University of Kerala

Four Year Under Graduate Programme
(UoK FYUGP)

Syllabus

Major Discipline Mathematics

May 2024

About the Discipline

The mathematics discipline encompasses a vast array of topics, theories, and applications that explore the nature of numbers, shapes, patterns, and relationships. It's a fundamental science that serves as a cornerstone for many other disciplines, including physics, engineering, economics, computer science, and more. Mathematics is a dynamic field with ongoing research and innovation. Mathematicians explore new theories, develop novel techniques, and apply mathematical principles to address emerging challenges and questions across diverse domains. Overall, the mathematics discipline is a rich and multifaceted field that continues to evolve, with applications ranging from the abstract realms of pure mathematics to the practical domains of applied sciences and engineering.

Graduate Attributes

Graduate attributes bridge the gap between academia and the real world, fostering lifelong learning and meaningful contributions. They denote the skills, competencies and high-level qualities that a student should acquire during their university education. Apart from gathering content knowledge, these attributes go beyond the assimilation of information to its application in various contexts throughout a graduate's life. It aims in inculcating the art of critical thinking, problem solving, professionalism, leadership readiness, teamwork, communication skills and intellectual breadth of knowledge. The University of Kerala envisages to pave the path in guiding the student's journey to shape these attributes uniquely, making them integral to personal growth and success in various spheres of life. The University strives to ensure that these graduate attributes are not just checkboxes, but they play a pivotal role in shaping the students into capable, compassionate and responsible individuals with a high degree of social responsibility.

Programme Outcomes (PO)

PO-1: Critical thinking.

- Analyse information, objectively, and make a reasoned judgement.
- Draw reasonable conclusions from a set of information, and discriminate between useful and less useful details to solve problems or make decisions.
- Identify logical floss in the arguments of others.
- Evaluate data, fax, observable phenomena and research findings to draw valet and relevant results that are domain specific.

PO-2: Complex problem-solving.

- Solve different kinds of problems in familiar and non-familiar contexts and apply the learning to real life situations.
- Analyse a problem, generate and implement a solution and assess the success of the plan.
- Understand how the solution will affect both the people in world and the surrounding environment.

PO-3: Creativity.

- Produce or develop original work, theories and techniques.
- Think in multiple ways for making connections between seemingly unrelated concepts or phenomena.
- Add a unique perspective or improve existing ideas or solutions.
- Generate, develop and express origin ideas that are useful or have values.

PO-4: Communication skills

- Convey or share ideas or feelings effectively. Use words in delivering the intended message with utmost clarity.
- Engage the audience effectively.
- Be a good listener who are able to understand, respond and empathise with the speaker.
- Confidently share views and express himself or herself.

PO-5: Leadership qualities

- Work effectively and lead respectfully with diverse teams.
- Build a team working towards a common goal.
- Motivate a group of people and make them achieve the best possible solution.
- Help and support others in their difficult times to tide over the adverse situation with courage.

PO-6: Learning 'how to learn' skills

- Acquire new knowledge and skills, including learning how to learn skills, that are necessary for pursuing learning activities throughout life, through self past and self directed learning.
- Work independently, identify appropriate resources required for further learning.
- Acquire organisational skills and time management to set self defined goals and targets with timelines.
- Inculcate a healthy attitude to be a lifelong learner.

PO-7: Digital and technological skills

- Use ICT in a variety of learning and work situations, access, evaluate, and use a variety of relevant information sources.
- Use appropriate software for analysis of data.
- Understand the pit falls in the digital world and keep safe from them.

PO-8: Value inculcation

- Embrace and practice constitutional, humanistic, ethical, and moral values in life, including universal human values of truth, righteous conduct, peace, love, nonviolence, scientific temper, citizenship values.
- Formulate a position or argument about an ethical issue from multiple perspectives.
- Identify ethical issues related to work and follow ethical practises, including avoiding unethical behaviour, such as fabrication or misrepresentation of data, or committing plagiarism and adhering to intellectual property rights.

- Adopt an objective, and biased, and truthful actions in all aspects of work.

Programme Specific Outcomes

PSO-1: Acquire strong understanding of foundational Mathematical concepts across various areas

PSO-2: Equip the student with skills to analyze problems, formulate a hypothesis, evaluate and validate results, and draw reasonable conclusions thereof.

PSO-3: Employ mathematical ideas encompassing logical reasoning, analytical, numerical ability, theoretical skills to model real-world problems and solve them.

PSO-4: Develop critical thinking, creative thinking, self confidence for eventual success in career.

PSO-5: To prepare the students to communicate mathematical ideas effectively and develop their ability to collaborate both intellectually and creatively in diverse contexts.

PSO-6: Recognize the importance of lifelong learning and professional development in mathematics and related fields, exhibiting the motivation and initiative to stay updated with advancements in the field and continuously improve their skills and knowledge.

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University of Kerala

Discipline	Mathematics				
Course Code	UK1DSCMAT100				
Course Title	Foundations of Mathematics				
Type of Course	DSC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	1. Definition and preliminary results of matrices. 2. Understanding on methods to solve a system of simultaneous of equations. 3. Basic knowledge of various number system.				
Course Summary	This course includes set theory, determinants and matrices, number theory and solution of system of equations using matrices and number theory				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Sets -Relations - Functions**		**12**
	1	Sets: Sets and Elements, Subsets, Venn Diagram, Set Operations. Relation: Product sets, Relations, Types of Relations, Equivalence Relations, Partial Ordering Relations Functions: Functions, One–to-One, Onto and Invertible Functions. (Chapter 1: Sections 1.2, 1.3, 1.4, Chapter 2: 2.2, 2.3, 2.6, 2.8, Chapter 3: 3.2, 3.3. of Text[2])	

Module	Unit	Contents	Hrs
II	**Matrices and Determinants**		**12**
	2	Definition, Properties of Determinants and problems, Special Matrices Review of Matrix operations and Related Matrices Rank of a matrix-Elementary transformation, Equivalent matrix , Elementary matrices, Normal form (Chapter 1: Section 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7.1 to 2.7.7 of Text[1])	
III	**Solution of system of equation**		**10**
	3	Solution of Linear system equation method Cramer's Rule, Matrix Inversion Method Consistency of linear system of equation, Rouche's Theorem (Statement only), System of homogeneous equation (Chapter 2: Sections 2.9, 2.9.1, 2.9.2, 2.10 of Text[1])	
IV	**Number Theory**		**26**
	4	Mathematical induction, The division algorithm, Pigeonhole principle, divisibility relations, inclusion-exclusion principle *(These topics can be found in Chapter 1 section 1.3, Chapter 2 sections 2.1, 2.5 of Text [3] . The topics from the subsection 'A Number-Theoretic Function' onwards are excluded for examination. But Theorem 2.12 and Lemma 2.25 to be discussed.)*	
	5	Prime and composite numbers, infinitude of primes, GCD, linear combination of integers, pairwise relatively prime integers, the Euclidean algorithm for finding GCD the fundamental theorem of arithmetic, canonical decomposition of an integer into prime factors, LCM. *(These topics can be found in Chapter 3 sections 3.1 to 3.4 of Text [3]. The subsections marked as optional, Theorems 3.1, 3.2, 3.3, 3.12, 3.14, and Lemma 3.2 are excluded for examination.)*	
	6	Congruences, Modular exponentiation. *These topics can be found in Chapter 4 sections 4.1 and 4.2 Text [3]. The subsections marked as optional and 'The monkey and coconut puzzle revisited' are excluded for examination.*	

Textbooks

1. B.S. Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna Publishers, 2012

2. Seymour Lipschutz, Marc Lipson. Discrete Mathematics, 3rd Edition, Schaum's outline, 2007.

3. Thomas Koshy, Elementary Number Theory with Applications, 2nd Edition, Academic Press, 2007.

References

1. David M. Burton, Elementary Number Theory, Seventh Edition, McGraw-Hill, 2011.
2. Gilbert Strang, Introduction to Linear Algebra , 5th Edition, 2005.
3. G A Jones, J M Jones, Elementary Number Theory, Springer, 1998.
4. Lee W. Johnson, R Dean Riess, Jimmy T. Arnold, Introduction to Linear Algebra, Fifth Edition, Addison Wesley, 2019.
5. Seymour Lipschutz. Set Theory and Related Topics, 3rd Edition, Schaum's outline, 1998.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Describe the basic concept of set theory, determinants, Matrices and numbers	PSO1, PO1, 2, 4, 8	U	F,C	L	
CO 2	Solve system of linear equations using determinants, Matrices	PSO2, PO1, 2, 3, 4, 7, 8	Ap	P	L	
CO 3	Illustration of Mathematical Induction, Division Algorithm and Euclidean Algorithm	PSO1, PO1, 2, 3, 4, 6, 7, 8	U	F,C	L	
CO 4	Categorise functions based on the properties	PSO4, PO1	An	F,C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	1	1	2	2	2	1	3	1	1	2	2
CO2	2	3	2	2	1	1	2	3	1	2			1	2
CO3	3	2	2	1	1	1	3	2	1	3			1	1
CO4	2	2	1	3	1	1	3	1	1	1		1	1	1

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK1DSCMAT101				
Course Title	Differential Calculus and Linear Algebra				
Type of Course	DSC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Derivative of functions 2. Matrices				
Course Summary	This course provides a comprehensive idea of differentiation, its applications and solutions of linear equations				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Differentiation**	**18**
	1	Basic concepts and techniques of Differentiation(review only).	
	2	Tangent lines and rate of change, Derivative of a function	
	3	Implicit differentiation	
	4	Rectilinear motion, Rolle's theorem, Mean value theorem	
	5	Derivatives of logarithmic, exponential and inverse trigonometric functions.	
	Chapter 2: Section 2.1, 2.2, 2.7, Chapter 3: 3 section 3.6, chapter 6: section 6.2(differentiation only), 6.3(differentiation only) of Text [2]		
II		**Applications of Differentiation**	**18**
	6	Relative rates	
	7	Analysis of functions - Increasing, Decreasing, concavity	

Module	Unit	Contents	Hrs
	8	Analysis of functions - Relative extrema, Absolute maxima and minima.	
	9	Applied maxima and minima problems.	
	Chapter 2: Section 2.8, chapter 3: section 3.1,3.2(graphing of polynomials is not required), 3.4, 3.5. of Text [2]		
III	**System of Linear equations**		**12**
	10	Linear systems of equations, Coefficient matrix, Augmented matrix, Elementary row operations, Guass elimination	
	11	Rank of a matrix.	
	12	Existence and uniqueness of solutions	
	13	Solving systems of equations using cramer,s rule,.	
	Chapter 7: Section 7.3, 7.4(rank of matrix only), 7.5, 7.7 of Text [1]		
IV	**Eigen values and Diagonalization**		**12**
	14	Eigen values and eigen vectors	
	15	Some applications of eigen value problems	
	16	Diagonalization of Matrices	
	Chapter 8: Section 8.1, 8.2, 8.4(quadratic forms excluded) of Text [1]		
Practical	Practical sessions can be given using suitable software like sagemath (not meant for examination purpose)		**15**

