weir. *Thomas' Calculus*. 15th ed. Pearson, 2023.
5. Evans, Lawrence C. *Partial Differential Equations: An Introduction*. 2nd ed. American Mathematical Society, 2010.

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.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.A. / B.Sc. / B.Com. (Honours)**					
Course Name	**Advanced Mathematical Tool for Quantitative Analysis**					
Type of Course	**Discipline Specific Course (DSC B)**					
Course Code	MCE2DSCMAT101					
Course Level	**100-199**					
Course Summary	This course delves into various mathematical concepts and their applications. It includes Cramer's Rule and determinants, which are used to solve systems of linear equations. It includes the concept of differentiation and its applications in finding maximum/minimum values of functions. The course also covers exponential and logarithmic functions and their properties. By the end of this course, the student will have a solid understanding of these mathematical tools and their relevance in various fields.					
Semester	2	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		3	0	1	0	75
Pre-requisites, if any	Mathematical Foundation for Quantitative Analysis					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, student will be able to:			
1	Solve system of equations using matrices	A	1,2,6,10
2	Find out derivative and total derivative	A	1,2,3
3	Solve optimization problems	An	1,2,6
4	Apply various properties of exponential and	An	1,2,6,10

	logarithmic function		

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.
1	1.1	Condition for non-singularity of matrix	20	1
	1.2	Test of non-singularity by use of determinants, rank of Matrix		1
	1.3	Finding inverse of matrix,		1
	1.4	Cramer's rule		1
	1.5	Application to market and national income model		1
		Practicum: problems		1
	Section 5.1-5.4			
2	2.1	Differential, Total differential	20	2
	2.2	Rules of differentials		2
	2.3	Total derivatives		2
	2.4	Derivative of implicit functions		2
	2.5	**Practicum:** Problems		2
	Section 8.1-8.5			
3	3.1	Optimum values and extreme values	20	3
	3.2	Relative maximum and relative minimum, first derivative test		3

	3.3	Second and higher derivatives		3
	3.4	Second derivative test		3
	3.5	Practicum: Problems		3
	Section 9.1-9.4(up to example 2)			
4	4.1	The nature of exponential function	15	4
	4.2	Natural exponential functions and the problem of growth, Logarithms, logarithmic function		4
	4.3	Derivatives of exponential and logarithmic function		4
	4.4	Further application of logarithmic and exponential functions		4
	Chapter10 (exclude section 10.6)			

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 **P**racticum 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. 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

Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA)**	
		Components	**Mark Distribution**

		Module Test -1			5 Marks	
		Module Test -2			5 Marks	
		Module Test -3			5 Marks	
		Module Test -4			5 Marks	
		Assignment			5 Marks	
		Quiz/Viva			5 Marks	
		Total			30 Marks	
	B	**End Semester Examination (Written)**				
		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**

Text Book:

Chiang, C.,Fundamental Methods of Mathematical Economics, McGraw Hills, *(Latest Edition).*

SUGGESTED READINGS:

1. Simon, Carl P., and Lawrence Blume. *Mathematics for economists*. Vol. 7. New York: Norton, 1994.

2. Knut Sydsaeter, Peter Hammond, Arne Strom, Essential Mathematics for Economic Analysis (4th Edition), Pearson Publication, 2012.

3. Budnick, Frank, Applied Mathematics for Business, Economics and Social Sciences, McGraw Hills Education, 2017.

4. Dowling E. T., Mathematics for economists, Schum Series (latest edition).

5. Rosser, Mike, Basic Mathematics for Economists, Routledge, Taylor & Francis Group, 2003.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	B.Sc. Mathematics Honours					
Course Name	Applicable Mathematics					
Type of Course	Multi–disciplinary Course - MDC					
Course Code	MCE2MDCMAT100					
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	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		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)

Units	Course Description	Hours	CO. NO:
1	**Matrices & Polynomials**	24	
1.1	Matrices, Different types of matrices associated with a matrix		1
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 2.7Text 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)			
	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)			
Teaching and Learning Approach	Classroom Procedure(Mode of transaction)Direct Instruction, Brainstorming Lecture, Explicit Teaching, Active Co- operative Learning,		

	MODE OF ASSESSMENT		
Assessment Types	**A**	**Continuous Comprehensive Assessment (CCA) 25 Marks**	
		Components	**Mark Distribution**
		Module Test -1	**5 Marks**
		Module Test -2	**5 Marks**
		Module Test -3	**5 Marks**
		Assignment/ Seminar	**5 Marks**
		Quiz/Viva voce	**5 Marks**
		Total	**25 Marks**
	B	**End Semester Evaluation(ESE) 50 Marks**	
		Question Pattern (MCQ Examination)	
		Maximum Time 75 Minutes, Maximum Marks 50	
		Module	**Number of Questions**

		I	**8**
		II	**14**
		III	**8**
		Answer any 25 questions out of 30 Multiple Choice Questions.	
		Each question carries 2 marks.	

TEXT BOOKS:

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.

	MAHARAJA'S COLLEGE, ERNAKULAM(Govt. Autonomous)
Programme	**B.Sc. Mathematics Honours**
Course Name	Mathematical Insights: Equations, Multiple Integrals and Conics
Type of Course	**Discipline Specific Course (DSC A)**
Course code	MCE3DSCMAT200
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**

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 parameterizing plane curves and working with polar coordinates. Analyze conic sections and conics in polar coordinates.	A, An	1,2,3,6,9,10
2	Understand the relationship between roots and coefficients in equations. Apply transformations to equations and analyse special cases.	U, A	1,2,3,10
3	Utilize double integrals for area computations and problem-solving in polar forms.	A	1,2,3,6,10
4	Master triple integrals in rectangular, cylindrical, and spherical coordinates.	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
		Analytic Geometry		**20**
	1.1	Parametrization of Plane curves	1	
	1.2	Polar Coordinates	1	
1	1.3	Conic sections	1	
	1.4	Conics in polar coordinates	1	
	1.5	**Problems (Practicum)**	1	
	Text 2: Chapter 11 - Sections: 11.1 (Brachistochrone and Tautochrone excluded), 11.3, 11.6 & 11.7			
2		**Theory of Equations**		
	2.1	Roots of Equation and Relation connecting the roots and coefficients of equation	2	
	2.2	Transformation of Equations and special cases	2	
	2.3	Character and Position of the roots of an equation	2	**15**
	2.4	Some general theorems (without proof) and Descartes' rule of signs (without proof)	2	
		Problems (Practicum)	2	

	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	3	
	3.2	Area by double integration	3	
	3.3	Double integrals in Polar Forms	3	
	Text 2: Chapter 15 - Sections: 15.2 to 15.4			
4		**Triple Integrals**		**20**
	4.1	Triple Integrals in Rectangular Coordinates	4	
	4.2	Triple Integrals in Cylindrical and Spherical Coordinates	4	
	4.3	Substitutions in Double Integrals	3	
	4.4	Substitutions in Triple Integrals	3	
	4.5	**Problems (Double and Triple integrals) (Practicum)**	3,4	
	Text 2: Chapter 15 - Sections: 15.5, 15.7 & 15.8			

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 -1			5 Marks	
		Module Test -2			5 Marks	
		Module Test -3			5 Marks	
		Module Test -4			5 Marks	
		Assignment/ Seminar			5 Marks	
		Quiz/Viva			5 Marks	
		Total			30 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	**6Marks**	**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**

TEXT BOOKS:

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*. 2nded 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

	MAHARAJA'S COLLEGE, ERNAKULAM **(Govt. Autonomous)**

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Unlocking Mathematics: Exploring Complex Number, Vectors and Equivalence relations**					
Type of Course	**Discipline Specific Course (DSC A)**					
Course Code	**MCE3DSCMAT201**					
Course Level	**200-299**					
Course Summary	This course serves as an essential bridge to advanced mathematical concepts, focusing an in-depth exploration of relations, equivalence relations, partial ordering, complex numbers, exploring their fundamental characteristics, vector differentiation, and vector integration. Students will explore the properties of relations, will gain proficiency in understanding complex numbers, and delve into the derivatives and integrals of vector functions. The course begins with "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 second segment delves into basic properties of complex plane. It explores complex number's exponential representations and their geometric importance. 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	Total Hours per week
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		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	Understand the concepts of equivalence relations and partially ordered sets.	U	1,2,9
2	Understand the basic properties of complex plane, its geometrical dimensions. Identify regions of complex plane and behavior of complex variables.	U	1,2,3,10
3	Explore vector functions, derivatives, arc length, and curvature of curves and their applications.	A	1,2,3,10
4	Master line integrals, vector fields, and their applications.	An	1,2,3,9
5	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)

Units	Course Description	Hours	CO. NO:
1	Equivalence relations and Partial ordering	18	
1.1	Equivalence Relations	8	1
1.2	Partially Ordered Set	4	1
1.3	Hasse Diagrams	3	1
1.4	Lattices	3	1

Text1–Sections:9.5,9.6			
2		18	
2.1	Basic Properties of Complex Numbers	5	2
2.2	Exponential form of Complex Numbers	5	2
2.3	Roots of Complex Numbers	5	2
2.4	Regions in the complex Plane	3	2
Text2–Sections:1-11			
3	Vector Differentiation	20	
3.1	Vector Algebra(Review),Vector functions, Derivatives of vector functions	5	3
3.2	Arc length and unit tangent vector	4	3
3.3	Curvature and normal vectors of a curve	6	3
3.4	Directional derivatives and Gradient vectors	5	3
Text3–Sections:13.1,13.3,13.4,14.5			
4	Vector integration	19	
4.1	Line integrals	3	4
4.2	Vector fields and line integrals: work, circulation and flux	5	4
4.3	Path independence, conservative field and potential function (proofs of theorems excluded)	5	4
4.4	Green's theorem in plane (statement and problems only)	4	4
4.5	Curl, Divergence in three dimensions	2	4
Text 3 – Sections: 16.1 to 16.4,16.7(Curl only) 16.8 (Divergence in three dimensions only)			

<table>
<tr><td>Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
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<tr><td></td><td></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td></td><td></td><td colspan="3">Module Test -1</td><td colspan="2">5 Marks</td></tr>
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<tr><td></td><td></td><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

TEXTBOOKS

1. Rosen, Kenneth H. Discrete Mathematics and Its Applications(7thed.).McGraw Hill Publishing Co.NewDelhi,2013.
2. Brown, James Ward., Churchil, Ruel V. Complex Variables and Applications (8^{th} Edition), McGraw-Hill Publications, 2009.
3. Thomas, GeorgeB.,Jr.,MauriceD.Weir.Thomas'Calculus.12th ed.Pearson,2009.

SUGGESTED READINGS

1. Howard Anton, Irlbivens, Stephens Davis, Calculus(10th Edition), Wiley .
2. Griffiths, DavidJ. Introduction to Electromagnetism. 4th ed. Cambridge University Press,2013.
3. Joyce, David D., and George C. Parker. Vector Calculus and Its Applications. 4th ed. Jones&BartlettPublishers,2022.
4. Schroeder, GlennN. Vector Analysis for Computer Graphics.3rded.AKPeters/CRCPress,2017.
5. Tenenbaum, Morris T.,and Harry Pollard. Mathematics for the Non mathematician: An Intuitive Approach.8th ed.DoverPublications,2013.
6. Ponnusamy,S., Herb Silverman. Complex variables with applications. Springer Science & Business Media,2007.
7. Krantz, Steven G. Complex Variables: a physical approach with applications and MATLAB.CRCPress,2007.
8. Kasana, Harvir Singh. Complex variables: theory and applications. PHILearning Pvt.Ltd.,2005

ADVANCED LEARNING

1. Borceux, Francis. Universal Algebra.2nded.Springer,2003.
2. Farin,SusanE.,andWayneS.Sayle.VectorCalculus.5thed.Freeman,2018.
3. Hayes, Martin H. C. Introduction to Mathematical Proofs.2nded.OxfordUniversityPress,2021.
4. Maddox, Randall. A Transition to AdvancedMathematics.8thed.American Mathematical Society,2023.
5. Velleman, Daniel J. How to Prove It: A Structured Approach.4th ed.Pearson,2015.
6. Saff, E. B., Snider, A. D. Fundamentals of Complex Analysis with Applications to Engineering, Science and Mathematics,(2002).
7. Jeffrey, Alan. Complex analysis and applications.CRCPress,2005.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.A./B.Sc./B.Com. (Honours)**					
Course Name	**Mathematical Tools for Physical Sciences**					
Type of Course	**Discipline Specific Course (DSC B/C)**					
Course Code	MCE3DSCMAT202					
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	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		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 completion of the course, student will be able to:			
1	Distinguish between cartesian and polar co- ordinates and find the curvature and directional derivatives of curves.	K	1, 2, 3, 4, 10