Textbooks

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10^{th} Edition Wiley, 2011

2. Howard Anton, Irel Bivens, Stephens Davis, *Calculus* 10^{th} Edition Wiley, 2012

References

1. G. B. Thomas, R. L. Finey, *Calculus*, 9^{th} Edition, Addison-Weseley Publishing Company, 2004

2. Joel Hass, Maurice D, Weir, *Thomas Calculus Early Transcendentals* 12^{th} Edition, Addison-Weseley Publishing Company, 2006

3. J. Stewart, *Calculus with Early Transcendentals Functions* 7^{th} Edition, Cengage India, 2008

4. David C Lay, Linear Algebra and its Applications, Pearson, 2003

5. T.S. Blyth, E.F. Robertson, Linear Algebra, Second Edition, Springer, 2013

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the fundamental concepts of Differentiation	PSO1, 2	U	F,C	L	
CO 2	Explore Differentiation techniques to functions involving vectors and matrices	PSO 2,4	An, C	C, M	L	
CO 3	Develop problem-solving skills through the application of differentiation concepts and systems of linear equations	PSO 2,3	An, C	P, M	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	2	2	3	3	3	-	1	-	-	2	1	1
CO2	1	3	1	2	1	1	1	1	3	-	-	2	1	1
CO3	1	3	2	3	2	3	1	3	3	-	-	3	1	1

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- End Semester Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	—-	—-	✓
CO2	✓	✓		✓
CO3	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK1DSCMAT102				
Course Title	Differentiation, Sequence and Series				
Type of Course	DSC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4	-	-	4
Pre-requisites	1. Functions and limits 2. Arithmetic and geometric progression				
Course Summary	This course provides a detailed study of differentiation and convergence of sequence and series				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Differentiation**	**20**
	1	Tangent lines and limits (review only), One sided limits (review only), Limits at infinity, Infinite limits, Continuity (up to continuity of composite functions) *(Chapter 1 Sections 1.1, 1.3, 1.4 and 1.5 of Text 1)*	
	2	Tangent lines and rate of change, The derivative function *(Chapter 2 Sections 2.1, 2.2 of Text 1)*	
	3	Introduction to Techniques of Differentiation, The Product and Quotient Rules, Derivatives of Trigonometric Functions (review only)	
	4	The Chain Rule, Implicit Differentiation *(Chapter 2 Sections 2.6, 2.7 of Text 1)*	
II		**Differentiation of exponential and logarithmic functions**	**10**
	5	Exponential and logarithmic functions (review only) *(Chapter 6 Section 6.1 of Text [1])*	

Module	Unit	Contents	Hrs
	6	Derivatives involving Exponential and logarithmic functions *(Chapter 6 Section 6.2 of Text [1])*	
	7	L'Hôpital's rule *(Chapter 6 Section 6.5 of Text [1])*	
III		**Sequences and Series**	**12**
	8	Sequences, their limits, convergence and related theorems (without proof). *(Chapter 9 Sections 9.1, 9.2 of Text 1)*	
	9	Infinite series, their convergence and sums, geometric Series and harmonic series *(Chapter 9 Section 9.3 of Text [1])*	
IV		**Convergence and Divergence tests**	**18**
	10	Algebraic properties of infinite series, Integral test, p-series *(Chapter 9 Section 9.4 of Text [1] (avoid proofs of theorems))*	
	11	Comparison test, limit comparison test, Ratio test, Root test*(Chapter 9 Section 9.5 of Text [1])*	
	12	Alternating Series - Absolute and conditional Convergence, Ratio test for absolute convergence, Power series, Maclaurin and Taylor Polynomials Maclaurin and Taylor series *(Chapter 9 Sections 9.6, 9.7 of Text [1] (avoid proofs of theorems))*	

Textbooks

1. Howard Anton, Irl Bivens, Stephens Davis, *Calculus* 10^{th} Edition ,Wiley, 2012.

References

1. Joel Hass, Maurice D. Weir, *Thomas Calculus Early Transcendentals*, 12^{th} Edition, Addison-Weseley Publishing Company, 2004.

2. Mary L Boas, *Mathematical Methods in Physical Science*, 3^{rd} Edition, 2006.

3. K. F. Riley, .M. P. Hobson, S. J. Bence, *Mathematical Methods for Physics and Engineering*, Third Edition, Cambridge University Press, 2006.

4. J Stewart, *Calculus with Early Transcendental Functions*, 7^{th} Edition, Cengage India Private Limited, 2008.

5. G B Thomas, R L Finney, *Calculus*, 9^{th} Edition, Addison-Weseley Publishing Company, 2004.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the fundamental concepts of Differentiation	PSO1, 2, PO1, 3, 6, 7, 8	U	F,C	L	
CO 2	Explore Differentiation techniques to functions involving vectors and matrices	PSO 2,4, PO1, 3, 6, 7, 8	An, C	C, M	L	
CO 3	Develop problem-solving skills through the application of differentiation concepts and systems of linear equations	PSO 2,3, PO1, 3, 6, 7, 8	An, C	P, M	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	2	2	3	3	3	-	1	-	-	2	1	1
CO2	1	3	1	2	1	1	1	1	3	-	-	2	1	1
CO3	1	3	2	3	2	3	1	3	3	-	-	3	1	1

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam

- Programming Assignments
- End Semester Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	—-	—-	✓
CO2	✓	✓		✓
CO3	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK1DSCMAT103				
Course Title	Differentiation and Linear System of Equations				
Type of Course	DSC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Functions and Limits 2. Matrices Solution of system of linear equations in two variables				
Course Summary	This course provides brief idea about differentiation and basics of Linear Algebra				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Differentiation**	**20**
	1	Tangent lines and limits (review only), One sided limits (review only), Limits at infinity, Infinite limits, Continuity (up to continuity of composite functions) *(Chapter 1 Sections 1.1, 1.3, 1.4 and 1.5 of Text [1])*	
	2	Tangent lines and rate of change, The derivative function *(Chapter 2 Sections 2.1, 2.2 of Text [1])*	
	3	Introduction to Techniques of Differentiation, The Product and Quotient Rules, Derivatives of Trigonometric Functions (review only)	
	4	The Chain Rule, Implicit Differentiation *(Chapter 2 Sections 2.6, 2.7 of Text [1])*	

Module	Unit	Contents	Hrs
II	**Differentiation of exponential and logarithmic functions**		**10**
	5	Exponential and logarithmic functions (review only) *(Chapter 6 Section 6.1 of Text [1])*	
	6	Derivatives involving Exponential and logarithmic functions *(Chapter 6 Section 6.2 of Text [1])*	
	7	L'Hôpital's rule *(Chapter 6 Section 6.5 of Text [1])*	
III	**Matrices and Systems of linear equations**		**15**
	8	Linear Systems of Equations, Gauss Elimination, Linear Independence, Rank of a Matrix. *(Sections 7.2, 7.4 of Text [2] (avoid vector space))*	
	9	Solutions of Linear Systems: Existence, Uniqueness *(Chapter 7 Section 7.5 of Text [2] (omit proofs of theorems))*	
	10	Determinants Cramer's Rule *(Chapter 7 Section 7.7 of Text [2])*	
IV	**Eigen values and Eigen vectors**		**15**
	11	The Matrix Eigenvalue Problem. Determining Eigenvalues and Eigenvectors *(Chapter 8 Section 8.1 of Text [2])*	
	12	Symmetric, Skew-Symmetric, and Orthogonal Matrices *(Chapter 8 Section 8.3 of Text [2])*	
	13	Diagonalization, Quadratic Forms *(Chapter 8 Section 8.4 of Text [2] except eigen bases)*	
Practical	Practical sessions can be given using suitable software like sagemath (not meant for examination purpose)		**15**

Textbooks

1. H Anton, Irl Bivens, S Davis, *Calculus*, 10^{th} Edition, John Wiley & Sons. 2012.

2. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley Publishers, 10^{th} Edition, 2018.

References

1. T S Blyth, E F Robertson, *Linear Algebra*, Second Edition, Springer, 2013.

2. David C Lay, *Linear Algebra and its applications*, Pearson, 2003.

3. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12^{th} Edition, Addison-Weseley Publishing Company, 2004.

4. Lee W. Johnson, R Dean Riess, Jimmy T. Arnold, *Introduction to Linear Algebra*, Fifth Edition, Addison Wesley, 2001.

5. J Stewart, *Calculus with Early Transcendental Functions*, 7^{th} Edition, Cengage India Private Limited, 2004.

6. Thomas Banchoff, John Wermer, *Linear Algebra Through Geometry*, 2nd Edition, Springer, 2012.

7. G B Thomas, R L Finney, *Calculus*, 9th Edition, Addison-Weseley Publishing Company, 2006.

E-resources

1. https://www.geogebra.org/m/z3jEUrvv
2. https://www.khanacademy.org

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concept of differentiability	PSO 1	U	F, C	L	
CO 2	Apply the concept of differentiability	PSO 2, 4	Ap, An	P	L	
CO 3	Understand the concepts of Matrix operations and their algebraic properties, System of linear equations and their Matrix representation, Gauss Elimination	PSO 1	U	F, C	L	
CO 4	Able to find the eigen values powers of matrices and diagonalization of matrices	PSO 2, 4	Ap, An	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	-	-	-	-	-	-	-	-	-	1	2	-	-
CO2	-	2	-	2	-	-	-	-	-	-	-	2	-	1
CO3	2	-	-	-	-	-	-	-	-	-	1	2	-	-
CO4	-	2	-	2	-	-	-	-	-	-	-	2	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK1DSCMAT104				
Course Title	Differentiation and Theory of Numbers				
Type of Course	DSC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	1. Functions, limits and continuity 2. Natural numbers				
Course Summary	This course provides a brief idea about differentiation and theory of numbers				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Differentiation**	**20**
	1	Tangent lines and limits (review only), One sided limits (review only), Limits at infinity, Infinite limits, Continuity (up to continuity of composite functions) *(Chapter 1: Sections 1.1, 1.3, 1.4 and 1.5 of Text [1])*	
	2	Tangent lines and rate of change, The derivative function *(Chapter 2 Sections 2.1, 2.2 of Text 1)*	
	3	Introduction to Techniques of Differentiation, The Product and Quotient Rules, Derivatives of Trigonometric Functions (review only)*(Chapter 2: Sections 2.3, 2.4, 2.5 of Text [1])*	
	4	The Chain Rule, Implicit Differentiation *(Chapter 2: Sections 2.6, 2.7 of Text [1])*	
II		**Differentiation of exponential and logarithmic functions**	**10**
	5	Exponential and logarithmic functions (review only) *(Chapter 6 Section 6.1 of Text 1)*	