2	Evaluate Fourier series of different periodic functions in various Scientific problems.	E	1, 2, 3
3	Analyse the nature of differential equations.	An	1
4	Understand and apply Laplace transform, inverse Laplace transform and to solve ODE.	U	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	Hrs	CO No.	
1		**Vector Calculus**			
	1.1	Polar coordinates	20	1	
	1.2	Curves in Space and tangents, Velocity and Acceleration, Arc length in space		1	
	1.3	Curvature and Normal vectors of a curve		1	
	1.4	Directional derivatives and gradient vectors		1	
		Text 1: Chapter 11 – sections: 11.3 **Chapter 13 – Sections: 13.1,13.3,13.4** **Chapter 14 – Section: 14.5 Theorems – Statements Only**			
2		**Fourier Series**			
	2.1	Fourier series		2	
	2.2	Functions of any period p=2L		2	
	2.3	Even and odd functions and half range expansions		2	

		Problems from section 2.2 and 2.3 (Practicum)	15	
		Text 2 : Chapter 10 - Sections: 10.2 to 10.4		
3		**Differential Equations**		
	3.1	Introductory Remarks, Nature of solutions	3	
	3.2	Separable Equations	3	
	3.3	First Order Linear Equations	3	
	3.4	Exact Equations	3	
		Text 3: Chapter 1 – Sections: 1.1 to 1.5		
4		**Laplace Transforms**		
	4.1	Laplace Transform, Inverse Transforms, Linearity, Shifting.	4	
	4.2	Transforms of Derivatives and Integrals, Differential equations.	4	
	4.3	Unit Step functions. Second shifting theorem, Dirac's delta function	4	
	4.4	Differentiation and integration of transforms,	4	
	4.5	Convolution, integral equations	4	
		Problems from section 4.2 and 4.5 (Practicum)		
		Text 2 : Chapter 5 [Sections 5.1 to 5.5] **Proof of theorems excluded**		
5		**Teacher Specific Content**		

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

Teaching and Learning Approach	***Classroom Procedure (Mode of transaction)***					
	Direct Instruction, Brainstorming Lecture, Explicit Teaching, Active Co- operative Learning.					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**				
		Components			**Mark Distribution**	
		Module Test -1			5 Marks	
		Module Test -2			5 Marks	
		Module Test -3			5 Marks	
		Module Test -4			5 Marks	
		Assignment/ Seminar			5 Marks	
		Quiz/Viva			5 Marks	
		Total			30 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**

TEXT BOOKS:

1. Thomas, George B Jr. *Thomas' Calculus, Twelfth Edition*, Pearson, 2010
2. Kreyszig, Erwin. *Advanced Engineering Mathematics, Wiley student edition, 8th edition, 2006.*
3. Simmons, G.F., Krantz, S.G. *Differential Equations*, Tata McGraw Hill-New Delhi, 2007.

SUGGESTED READINGS:

1. Spivak, Michael. *Calculus and Applications*. 11th ed. Pearson, 2023
2. Stewart, James. *Calculus: Early Transcendentals*. 10th ed. Cengage Learning, 2023.
3. Thompson, Silvanus P. *Calculus Made Easy*. 5th ed. Dover Publications, 2014.
4. Joel L. Schiff. *The Laplace Transform-Theory and Applications*. Springer 1999.
5. Rajendra Bhatia. *Fourier Series (2nd ed.) Texts and Readings in Mathematics*. Hindustan Book Agency, Delhi 2003.
6. Siddiqi, A.H., Manchanada, P. *A first course in Differential Equations*, Mc Millan.
7. Grewal, B. S., *Higher Engineering Mathematics*, *44th Edition*, Khanna Publishers, 2021.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.A./B.Sc./ B. Com. (Honours)**					
Course Name	**Applied Mathematics in Quantitative Analysis**					
Type of Course	**Discipline Specific Course (DSC B/C)**					
Course Code	**MCE3DSCMAT203**					
Course Level	**200-299**					
Course Summary	This course contains difference equations, integration, applications of differentiation, and an introduction to quasi-concave and quasi-convex functions. The expertise of this course will enable the students to apply the mathematical tools in various real life problems.					
Semester	3	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		3	0	1	0	**75**
Pre-requisites, if any	Basic differentiation, Partial differentiation					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, student will be able to:			
1	Find the extreme value of two variable functions	S	1,2,8,10
2	Find the integral of various types of functions and apply it in various problems	A	1,2,3
3	apply the quasi concavity and quasi convexity	**A**	**1,3,8,10**
4	apply the difference equation technique	A	1,2,8
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	Hrs	CO No.
1	1.1	The differential version of optimal condition	20	1
	1.2	Extreme value of a function of two variables		1
	1.3	Quadratic forms - An excursion		1
	1.4	Objective functions with more than two variables		1
		Practicum: Exercise 11.2,11.3,11.4		1
		Text 1: Chapter 11 - (exclude *n* variable case) 11.1-11.4		
2	2.1	Indefinite integral	15	2
	2.2	Definite integral		2
	2.3	Improper integrals		2
	2.4	Some economic applications of integrals		2
		Practicum: Problems		2
		Text 1 section 14.1-14.5		
3	3.1	Effects of a constraint	**20**	**3**
	3.2	Finding the stationary values (exclude *n* variable case and multi constraint case)		3
	3.3	Second order condition (exclude *n* variable case and multi constraint case)		3
	3.4	Quasi concavity and Quasi convexity, Utility maximization and consumer demand (first order condition only)		3
		Practicum: Exercise 12.2, Exercise 12.4 and 12.5		
		Text 1: Chapter 12- Sections12.1-12.5		

4	**4.1**	Discrete time differences and difference equations	20	4
	4.2	Solving a first order difference equation		4
	4.3	The dynamic stability of Equilibrium		4
	4.4	The cobweb model, the market model with inventory		4
		Text 1: Chapter 17 - Sections: 17.1 to 17.5.		
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, 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 -1		5 Marks	
		Module Test -2		5 Marks	
		Module Test -3		5 Marks	
		Module Test -4		5 Marks	
		Assignment/ Seminar		5 Marks	
		Quiz/Viva		5 Marks	
		Total		30 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**

TEXT BOOK :

Chiang, C., Fundamental Methods of Mathematical Economics, McGraw Hills, (Latest Edition).

SUGGESTED READINGS:

1. Carl P. Simon and Lawrence, Mathematics for Economists, Blume Viva Books, 2018
2. Knut Sydsaeter, Peter Hammond Prof. Arne Strom, Essential Mathematics for Economic Analysis (4th Edition), Pearson Publication, 2012.
3. Budnick, Frank, Applied Mathematics for Business, Economics and Social Sciences, McGraw Hills Education, 2017.
4. Dowling E. T., Mathematics for economists, Schum Series (latest edition)
5. Rosser, Mike, Basic Mathematics for Economists, Routledge, Taylor & Francis Group, 2003.

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	B.Sc. Mathematics Honours					
Course Name	Fundamentals of Investment Science					
Type of Course	Discipline Specific Elective – DSE					
Course Code	MCE3DSEMAT200					
Course Level	200-299					
Course Summary	This course is aimed at the introductory investments class with students who have relatively little familiarity with investments. This course equips the students with the foundational knowledge and tools to make informed investment decisions. Through a blend of theory and practical application, you'll gain a solid understanding of Investment Fundamentals, Investment Analysis, Portfolio Construction, Investment Strategies, etc.					
Semester	3	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		4	0	0	0	60
Pre-requisites, if any	12th level Mathematics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the completion of the course, student will be able to:		
1	Evaluate return and understand the risk associated	E	1,2,3,5,6,7,8,9,10
2	Create investment portfolio	C	1,2,3,5,6,7,8,9,10
3	Invest in the mutual fund by analysing the current situation	S	1,2,3,5,6,7,8,9,10
4	Involve in bond transactions wisely	S	1,2,3,5,6,7,8,9,10
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	Hrs	CO No.
1	**1.1**	Returns	13	1
	1.2	The historical reward		1
	1.3	Average return: the first lesson, Return variability		1
	1.4	The second lesson More on average return		1
	1.5	Risk and return,Summary and Conclusions		1
		Text 1: Chapter 1 - Sections: 1.1 to 1.7		
2	2.1	Brokerage accounts	13	2
	2.2	Short sale		2
	2.3	Investor objectives, constraints and strategies		2
	2.4	Forming an investment portfolio, Summary and conclusions		2
		Text 1: Chapter 2 -Sections: 2.1-2.6		
3	3.1	Classifying securities, Interest bearing assets, Equities	17	**3**
	3.2	Derivatives, option contracts, Summary and conclusions		3
	3.3	Advantages and drawbacks of mutual fund investing, Investment companies and fund types, Mutual fund operations, Mutual fund cost and fees		3
	3.4	Short-term funds long-term funds, mutual fund performances, Closed end funds, Exchange-traded funds, and hedge funds, Summary and conclusions		3

		Text 1: Chapter 3,4 - Sections: 3.1 to 3.6, 4.1-4.9		

4	**4.1**	Interest rate history and Money market rates, Money market prices and rates	17	4
	4.2	Rates and Yields on fixed income securities, The term structure of interest rates, Traditional theories of the term structure, Determinants of normal rates: A modern perspective		4
	4.3	Bond basics, Straight bond prices and yield to maturity, more on yields		4
	4.4	Interest rate risk and Malkiel's theorems, bond risk measures based on duration,Dedicated portfolios and reinvestment risk, immunisation		4
		Text 1: Chapter 9& 10		

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 -1		5 Marks	
		Module Test -2		5 Marks	
		Module Test -3		5 Marks	
		Module Test -4		5 Marks	
		Assignment/ Seminar		5 Marks	
		Quiz/Viva		5 Marks	
		Total		30 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	**6Marks**	**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**

TEXT BOOK:

1. Bradford D Jordan Thomas W Miller Jr , Fundamentals of investment valuation and management fifth edition**,** McGraw-Hill/Irwin, 2009.

SUGGESTED READINGS:

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 (2^{nd} Edition), Cambridge University Press, USA, 2003.
4. Kevin J Hastings. Introduction to Financial Mathematics, CRC Press, 2015.
5. Robert Buchanan. *An Undergraduate Introduction to Financial Mathematics.*
6. Lerner and Zima. *Business Mathematics (Schaum's Outline Series).*
7. Brealy and Myers. *Corporate Finance*, Mc Graw Hill, 2023.
8. Sharpe, N.J. and Bailey Upper Saddler. River. *Investment* Prentice Hall, 1999.
9. Bodie, Kane and Marcus. *Investments*, McGraw-Hill Irwin, 2005.

	MAHARAJA'S COLLEGE, ERNAKULAM **(Govt. Autonomous)**

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Game Theory and Project Management**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	**MCE3DSEMAT201**					
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	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		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 noncritical 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**			

<table>
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<tr><td colspan="2" rowspan="20">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="8"></td><td colspan="3">Components</td><td>Mark Distribution</td></tr>
<tr><td colspan="3">Module Test -1</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test -2</td><td>5 Marks</td></tr>
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<tr><td colspan="3">Total</td><td>30 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="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>
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<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

TEXT BOOK:

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.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B. Sc. Mathematics Honours**					
Course Name	**Mathematical Musings beyond Classroom**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	**MCE3DSEMAT202**					
Course Level	**200-299**					
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	**3**	**Credits**			**4**	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	
		4	0	0	0	60
Pre-requisites, If any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, student will be able to:			
1	Understand the evolution of mathematical thought and its role in shaping scientific and technological advancements.	U	6
2	Explore the intersection of mathematics with other fields, as portrayed in films.	An	3,5,7
3	Demonstrate how mathematics intersects with various disciplines, including science, arts, and humanities.	C	3
4	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 Textsof Mathematics.	1	
	1.2	Text Book 1Chapter- 1: Nothing Doing [The Origin of Zero], Chapter- 3: Nothing Ventured [Zero Goes East]	1	
	1.3	Text Book 2Part Five: Data (Chapter- 22: The New Normal, Chapter- 23: Chances Are, Chapter- 24: Untangling the Web)	1	
	1.4	Text Book 3Chapter- 3: Einstein vs. Dostoevsky	1	
	Text 1, Text 2, and Text 3			
2		**Math Meets the Silver Screen**		**15**
	2.1	Introduction to Mathematics on the Silver Screen.	2	
	2.2	The film *A Beautiful Mind* (2001) directed by Ron Howard.	2	
	2.3	The film *The Imitation Game* (2014) directed by Morten Tyldum.	2	
	2.4	The film *The Man Who Knew Infinity* (2015) directed by Matthew Brown.	2	
	2.5	The film *Hidden Figures* (2016) directed by Theodore Melfi.	2	
3		**Mathematical Prelude: Kerala's Historical Journey**		**15**
	3.1	The Actors, The Social Background.	3	
	3.2	The Motivation and Method, The Madhava-Gregory Series for the Inverse Tangent, The Madhava- Newton Power Series for the Sine and Cosine.	3	

Module	Units	Course Description	CO No:	Hours
1		**Exploring Enchanting Texts**		**15**
	3.3	Transmission of Kerala Mathematics: Establishing Transmissions: A Digression, The Case for Transmission: Applying the Neugebauer Criteria.	3	
	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.	3	
	Text 4: Chapter- 10: A Passage to Infinity: The Kerala Episode.			
4		**Unveiling the Philosophy of Mathematics**		**15**
	4.1	Text Book 5Part One, Chapter- 5: Five Classical Puzzles.	4	
	4.2	Text Book 6Chapter- 1: Mathematics and Its Philosophy (Sections 1.1 &1.2).	4	
	4.3	Text Book 6Chapter- 2: The Limits of Mathematics.	4	
	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**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Direct Instruction, Brain Storming Approach, Interactive Instruction, Watching Movies, Group Discussion, and Presentation by Individual Student/ Group Representatives.		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA)**	
		Components	**Mark Distribution**
		Module Test -1	5 Marks
		Module Test -2	5 Marks

		Module Test -3			5 Marks	
		Module Test -4			5 Marks	
		Assignment			5 Marks	
		Quiz/Viva			5 Marks	
		Total			30 Marks	
	B	**End Semester Examination (Written)**				
		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**

TEXT BOOK:

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.

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**B.A./B.Sc./B.Com.(Honours)**					
Course Name	**Mathematics of Nature and Art**					
Type of Course	**Multi–disciplinary Course - MDC**					
Course Code	MCE3MDCMAT200					
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**	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical/ Practicum	Others	
		3	0	0	0	**45**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, 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	Analyse 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.	Hrs
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, Fibonacci and music, Fibonacci and poetry.	2	

Module	Units	Course description	CO No.	Hrs
	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, Convergence 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
Assessment Types	**MODE OF ASSESSMENT**

	A	**Continuous Comprehensive Assessment (CCA) 25 Marks**				
		Components			**Mark Distribution**	
		Module Test -1			5 Marks	
		Module Test -2			5 Marks	
		Module Test -3			5 Marks	
		Assignment/ Seminar			5 Marks	
		Quiz/Viva			5 Marks	
		Total			25 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	**3**	**2**	**1**	**6**
		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**

TEXT BOOK:

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.Pvt.Ltd.

2. Mario Livio. The Golden Ratio, Broadway Books, New York.

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Mastering Problem Solving Through Vedic Mathematics**					
Type of Course	**Value Addition Course- VAC**					
Course Code	**MCE3VACMAT200**					
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**	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical/ Practicum	Others	
		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, student will be able to:			
1	Develop a comprehensive understanding of Vedic Mathematics principles, techniques, and their historical context. Attain proficiency in mental calculation techniques for basic computations.	U	1,2,3,4,8,10

2	Apply Vedic Mathematics to solve various mathematical problems, including algebraic expressions and equations, demonstrating versatility in problem-solving. Develop advanced problem-solving skills by systematically using Vedic Mathematics techniques to confidently handle complex scenarios.	A, An	1,2,3,4,8,10
3	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
4	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
5	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.	Hrs
1		**Foundations of Vedic Mathematics**		**12**
	1.1	Overview of Vedic Mathematics- History and its importance, Vedic Sutras and sub-sutras.	1,3,5	
	1.2	Addition : Ekadhikena Purvena	1	
	1.3	Subtraction :Nikhilam Navatascaramam Dasatah, Digit Separator Method	1	
	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	
	1.5	Division : Urdhva – Tiryakgbhyam	1	

Module	Units	Course description	CO No.	Hrs
	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	2,5	
	2.2	Square roots : Duplex Method	2	
	2.3	Cubes: Cubes of two-digit numbers using Nikhilam	2,5	
	2.4	Cube roots : Cube Root of a number having less than 7 digits using Beejank	2,5	
	2.5	Divisibility and simple Osculators	2	
	2.6	Applications: Ratio and proportions, Percentage, Profit and Loss, Simple interest, Compound Interest	3	
	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 $ax + by,\ ax^2 + bx + c$	4	
	3.2	Simple Equations: Solving simple equations in one variable	4	
	3.3	Simultaneous Simple Equations : Solution of system of linear equations in two variables	4	
	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**

<table>
<tr><td></td><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 25 Marks</td></tr>
<tr><td></td><td></td><td colspan="3">Components</td><td>Mark Distribution</td></tr>
<tr><td></td><td></td><td colspan="3">Module Test -1</td><td>5 Marks</td></tr>
<tr><td></td><td></td><td colspan="3">Module Test -2</td><td>5 Marks</td></tr>
<tr><td></td><td></td><td colspan="3">Module Test -3</td><td>5 Marks</td></tr>
<tr><td></td><td></td><td colspan="3">Assignment/ Seminar</td><td>5 Marks</td></tr>
<tr><td></td><td></td><td colspan="3">Quiz/Viva</td><td>5 Marks</td></tr>
<tr><td></td><td></td><td colspan="3">Total</td><td>25 Marks</td></tr>
<tr><td></td><td>B</td><td colspan="5">End Semester Evaluation (ESE) 50 marks</td></tr>
<tr><td></td><td></td><td colspan="5">Question Pattern

[Maximum Time 75Minutes, Maximum Marks 50]</td></tr>
<tr><td></td><td></td><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></td><td></td><td>2 Marks</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td></td><td></td><td>I</td><td>3</td><td>2</td><td>2</td><td>7</td></tr>
<tr><td></td><td></td><td>II</td><td>3</td><td>2</td><td>1</td><td>6</td></tr>
<tr><td></td><td></td><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td></td><td></td><td>Total no of questions</td><td>8</td><td>6</td><td>4</td><td>18</td></tr>
<tr><td></td><td></td><td>Number of questions to be answered</td><td>5</td><td>4</td><td>2</td><td>11</td></tr>
<tr><td></td><td></td><td>Total Marks</td><td>10</td><td>20</td><td>20</td><td>50</td></tr>
</table>

TEXT BOOKS:

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.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Matrix and Number Theory**					
Type of Course	**Discipline Specific Course (DSC A)**					
Course Code	MCE4DSCMAT200					
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	Analyse 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	Analyse 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

), 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	Hours	CO NO:
1	1.1	Matrix Operations	20	1
	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 andindependence/dependence of rows and columns of matrices		4
	2.2	Row equivalent matrices		4
	2.3	Row rank, column rank and rank of a matrix	**15**	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
	3.2	The Greatest Common Divisor		5
	3.3	The Euclidean Algorithm	**20**	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	**20**	5
	4.2	Fermat's Theorem and pseudoprimes		6
	4.3	Wilson's Theorem		7
	4.4	Euler's Phi Function and Theorem		8
	Text 2: Chapter 4 – section: 4.2; Chapter 5 – Sections: 5.2 (Up to Theorem5.2), 5.3 (Up to Theorem 5.5); Chapter 7 – Sections: 7.2 (Theorem 7.2-Statement only and applications) & 7.3			

		Practicum
Module 1		**Question No.2.16,2.17,2.19,2.22,2.28,2.23,2.24** (Lipschutz, S., Lipson, M.. *Schaum's outline of theory and problems of linear algebra (4th ed*.). McGraw-Hill)
Module 2		**Question No 3.12,3.15,3.18,3.23** Lipschutz, S., Lipson, M.. *Schaum's outline of theory and problems of linear algebra (4th ed*.). McGraw-Hill.
Module 3		**Problems 2.3, Question No. 4, 7, 12, 21 [**Burton, David M.. *Elementary number theory (7th ed.).* McGraw-Hill Education, 2017] Chapter 1, Exercise **Question No. 10,11 [**Apostol, T. M. . *An Introduction to Analytic Number Theory* (2nd ed.). Springer, 1976.
Module 4		**Problems 4.2Question No. 4Problem 5.2 Question No. 1[**Burton, David M.. *Elementary number theory (7th ed.).* McGraw-Hill Education, 2017]Chapter 5, Exercise **Question No. 3 [**Apostol, T. M. . *An Introduction to Analytic Number Theory* (2nd ed.). Springer, 1976.
5		**Activities**
	5.1	(i) Activity for advanced learners:Proofs of theorems in Modules 1 and 2Use of computational software or tools (like Python, Sagemath etc.) to perform the matrix operations in the modules 1 and 2
	5.2	Illustrate the technique of Sieve of Eratosthenes for finding all primes below a given integer Apply Congruence relation to encrypt and decrypt a message using Caesar Cipher and Vigenere's approach.

		(meant for internal evaluation only)for Activity (i) Chapters 1, 3, 4 of Textbook 1 for Activity (ii) any suitable textbook of students' choice (depending on the software used)for Activity (iii) Chapter 3-Sec. 3.2 of Textbook 2for Activity (iv) Chapter 10 of Textbook 2

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 -1			5 Marks	
		Module Test -2			5 Marks	
		Module Test -3			5 Marks	
		Module Test -4			5 Marks	
		Assignment/ Seminar			5 Marks	
		Quiz/Viva			5 Marks	
		Total			30 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	**6Marks**	**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**

TEXT BOOKS

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

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**A Journey Through the Basics of Mathematical Analysis**					
Type of Course	**Discipline Specific Course (DSC A)**					
Course Code	MCE4DSCMAT201					
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	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		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	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
2	Analyze the concept of completeness property in real numbers and apply the supremum property in mathematical analysis and problem-solving. Identify various numerical representations of real numbers and categorize different types of intervals.	An	1,2,3, 10
	Understand the basic properties of complex plane, its geometrical dimensions and complex functions. Identify regions of complex plane and behaviour of continuous and differentiable functions of complex variables	An	1,2,3
5	Analyse analytic and harmonic of functions of complex variables. Categorise the basic properties of some elementary functions of complex variables.		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.	1	
	1.4	Absolute Value and the Real Line.	1	

	Text 1: Chapter 1 - Section: 1.3 (Concepts, statements of the theorems, informal proofs and problems only); Chapter 2 - Sections:2.1 & 2.2.		
2.1	The Completeness property of R	2	**20**
2.2	Applications of supremum property	2	
2.3	Intervals	2	
	Problems (Practicum) Section 1.3, Exercise 1-7 **Principles of Real Analysis Malik and Arora**	**2**	
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).			
3.1	Basic Properties of Complex Numbers	3	**20**
3.2	Exponential form of Complex Numbers	3	
3.3	Roots of Complex Numbers	3	
3.4	Regions in the complex Plane	3	
3.5	Functions of the complex Variables	3	
3.6	Limits and Continuity	3	
3.7	Differentiation of Complex functions and CR Equations	3	
3.8	Analytic and Harmonic functions	3	
	Practicum: Problems	**3**	
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)			
4.1	Exponential functions	4	**20**
4.2	Logarithmic functions	4	
4.3	Trigonometric and Hyperbolic functions	4	
4.4	Inverse Trigonometric and Hyperbolic functions	4	
	Problems (Practicum)	4	
	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 **P**racticum 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="20">Teaching and Learning Approach</td><td colspan="5">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="5">Lecture, Tutorial and Activity oriented</td></tr>
<tr><td rowspan="19">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="9"></td><td colspan="3">Components</td><td>Mark Distribution</td></tr>
<tr><td colspan="3">Module Test -1</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test -2</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test -3</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test -4</td><td>5 Marks</td></tr>
<tr><td colspan="3">Assignment/ Seminar</td><td>5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva</td><td>5 Marks</td></tr>
<tr><td colspan="3">Total</td><td>30 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="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>6Marks</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>
</table>

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

TEXT BOOKS:

1. Bartle, Robert G., Sherbert, Donald R. *Introduction to Real Analysis (4thEdition)*, 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.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.A/B.Sc/B.Com (Honours)**					
Course Name	**Mathematical Tools for Physical Sciences**					
Type of Course	**Discipline Specific Course (DSC B/C)**					
Course Code	MCE4DSCMAT202					
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	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		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 completion of the course, student will be able to:			
1	Distinguish between cartesian and polar co- ordinates and find the curvature and directional derivatives of curves.	K	1, 2, 3, 4, 10

2	Evaluate Fourier series of different periodic functions in various Scientific problems.	E	1, 2, 3
3	Analyse the nature of differential equations.	An	1
4	Understand and apply Laplace transform, inverse Laplace transform and to solve ODE.	U	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	Hrs	CO No.	
1		**Vector Calculus**			
	1.1	Polar coordinates	20	1	
	1.2	Curves in Space and tangents, Velocity and Acceleration, Arc length in space		1	
	1.3	Curvature and Normal vectors of a curve		1	
	1.4	Directional derivatives and gradient vectors		1	
		Text 1: Chapter 11 – sections: 11.3 **Chapter 13 – Sections: 13.1,13.3,13.4** **Chapter 14 – Section: 14.5 Theorems – Statements Only**			
2		**Fourier Series**			
	2.1	Fourier series		2	
	2.2	Functions of any period p=2L		2	
	2.3	Even and odd functions and half range expansions		2	