Module	Unit	Contents	Hrs
	6	Derivatives involving Exponential and logarithmic functions *(Chapter 6 Section 6.2 of Text 1)*	
	7	L'Hôpital's rule *(Chapter 6 Section 6.5 of Text 1)*	
III		**The Euclidean Algorithm**	**15**
	8	Mathematical induction, recursion, The division algorithm *(Chapter 1 Sections 1.3, 3.4 of Text [2])*	
	9	The division algorithm, Pigeonhole principle, divisibility relations, inclusion-exclusion principle *(Chapter 2 Sections 2.1, 2.5 of Text [2] The topics from the subsection 'A Number-Theoretic Function' onwards are excluded for examination. But Theorem 2.12 and Lemma 2.25 to be discussed.)*	
	10	Prime and composite numbers, infinitude of primes, GCD, linear combination of integers, pairwise relatively prime integers, the Euclidean algorithm for finding GCD *(Chapter 3 Section 3.1 of Text [2]. The subsections marked as optional, Theorems 3.1, 3.2, 3.3, 3.12, 3.14, and Lemma 3.2 are excluded for examination.)*	
IV		**Congruences**	**15**
	11	The fundamental theorem of arithmetic, canonical decomposition of an integer into prime factors *(Chapter 3 Sections 3.3 of Text [2]. The subsections marked as optional, Theorem 3.14 are excluded for examination.)*	
	12	LCM *(Chapter 3 Section 3.4 of Text [2])*	
	13	congruences, modular exponentiation *(Chapter 4 Section 4.1 of Text [2]. The subsections marked as optional and 'The monkey and coconut puzzle revisited' are excluded for examination.)*	

Textbooks

1. H Anton, I Bivens, S Davis, *Calculus*, 10^{th} Edition, John Wiley & Sons, 2012
2. Thomas Koshy, *Elementary Number Theory with Applications*, 2^{nd} Edition, Academic Press, 2007.

References

1. David M. Burton, *Elementary Number Theory*, 7^{th} Edition, McGraw Hill, 2011.
2. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12^{th} Edition, Addison-Weseley Publishing Company, 2004.
3. G A Jones, J M Jones, *Elementary Number Theory*, Springer, 1998.
4. J Stewart, *Calculus with Early Transcendental Functions*, 7^{th} Edition, Cengage India Private Limited, 2008.

5. G B Thomas, R L Finney, *Calculus*, 9^{th}, Addison-Weseley Publishing Company, 2004.

E-resources

1. https://www.geogebra.org/m/z3jEUrvv
2. https://www.khanacademy.org

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concept of differentiability	PSO 1, PO5, 6	U	F,C	L	
CO 2	Apply the concept of differentiability	PSO 2, 4, PO6, 8	Ap, An	P	L	
CO 3	Examine integrated approach to number theory	PSO 1, 3, PO1, 2, 6	U	F, C	L	
CO 4	Apply the concept of congruences	PSO 2, 3, 4, PO1, 2, 5, 6	Ap, An	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	-	-	-	-	-	-	-	-	-	1	2	-	-
CO2	-	2	-	2	-	-	-	-	-	-	-	2	-	1
CO3	2	-	1	-	-	-	1	1	-	-	-	1	-	-
CO4	-	2	2	1	-	-	1	2	-	-	1	1	-	-

(

- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK1DSCMAT105				
Course Title	Differentiation and Complex Numbers				
Type of Course	DSC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	1. Functions, limits and continuity 2. Complex numbers				
Course Summary	This course provides basics on differentiation and complex numbers				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Differentiation**	**20**
	1	Tangent lines and limits (review only), One sided limits (review only), Limits at infinity, Infinite limits, Continuity (up to continuity of composite functions) *(Chapter 1 Sections 1.1, 1.3, 1.4 and 1.5 of Text [1])*	
	2	Tangent lines and rate of change, The derivative function *(Chapter 2 Sections 2.1, 2.2 of Text [1])*	
	3	Introduction to Techniques of Differentiation, The Product and Quotient Rules, Derivatives of Trigonometric Functions (review only) Chapter? : Section? of Text [1]	
	4	The Chain Rule, Implicit Differentiation *(Chapter 2 Sections 2.6, 2.7 of Text [1])*	
II		**Differentiation of exponential and logarithmic functions**	**10**
	5	Exponential and logarithmic functions (review only) *(Chapter 6 Section 6.1 of Text [1])*	

Module	Unit	Contents	Hrs
	6	Derivatives involving Exponential and logarithmic functions *(Chapter 6 Section 6.2 of Text 1)*	
	7	L'Hôpital's rule *(Chapter 6 Section 6.5 of Text [1])*	
III		**Complex Numbers**	**15**
	8	Sums and Products, Basic Algebraic Properties *(Chapter 1 Sections 1, 2 of Text [2])*	
	9	Further Properties of complex numbers, Vectors and Moduli *(Chapter 1 Sections 3, 4 of Text [2])*	
	10	Complex Conjugates *(Chapter 1 Section 5 of Text [2])*	
IV		**Argument and roots of complex numbers**	**15**
	11	Exponential Form, Products and Powers in Exponential Form *(Chapter 1 Sections 6, 7 of Text [2])*	
	12	Arguments of Products and Quotients *(Chapter 1 Section 8 of Text [2])*	
	13	Roots of Complex Numbers, Examples *(Chapter 1 Sections 9, 10 of Text [2])*	

Textbooks

1. H Anton, I Bivens, S Davis, *Calculus*, 10th Edition, John Wiley & Sons, 2012

2. James Ward Brown, Ruel V. Churchill, *Complex Variables and Applicatons*, 8th edition, McGraw Hill, 2001.

References

1. Dennis G. Zill, Patric D Shanahan, *A First Course in Complex Analysis with Applications*, Jones and Bartlett Publishers, 2003.

2. Edward B. Saff, Arthur David Snider, *Fundamentals of Complex Analysis with Applications to Engineering and Science*, 3rd Edition, Pearson Education India, 2017.

3. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th Edition, Wiley-India, 2011.

4. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12th Edition, Addison-Weseley Publishing Company, 2004.

5. John H Mathews and Russel W Howell, *Complex Analysis for Mathematics and Engineering*, Sixth Edition, Jones and Bartlett Publishers, 2012.

6. J Stewart, *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited, 2008.

7. G B Thomas, R L Finney, *Calculus*, 9th, Addison-Weseley Publishing Company, 2004.

E-resources

1. https://www.geogebra.org/m/z3jEUrvv
2. https://www.khanacademy.org

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concept of differentiability	PSO 1, PO5, 6	U	F,C	L	
CO 2	Apply the concept of differentiability	PSO 2, 4, PO6, 8	Ap, An	P	L	
CO 3	Understand the concepts of complex numbers and their algebraic operations	PSO 1, PO6	U	F, C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	-	-	-	-	-	-	-	-	-	1	2	-	-
CO2	-	2	-	2	-	-	-	-	-	-	-	2	-	1
CO3	2	-	-	-	-	-	-	1	-	-	-	1	-	-

(**- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)**

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar

- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓

University of Kerala

Discipline	Mathematics				
Course Code	UK1DSCMAT106				
Course Title	Number Theory and Linear System of Equations				
Type of Course	DSC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	1. Natural Numbers 2. Matrices				
Course Summary	This course provides a study on number theory and linear system of equations				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**The Euclidean Algorithm**		**15**
	1	Mathematical induction, recursion, The division algorithm *(Chapter 1 Sections 1.3, 3.4 of Text [2])*	
	2	The division algorithm, Pigeonhole principle, divisibility relations, inclusion-exclusion principle *(Chapter 2 Sections 2.1, 2.5 of Text [2] The topics from the subsection 'A Number-Theoretic Function' onwards are excluded for examination. But Theorem 2.12 and Lemma 2.25 to be discussed.)*	
	3	Prime and composite numbers, infinitude of primes, GCD, linear combination of integers, pairwise relatively prime integers, the Euclidean algorithm for finding GCD *(Chapter 3 Section 3.1 of Text [2]. The subsections marked as optional, Theorems 3.1, 3.2, 3.3, 3.12, 3.14, and Lemma 3.2 are excluded for examination.)*	

Module	Unit	Contents	Hrs
II		**Congruences**	**15**
	4	The fundamental theorem of arithmetic, canonical decomposition of an integer into prime factors *(Chapter 3 Sections 3.3 of Text [2]. The subsections marked as optional, Theorem 3.14 are excluded for examination.)*	
	5	LCM *(Chapter 3 Section 3.4 of Text [2])*	
	6	congruences, modular exponentiation *(Chapter 4 Section 4.1 of Text [2]. The subsections marked as optional and 'The monkey and coconut puzzle revisited' are excluded for examination.)*	
III		**Matrices and Systems of linear equatios**	**15**
	7	Linear Systems of Equations, Gauss Elimination, Linear Independence, Rank of a Matrix. *(Sections 7.2, 7.4 of Text [2] (avoid vector space))*	
	8	Solutions of Linear Systems: Existence, Uniqueness *(Chapter 7 Section 7.5 of Text 2(omit proofs of theorems)*	
	9	Determinants Cramer's Rule *(Chapter 7 Section 7.7 of Text [2])*	
IV		**Eigen values and Eigen vectors**	**15**
	10	The Matrix Eigen value Problem. Determining Eigen values and Eigen vectors *(Chapter 8 Section 8.1 of Text [2])*	
	11	Symmetric, Skew-Symmetric, and Orthogonal Matrices *(Chapter 8 Section 8.3 of Text [2])*	
	12	Diagonalization, Quadratic Forms *(Chapter 8 Section 8.4 of Text [2] (except eigen bases))*	

Textbooks

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley, 10^{th} Edition, 2011.
2. Thomas Koshy, *Elementary Number Theory with Applications*, 2nd Edition, Academic Press, 2007.

References

1. T S Blyth, E F Robertson, *Linear Algebra*, Second Edition, Springer, 2013.
2. David C Lay, *Linaer algebra and its applications*, Pearson, 2003.
3. David M. Burton, *Elementary Number Theory*, 7th Edition, McGraw Hill, 2011.
4. G A Jones, J M Jones, *Elementary Number Theory*, Springer, 1998.
5. Lee W. Johnson, R Dean Riess, Jimmy T. Arnold, *Introduction to Linear Algebra*, Fifth Edition, Addison Wesley, 2019
6. Thomas Banchoff, John Wermer, *Linear Algebra Through Geometry*, 2nd Edition, Springer, 2012.

E-resources

1. https://www.khanacademy.org

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Examine integrated approach to number theory	PSO 1, 3, PO2	U	F, C	L	
CO 2	Apply the concept of congruences	PSO 2, 3, 4, PO1, 2, 5, 6	Ap, An	P	L	
CO 3	Understand the concepts of Matrix operations, their algebraic properties, System of linear equations and their Matrix representation, Gauss Elimination	PSO 1, PO1, 2, 5, 6	U	F, C	L	
CO 4	Able to find the eigen values of powers of matrices and diagonalization of matrices	PSO 2, 4, PO1, 2, 6	Ap, An	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO3	2	-	1	-	-	-	-	1	-	-	-	1	-	-
CO4	-	2	2	1	-	-	1	2	-	-	1	1	-	-
CO3	2	-	-	-	-	-	2	1	-	-	1	2	-	-
CO4	-	2	-	2	-	-	2	2	-	-	-	2	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Descipline	Mathematics				
Course Code	UK1DSCMAT107				
Course Title	Relations, Functions and Number theory				
Type of Course	DSC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	Sets				
Course Summary	Sets, relations, functions and basics of number theory				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Set theory**	**12**
	1	Definition, types and operations on sets *(This topic can be found in Chapter 2 of Text [2])*	
	2	Partition of Set: POSET - HASSE diagrams for partial ordering - lub, glb. *(These topics can be found in Chapter 2 of Text [2])*	
	3	Lattices: Definition and Examples *(This topic can be found in Chapter 2 of Text [2] (avoid proof of theorems, properties and principles of duality))*	
II		**Relations and Functions**	**18**
	4	Relations - Definition, Relation and Digraph *(These topics can be found in Chapter 4 of Text [2])*	
	5	The matrix of a relation, Properties of relations, Equivalence relations *(These topics can be found in Chapter 4 of Text [2])*	

Module	Unit	Contents	Hrs
	6	Transitive closure, Warshal's algorithm, Functions *(These topics can be found in Chapter 4 of Text [2]) (Avoid computer programs)*	
III		**The fundamental theorem of arithmetic**	**15**
	7	Mathematical induction, binomial theorem *(Chapter 1 Sections 1.1, 1.2 of Text [1])*	
	8	The division algorithm, the greatest common divisor, the Euclidean algorithm, prime numbers *(Chapter 2 Sections 2.1, 2.2, 2.3 of Text [1])*	
	9	The fundamental theorem of arithmetic *(Chapter 3 Section 3.1 of Text [1])*	
IV		**Congruences**	**15**
	10	Basic properties of congruences, binary and decimal representation of integers *(Chapter 4 Sections 4.1, 4.2, 4.3 of Text [1])*	
	11	Fermat's theorem, Wilson's Theorem (Avoid proofs of theorems) *(Chapter 5 Sections 5.1, 5.2 of Text [1])*	
	12	The sum and number of divisors *(Chapter 6 Section 6.1 of Text [1])*	

Textbooks

1. David M. Burton, *Elementary Number Theory*, 7th Edition, McGraw Hill, 2011.

2. T. Veerarajan, *Discrete Matematics with Graph Theory and Combinatorics*, Tata McGraw Hill, 2007.

References

1. G A Jones, J M Jones, *Elementary Number Theory*, Springer, 1998.

2. C L Liu, D P Mohapatra, *Elements of Discrete Mathematics, A Computer oriented approach*, Tata McGraw-Hill, 2008.

3. Rajendra Akerkar, Rupali Akerkar, *Discrete Mathematics*, Perason Education, 2007.

4. R M Somasundaram, *Discrete Mathematical Structures*, Prentice Hall of India, 2003.

5. Thomas Koshy, *Elementary Number Theory with Applications*, 2nd Edition, Academic Press, 2007.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concept of set theory	PSO 1, PO2, 6	R, U	F,C	L	
CO 2	Analyze real world problems	PSO 1, 2, PO1, 2, 3, 4, 5, 6	Ap, An	P	L	
CO 3	Examine integrated approach to number theory	PSO 1, 3, PO1, 2, 6	U	F, C	L	
CO 4	Apply the concept of congruences	PSO 2, 3, 4, PO1, 2, 5, 6	Ap, An	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	-	-	-	-	-	-	1	-	-	-	1	-	-
CO2	2	2	-	-	-	-	2	2	1	1	2	1	-	-
CO3	3	-	2	-	-	-	1	1	-	-	-	1	-	-
CO4	-	2	3	2	-	-	1	2	-	-	1	1	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK1DSCMAT108				
Course Title	Differential Calculus				
Type of Course	DSC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	Functions				
Course Summary	Brief review of calculus, Polynomial and elementary transcendental functions and their applications, derivatives, extremum problems, curve-sketching, approximations, Use of symbolic manipulation and graphics software in calculus.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Functions, limits and continuity**	**10**
	1	Families of functions, inverse functions, exponential and logarithmic functions, Computing limits of functions, limits at infinity, Continuity, Intermediate value theorem and applications, Continuity of various functions. Sections 0.3,0.4,0.5, 1.2, 1.3, 1.5, 1.6 of Text I	
II		**Introduction to derivatives**	**15**
	2	The derivative of a function, Algebra of derivatives, Derivatives of various functions, The chain rule. Sections 2.2, 2.3, 2.4 2.5, 2.6 (Proofs of theorems excluded)	

Module	Unit	Contents	Hrs
III	**Techniques of differentiation**		**15**
	3	Implicit differentiation, derivatives of logarithmic, exponential and inverse trigonometric functions, related rates and local linear approximation, L'Hopital rule. Sections 2.7, 2.8, 2.9, 6.1, 6.2(Integrals involving logarithmic functions excluded), 6.3,6.5	
IV	**Analysis of functions using derivatives**		**20**
	4	Increasing, decreasing and concavity, extremum problems, graphing polynomials, absolute maxima and minima, Rolle's theorem, Mean-value theorem Sections 3.1, 3.2, 3.4, 3.8	

Textbooks

1. H Anton, I Bivens, S Davis, *Calculus*, 10th Edition, John Wiley & Sons, 2012.

References

1. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12th Edition, Addison-Weseley Publishing Company, 2004.
2. J Stewart, *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited, 2004.
3. G B Thomas, R L Finney, *Calculus*, 9th Edition, Addison-Weseley Publishing Company, 2004.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understand the basic concept of functions, limit, continuity and derivatives	PSO1,2, PO1	U	F,C	L,T	
CO 2	Analyse the properties of functions using derivatives	PSO2, PO3, 4	An	F	L,T	
CO 3	Apply deferentiation techniques to solve various problems	PSO1,3, PO2, 3	U,An	C	L,T	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)

(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1					3							
CO2		2							1	3				
CO3	2		3					2	2					

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK1DSCMAT109				
Course Title	Mathematics for Social Science I				
Type of Course	DSC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	Basic knowledge of Mathematics in Secondary level				
Course Summary	This course includes basic set theory, solutions of linear and quadratic equations, linear programming problems and functions				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Theory of sets**		**15**
	1	Finite and infinite sets, set operations	
	2	Ordered pairs, Cartesian products, Relations	
	3	Functional Relations and Functions	
	Chapter 1: Sections 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.14, 1.15,1.16, 1.17		
II	**Linear Equations**		**15**
	4	Equations and identities -Linear and quadratic equations	
	5	Solution of equations, Solutions of quadratic equations, Solution of simultaneous equations	
	6	Applications	
	Chapter 3: Section 3.1.		
III	**Linear Programming**		**18**

Module	Unit	Contents	Hrs
	7	Introduction, Basic assumptions, The general linear Programming Problem (For two variables only)	
	8	Geometry of Linear Programming Problem (Graphical Solution)	
	9	Feasible and basic feasible solutions, Concept of degeneracy, multiple optimal solutions, Problems with no feasible solution (simple problems only)	
	Chapter 18: Section 18.1, 18.2, 18.4, 18.5, 18.6		
IV	**Functions and Curves**		**12**
	10	Demand functions and curves	
	11	Total Revenue curve, Cost Curves.	
	Chapter 4: Appendix		

Textbook

1. B.C. Mehta, G.M.K. Madnani, *Mathematics for Economics*. Sultan Chand & Sons, 1976.

References

1. Agarwal B.M, Business Mathematics and Statistics, Vikas Publishing House,New Delhi, 2009.

2. Allen, R.G.D., Mathematical Analysis for Economists. New Delhi: AITBS Publishers, 2008.

3. Yamane, Taro, Mathematics for Economists: An Elementary Survey. New Delhi: Prentice Hall of India, 2012.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concepts of sets, ordered pairs, relations and functions	PSO1, PO1, 2, 3, 4, 7	R, U	F,C	L	
CO 2	Solve linear and quadratic equations	PSO3, PO1, 2, 3, 6, 7,8	U	P	L	
CO 3	Analyze and interpret solutions of linear programming problems using graphical method	PSO4, PO1, 2, 3, 4, 5, 6, 7,8	An	P	L	
CO 4	Create Diagrams to represent Demand Functions, Total Revenue and Cost Functions	PSO5, PO1, 2, 3, 4, 5, 6, 7,8	An	C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	2	3	1	3	-	-	1	-
CO2	-	-	3	-	-	-	2	3	2	-	-	1	3	2
CO3	-	-	-	3	-	-	3	3	3	1	1	3	2	2
CO4	-	-	-	-	3	-	3	2	1	2	2	2	3	1

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK1DSCMAT110				
Course Title	Matrices and Linear Equations				
Type of Course	DSC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	Matrices				
Course Summary	This is a brief introductory course on matrices and system of linear equations				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**System of linear equations and matrices**		**10**
	1	Introduction to Systems of Linear Equations, Gaussian Elimination, Matrices and Matrix Operations, Inverses;Algebraic Properties of Matrices, [Section 1.1 to 1.4 of the Text]	
II	**Further properties of matrices**		**15**
	2	Elementary matrices and method for finding inverse, more on linear systems and invertible matrices, diagonal, triangular and symmetric matrices, matrix transformations [Section 1.5 to 1.8 of the Text]	
III	**Determinants**		**15**
	3	Determinants by cofactor expansion, evaluating determinants by row reduction, properties of determinants, Cramer's rule	