		Problems from section 2.2 and 2.3 (Practicum)	15		
		Text 2 : Chapter 10 - Sections: 10.2 to 10.4			
3		**Differential Equations**			
	3.1	Introductory Remarks, Nature of solutions	15	3	
	3.2	Separable Equations		3	
	3.3	First Order Linear Equations		3	
	3.4	Exact Equations		3	
		Text 3: Chapter 1 – Sections: 1.1 to 1.5			
4		**Laplace Transforms**			
	4.1	Laplace Transform, Inverse Transforms, Linearity, Shifting.	25	4	
	4.2	Transforms of Derivatives and Integrals, Differential equations.		4	
	4.3	Unit Step functions. Second shifting theorem, Dirac's delta function		4	
	4.4	Differentiation and integration of transforms,		4	
	4.5	Convolution, integral equations		4	
		Problems from section 4.2 and 4.5 (Practicum)			
		Text 2 : Chapter 5 [Sections 5.1 to 5.5] **Proof of theorems excluded**			
5		**Teacher Specific Content**			

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

Teaching and Learning Approach	***Classroom Procedure (Mode of transaction)***					
	Direct Instruction, Brainstorming Lecture, Explicit Teaching, Active Co- operative Learning.					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**				
		Components			**Mark Distribution**	
		Module Test -1			5 Marks	
		Module Test -2			5 Marks	
		Module Test -3			5 Marks	
		Module Test -4			5 Marks	
		Assignment/ Seminar			5 Marks	
		Quiz/Viva			5 Marks	
		Total			30 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**

TEXT BOOKS:

4. Thomas, George B Jr. *Thomas' Calculus, Twelfth Edition*, Pearson, 2010

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

6. Simmons, G.F., Krantz, S.G. *Differential Equations*, Tata McGraw Hill-New Delhi, 2007.

SUGGESTED READINGS:

8. Spivak, Michael. *Calculus and Applications*. 11th ed. Pearson, 2023
9. Stewart, James. *Calculus: Early Transcendentals*. 10th ed. Cengage Learning, 2023.
10. Thompson, Silvanus P. *Calculus Made Easy*. 5th ed. Dover Publications, 2014.
11. Joel L. Schiff. *The Laplace Transform-Theory and Applications*. Springer 1999.
12. Rajendra Bhatia. *Fourier Series (2nd ed.) Texts and Readings in Mathematics*. Hindustan Book Agency, Delhi 2003.
13. Siddiqi, A.H., Manchanada, P. *A first course in Differential Equations*, Mc Millan.
14. Grewal, B. S., *Higher Engineering Mathematics*, *44th Edition*, Khanna Publishers, 2021.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.A./B.Sc./ B. Com(Honours)**					
Course Name	**Applied Mathematics in Quantitative Analysis**					
Type of Course	**Discipline Specific Course (DSC B/C)**					
Course Code	**MCE4DSCMAT203**					
Course Level	**200-299**					
Course Summary	This course contains difference equations, integration, applications of differentiation, and an introduction to quasi-concave and quasi-convex functions. The expertise of this course will enable the students to apply the mathematical tools in various real life problems.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		3	0	1	0	**75**
Pre-requisites, if any	Basic differentiation, Partial differentiation					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, student will be able to:			
1	Find the extreme value of two variable functions	S	1,2,8,10
2	Find the integral of various types of functions and apply it in various problems	A	1,2,3
3	apply the quasi concavity and quasi convexity	**A**	**1,3,8,10**
4	apply the difference equation technique	A	1,2,8
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	Hrs	CO No.
1	1.1	The differential version of optimal condition	20	1
	1.2	Extreme value of a function of two variables		1
	1.3	Quadratic forms - An excursion		1
	1.4	Objective functions with more than two variables		1
		Practicum: Exercise 11.2,11.3,11.4		1
		Text 1: Chapter 11 - (exclude *n* variable case) 11.1-11.4		
2	2.1	Indefinite integral	15	2
	2.2	Definite integral		2
	2.3	Improper integrals		2
	2.4	Some economic applications of integrals		2
		Practicum: Problems		2
		Text 1 section 14.1-14.5		
3	3.1	Effects of a constraint	**20**	**3**
	3.2	Finding the stationary values (exclude *n* variable case and multi constraint case)		3
	3.3	Second order condition (exclude *n* variable case and multi constraint case)		3
	3.4	Quasi concavity and Quasi convexity, Utility maximization and consumer demand (first order condition only)		3
		Practicum: Exercise 12.2, Exercise 12.4 and 12.5		
		Text 1: Chapter 12- Sections12.1-12.5		

4	**4.1**	Discrete time differences and difference equations	20	4
	4.2	Solving a first order difference equation		4
	4.3	The dynamic stability of Equilibrium		4
	4.4	The cobweb model, the market model with inventory		4
		Text 1: Chapter 17 - Sections: 17.1 to 17.5.		
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, 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 -1		5 Marks	
		Module Test -2		5 Marks	
		Module Test -3		5 Marks	
		Module Test -4		5 Marks	
		Assignment/ Seminar		5 Marks	
		Quiz/Viva		5 Marks	
		Total		30 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**

TEXT BOOK :

Chiang, C., Fundamental Methods of Mathematical Economics, McGraw Hills, (Latest Edition).

SUGGESTED READINGS:

1. Carl P. Simon and Lawrence, Mathematics for Economists, Blume Viva Books, 2018
2. Knut Sydsaeter, Peter Hammond Prof. Arne Strom, Essential Mathematics for Economic Analysis (4th Edition), Pearson Publication, 2012.
3. Budnick, Frank, Applied Mathematics for Business, Economics and Social Sciences, McGraw Hills Education, 2017.
4. Dowling E. T., Mathematics for economists, Schum Series (latest edition)
5. Rosser, Mike, Basic Mathematics for Economists, Routledge, Taylor & Francis Group, 2003.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**The Share Market Basics**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	MCE4DSEMAT200					
Course Level	**200-299**					
Course Summary	This course is designed for beginners with little to no knowledge of the stock market. It will equip you with the fundamental understanding to navigate the financial world and make informed investment decisions. This course is intended for informational purposes only and does not constitute financial advice.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		4	0	0	0	**60**
Pre-requisites, if any	**12th level Mathematics**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, student will be able to:			
1	Evaluate the market efficiency	E	1,2,3,5,6,7,8,9,10
2	invest in share market by attaining the skill on behavioural finance	S	1,2,3,5,6,7,8,9,10
3	Understand the concept beta	**U**	1,2,3,5,6,7,8,9,10**v**
4	Skill fully analyse the market	S	1,2,3,5,6,7,8,9,10
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	Hrs	CO No.
1	**1.1**	Introduction to market Efficiency, Foundations of market efficiency, Forms of market efficiency,	13	1
	1.2	why would a market be efficient, Some implications of market efficiency		1
	1.3	Informed traders and insider trading		1
	1.4	How efficient are markets, market efficiency, and performance of`professional money managers		1
	1.5	Anomalies, Bubbles and crashes		1
	Text 1: Chapter 7 - Sections: 7.1 to 7.11			
2	2.1	Introduction to behavioural finance, prospect theory	13	2
	2.2	Overconfidence, misperceiving randomness, and overreacting to chance events		2
	2.3	Sentiment-based risk and limits to arbitrage		2
	2.4	Technical Analysis		2
	Text 1: Chapter 8 - Sections: 8.1 to 8.6			
3	3.1	Announcements surprises and expected returns risk: systematic and unsystematic	17	3
	3.2	Diversification, systematic risk and unsystematic risk, systematic risk and beta		3
	3.3	The security market line, more on beta		3
	3.4	Extending CAPM		3
	Text 1: Chapter 12			
4	**4.1**	Performance evaluation ,	17	5
	4.2	comparing performance measures		5
	4.3	Investment risk management		6
	4.4	More on computing value at risk		6
	Text 1: Chapter 13			

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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<tr><td>Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td></td><td colspan="6">Lecture, Teaching, Interactive Instruction, Seminar, Group Assignment, Library Work and Group Discussion</td></tr>
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<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="9"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test -1</td><td colspan="2">5 Marks</td></tr>
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<tr><td colspan="3">Quiz/Viva</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Total</td><td colspan="2">30 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>6Marks</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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<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>

TEXT BOOK:

Bradford D Jordan Thomas r Jr, Fundamentals of Investment Valuation and Management, fifth edition,

SUGGESTED READINGS:

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.*
5. *Robert Buchanan. An Undergraduate Introduction to Financial Mathematics.*
6. *Lerner and Zima. Business Mathematics (Schaum's Outline Series).*
7. *Brealy and Myers. Corporate Finance, Mc Graw Hill, 2023.*
8. *Sharpe, N.J. and Bailey Upper Saddler. River. Investment Prentice Hall, 1999.*
9. *Bodie, Kane and Marcus. Investments, McGraw-Hill Irwin, 2005.*

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Mathematical Modelling**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	MCE4DSEMAT201					
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	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		4	0	0	0	**4**
Pre-requisites, if any	**Basic Calculus and Differential Equations**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, 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 of 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. Solve Mathematical Modelling of population problems using first order differential equation.	**A**	1,2,3,10
4	Use Second Order Differential equation to create mathematical models of real life. Solve Mathematical Modelling of trajectory related problems using second order differential equation	U, 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	Hrs	CO No.	
1	**1.1**	**Simple Situations Requiring Mathematical Modelling**		1	
	1.2	The technique of Mathematical Modelling	13	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	
	2.2	Linear Growth and Decay Models	17	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			**3**
	3.2	Mathematical Modelling in Epidemics	15		3
	3.3	Compartment Models			3
	3.4	Economics Related Models			3
		Text 1: Chapter 3 - Sections: 3.1 to 3.4			
4	**4.1**	**Mathematical Modelling of Planetary Motion**		4	
	4.2	Mathematical Modelling of Circular motion and Motion of Satellites	15	4	
	4.3	Mathematical Modelling through Linear Differential Equations of Second Order		4	
	4.4	Miscellaneous Problems		4	
		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**

<table>
<tr><td rowspan="11"></td><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="9"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test -1</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -2</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -3</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -4</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</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Total</td><td colspan="2">30 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>

Text Book:

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**.**

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Transforms and Fourier Series**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	MCE4DSEMAT202					
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/week
		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	**U,** A	1,2,3,10
2	Apply various operations on Laplace transforms	A	2,3
3	Solve problems using Fourier series	E	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 -1		5 Marks	
		Module Test -2		5 Marks	
		Module Test -3		5 Marks	
		Module Test -4		5 Marks	
		Assignment/ Seminar		5 Marks	
		Quiz/Viva		5 Marks	
		Total		30 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**

TEXT BOOK:

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.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics**					
Course Name	**Operations Research**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	**MCE4DSEMAT203**					
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. Solve an LP problem by the graphical method.	U,A	1,2,3
2	Interpret the optimal solution of LP problems.Formulate the dual LP problem and understand the relationship between primal and dual LP problems.	A,U	1, 2,6,10
3	Recognize, formulate, and solve a transportation problem involving a large number of shipping routes.	**C**	1,2,3,6,10

4	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)	1	
	1.3	**a)** Some Exceptional Cases	1	
	1.4	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	2	**18**
	2.2	The Simplex Method (Example up to 2.16.4)	2	
	2.3	Artificial Variable Techniques: Big-M Method only (Example up to 2.17.4)	2	
	2.4	Special Cases in Simplex Method Application	2	
	2.5	Duality in Linear Programming	2	
	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, Matrix Terminology	3	**16**
	3.2	Formulation and Solution of Transportation Model	3	
	3.3	Variants in Transportation Problem	3	

	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	4	**14**
	4.2	Solution of the Assignment Model	4	
	4.3	Hungarian Method for Solution of the Assignment Problems	4	
	4.4	Formulation and Solution of the Assignment Model	4	
	4.5	Variation of Assignment Problem: Non-square Matrix and Maximization Problem	4	
	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 -1		5 Marks	
		Module Test -2		5 Marks	
		Module Test -3		5 Marks	
		Module Test -4		5 Marks	
		Assignment/ Seminar		5 Marks	
		Quiz/Viva		5 Marks	
		Total		30 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**

TEXT BOOK:

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.

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Business Mathematics**					
Type of Course	**Value Addition Course- VAC**					
Course Code	MCE4VACMAT200					
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**	Total Hours / Week
Course Details	**Learning Approach**	Lecture	Tutorial	Practical/ Practicum	Others	
		3	0	0	0	**45**
Pre-requisites, if any	Elementary Arithmetic					

COURSE OUTCOMES (CO)

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

3	Sketch graphs of linear equations and solve simultaneous equations using graphical methods.	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.	Hrs
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	**Classroom Procedure (Mode of transaction)**

<table>
<tr><td>Approach</td><td colspan="6">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 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="11">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"></td><td colspan="2"></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="4">B</td><td colspan="5">End Semester Examination(Written)</td></tr>
<tr><td colspan="5">Question Pattern [Maximum Time 90 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>
</table>

		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**

TEXT BOOK:

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.

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

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Document preparation using LaTeX**					
Type of Course	**Skill Enhancement Course (SEC)**					
Course Code	**MCE4SECMAT200**					
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**	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical/ Practicum	Others	
		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, 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.	Hrs
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			

Module	Units	Course Description	CO No.	Hrs
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)***		
	Interactive Instructions using ICT tools**,** Hands on Training		
Assessment Types	**MODE OF ASSESSMENT**		
		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.	
	A	**Continuous Comprehensive Assessment (CCA) 25 Marks**	
		Components	**Mark Distribution**
		Module Test -1	5 Marks

		Module Test -2			5 Marks	
		Module Test -3			5 Marks	
		Assignment/ Seminar			5 Marks	
		Quiz/Viva			5 Marks	
		Total			25 Marks	
	B	**End Semester Evaluation (ESE) 50 marks**				
		Question Pattern [Maximum Time 75Minutes, Maximum Marks 50]				
		Module	**Part A**	**Part B**	**Part C**	**Total**
			2 Marks	**5 Marks**	**10 Marks**	
		I	**3**	**2**	2	7
		II	**3**	**2**	1	6
		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**

TEXT BOOK:

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

SUGGESTED READINGS:

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

3.

	MAHARAJA'S COLLEGE, ERNAKULAM(Government Autonomous)			
Programme	B. Sc. Mathematics Honours			
Course Name	**INTERNSHIP**			
Type of Course	INT			
Course Code	MCE4INTMAT200			
Semester		Credits	**2**	

A. Internship Guidelines

- 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.
- TheDepartmentshallapprovetheinstitutionwhereeverystudentisplanningforinternship. Internal mentors shall be assigned to the students for necessary guidance.
- Thenatureoftheworkshalldependonthetypeoforganisationselected.Online internship can be permitted depending on the nature of the work. The internship shall be 60 to 120 hours duration after the fourth semester.
- The student shall prepare a Work Record and submit the same to the department periodically as decided by the internal mentor. At the end of the Internship tenure, an Internship Report shall also be submitted.

B. 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 / educational sector.

- Foster collaboration between academic institutions and industry/research organizations**.**

C. Evaluation of Internship : Total 50 Marks

The evaluation of internship shall be done by a committee constituted by the Department Council. The scheme of CCA and ESE is given below :

Components of Evaluation of Internship	Weightage	Marks for Internship 2 Credits/ 50 Marks
CCA	**30%**	**15**
ESE	**70 %**	**35**

ContinuousComprehensiveAssessment-15marks

CCAshallbebasedontheWorkRecord.Itshallbeevaluatedby theinternalmentor& the Head of the Department.

1. Feedback from the hosting organization (5 marks).
2. Supervisor/Internal Mentor feedback (10 marks).

FortheEndSemesterEvaluation-35 marks

1. Presentation (15 marks).
2. Internship report (10 marks).
3. Viva Voce (10 marks).

Theevaluationofthereportandpresentation/vivashallbedonebyaBoardofInternalExaminers as decided in the Department Council.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	A Voyage Into Complex Analysis					
Type of Course	Discipline Specific Course (DSC A)					
Course Code	MCE5DSCMAT300					
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 residues 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	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		3	0	2	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 completion of the course, 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	Hrs	CO No.
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 54			
2		Series of Complex Functions	15	

	2.1	Convergence of sequences and series		6
	2.2	Taylor series, Proof of Taylor's Theorem, Examples		6
	2.3	Laurent Series, Examples		6
		Problems (Practicum)		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, 72 to 76			
4		Evaluation of Improper Integrals	20	
	4.1	Evaluation of improper integrals, Example		7
	4.2	Improper integrals from Fourier analysis. Jordan's Lemma (statement only)		7
	4.3	Definite integrals involving sines and cosines		7
		Problems (Practicum)		7
	Text 1: Sections: 78 to 81 & 85			

5	Teacher Specific Content		
	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. Lecture methods 2. Problem solving Methodologies 3. Activity based Tutorials/ Practical 4. Software based visualisation of concepts		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**

<table>
<tr><td rowspan="10"></td><td rowspan="8"></td><td colspan="3">Module Test -1</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test -2</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test -3</td><td>5 Marks</td></tr>
<tr><td colspan="3">Module Test -4</td><td>5 Marks</td></tr>
<tr><td colspan="3">Assignment/ Seminar</td><td>5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva</td><td>5 Marks</td></tr>
<tr><td colspan="3">Total</td><td>30 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="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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<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>

TEXT BOOK:

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.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Towards Mathematical Precision: Limits And Convergence**					
Type of Course	**Discipline Specific Course (DSC A)**					
Course Code	MCE5DSCMAT301					
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 acomprehensive understanding of the mathematical structures crucial tocalculus. Topics include limits of sequences, monotone sequences,sub sequences, proper divergence, Cauchy sequences, and infinite serieswith a focus on convergence criteria, comparison tests, and specialattention to tests like Root and Ratio, Raabe's, Alternating Series,Dirichlet and Abel test. The course also discusses the limit concepts ofreal functions. By course end, students possess a solid foundation formathematical analysis.					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		4		0		60
Pre-requisites, if any	Fundamental of real analysis.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, student will be able to:			
1	Analyze convergence methods for sequences to determine limits. Investigate and analyze the properties and behavior of monotone sequences.	A, An	1, 2, 3,10
2	Understand and analyze subsequences, demonstrating proficiency in their properties. Analyze and apply Cauchy sequences, focusing on their convergence properties.	A, An	1, 2, 3, 10
3	Understand infinite series, apply convergence/divergence tests, develop concepts of absolute convergence, and use specific tests for non-absolute convergence.	A,C, U	1, 2, 3,10
4	Develop and apply theories to determine limits of functions at specific points and understand their properties.	A, C, 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.	Hrs
1	1.1	Sequences and Their Limits	1	15
	1.2	Limit Theorems	1	
	1.3	Monotone Sequences	1	
	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	Sub sequences and the Bolzano-Weierstrass Theorem	2	15
	2.2	The Cauchy Criterion .	2	
	2.3	Properly Divergent Sequences	2	
	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.	3	15
	3.2	Absolute Convergence, Grouping and rearrangements of series	3	
	3.3	Tests for Absolute Convergence: Limit comparison Test II, The Root and Ratio Test (Concepts and Problems only)	3	
	3.4	The Raabe's Test (Concepts and Problems only)	3	
	3.5	Test for Non absolute Convergence: Alternating Series Test, The Dirichlet and Abel test. (Concepts and Problems only	3	
	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	4	15
	4.2	Limit Theorems	4	
	4.3	Some Extensions of the Limit Concept	4	
		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**			

Teaching and Learning Approach	***Classroom Procedure (Mode of transaction)***					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**				
		Components			**Mark Distribution**	
		Module Test -1			5 Marks	
		Module Test -2			5 Marks	
		Module Test -3			5 Marks	
		Module Test -4			5 Marks	
		Assignment/ Seminar			5 Marks	
		Quiz/Viva			5 Marks	
		Total			30 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	**6Marks**	**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**

TEXT BOOK:

1. Robert G Bartle., Donald R Sherbert. *Introduction to Real Analysis (4thEdition)*, 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.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Fundamentals of Groups and Rings**					
Type of Course	**Discipline Specific Course (DSC A)**					
Course Code	MCE5DSCMAT302					
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	Total Hours / Week
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		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 completion of the course, 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.	An	1,2,3,4,5
4	Analyse rings, fields, and integral domains, and thus become adept in algebraic structures.	An	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	Hrs	CO No.
1	1.1	Binary Operations – Definitions and Examples	20	1
	1.2	Groups – Definition, Examples		1
	1.3	Groups - Elementary Properties		1
	1.4	Group Isomorphism, Group Tables and Examples of Abelian Groups		1
		Practicum **Problems from sections 2 and 3**		
		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**	20	2
	2.2	Symmetric Groups and Disjoint Cycles		2
	2.3	Subgroups, Cyclic Groups and Cyclic Subgroups		2
		Practicum **Problems from sections 4, 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	20	3
	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
		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	15	4
	4.2	Integral Domain, Characteristic of a Ring		4
	4.3	Field of Quotients of an Integral Domain (Statement only)		4
		Text 1: Chapter 22 – Sections: 22.1to 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 Content***(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>Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td></td><td colspan="6">Lectures, Tutorials, Interactive Sessions, Blended Learning</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="9"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test -1</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -2</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>
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[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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<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

TEXT BOOKS:

1. Fraleigh, John B.;. Brand, Neal E, *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. 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

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B. Sc. Mathematics Honours**					
Course Name	**Differential Equations and Applications**					
Type of Course	**Discipline Specific Course (DSC A)**					
Course Code	**MCE5DSCMAT303**					
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	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practicum	Others	
		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 completion of the course, 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)			

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	2	**10**
	2.2	A Special Transformation	2	
	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**

<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: Explicit Teaching, Lecture. Interactive Instruction: Active Co-operative Learning, Group Assignments</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>
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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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<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

TEXT BOOK:

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 and Historical Notes.* 3rd ed. CRC Press, Taylor & Francis. 2016

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Numerical methods**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	**MCE5DSEMAT300**					
Course Level	**300-399**					
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	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		4	0	0	0	60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, 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	Hrs	CO No.	
1	1.1	Numerical Analysis: Mathematical Preliminaries, Errors and Their Computations.		1	
	1.2	Introduction, Bisection Method, Method of False Position.	15	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	
	2.2	Newton's Formulae for Interpolation.	15	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	
	3.2	Divided Differences and Their Properties.	15	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.	15	1,3	
	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 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 -1		5 Marks	
		Module Test -2		5 Marks	
		Module Test -3		5 Marks	
		Module Test -4		5 Marks	
		Assignment/ Seminar		5 Marks	
		Quiz/Viva		5 Marks	
		Total		30 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**

TEXT BOOKS:

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

Suggested Readings

1. *Chapra, S**te**ven C. Applied Numerical Methods with MATLAB for Engineers and Scientists (4th ed.).* McGraw-Hill Education, 2018.

2. Fausett, Laurene V. *Applied Numerical Analysis Using MATLAB.* Pearson. India, 2009.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Exploring the Harmony of Automata**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	MCE5DSEMAT301					
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

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

TEXT BOOKS:

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

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Inventory Management and Simulation: The Basics of Business Success**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	MCE5DSEMAT302					
Course Level	**300-399**					
Course Summary	The courseaimed at building valuable skills for streamlining business operations and ensuring customer satisfaction.The course will coverdifferent inventory control methods. The students will learn about different quality control techniques, how to implement them, and how they relate to inventory management.					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practicum	Others	
		4	0	0	0	**60**
Pre-requisites, if any	Basic Mathematics					

COURSE OUTCOMES (CO)

Co no.	Expected course outcome	Learning domains *	Po no
Upon the completion of the course, student will be able to:			
1	Identify various inventory problems and classify them	U	1,2,3,6,9,
2	Analyse inventory management problems	A	1,2,3,6,9,10
3	Understand simulation techniques	**U**	1,2,3,6,9,1
4	Apply quality control techniques	A	1,2,3,6,9,1
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	Hrs	CO No.
1	**1.1**	Necessity for maintaining inventory	13	1
	1.2	inventory costs		1
	1.3	Inventory control problem		1
	1.4	Classification of fixedorder quantity inventory models		1
	1.5	Inventory models withdeterministic demand		1
		Text 1: Chapter 12 - Sections: 12.1-12.5		
2	2.1	Inventory models with probabilistic demand	13	2
	2.2	Inventory models with a price break		2
	2.3	Multi item deterministic model		2
	2.4	Forecasting of demand, forecasting methods		
	2.5	When to order, Selective inventory management techniques, Periodic review system		2
		Text 1: Chapter 12 - Sections: 12.6-12.13		
3	3.1	Introduction, when to use simulation, what is the simulation	17	3
	3.2	Advantages of simulation technique, limitations of the		3

		simulation technique		
	3.3	Application of simulation, Monte Carlo simulation		3
	3.4	Generation of random numbers, simulation languages		3
		Text 1: Chapter 13		
4	**4.1**	Definition, Objectives of quality control		4
	4.2	Steps in quality control problem, advantages of statistical quality control	17	4
	4.3	Causes of variation in quality,Techniques of SQC, control charts, control charts for variables, control charts for attributes		4
	4.4	Inspection, objectives of inspection, types of inspection,product control,acceptance sampling, single sampling plan,OCC, Double sampling plan, Multiple sequential sampling		4
		Text 1: Chapter 9& 10		

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 -1			5 Marks	
		Module Test -2			5 Marks	
		Module Test -3			5 Marks	
		Module Test -4			5 Marks	
		Assignment/ Seminar			5 Marks	
		Quiz/Viva			5 Marks	
		Total			30 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	**6Marks**	**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**

TEXTBOOK:

Gupta, Prem Kumar, and D. S. Hira. "Operations research, revised edition, S." *New Delhi: S Chand & Company* (2008).