Module	Unit	Contents	Hrs
IV	**Euclidean vector spaces**		**20**
	4	Vectors in 2 space, 3 space and n-space, Norm, dot product, and distance in R^n, Orthogonality, the geometry of linear systems, cross product	

Textbook

1. H Anton, C Rorres. Elementary linear algebra, 11th Edition, John Wiley & Sons.

References

1. David Poole, Linear Algebra, a modern introduction, Brooks/Cole Cengage learning
2. Lee W.Johnson, R. Deanriess, Jimmy T. Arnold, Introduction to Linear Algebra, 5^{th} edition, Addison Wisely

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understands system of linear equations	PSO1, 2, PO1	U	F,C	L,T	
CO 2	Perform various operations on matrices and determinants	PSO2, PO3, 4	An	F	L,T	
CO 3	Understand the concept of vectors in Euclidean spaces	PSO1, 3, PO2, 3	U,An	C	L,T	
CO 4	Apply matrices to solve system of linear equations	PSO1, 3	Ap	C	L,T	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1					3							
CO2		2							1	3				
CO3	2		3					2	2					
CO4	2		3											

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			
CO2	✓			
CO3	✓			
CO4	✓			✓

University of Kerala

Discipline	Mathematics				
Course Code	UK1MDCMAT100				
Course Title	Numerical Ability - I				
Type of Course	MDC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	3	3			3
Pre-requisites	Basic Mathematical Operations				
Course Summary	This course is primarily meant for students who have not undergone a Mathematics course beyond their secondary school. The course is expected to improve the student's basic mathematical skills and to understand the mathematics used in their respective fields better.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**HCF, LCM, Percentage and Average**	**11**
	1	Highest Common Factor, Methods of finding HCF, Least Common Multiple, Methods of finding LCM, Problems involving HCF and LCM. *(Chapter 2 of Text [1])*	
	2	Percentage, Problems involving percentage. *(Chapter 5 of Text [1])*	
	3	Average, Problems involving average. *(Chapter 6 of Text [1])*	
II		**Ratio and Proportion, Profit and Loss**	**12**
	4	Ratio, Types of Ratios, Proportion, Problems involving Ratio and Proportion. *(Chapter 7 of Text [1])*	

Module	Unit	Contents	Hrs
	5	Partnership, Problems involving partnership. *(Chapter 8 of Text [1])*	
	6	Profit and Loss, Problems involving profit and loss. *(Chapter 9 of Text [1])*	
III		**Time, Work and Wages, Pipes and Cisterns**	**11**
	7	Problems involving Time, Work and Wages. *(Chapter 10 of Text [1])*	
	8	Problems involving Pipes and Cisterns. *(Chapter 11 of Text [1])*	
IV		**Time and Distance, Boats and Streams**	**11**
	9	Problems involving Time and Distance. *(Chapter 12 of Text [1])*	
	10	Problems involving Boats and Streams. *(Chapter 13 of Text [1])*	
	11	Alligation Rule, Problems involving Alligation. *(Chapter 15 of Text [1])*	

Textbook

1. Dinesh Khattar, *Quantitative Aptitude for Competitive Examinations*, Fourth Edition, Pearson, 2016

References

1. H Kruglak, JT Moore, RA Mata-Toledo, *Schaum's outline of theorey and problems of Basic Mathematics, with Applications to Science and Technology*, Second Edition, McGraw-Hill, 1998.

2. Rajesh Verma, *Fast Track Objective Arithmetic*, Arihant, 2018.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand basic level mathematics used in real life situations	PSO1, PSO2, PSO3, PO1, PO2, PO5	U, An, E	C, P	L	
CO 2	Do maths problems quickly using ready to use formulae	PSO3, PO2	R, Ap	P	L	
CO 3	Understand the concepts of Ratio and Percentage	PSO1, PO1, PO2, PO5	U, E	P	L	
CO 4	Understand the concepts of direct proportion and inverse proportion	PSO1, PO1	U, E	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	-	-	-	2	1	-	-	1	-	-	-
CO2	-	-	3	-	-	-	-	1	-	-	-	-	-	-
CO3	2	-	-	-	-	-	2	1	-	-	1	-	-	-
CO4	2	-	-	-	-	-	2	-	-	-	-	-	-	-

(- -Nil, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam

- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		
CO2	✓			✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK1MDCMAT101				
Course Title	Mathematical Thinking				
Type of Course	MDC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	3	3			3
Pre-requisites	Basic School Mathematics				
Course Summary	This course is an introduction to the foundations of logic, proof, fundamental properties of integers and linear Diophantine equations.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Foundations of Logic and Proof**	**15**
	1	Logical connectives, Quantifiers, Techniques of proof. Basic set operations, Relations and Functions (Chapter 1: Sections 1, 2, 3 of in Text [2], Chapter 2: Sections 1, 2, 3 of in Text [2])	
II		**Divisibility of integers**	**15**
	2	Divisibility, Euclid's Theorem, The Sieve of Eratosthenes, The Division Algorithm, The Greatest Common Divisor, The Euclidean Algorithm, Fermat and Mersenne Numbers. (Chapter: Section 1.1 (Not for examination), 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9 of Text [1])	

Module	Unit	Contents	Hrs
III	**Diophantine equations and the Fundamental Theorem of Arithmetic**		**15**
	3	Diophantine equations, The Postage Stamp Problem. The Fundamental Theorem of Arithmetic, Euclid and the Fundamental Theorem of Arithmetic. (Chapter 2: Sections 2.1, 2.2, Chapter 3: Sections 3.1, 3.2, 3.3 of Text [1])	

Textbooks

1. James S.Kraft, Lawrence C. Washington. Elementary Number Theory, CRC Press, 2014.

2. S R Lay. Analysis with an Introduction to Proof, 5th Edition, Pearson Education, 2015.

References

1. J P D'Angelo, D B West. Mathematical Thinking - Problem Solving and Proofs 2^{nd} Edition, Prentice Hall, 2018.

2. Daniel J Velleman. How to Prove it : A Structured Approach, 2^{nd} Edition, Cambridge University Press, 2006

3. Elena Nardi, Paola lannonne. How to Prove it : A brief guide for teaching Proof to Year 1 mathematics undergraduates, University of East Anglia, Centre for Applied Research in Education, 2006.

4. James S.Kraft, Lawrence C. Washington, An Introduction to Number Theory with Cryptography, CRC Press, 2014.

5. G A Jones, J M Jones, Elementary Number Theory, Springer, 1998.

6. Thomas Koshy, Elementary Number Theory with Applications, 2^{nd} Edition, Academic Press, 2007.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Describe the basic methods of Proof	PSO1, PSO2, PSO3	U, Ap	F,C	L,T	
CO 2	Apply division algorithm to solve various problems.	PSO1, PSO2	U,Ap	F	L,T	
CO 3	Describe Fundamental Theorem of Arithmetic	PSO1, PSO3	R, U,An	C	L,T	
CO 4	Solve Diophantine equations	PSO2, PSO3	R,U,An	C	L,T	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	2	-	-	-	-	-	-	-	-	-	-	-
CO4	-	2	3	-	-	-	-	-	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics					
Course Code	UK2DSCMAT100					
Course Title	Theory of equations, Differential Calculus and Geometry					
Type of Course	DSC					
Semester	II					
Academic Level	100-199					
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week	
	4	4		1	5	
Pre-requisites	1. Awareness on polynomials 2. Knowledge on the concepts of functions, differentiation and basic geometry					
Course Summary	This course includes theory of equations, differential calculus, polar co-ordinates and conic sections					

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Theory of Equations**		**20**
	1	Introduction, General Properties, Transformation of Equation, Reciprocal Equation, Solution of cubic Equations-Cardan's Method. Solution of biquadratic equation- Ferrari's method, Descarte's method.	
	Chapter 1: Section 1.1 to 1.6 of Text[2]		

Module	Unit	Contents	Hrs
		Practical: Solving Equations in SageMath - write a function $f(x)$ in sagemath, show the function using show(), generate LaTeX code using $latex()$, function in $$...$$, value of $f(x)$, numerical value of $f(x)$ using $.n()$, solving functions using $solve(f(x) == 0, x)$, solution in dictionary form $solve(f(x) == 0, x, solution\_dict = True)$, finding roots using $f(x).roots()$, declaring variable using $var()$ and solve functions of two or more variables. Explore sage reference or tutorial using help menu. (not meant for examination purpose)	
II		**Differential calculus I**	**20**
	2	Related Rates, Analysis of function- Increasing, Decreasing and Concavity. Relative Extrema Graphing polynomials Absolute Maxima and minima	
		Chapter2: Section 2.8 and Chapter 3: Section 3.1,3.2, 3.4 of Text[1]	
		Practical: Differentiating function n times. Plotting graph using $plot()$ with necessary attributes as parameters, plot derivative of function, finding root in an interval using $find\_root()$, finding critical points, finding local maximum and local minimum of a function in an interval using in-built functions $find\_local\_maximum()$ and $find\_local\_minimum()$ (not meant for examination purpose)	
III		**Differential calculus II**	**20**
	3	Applied Maxima and Minima Problems (excluding application to economics, Relative Motion, Mean value theorem, Rolle's Theorem, L-Hopital's rule and Indeterminate forms.	
		Chapter 3: Section 3.5, 3.6, 3.8, and Chapter 6: Section 6.5 of Text[1]	
		Practical: Verify Mean value theorem and Rolle's Theorem using sagemath, Draw the graph of $\frac{\sin x}{x}$ using sagemath and observe the limit at $x = 0$. Evaluate the limits of various indeterminate forms using sagemath. (not meant for examination purpose)	
IV		**Polar coordinates and Conics Section**	**15**
	4	Polar Co-ordinate, Conic Section, Rotation of axes Second degree equation, Conic section in polar coordinates(Excluding the solution on Application in astronomy)	
		Chapter 10: Section 10.2, 10.4, 10.5, 10.6 of Text[1]	
		Practical: Draw graphs using $polar\_plot()$ and $implicit\_plot()$. (not meant for examination purpose)	

Textbooks

1. H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons, 2012

2. B.S. Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna Publishers, 2012.

References

1. Barnard and Child, Higher Algebra, Mac Millan, 2000.

2. Joel Hass, Maurice D. Weir, Thomas' Calculus Early Transcendentals, 12th Edition, Addison-Weseley Publishing Company, 2004.