Extra reading

1. Nicolas Vandeput, Inventory Optimization: Models and Simulations, Publisher: De Gruyter
2. Edward G. Schilling, Demystifying Quality Control by
3. Wayne L.Winston, Simulation Modeling and Analysis with Arena
4. Martin Christopher, Fundamentals of Inventory Management
5. William J. Kennedy, Quantitative Models for Inventory and Production Planning

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**B.Sc.Mathematics Honours**					
Course Name	**Introduction to Python for Mathematical Computation**					
Type of Course	**Skill Enhancement Course (SEC)**					
Course Code	**MCE5SECMAT300**					
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**	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	
		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, student will be able to:			
1	Discuss the basics of Python programming language.	U, S	1,2

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

Module	Units	Course Description	CO No.	Hrs
	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	

Module	Units	Course Description	CO No.	Hrs
	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	`		
	Interactive instructions using ICT tools Hands on training		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA)**Practical sessions or exams may be organised for each module and the CCA should be based on these hands on experiences.	
		Components	**Mark Distribution**
		Teacher Specific Content	20 Marks

<table>
<tr><td rowspan="11">Teaching and Learning Approach</td><td colspan="6">`</td></tr>
<tr><td colspan="6">Interactive instructions using ICT tools Hands on training</td></tr>
<tr><td></td><td colspan="3">Assignment/Quiz</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Examination (Written)</td></tr>
<tr><td rowspan="9"></td><td colspan="5">Question Pattern [Maximum Time 90 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>

TEXT BOOK:

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 – 3 rd 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.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Mathematical Analysis**					
Type of Course	**Discipline Specific Course (DSC A)**					
Course Code	MCE6DSCMAT300					
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'Hôpital's Rules and Taylor'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	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		3		1		75
Pre-requisites, if any	Limits and Convergence					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, student will be able to:			
1	Comprehend the concept of continuous functions and demonstrate proficiency in understanding their properties.	A,U	1, 2, 3
2	Understand uniform continuity, comparing and contrasting it with continuity.	U	1, 2, 3
3	Comprehend the concept of differentiation	A,U	1, 2, 3, 10
4	Develop comprehensive understanding of the Mean Value Theorem, L'Hôpital's Rules and Taylor's theorem.	A, U	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.	Hrs
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	
	2.3	**Problems (Practicum)**		
	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 **P**racticum 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>Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td rowspan="20">Assessment Types</td><td colspan="6">Lecturing</td></tr>
<tr><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 -1</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -2</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -3</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -4</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</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Total</td><td colspan="2">30 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>6Marks</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>

TEXT BOOK:

1. Bartle, Robert G., Sherbert, Donald R. *Introduction to Real Analysis (4thEdition),* 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.

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MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Fundamentals of Linear Algebra**					
Type of Course	**Discipline Capstone Course (Advanced) – DSC A**					
Course Code	MCE6DSCMAT301					
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	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		3	0	1	0	**75**

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	Hrs	CO No.
1	1.1	Vector Spaces: Definition and examples	20	1
	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)		
	Text 1: Chapter 5			
2	2.1	Linear Mappings	20	2
	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	20	3
	3.2	Characteristic Polynomial, Characteristic Equation and Algebraic Multiplicity		3
	3.3	Eigen Space and Geometric Multiplicity		3
		Problems (Practicum)		
		Text 1: Chapter 9 (up to and including theorem 9.2)		
4	4.1	Determinantal Mapping	15	4
	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 Content**			4

	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>Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td></td><td colspan="6">Lectures, Tutorials, Interactive Sessions, Blended Learning</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="9"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test -1</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -2</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -3</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -4</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</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Total</td><td colspan="2">30 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>6Marks</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>

TEXT BOOK:

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

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 CourseWare available at https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/video_galleries/video-lectures/

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Applications of Calculus and Linear Algebra in Finance**					
Type of Course	**Discipline Specific Course (DSC A)**					
Course Code	MCE6DSCMAT302					
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	Analyze 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	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
		Application of Calculus in Finance		
1	1.1	Production Functions, Cost Functions, Revenue and Profit Functions, Demand Functions and Elasticity **(Practicum)Exercise problems (Text 1)**	1	**15**
	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			
		Linear Algebra in Finance		
2	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	**20**
	2.2	Application to Portfolio Theory, IS-LM analysis via Cramer'S Rule **(Practicum)Exercise problems Text1 section 9.3**	2	

	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	3	**Optimization in Finance**	3	**20**
	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	
	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			
		Advanced Calculus in Finance		
	4.1	Concave functions in Economics, quasi concave and quasi convex Functions, Calculus Criteria, Pseudo concave functions	4	
4	4.2	Concave programming-Unconstrained Problems, Constrained Problems, Saddle Point Approach**(Practicum)Exercise of section 21.5 Text 1**	4	**20**
	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 Economic	4	
	Text 1: Chapter 21- sections: 21.2(Concave functions in Economics)21.3 to21.5; 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 applicationof theoretical knowledge and skills.It' s purpose is to encourage creativity and develop ProblemSolving Skills. The practicum component is to be done in the classroom under thestrict guidance of the teachers.A minimum of 30 problems is to be solved, and a handwrittencopy of the solutions should be kept in the department.

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[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
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</table>

TEXT BOOKS:

1. Carl P. Simon and Lawrence, Mathematics for Economists, Blume Viva Books, 2018
2. Sydsæter, Knut, Peter J. Hammond, Arne Strom. *Essential mathematics for economic analysis*. Pearson Education, 4th edition 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

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Course Name	**An Invitation to Fuzzy Mathematics**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	**MCE6DSEMAT300**					
Course Level	**300-399**					
Course Summary	This course provides a comprehensive introduction to fuzzy set theory and its applications. It begins with a foundational overview of crisp sets before delving into the core concepts of fuzzy sets, including membership functions, alpha-cuts, and set operations. The course then explores fuzzy relations, equivalence relations, and compatibility relations. A significant portion is dedicated to fuzzy graph theory, covering its fundamentals, different types of fuzzy graphs, and concepts like connectivity, bridges, and cut vertices.					
Semester	**6**	**Credits**			**4**	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	
		4	0	0	0	60
Pre-requisites, If any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, 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 Graphs	I	1,7

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	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	2	**15**
	3.2	Binary Fuzzy Relations	3	
	3.3	Binary Relation on a single set	3	
	3.4	Fuzzy Equivalence Relations & Compatibility Relations	3	

Module	Units	Course Description	CO No:	Hours
	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 -1	5 Marks
		Module Test -2	5 Marks
		Module Test -3	5 Marks
		Module Test -4	5 Marks
		Assignment/ Seminar	5 Marks
		Quiz/Viva	5 Marks
		Total	30 Marks
	B	**End Semester Evaluation (ESE) 70 marks**	

		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]			
		Module	Part A 2 Marks	Part B 6Marks	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

TEXT BOOK:

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. Zimmermann, Hans-Jürgen. *Fuzzy set theory—and its applications*. Springer Science & Business Media, 2011.
2. Dubois, D., and H. Prade. "Fuzzy sets and systems: theory and applications." Mathematics in science and engineering (144 (1980).
3. John N. Mordeson, Davender S. Malik. Fuzzy Graphs: Theory and applications.

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Combinatorics**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Level	**300-399**					
Course Code	MCE6DSEMAT301					
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**.** Mainly deals with counting problems.					
Semester	**6**	**Credits**			**4**	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	
		4	0	0	0	60
Pre-requisites, If any	Elementary Algebra, Basic Set theory, Basic understanding of Probability theory					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, student will be able to:			
1	Provides a valuable toolkit for students preparing for various exams, offering a wealth of problems that sharpen logical reasoning and problem-solving skills.	S	1,2
2	Apply combinatorial methods to model and analyze real-world problems, emphasizing the translation of problems into mathematical language.	A, An	1,2,3,4
3	Apply Pigeonhole principal and ramsey numbers in various real life problems.	U	1,2,3

4	Develop critical thinking skills by analyzing and synthesizing complex combinatorial problems, evaluating different approaches, and selecting the most suitable strategies.	C	1,2,3,4,10
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Two basic counting principles	1	15
	1.2	Permutations	1	
	1.3	Circular permutations	1	
	1.4	Combinations	1	
	Text 1: Chapter 1- Sections: 1.1 to 1.4			
2	2.1	The injection and bijection principles	2	15
	2.2	Arrangements and selections with repetitions	2	
	2.3	Distribution Problems	2	
	Text 1: Chapter 1- Sections: 1.5 to 1.7			
3	3.1	Introduction	3	15
	3.2	The Pigeonhole principle	3	
	3.3	More examples	3	
	3.4	Ramsey Type problems and Ramsey numbers	3	
	3.5	Bounds for Ramsey Numbers	3	
	Text 1: Chapter 3 - Sections: 3.1 to 3.5 (Theorems 3.5.1 and 3.5.2 – statements only)			
4	4.1	Introduction	4	15

	4.2	The Principle of Inclusion and Exclusion:	4	
	4.3	A generalization	4	
	4.4	Integer solutions and shortest routes	4	
	4.5	The Sieve of Eratosthenes and Euler function	4	
	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 -1		5 Marks	
		Module Test -2		5 Marks	
		Module Test -3		5 Marks	
		Module Test -4		5 Marks	
		Assignment/ Seminar		5 Marks	
		Quiz/Viva		5 Marks	
		Total		30 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**

TEXTBOOK:

1. Chen, Chuan-Chong, 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.

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**B.Sc. Mathematics**					
Course Name	**Computations and Graphics Using Scilab**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	**MCE6DSEMAT302**					
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	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		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

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
4	Apply Scilab to plot various mathematical functions, expressions and solving differential equations.	A,S	2
nderstand (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 (Solving Linear Systems, Some useful Functions- sort, length, sum and product)	3	
	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 -1	5 Marks
		Module Test -2	5 Marks
		Module Test -3	5 Marks
		Module Test -4	5 Marks
		Assignment/ Seminar	5 Marks
		Quiz/Viva	5 Marks
		Total	30 Marks
	B	**End Semester Evaluation (ESE) 70 marks**	

		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]				
		Module	Part A 2 Marks	Part B 6Marks	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

TEXT BOOK:

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

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Mathematical Computation and Visualization with R**					
Type of Course	**Value Addition Course (VAC)**					
Course Code	**MCE6VACMAT300**					
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**	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical/ Practicum	Others	
		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, 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

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the successful completion of the course, student will be able to:			
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.	Hrs
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 – Sections: 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**		
	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	**15**
	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)**		
	Interactive instructions using ICT tools Hands on training		
	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:Introduction -** Outline the goals and expectations for the class **Recap and Review -** Briefly review the key concepts covered **Theory and Conceptual Understanding -** Discuss theoretical aspects and provide real-world examples **Hands-On Computation with R -** Conduct practical exercises using R to reinforce mathematical concepts **Group Project -** Assign a group project **Homework Assignment -** Assign relevant homework to reinforce learning		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 25 Marks**	
		Components	**Mark Distribution**
		Module Test -1	5 Marks
		Module Test -2	5 Marks
		Module Test -3	5 Marks
		Assignment/ Seminar	5 Marks
		Quiz/Viva	5 Marks
		Total	25 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	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

TEXT BOOK:

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*, 2 nd edition, Chapman & Hall/CRC, 2014.

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Computations and Graphics using SageMath**					
Type of Course	**Skill Enhancement Course (SEC)**					
Course Code	MCE6SECMAT300					
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**	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical/ Practicum	Others	
		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, student will be able to:			
1	Discuss the basic commands used for mathematical calculations using SageMath	**U, S**	**1,2**
2	Apply basic programming skills in SageMath to compute the limits and derivatives of various functions	**A, S**	**1,2,3,4**

3	Apply SageMath 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.	Hrs
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, Partial 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**

Module	Units	Course Description	CO No.	Hrs
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, Partial 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))			
	3.2	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	***Classroom Procedure (Mode of transaction)***
	Interactive instructions using ICT tools Hands on training

Learning Approach						
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) 25 Marks**				
		Components			**Mark Distribution**	
		Module Test -1			5 Marks	
		Module Test -2			5 Marks	
		Module Test -3			5 Marks	
		Assignment/ Seminar			5 Marks	
		Quiz/Viva			5 Marks	
		Total			25 Marks	
	B	**End Semester Evaluation (ESE) 50 marks**				
		Question Pattern **[Maximum Time 75Minutes, 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**

TEXT BOOK:

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.

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	B.Sc. Mathematics (Honours)					
Course Name	**Advanced Linear Algebra**					
Type of Course	Discipline Capstone Course (Advanced) – DCC					
Course Code	MCE7DCCMAT400					
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 triangulation and diagonalisation, direct sum decomposition, and invariant direct sums.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		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 completion of the course, 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	U,An	2,3,10
3	Compute the characteristic polynomial, eigenvectors, eigenvalues	A,E	2, 3

	and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result		
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	Hrs	CO No.
1	1.1	Review on Fields, Vector spaces, subspaces, basis and dimension (Theorems-Statements only)	20	1
	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	20	1,2
	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.	20	3

	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	15	3,4
	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 Content	Hrs	
	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, Tutorials, Interactive Sessions, Blended Learning		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**	
		Components	**Mark Distribution**
		Module Test -1	5 Marks
		Module Test -2	5 Marks
		Module Test -3	5 Marks
		Module Test -4	5 Marks
		Assignment/ Seminar	5 Marks
		Quiz/Viva	5 Marks

		Total			30 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	**6Marks**	**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**

TEXT BOOK:

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 VideoLectures | 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.

	MAHARAJA'S COLLEGE, ERNAKULAM **(Govt. Autonomous)**

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Theory of Complex Functions**					
Type of Course	**Discipline Capstone Course(Advanced) – DCC**					
Course Code	**MCE7DCCMAT401**					
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.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		4	0	0	0	**60**
Pre-requisites, if any	Basic awareness of complex numbers					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, 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 Möbius transforms.	U	1, 2, 3
2	Illustrate complex analytic functions as power series expansions, recognizing the convergence properties and regions of validity of theserepresentations.	A	1, 2
3	Analyze various versions of Cauchy's theoremand applying them to solve complex integration problems. Explain the fundamental principles of complex integration.	An	1,2,3,10
4	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
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	1	
	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	2	**15**
	2.2	Power series representation of analytic functions	2	
	2.3	Zeroes of an analytic function	2	
	2.4	The index of a closed curve	2	

	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	
	3.3	Counting zeros, Open mapping theorem	3	
	3.4	Goursat theorem	3	
	Text 1: Chapter 4 – Sections: 5 to 8 (only statement of third version of Cauchy's theorem)			
4	4.1	Classification of singularities	4	**15**
	4.2	Residues	4	
	4.3	Argument Principle	4	
	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)***				
Assessment Types	**MODE OF ASSESSMENT**				
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**			
		Components		**Mark Distribution**	
		Module Test -1		5 Marks	
		Module Test -2		5 Marks	
		Module Test -3		5 Marks	
		Module Test -4		5 Marks	
		Assignment/ Seminar		5 Marks	
		Quiz/Viva		5 Marks	
		Total		30 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**

TEXT BOOK:

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

SUGGESTED READINGS:

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

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	B.Sc. Mathematics Honours					
Course Name	Introduction to Metric Spaces					
Type of Course	Discipline Capstone Course (Advanced) – DCC					
Course Code	MCE7DCCMAT402					
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	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		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 completion of the course, 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	Hrs	CO No.
1	1.1	Inequalities	15	1
	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	15	3
	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	15	4
	3.2	Uniform continuity		2,4
	3.3	Homeomorphism , Equivalent metrics and Isometry		2,4
	Text 1: Chapter 3 – Sections: 3.1, 3.4 & 3.5			
4	4.1	Connectedness	15	4,5
	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

Teaching and Learning Approach	***Classroom Procedure (Mode of transaction)***				
Assessment Types	**MODE OF ASSESSMENT**				
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**			
		Components		**Mark Distribution**	
		Module Test -1		5 Marks	
		Module Test -2		5 Marks	
		Module Test -3		5 Marks	
		Module Test -4		5 Marks	
		Assignment/ Seminar		5 Marks	
		Quiz/Viva		5 Marks	
		Total		30 Marks	
	B	**End Semester Evaluation (ESE) 70 marks**			
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**			
		Module	**Part A** **2 Marks**	**Part B** **6Marks**	**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**

TEXT BOOK:

1. Satish Shirali, Harikrishnan L Vasudeva, Metric 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.

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Algebraic Structures in Depth : Groups and Rings**					
Type of Course	**Elective – DCE**					
Course Code	MCE7DCEMAT400					
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	Total Hours Per week
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		4	0	0	0	60
Pre-requisites, if any	Fundamentals of Groups and Rings					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	PO No	Learning Domains *
Upon the completion of the course, 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, 10
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.	Hrs
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	
	1.7	**Section 9 problems 1to17, section12 problems 1 to 16**		
	Text 1: Sections: 9(9.2, 9.5,9.19,9.20 statement only) & 12(12.8,12.14 statement only)			
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	
	2.6	**Section 13 problem 1 to 17, section 14 problem 1 to 11**		
	Text 1: Sections: 13(13.22 statement only) & 14(14.19 and 14.20statement only)			
3	3.1	Isomorphism theorems	2	14
	3.2	Sylow theorems	4	
	3.3	3 Applications of the Sylow theorems	4	
	3.4	**Section 16 problem 1 to 5, section 17 problems 1 to 13**		
	Text 1: Sections: 16(16.2, 16.8 statement only) & 17(17.4, 17.7 and 17.12 statement only)			
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	
	4.6	**Section 30 problems 1 to 10 and section 31 problems 1 to 15**		
	Text 1: Sections: 30 (30.6,30.11,30.16 statement only)& 31.1 to 31.20(31.17,31.18,31.19 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**			

<table>
<tr><td>Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td></td><td colspan="6">Direct Instruction, Brainstorming Lecture, Explicit Teaching, Active Co-operative Learning.</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="8"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test -1</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -2</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -3</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -4</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</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Total</td><td colspan="2">30 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>6Marks</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>

TEXT BOOK:

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

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	B.Sc. Mathematics Honours					
Course Name	Real Analysis					
Type of Course	Elective– DCE					
Course Code	MCE7DCEMAT401					
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	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		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 completion of the course, student will be able to:			
1	Understand and analyse 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 foster 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	U, An	1,2,3,10

	and its properties.		
6	To understand Equicontinuous families of functions, Weierstrass theorem and understand power series	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	Hrs	CO No.
1	1.1	Introduction, properties of monotonic functions, functions of bounded variation	15	1
	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	15	3
	2.2	Properties of the integral		4
	2.3	Integration and differentiation.		4
	2.4	Integration of vector valued functions.		4
	Text 2: Chapter 6 - Sections: 6.1 to 6.25			
3	3.1	Sequence and series of functions - Discussion of main problem.	15	5
	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.	15	6
	4.2	The Weierstrass theorem		6
	4.3	Power series		6
	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, Tutorials, Activity, cooperative learning, Direct instruction, Brainstorming				
Assessment Types	**MODE OF ASSESSMENT**				
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**			
		Components		**Mark Distribution**	
		Module Test -1		5 Marks	
		Module Test -2		5 Marks	
		Module Test -3		5 Marks	
		Module Test -4		5 Marks	
		Assignment/ Seminar		5 Marks	
		Quiz/Viva		5 Marks	
		Total		30 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**

TEXT BOOK:

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.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B Sc Mathematics Honours**					
Course Name	**Graph Theory**					
Type of Course	**Elective – DCE**					
Course Code	**MCE7DCEMAT402**					
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	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		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

CO No:	Expected Course Outcome	Learning Domains	PO No:
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, K5 and K3, 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 -1		5 Marks	
		Module Test -2		5 Marks	
		Module Test -3		5 Marks	
		Module Test -4		5 Marks	
		Assignment/ Seminar		5 Marks	
		Quiz/Viva		5 Marks	
		Total		30 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**

TEXT BOOK:

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.

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**Applied Economics Honours**					
Course Name	**Principles of Quantitative Analysis**					
Type of Course	**Discipline Specific Course (DSC B)**					
Course Code	MCE7DSCMAT400					
Course Level	**400-499**					
Course Summary	This is an advanced course in Mathematics especially for Economics students					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		4	0	0	0	**60**
Pre-requisites, if any	Algebra of real numbers, set theory,Differentiation					

COURSE OUTCOMES (CO)

Co no.	Expected course outcome	Learning domains *	Po no
Upon the completion of the course, student will be able to:			
1	Analyse how economies evolve over time with the help of sequences	A	1, 2,6,, 10
2	Identify optimal solutions within realistic boundaries.	S	1, 2, 3, 6,10
3	Complex economic systems with the help of vector space	**A**	**1,2,6,10**
4	Solve complex optimization problems and make better economic forecasts	a	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	Hrs	CO No.
1	**1.1**	Sequence of real numbers	13	1
	1.2	Sequences in $\mathbb{R}^m$		1
	1.3	Open set ,closed set		1
	1.4	Compact set, functions between Euclidean spaces		1
	1.5			1
	Text 1: Chapter 12 - (exclude *proof)*Section 13.1			
2	2.1	**Cauchy sequences**	17	2
	2.2	Compact sets		2
	2.3	Connected sets		2
	2.4	Alternative forms		2
	2.5			3
	Text 1: Chapter 29 section 29.1-29.4 exclude proof			
3	3.1	Vector spaces and subspaces	15	**3**
	3.2	Basis and dimension of a proper subspace		3
	3.3	Row space, Column space, Null space		3
	3.4	Abstract vector space		3
	Text 1: Chapter 27 Sections27.1-27.6 Exclude proof			
4	**4.1**	First order linear differential Equation with constant coefficient and constant term	15	4
	4.2	Variable coefficient and variable term		4
	4.3	Exact differential equation		4
	4.4	Non-linear differential equation of first order and first degree		4
		Text 2: Chapter 15 - Sections: 15.1, 15.3.15.4 and 15.5		
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, 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 -1	5 Marks
		Module Test -2	5 Marks

		Module Test -3			5 Marks	
		Module Test -4			5 Marks	
		Assignment/ Seminar			5 Marks	
		Quiz/Viva			5 Marks	
		Total			30 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	**6Marks**	**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**

TEXT BOOK:

1. .Carl P. Simon and Lawrence Blume, Mathematics for economists, W. W. Norton and Company, 1994.

SUGGESTED READINGS:

1. Anjan Mukherji and Subrata Guha, Mathematical Methods and Economic Theory, OUP India, 2011
2. K. G. Binmore, Mathematical analysis, Cambridge University Press, 1991.
3. Avinash K. Dixit, Optimization in economic theory, Oxford University Press,
4. David Gale, The theory of linear economic models, McGraw-Hill, 1960.
5. G. Hadley, Linear algebra, Narosa Publishing House, 1987.
6. Carl P. Simon and Lawrence Blume, Mathematics for economists, W. W. Norton and Company, 1994.
7. Alton H. Smith and Jr. Walter A. Albrecht, Fundamental concepts of analysis, Prentice Hall of India, 1966.
8. Gilbert Strang, Introduction to linear algebra, Wellesley-Cambridge Press, 2003.
9. Rangarajan K. Sundaram, A first course in optimisation theory, Cambridge University Press, 1996.
10. Patrick Suppes, Introduction to logic, Affiliated East-West Press, 1957.
11. Knut Sydsaeter and Peter J. Hammond, Mathematics for economic analysis, first, fourth impression ed., Pearson Education, 2009.
12. Alfred Tarski(1965), Introduction to logic and to the methodology of deductive science, Oxford University Press, 1965.

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.A./ B.Sc. /B.Com(Honours)**					
Course Name	**Dynamic Optimization**					
Type of Course	**Discipline Specific Course (DSC B)**					
Course Code	MCE7DSCMAT401					
Course Level	**400-499**					
Course Summary	*D*ynamic optimization course equips the students with the tools to make the best decisions over time. It tackles situations where your choices now affect what options are available later. The course focuses on two main approaches: dynamic programming and optimal control.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		4	0	0	0	60
Pre-requisites, if any	Difference equation, Differential Equation					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	PO No	Learning Domains *
Upon the completion of the course, student will be able to:			
1	understand continuous, and discrete Time Processes,	U	1,2,3
2	apply optimal control theory	A	1,2,5,6,8,10
3	analyse the infinite Horizon problem	An	1,2,5,6,8
4	Evaluate Economic growth	E	1,2,6,8,9,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	CO No.	Hrs
1	1.1	Continuous Time Processes,	1	13
	1.2	Discrete Processes	1	
	1.3	Motion on the plane	1	
	1.4	Stability of Periodic Points,The logistic map	1	
	Text 1 Chapter 13 section 13.1 to13.3			
2	2.1	Introduction to the Optimal Control Theory	2	17
	2.2	A Basic Optimal Control Problem	2	
	2.3	Necessary Conditions	2	
	2.4	The Maximum Principle for the Basic Problem	2	
	Text 1 Chapter 14 section 14.1 to14.4			
3	3.1	Sufficient Conditions for an Optimal Control	3	17
	3.2	Variants of the Basic Problem	3	
	3.3	Infinite Horizon Problems	3	
	Text 1 Chapter 14 section 14.5 to14.7			
4	4.1	Introduction, The Stability of Competitive Equilibrium	5	13
	4.2	Optimal Economic Growth Ramsey-Cass-Koopmans Model	5	
	4.3	The Social Planner's Problem	5	
	Text 1 Chapter 15 section 15.1 to15.4			
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 -1	5 Marks
		Module Test -2	5 Marks
		Module Test -3	5 Marks
		Module Test -4	5 Marks
		Assignment/ Seminar	5 Marks
		Quiz/Viva	5 Marks
		Total	30 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	**6Marks**	**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**
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TEXTBOOK:

1. Anjan Mukherji and Subrata Guha, Mathematical Methods and Economic Theory, OUP India, 2011.

SUGGESTED READINGS:

1. K. G. Binmore, Mathematical analysis, Cambridge University Press, 1991.
2. Avinash K. Dixit, Optimization in economic theory, Oxford University Press,
3. David Gale, The theory of linear economic models, McGraw-Hill, 1960.
4. G. Hadley, Linear algebra, Narosa Publishing House, 1987.
5. Carl P. Simon and Lawrence Blume, Mathematics for economists, W. W. Norton and Company, 1994.
6. Alton H. Smith and Jr. Walter A. Albrecht, Fundamental concepts of analysis, Prentice Hall of India, 1966.
7. Gilbert Strang, Introduction to linear algebra, Wellesley-Cambridge Press, 2003.
8. Rangarajan K. Sundaram, A first course in optimisation theory, Cambridge University Press, 1996.
9. Patrick Suppes, Introduction to logic, Affiliated East-West Press, 1957.
10. Knut Sydsaeter and Peter J. Hammond, Mathematics for economic analysis, first, fourth impression ed., Pearson Education, 2009.
11. Alfred Tarski(1965), Introduction to logic and to the methodology of deductive science, Oxford University Press, 1965.