3. T. K. Manicavachagom Pillay, T. Natarajan, K.S. Ganapathy, Algebra Volume I Ananda Book Depot, 1996.

4. J Stewart, Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited, 2004.

5. G B Thomas, R L Finney, Calculus, 9th Edition, Addison-Weseley Publishing Company, 2004.

E- resources

1. https://www.sagemath.org/help.html

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Describe algebraic techniques to solve polynomial equations and to identify conic sections	PSO2, PO1, PO2, 3, 4, 7, 8	U,E	F,P	L	
CO 2	Apply differentiation techniques to analyse extrema of functions and solving real life problems	PSO4, PO1, 2, 3, 4, 7, 8	U,An	F,P	L	
CO 3	Sketching parabola, ellipse and hyperbola, and relating polar and cartesian co-ordinates	PSO5, PO1, 2, 3, 7, 8	U,E	F,P	L	
CO 4	Analysing parametric representation of curves	PSO2, PO1, 2, 3, 4, 6, 7, 8	R,An	F,P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	2	1	1	3	3	2	1			1	2
CO2	2	2	2	3	2	1	3	2	2	1			1	2
CO3	2	2	2	2	3	1	3	2	3	1			2	1
CO4	2	3	2	2	2	1	3	2	2	1		1	1	1

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT101				
Course Title	Integration and Multivariate Calculus				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Derivative of functions 2. Vectors				
Course Summary	This course equip the students to find the integral of functions, its applications, partial derivatives of functions and to know about the basic concepts of vector valued functions				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Integration**	**19**
	1	Basic concepts and techniques of Integration. (review only).	
	2	An overview of area problem, Definite integral, properties.	
	3	Fundamental theorem of Integral Calculus	
	4	Rectilinear motion revisited using integration, Average value of a function	
	5	Evaluation of definite integral by substitution	
	6	Integrals of logarithmic, exponential and inverse trigonometric functions	
	Chapter 4: Section 4.1, 4.5, 4.6, 4.7, 4.8, 4.9, Chapter 3 section 3.6, chapter 6: section 6.2(integration only), 6.3(integration only) of Text [2]		

Module	Unit	Contents	Hrs
	Practical: Defing functions, Finding integral of a function using sagemath, Convergence of improper integral, Finding numerical value of integral. (not meant for examination purpose)		
II	**Applications of Integration**		**23**
	7	Area between two curves	
	8	Length of a plane curve	
	9	Volume of solid of revolution(problems only)	
	10	Area of a surface of revolution	
	Chapter 5: Section 5.1, 5.2, 5.4, 5.5 Relevant problems in sections 6.2 and 6.3 are included of Text [2]		
	Practical: Integral as signed area under the curve. Plotting a function and its integral. Average value of f in an interval. (not meant for examination purpose)		
III	**Vector Calculus 1**		**19**
	11	Introduction to vector valued functions	
	12	Calculus of vector valued functions	
	13	Unit tangent, normal and bi-normal vectors	
	14	Motion along a curve	
	Chapter 12: Section 12.1, 12.2, 12.4 and 12.6 of Text [1]		
	Practical: Finding partial derivatives, gradient, divergence, curl and Laplacian. (not meant for examination purpose)		
IV	**Partial Differentiation**		**14**
	15	Functions of two or more variables	
	16	Limit and Continuity	
	17	Partial derivatives	
	18	Chain rule, Implicit differentiation	
	19	Maxima and minima of functions of two variables	
	20	Langrange multiplier	
	Chapter 13: Section 13.1, 13.2, 13.3, 13.5, 13.8, 13.9 of Text [1]		

Textbooks

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10^{th} Edition Wiley, 2018.

2. Howard Anton, Irel Bivens, Stephens Davis, *Calculus* 10^{th} Edition Wiley, 2012.

References

1. Ian Sneddon, *Elements of Partial Differential Equations*, Mc Graw- Hill, 2013.

2. Peter. V. O Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007.

3. M. D. Raisinghaniya, *Ordinary and Partial Differential Equations*, S Chand 18^{th} Edition, 2008.

4. G. F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata McGraw-Hill, 2003.

5. G. B. Thomas, R. L. Finey, *Calculus*, 9^{th} Edition, Addison-Weseley Publishing Company, 2004.

E- resources

1. https://www.sagemath.org/help.html

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the fundamental concepts of Integration and Vector valued function.	PSO1, 2 PO1, 3, 6, 7, 8	U, Ap	F,C	L	
CO 2	Analyze the various techniques both in Integration and in Vector Calculus	PSO 2,3 PO1, 2, 3, 6, 7, 8	U, An	C,P	L	
CO 3	Develop problem-solving techniques	PSO 1,2,3,4, PO1, 2, 3, 6, 7, 8	An, E	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	2	2	3	3	3	-	1	-	-	2	1	1
CO2	1	3	1	2	1	1	1	1	3	-	-	2	1	1
CO3	1	3	2	3	2	3	1	3	3	-	-	3	1	1

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- End Semester Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	—-	—-	✓
CO2	✓	✓		✓
CO3	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT102				
Course Title	Integration and Applications of differentiation				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Integration of elementary functions 2. Differentiation				
Course Summary	This course enables the student to understand the applications of differentiation and evaluate the integrals				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Applications of Derivatives**	**20**
	1	Increase, Decrease, and Concavity *(Chapter 3: Section 3.1 of Text [1])*	
	2	Relative Extrema *(Chapter 3: Section 3.2 of Text [1])*	
	3	Absolute Maxima and Minima *(Chapter 3: Section 3.4 of Text [1])*	
	Practical: Finding first and second derivatives of a function, plotting graphs using $plot()$, finding value of a function, finding maximum and minimum of a function in an interval. (not meant for examination purpose)		
II		**Maximum Minimum Problems**	**20**
	4	Applied Maximum and Minimum Problems *(Chapter 3: Section 3.5 of Text [1])*	
	5	Rectilinear Motion *(Section 3.6 of Text [1])*	
	6	Rolle's Theorem; Mean-Value Theorem *(Chapter 3: Section 3.8 of Text [1])*	

Module	Unit	Contents	Hrs
	Practical: Verify Rolle's Theorem and Mean-Value Theorem (not meant for examination purpose)		
III	**Definite Integral**		**20**
	7	Integration by Substitution, The Definite Integral *(Chapter 4: Sections 4.3, 4.5 of Text [1])*	
	8	Average Value of a Function and its Applications *(Chapter 4: Section 4.8 of Text [1])*	
	9	Evaluating Definite Integrals by Substitution *(Chapter 4: Sections 4.9 of Text [1])*	
	Practical: Finding indefinite and definite integral, average value of a function. (not meant for examination purpose)		
IV	**Evaluation of Integrals**		**15**
	10	Integration by Parts *(Chapter 7: Section 7.2 of Text [1])*	
	11	Integrating Trigonometric Functions *(Chapter 7: Section 7.3 of Text [1])*	
	12	Trigonometric Substitutions *(Chapter 7: Section 7.4 of Text [1])*	

Textbooks

1. H Anton, I Bivens, S Davis, *Calculus*, 10th Edition, John Wiley & Sons.

References

1. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12th Edition, Addison-Weseley Publishing Company, 2004.

2. J Stewart, *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited, 2004.

3. G B Thomas, R L Finney, *Calculus*, 9th Edition, Addison-Weseley Publishing Company, 2004.

E-resourses

1. https://www.sagemath.org/help.html

2. https://www.geogebra.org/m/ngfvakga

3. https://www.geogebra.org/m/AzVR5uU7

4. https://www.geogebra.org/m/yyu2my9w

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concept of integration	PSO 1	U	F, C	L	
CO 2	Evaluation of integrals of functions and learn its physical interpretation through various examples	PSO 2, 4	Ap, An	P	L	
CO 3	Define maxima, minima, critical points and points of inflection	PSO 1	U	F, C	L	
CO 4	Apply the concept of differentiation in real life situation	PSO 3, 4	Ap, An	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO2	-	3	-	3	-	-	-	3	2	-	-	-	-	-
CO3	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO4	-	-	3	3	-	-	-	3	2	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT103				
Course Title	Integral Calculus and Vectors				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Integral of elementary functions 2. Vectors				
Course Summary	This course enable the students to find the integrals and know about the vector valued functions				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Definite Integral**	**20**
	1	Integration by Substitution, The Definite Integral *(Chapter 4: Sections 4.3, 4.5 of Text [1])*	
	2	Average Value of a Function and its Applications *(Chapter 4: Section 4.8 of Text [1])*	
	3	Evaluating Definite Integrals by Substitution *(Chapter 4: Sections 4.9 of Text [1])*	
	Practical: Finding indefinite and definite integral of various functions. Average value of a function. Convergence of improper integral, Finding numerical value of integral. (not meant for examination purpose)		
II		**Evaluation of Integrals**	**20**
	4	Integration by Parts *(Chapter 7: Section 7.2 of Text [1])*	
	5	Integrating Trigonometric Functions *(Chapter 7 Section 7.3 of Text 1)*	

Module	**Unit**	**Contents**	Hrs
	6	Trigonometric Substitutions *(Chapter 7: Section 7.4 of Text [1])*	
III		**Vector Algebra**	**18**
	7	Three dimensional space, vectors, Cylindrical surfaces, algebra of vectors, norm of a vector, vectors determined by length and angle, vectors determined by length and a vector in the same direction, resultant of two Concurrent forces. *(Chapter 11: Sections 11.1, 11.2 of Text [1])*	
	8	Dot Product, Projections, Algebraic properties of dot product, Angle between vectors, Direction angles *(Chapter 11: Section 11.3 of Text [1])*	
	9	Cross product - Algebraic and geometric properties of cross product, scalar triple product, Algebraic and geometric properties of scalar triple product *(Chapter 11: Section 11.4 of Text [1])*	
	Practical: define a vector field with generic components, define dot product and cross product of vector fields, Finding norm by defining $norm(u) == sqrt(u.dot(u))$, plotting vector field using 3D plot. (not meant for examination purpose)		
IV		**Vector Valued Functions**	**17**
	10	Introduction to vector valued Functions, Parametric Curves in 3-Space - The parametric equations (introduction only) vector valued functions (introduction only) vector form of a line segment (introduction only) *(Chapter 12: Sections 12.1 of Text [1])*	
	11	Calculus of vector-valued Functions - Limits and Continuity, Geometric interpretations of limits, Derivatives, Geometric interpretation of the derivative, derivative rules Derivatives of dot and cross products (fundamentals only) Integrals of vector valued functions and integral rules (fundamentals only)*(Chapter 12: Section 12.2 of Text [1])*	
	12	Unit Tangent, Normal and Binormal vectors (introduction only) Normal and Tangential Components of Acceleration *(Chapter 12: Section 12.4 of Text [1])*	
	Practical: drawing parametric curves, Finding limit, derivative and components of a vector function (not meant for examination purpose)		

Textbook

1. H Anton, I Bivens, S Davis, *Calculus*, 10th Edition, John Wiley & Sons, 2012.

References

1. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12th Edition, Addison-Weseley Publishing Company, 2004.
2. J Stewart, *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited, 2008.
3. G B Thomas, R L Finney, *Calculus*, 9th Edition, Addison-Weseley Publishing Company, 2004.