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**B. Sc. Mathematics Honours**					
Course Name	**Functional Analysis**					
Type of Course	**Discipline Capstone Course (Advanced) – DCC**					
Course Code	MCE8DCCMAT400					
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	Total Hours/ Week
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		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 completion of the course, student will be able to:			
1	Analyze the characteristics of normed spaces and their impact on their elements. Evaluate the unique properties and behavior of finite-dimensional normed spaces.	U, An,E	1,2,9
2	Analyze the behavior and properties of linear operators and functionals. Understand the Hahn-Banach Theorem and its generalization to complex vector and normed spaces.	U, An,A	1,2,9
3	Evaluate the structure and properties of inner product and Hilbert spaces, focusing on completeness and orthogonality. Understand orthogonal complements, direct sums, and orthonormal sets and sequences.	U, An,A, E	1,2,9,10
4	Analyze functionals on Hilbert spaces and Hilbert adjoint operators. Evaluate properties of self-adjoint, unitary, and normal operators.	U, An,A, E	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	Hrs	CO No.
1	1.1	Vector space	20	1
	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		1
	1.5	Compactness and finite dimension.		1
		Problems from section 1.2 and 1.3 (Practicum)		
		Text 1: Chapter 2 - Sections: 2.1 to 2.5		
2	2.1	Linear operators.	18	2
	2.2	Bounded and continuous linear operators.		2

	2.3	Linear functionals (Algebraic dual, second algebraic dual and algebraic reflexivity are excluded)		2
	2.4	Linear operators and functionals on finite dimensional spaces (Proof of theorem 2.9-3 excluded)		2
	2.5	Normed space of operators, Dual spaces.		2
		Problems from sections 2.3 and 2.4 (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.	20	3
	3.2	Further properties of inner product spaces. (Proof of Completion theorem (3.2-3) excluded)		3
	3.3	Orthogonal complements		3
	3.4	Direct sums		3
	3.5	Orthonormal sets and sequences		3
	3.6	Series related to orthonormal sequences and sets (Example 3.5-1 excluded)		3
	3.7	Total orthonormal sets and sequences (Proof of theorem 3.6-5 excluded)		3
		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)	17	4
	4.2	Hilbert-adjoint operator.		4
	4.3	Self-Adjoint, Unitary and Normal Operators.		4
	4.4	Zorn's lemma.		4
	4.5	Hahn-Banach Theorem.		4
	4.6	Hahn-Banach Theorem for Complex Vector Spaces and Normed Spaces		4
		Text 1: Chapter 3 - Sections: 3.8 to 3.10; Chapter 4 - Sections: 4.1 to 4.3		
5	**Teacher Specific Content** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

<table>
<tr><td>Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td></td><td colspan="6">Lecture methods, Problem Solving Methodologies, Tutorials</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="8"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test -1</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -2</td><td colspan="2">5 Marks</td></tr>
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<tr><td colspan="3">Total</td><td colspan="2">30 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>6Marks</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>

TEXT BOOK:

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. Limaye, B V, *Linear Functional Analysis for Scientists and Engineers*, Springer 2016
3. Simmons, G F. *Introduction to Topology and Modern Analysis*, Mc Graw-Hill, New York,1963.
4. Siddiqi, A H. *Functional Analysis with Applications*, Tata Mc Graw-Hill, New Delhi, 1989.
5. Walter Rudin. *Functional Analysis*, *Second Edition*, International Series in Pure & Applied Mathematics, Tata Mc Graw Hill, 1973.

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**B Sc Mathematics Honours**
Course Name	**Measure Theory and Integration**
Type of Course	**Discipline Capstone Course (Advanced) – DCC**
Course Code	**MCE8DCCMAT401**
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. 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	2	0	75
Pre- requisites, If any	Fundamentals of Mathematical Analysis					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the completion of the course, 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	To understand 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**		
	1.1	Introduction	1	**20**
	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)		

Module	Units	Course Description	CO No:	Hours
	Text 1: Chapter 2 - Sections: 2.1 to 2.5			
2		**Measurable Functions**		
	2.1	Non measurable set	3, 4	**17**
	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)		
	Text 1: Chapter 2 - Sections: 2.6 to 2.7, Chapter 3- 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)		

Module	Units	Course Description	CO No:	Hours
	Text 1: Chapter 4 - Sections: 4.1 to 4.5; Chapter 6 - Section: 6.5			
4		**Measure spaces: Their properties and construction**		**18**
	4.1	Measures and Measurable Sets (Theorems without proof)	8	
	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 1: 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**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture and Tutorial		
	MODE OF ASSESSMENT		
	A	**Continuous Comprehensive Assessment (CCA)**	
		Components	**Mark Distribution**

<table>
<tr><td rowspan="12">Teaching and Learning Approach</td><td colspan="5">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="5">Lecture and Tutorial</td></tr>
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<tr><td>B</td><td colspan="5">End Semester Examination (Written)</td></tr>
<tr><td rowspan="10">Assessment Types</td><td colspan="5">Question Pattern
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</table>

TEXT BOOK:

1. Royden, H. L. , Fitzpatrick, P.M. *Real Analysis FourthEdition, 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).

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	B Sc Mathematics Honours					
Course Name	Basic Topology					
Type of Course	Elective-DCE					
Course Code	MCE8DCEMAT400					
Course Level	**400-499**					
Course Summary	Course introduces properties of topological spaces, including Compactness, Connectedness and Separation axioms					
Semester	8	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		3	0	2	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 completion of the course, 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 set 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	Hrs	CO No.
1	1.1	Definition and related concepts. Examples of topological spaces	20	1
	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	20	2
	2.2	Continuity. Related concepts		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	15	3
	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	20	5
	4.2	Path Connectedness (Practicum)		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 Content		

	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>Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td></td><td colspan="6">Chalk and talk, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment, Quiz</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="9"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test -1</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -2</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -3</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test -4</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</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Total</td><td colspan="2">30 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>

TEXT BOOK:

1. K. D. Joshi. Introduction to General Topology, Third Edition, New Age

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

MAHARAJA'S COLLEGE, ERNAKULAM
(Govt. Autonomous)

Programme	**B.Sc. Mathematics Honours**					
Course Name	**Exploring Field Extensions and Galois Theory**					
Type of Course	**Elective- DCE**					
Course Code	MCE8DCEMAT401					
Course Level	**400-499**					
Course Summary	The objective of the course is to learn more about field theory. The first module covers topics on the 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	Total Hours/week
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		3		1		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 completion of the course, students will be able to:			
1	Explain the 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 analyze 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, 3,5, 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.	Hrs
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 , Application to unique factorization in F[x]	1	
		Problems (Practicum) section 27 problem 1 to 17, section 28 problem 1 to 22)		
	Text 1: Sections: 27(27.1,27.2,27.4 statement only), 28 (28.6, 28.7, 28.19, 28.20 statement only) & 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) Section 39 problems 1 to 18 section 40 problems 1 to 8		
	Text 1: Sections: 39(39.14 statement only), 40 (40.1 to 40.18) (40.4, 40.6 statement only) & 42(42.5, 42.6, 42.9 statement only)			
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) Section 43 problem 1 to 22, section44 problem 1 to 17)		
	Text 1: Sections: 43 (43.19 and 43.20 statement only), 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(**proof excluded**)	4	
		Problems (Practicum) Section 45 problem 1 to 13 and section 46 problem 1 to 8		

	Text 1: Sections 45 (45.9 statement only)& 46	
5	**Teacher Specific Content** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**	

Practicum

Practicum is designed to provide supervised practical application of theoretical knowledge and skills. **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>Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)
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="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 Mark</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Mark</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Mark</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Mark</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Mark</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 Examination (Written)</td></tr>
<tr><td rowspan="6"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</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>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>
</table>

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

TEXT BOOK:

1. Fraleigh, John B., and Neal E. Brand. *A First Course in Abstract Algebra* 8thed,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, 201027

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

MAHARAJA'S COLLEGE, ERNAKULAM

(Govt. Autonomous)

Programme	**B Sc Mathematics Honours**
Course Name	**Optimization Techniques**
Type of Course	**Elective- DCE**
Course Code	MCE8DCEMAT402
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	Total Hours/ Week
Course Details	Learning Approach	Lecture	Tutorial	Practical/ Practicum	Others	
		3	0	1	0	**75**

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	Understand ILP, MILP problems, cutting plane, and Branch-and-Bound methods, enhancing problem-solving and optimization skills	U	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	Hrs	CO No.
1		Linear Programming		
	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.	20	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 from 1.1,1.2 and 1.3 (Practicum)		
		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	15	2
	2.2	Cutting Plane Method		2
	2.3	Branch and Bound Method		2
		Problems from sections 2.2 and 2.3 (Practicum)		
		Text 1: Chapter 6 – Sections: 6.3, 6.5, 6.6 & 6.8		
3		Flow in Networks		
	3.1	Graphs: Definition and Notations	15	3
	3.2	Minimum Path Problem, Spanning Tree of Minimum Length.		3
	3.3	Scheduling of Sequential Activities, Maximum Flow Problem.		3
		Text 1: Chapter 5 – Sections: 5.2 to 5.7		
		Non Linear Programming		
4	4.1	Taylor's Series Expansions Necessary and Sufficient Condition	25	4
	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
		Text 1: Chapter 11 – Sections: 11.2 to 11.7		
	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 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 -1	5 Marks

		Module Test -2			5 Marks	
		Module Test -3			5 Marks	
		Module Test -4			5 Marks	
		Assignment/ Seminar			5 Marks	
		Quiz/Viva			5 Marks	
		Total			30 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**

TEXT BOOKS:

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.

	MAHARAJA'S COLLEGE, ERNAKULAM(Government Autonomous)				
Programme	B.Sc. Mathematics Honours				
Course Name	**PROJECT**				
Type of Course	PRJ				
Course Code	MCE8PRJMAT400				
Course Level	400-499				
Course Summary	The student is expected to undertake a project under the supervision and guidance of a faculty member and submit a report				
Semester	**8**	Credits	**12**		

Project Preparation and Evaluation Guidelines

1. All students shall prepare and submit a project report as part of the Honours programme. The project has to be undertaken on an individual basis and shall be submitted in Semester 8.
2. The general guidelines of the Regulations shall apply for both Internal and External Evaluations of Project Report.
3. The Project shall be done under the supervision and guidance of faculty of the department.
4. Students shall submit the report in the prescribed format at least three weeks before the commencement of end semester examination of the eighth semester. Internal assessment shall be based on completion of the project, following the norms prescribed in general guidelines.
5. The area of the project shall be related to Mathematics.
6. The student shall submit copies of the project report, either printed or typed. There shall be a minimum of 40 pages and a maximum of 75 pages. The report may be hard bound or soft bound or spirally bound and the printing can be either double sided or single sided. A softcopy

of the report shall also be submitted to the department.

7. The report shall contain the following:
    - Title page with topic, details of the student with register number, supervisor details and month and year of submission.
    - Certificate from Supervising teacher and counter signed by the Head of the Department with department seal.
    - Declarationbythestudentwhichshallincludeplagiarismdetailsalso. Therelevantguidelines issued by the UGC and the University shall be strictly adhered to.
    - Acknowledgement
    - Contents
    - Preferably 4 to 5 chapters.
    - Bibliography(References may be presented in AMS style)

8. The student shall do progress presentation frequently. The final pre-submissionpresentationshallbeanopenpresentationwiththehelpofaudio-visualaidsandshallbe evaluated by a Board of Internal Examiners including the Guide and the Head of the Department, Final submission of the project report shall be based on the suggestions of the open presentation.
9. The End Semester Evaluations shall be done by an external examiner and the Head of the Department/the nominee of the Head of the Department. There shall be a vivo voce.
10. It is the responsibility of the student to put earnest effort into the completion of the project. The consequences of plagiarism beyond permissible level in project work may result in failure of the course, in addition to other consequences.

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.

EvaluationCriteria-12credit project

Total Marks–200(CCA-60andESA-140)

A) ContinuousComprehensiveAssessment-60 marks

Synopsis Presentation	20 marks
Technical Skill	20 marks
Report & Overall Performance	20 marks
Total	**60 marks**

B) EndSemesterAssessment-140marks

1. ***Report-70marks***

Relevance of the Topic	20 marks
Review of Literature	20 marks
Results and Discussion	30 marks
Total	**70 marks**

2. ***Viva Voce-70marks.***

Presentation	30 marks
Viva Voce	40 marks
Total	**70 marks**

It may be noted that any common regulation/ guideline issued by the University regarding Internship and Project shall supersede the above-mentioned guideline.