E-resourses

1. https://www.sagemath.org/help.html
2. https://www.geogebra.org/m/ngfvakga
3. https://www.geogebra.org/m/AzVR5uU7
4. https://www.geogebra.org/m/yyu2my9w

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concept of integration	PSO 1	U	F, C	L	
CO 2	Describe the integration of a function and learn its physical interpretation through various examples.	PSO 2, 4	Ap, An	P	L	
CO 3	Understand the concepts of three dimensional space, vectors, different vector operations, vector valued functions and calculus of vector valued functions	PSO 1	U	F, C	L	
CO 4	Able to find limits, derivatives of vector valued functions	PSO 2	Ap	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO2	-	3	2	3	-	-	-	3	2	-	-	-	-	-
CO3	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO4	-	3	3	-	-	-	3	2	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT104				
Course Title	Integral Calculus and Ordinary Differential Equations				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Integration 2. Differentiation				
Course Summary	This course enable the students to find the integrals and to solve certain differential equations				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Definite Integral**		**20**
	1	Integration by Substitution, The Definite Integral *(Chapter 4: Sections 4.3, 4.5 of Text [1])*	
	2	Average Value of a Function and its Applications *(Chapter 4: Section 4.8 of Text [1])*	
	3	Evaluating Definite Integrals by Substitution *(Chapter 4: Sections 4.9 of Text [1])*	
	Practical: Defing functions, Finding integral of a function using sagemath, Convergence of improper integral, Finding numerical value of integral. Finding average value of a function. (not meant for examination purpose)		
II	**Evaluation of Integrals**		**20**
	4	Integration by Parts *(Chapter 7: Section 7.2 of Text [1])*	
	5	Integrating Trigonometric Functions *(Chapter 7 Section 7.3 of Text 1)*	

Module	Unit	Contents	Hrs
	6	Trigonometric Substitutions *(Chapter 7: Section 7.4 of Text [1])*	
III		**Differential Equations**	**23**
	7	Solution curves without a solution (not meant for examination purpose), Separable Equations *(Chapter 2: Sections 2.1, 2.2 of Text [2])*	
	8	Linear Equations, Exact Equations *(Chapter 2: Section 2.3, 2.4 of Text [2])*	
	9	Solutions by Substitutions, A Numerical Method *(Chapter 2: Section 2.5, 2.6 of Text [2])*	
	10	Linear Models, Nonlinear Models *(Chapter 2: Section 2.7, 2.8 of Text [2])*	
	Practical: equation representing ODE, solving ODE numerically. (not meant for examination purpose)		
IV		**Higher Order Differential Equations**	**12**
	11	Initial-Value and Boundary-Value Problems, Homogeneous Equations, Nonhomogeneous Equations, Reduction of Order *(Chapter 3: Sections 3.1, 3.2 of Text [2])*	
	12	Homogeneous Linear Equations with Constant Coefficients *(Chapter 3: Section 3.3 of Text 2)*	
	13	Cauchy–Euler Equations *(Chapter 3: Section 3.6 of Text [2])*	

Textbooks

1. H Anton, I Bivens, S Davis, *Calculus*, 10th Edition, John Wiley & Sons, 2012

2. Dennis G. Zill, *Advanced Engineering Mathematics* 6th Edition, Jones & Bartlett Learning, 2016.

References

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley Publishers, 10th Edition, 2018.

2. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12th Edition, Addison-Weseley Publishing Company, 2004.

3. Peter V. O. Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007.

4. G. F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata McGraw- Hill, 2003.

5. J Stewart, *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited, 2008.

6. G B Thomas, R L Finney, *Calculus*, 9th Edition, Addison-Weseley Publishing Company, 2004.

E-resourses

1. https://www.sagemath.org/help.html
2. https://www.geogebra.org/m/ngfvakga
3. https://www.geogebra.org/m/AzVR5uU7
4. https://www.geogebra.org/m/yyu2my9w

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concept of integration	PSO 1	U	F, C	L	
CO 2	Describe the integration of a function and learn its physical interpretation through various examples.	PSO 2, 4	Ap, An	P	L	
CO 3	Demonstrate a thorough understanding of basic concepts in ordinary differential equations and initial value problems.	PSO 1	U	F, C	L	
CO 4	Able to solve various types of first-order, second order ordinary differential equations, including separable equations, linear equations and equations with constant coefficients	PSO 2, 5	Ap	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO2	-	3	-	2	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	3	-	-	-	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT105				
Course Title	Applications of Differentiation and Ordinary Differential Equations				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	1	5
Pre-requisites	Differentiation, Integration				
Course Summary	This course enable the students to understand the applications of differentiation and to solve certain differential equations				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Applications of Derivatives**	**20**
	1	Increase, Decrease, and Concavity *(Chapter 3: Section 3.1 of Text 1)*	
	2	Relative Extrema *(Chapter 3: Section 3.2 of Text [1])*	
	3	Absolute Maxima and Minima *(Chapter 3: Section 3.4 of Text [1])*	
	Practical: Value of function, derivative of function, concavity, extrema of functions. (not meant for examination purpose)		
II		**Maximum Minimum Problems**	**20**
	4	Applied Maximum and Minimum Problems *(Chapter 3: Section 3.5 of Text [1])*	
	5	Rectilinear Motion *(Section 3.6)*	
	6	Rolle's Theorem; Mean-Value Theorem *(Chapter 3: Section 3.8 of Text [1])*	

Module	Unit	Contents	Hrs
	Practical: Maxima and Minima of functions. (not meant for examination purpose)		
III	**Differential Equations**		**23**
	7	Solution curves without a solution (not meant for examination purpose), Separable Equations *(Chapter 2: Sections 2.1, 2.2 of Text [2])*	
	8	Linear Equations, Exact Equations *(Chapter 2: Section 2.3, 2.4 of Text [2])*	
	9	Solutions by Substitutions, Numerical Method *(Chapter 2: Section 2.5, 2.6 of Text [2])*	
	10	Linear Models, Nonlinear Models *(Chapter 2: Section 2.7, 2.8 of Text [2])*	
	Practical: equation representing ODE, drawing, solving ODE numerically. (not meant for examination purpose)		
IV	**Higher Order Differential Equations**		**12**
	11	Initial-Value and Boundary-Value Problems, Homogeneous Equations, Nonhomogeneous Equations, Reduction of Order *(Chapter 3: Sections 3.1, 3.2 of Text [2])*	
	12	Homogeneous Linear Equations with Constant Coefficients *(Chapter 3: Section 3.3 of Text 2)*	
	13	Cauchy–Euler Equations *(Chapter 3: Section 3.6 of Text [2])*	

Textbooks

1. H Anton, I Bivens, S Davis, *Calculus*, 10th Edition, John Wiley & Sons, 2012.

2. Dennis G. Zill, *Advanced Engineering Mathematics* 6th Edition, Jones & Bartlett Learning, 2016.

References

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley Publishers, 10th Edition, 2018.

2. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12th Edition, Addison-Weseley Publishing Company, 2004.

3. Peter V. O. Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007.

4. G. F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata McGraw- Hill, 2003.

5. J Stewart, *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited, 2008.

6. G B Thomas, R L Finney, *Calculus*, 9th Edition, Addison-Weseley Publishing Company, 2004.

E-resourses

1. https://www.sagemath.org/help.html
2. https://www.geogebra.org/m/ngfvakga
3. https://www.geogebra.org/m/AzVR5uU7
4. https://www.geogebra.org/m/yyu2my9w

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Define maxima, minima, critical points and points of inflection	PSO 1	U	F, C	L	
CO 2	Apply the concept of differentiation in real life situation	PSO 3, 4	Ap, An	P	L	
CO 3	Demonstrate a thorough understanding of basic concepts in ordinary differential equations and initial value problems.	PSO 1	U	F, C	L	
CO 4	Able to solve various types of first-order, second order ordinary differential equations, including separable equations, linear equations and equations with constant coefficients	PSO 2, 5	Ap	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	3	-	-	3	-	-	-	-	-	-	-
CO2	-	-	2	3	-	-	-	3	2	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	3	-	-	-	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT106				
Course Title	Linear Algebra and Graph Theory				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Matrices 2. Linear equations				
Course Summary	This course aims to solve systems of linear equations and to understand the basic concepts of graph theory				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Matrices and Systems of linear equatios**	**20**
	1	Linear systems of equations, Gauss elimination, linear Independence, rank of a matrix. *(Chapter7: Sections 7.2, 7.4 of Text [1] (vector space is not included))*	
	2	Solutions of linear systems: existence, uniqueness *(Chapter 7: Section 7.5 of Text [1] (proofs of theorems are not required))*	
	3	Determinants, Cramer's Rule *(Chapter 7: Section 7.7 of Text [1])*	
	Practical: Matrix constructors, product, augmented matrix, inverse of matrix, and determinant of matrices using softwares like sagemath. (not meant for examination purpose)		
II		**Eigenvalues and Eigenvectors**	**20**
	4	The Matrix Eigenvalue Problem. Determining Eigenvalues and Eigenvectors *(Chapter 8: Section 8.1 of Text [1])*	

Module	Unit	Contents	Hrs
	5	Symmetric, Skew-Symmetric, and Orthogonal Matrices *(Chapter 8: Section 8.3 of Text [2])*	
	6	Diagonalization, Quadratic Forms *(Chapter 8: Section 8.4 of Text [1] eigen bases is not included)*	
	Practical: Solving simultaneous equations. (not meant for examination purpose)		
III	**Graphs**		**20**
	7	Basic Concepts of graph theory, Graph terminology and special types of graphs Representation of graphs, *(Chapter 1: Sections 1.1 to 1.5 of Text [2])*	
	8	Graph isomorphism, connected graphs, disconnected graphs, definitions and examples of Euler's path, circuits, Hamiltonion Path, Hamiltonian circuits *(Chapter 2: Sections 2.1, 2.5, 2.6, 2.9 of Text [2])*	
	Practical: Drawing standard graphs, graph constructs, graph properties. graph representation-adjacency matrix (not meant for examination purpose)		
IV	**Trees and Spanning Trees**		**15**
	9	Trees, properties, pendant vertices, distance and centers, spanning trees, Rooted and binary trees *(Chapter 3: Sections 3.1 to 3.5 and 3.7 of Text [2])*	
	10	Fundamental circuits, finding all spanning trees in a graph, spanning trees in a weighted graph *(Chapter 3: Section 3.8, 3.9, 3.10 of Text [2] (proofs of theorems are not required))*	
	11	Incidence matrices, path matrices and adjacency matrices of graphs (definitions and examples only) *(Chapter 7: Sections 7.1, 7.8, 7.9 of Text [2] (proofs of theorems are not required))*	

Textbook

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley Publishers, 10^{th} Edition, 2018.
2. Narasingh Deo, *Graph Theory with Applications to Engineering and Computer Science*, PHI, 1974.

References

1. R. Balakrishnan, K. Ranganathan, *A Text book of Graph Theory*, Second Edition, Springer, 2012.
2. T S Blyth, E F Robertson, *Linear Algebra*, Second Edition, Springer, 2013.
3. David C Lay, *Linaer algebra*, Pearson, 2003.
4. Gary Chartrand and Ping Zhang, *Introduction to Graph Theory*, New Delhi, New York: Tata McGraw-Hill Pub. Co., 2006.

5. Lee W. Johnson, R Dean Riess, Jimmy T. Arnold, *Introduction to Linear Algebra*, Fifth Edition, Addison Wesley, 2019.

6. Robin J. Wilson, *Introduction to Graph Theory*, Pearson Education Asia, 5th Edition, 2010.

7. Thomas Banchoff, John Wermer, *Linear Algebra Through Geometry*, 2nd Edition, Springer, 2003.

E-resourses

1. https://www.sagemath.org/help.html
2. https://www.geogebra.org/m/ngfvakga
3. https://www.geogebra.org/m/AzVR5uU7
4. https://www.geogebra.org/m/yyu2my9w

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concepts of Matrix operations their algebraic properties, System of linear equations and their Matrix representation, Gauss Elimination	PSO 1	U	F, C	L	
CO 2	Able to find the eigen values, powers of matrices and diagonalization of matrices	PSO 2, 4	Ap, An	P	L	
CO 3	To define and understand the fundamental concepts of graph theory	PSO 1	U	F, C	L	
CO 4	To apply the concepts and theorems that are treated in the course for problem-solving	PSO 2, 4	Ap, An	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	-	-	-	-	-	1	1	-	-	1	2	-	-
CO2	-	2	-	2	-	-	2	2	-	-	-	2	-	-
CO3	2	-	-	-	-	-	1	1	-	-	1	1	-	-
CO4	-	2	-	3	-	-	2	1	1	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT107				
Course Title	Mathematics for Social Sciences - II				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	1.Knowledge of functions, particularly, demand functions, revenue functions and cost functions				
Course Summary	This course includes Differential calculus, its applications in matrix theory and game theory				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Basics of Differentiation**	**15**
	1	One variable Differentiation, Basic Definition, Process of differentiation, Rules of differentiation, Some Standard rules (without proof)	
	2	Derivative of higher order with simple problems involving polynomial functions(except trignometric and logarithmic functions)	
	Chapter 6: 6.3, 6.4, 6.5 of Text [1].		
II		**Applications of Derivatives**	**15**
	3	Sign of differential coefficients, Second derivative and nature of curve, Maximum and minimum value of a function, Order Condition for maximum-minimum extreme values.	

Module	Unit	Contents	Hrs
	4	Applications of simple derivatives: Differential Coefficient and elasticity of demand.	
	Chapter 6: Sections 6.3, 6.4, 6.5, and Chapter 7: Section 7.1 of Text [1]		
III	**Matrices**		**18**
	5	Addition, subtraction of Matrices, matrix multiplication, transpose of a matrix properties of transpose of a matrix	
	6	Some special form of square matrices, determinants, inverse of a matrix (cofactor method only)	
	Chapter 5: Sections 5.1, 5.2, 5.3, 5.5, 5.6, 5.7, 5.10, 5.13 and 5.15 of Text [1]		
IV	**Game Theory**		**12**
	7	Basic concepts of Game theory Classification and Description of games Pay-off matrix,	
	8	Saddle point solutions (Strictly Determined Games)	
	Chapter 20: Sections 20.1, 20.2, 20.3, 20.4 of Text [1]		

Textbook

1. B.C. Mehta, G.M.K. Madnani, Mathematics for Economics. Sultan Chand & Sons, 1976.

References

1. Agarwal B.M, Business Mathematics and Statistics, Vikas Publishing House,New Delhi, 2009.

2. Allen, R.G.D. , Mathematical Analysis for Economists. New Delhi: AITBS Publishers, 2008.

3. Yamane, Taro., Mathematics for Economists: An Elementary Survey. New Delhi: Prentice Hall of India, 2012.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concepts of derivatives, Maxima-minima	PSO1	R, U	F,C	L	
CO 2	Apply the concepts of differentiation in real life situations	PSO3, 5	Ap	C	L	
CO 3	The basic concepts of matrices	PSO3	U	P	L	
CO 4	The basic concepts of game theory	PSO1, PO1	U	F,C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	2	2	1	3	3	2	1	3
CO2	-	-	3	-	3	-	2	3	1	-	-	-	-	1
CO3	-	-	3	-	-	-	3	3	3	2	3	2	1	3
CO4	3	-	-	-	-	-	3	2	-	-	2	1	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT108				
Course Title	Integral Calculus and Series				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	1	5
Pre-requisites	Differential Calculus				
Course Summary	The course deals with Integrals, applications of integrals and the fundamental theorem of calculus. The intuitive idea of Infinite series and Taylor's theorem is also explained.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Integrals**	**20**
	1	Area problem, Indefinite Integral, Integration by substitution, Area as a limit, Definite Integral, Fundamental theorem of Calculus.	
	Chapter 4: Section 4.1 , 4.2, 4.3, 4.4, 4.5, 4.6 of Text [1]		
	Practical: Finding indefinte and definite integrals, shading area under the curve.(not meant for examination purpose)		
II		**Application of Integrals**	**20**
	2	Area between two curves, Length of a plane curve, Area of surface of revolution, Work.	
	Chapter 5: Section 5.1, 5.4, 5.5, 5.6 of Text [1]		
	Practical: Sketch graph of function, finding integrals, shading area between curves (not meant for examination purpose)		

Module	Unit	Contents	Hrs
III	**Infinite series**		**15**
	3	Sequences, Monotone sequences, Infinite series, Convergence tests, Comparison, ratio and root test.	
	Chapter 9: Section 9.1 , 9.2, 9.3, 9.4, 9.5 of Text [1]		
IV	**Taylors theorem**		**20**
	4	Alternating series, Absolute and conditional convergence, Maclaurin and Taylor Polynomials and series, Power series, Convergence of Taylor series, Modeling of Taylor series.	
	Chapter 9: Section 9.6, 9.7, 9.8, 9.9, 9.10 of Text [1]		
	Practical: Series representation, sum the series. convergent tests (not meant for examination purpose)		

Textbook

1. Howard Anton, Irel Bivens, Stephens Davis, *Calculus* 10^{th} Edition Wiley, 2012.

References

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley Publishers, 10$^{\text{th}}$ Edition, 2018.

2. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12$^{\text{th}}$ Edition, Addison-Weseley Publishing Company, 2004

3. J Stewart, *Calculus with Early Transcendental Functions*, 7$^{\text{th}}$ Edition, Cengage India Private Limited, 2008

4. G B Thomas, R L Finney, *Calculus*, 9$^{\text{th}}$ Edition, Addison-Weseley Publishing Company, 2004.

E- resources

1. https://www.sagemath.org/help.html

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understands the basic concept of Integrals and fundamental theorem of Calculus	PSO1, 2, PO1	U	F,C	L,T	
CO 2	Realise the concept of area between two curves	PSO2, PO3, 4	R, U	F	L,T	
CO 3	Develop a concrete idea about sequences and series	PSO1,3, PO2, 3	U,An	C	L,T	
CO 4	Use convergence tests to find limits	PSO3, PO3	Ap	C,P	T	As
CO 5	Apply integration in Modeling Taylor series	PSO1,3, PO3	Ap	C,P	T	As

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1					3							
CO2		2							1	3				
CO3	2		3					2	2					
CO4			2					3						
CO5	2		1					3						

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓			✓
CO3	✓	✓		✓
CO4	✓			✓

University of Kerala

Descipline	Mathematics				
Cours Code	UK2DSCMAT109				
Course Title	Matrices and Linear Equations				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	Matrices				
Course Summary	This is a brief introductory course on matrices and system of linear equations				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**System of linear equations and matrices**		**10**
	1	Introduction to Systems of Linear Equations, Gaussian Elimination, Matrices and Matrix Operations, Inverses;Algebraic Properties of Matrices, [Section 1.1 to 1.4 of the Text]	
II	**Further properties of matrices**		**15**
	2	Elementary matrices and method for finding inverse, more on linear systems and invertible matrices, diagonal, triangular and symmetric matrices, matrix transformations [Section 1.5 to 1.8 of the Text]	
III	**Determinants**		**15**
	3	Determinants by cofactor expansion, evaluating determinants by row reduction, properties of determinants, Cramer's rule	

Module	Unit	Contents	Hrs
IV	**Euclidean vector spaces**		**20**
	4	Vectors in 2 space, 3 space and n-space, Norm, dot product, and distance in R^n, Orthogonality, the geometry of linear systems, cross product	

Textbook

1. H Anton, C Rorres. Elementary linear algebra, 11th Edition, John Wiley & Sons, 2013

References

1. David Poole, Linear Algebra, a modern introduction, Brooks/Cole Cengage learning, 2005.

2. Lee W.Johnson, R. Deanriess, Jimmy Arnold, Introduction to Linear Algebra, Fifth edition, Addison Wisely, 2019.

Course Outcomes

CO No.	**Upon completion of the course the graduate will be able to**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture(L) Tutorial (T)**	**Assignment (As)**
CO 1	Understands system of linear equations	PSO1,2, PO1	U	F,C	L,T	
CO 2	Perform various operations on matrices and determinants	PSO2, PO3, 4	An	F	L,T	
CO 3	Understand the concept of vectors in Euclidean spaces	PSO1,3, PO2, 3	U,An	C	L,T	
CO 4	Apply matrices to soleve system of linear equations	PSO1,3	Ap	C	L,T	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1					3							
CO2		2							1	3				
CO3	2		3					2	2					

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1		✓		✓
CO2		✓		✓
CO3	✓			✓
CO4	✓			✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT110				
Course Title	Partial Differentiation and Analytic functions				
Type of Course	DSC				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	1. Integration 2. Differentiation				
Course Summary	Integration and applications of Differentiation				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Multivariate Calculus**	**18**
	1	Functions of Two or More Variables, Limits and Continuity *(Chapter13: Sections 13.1, 13.2 of Text[1])*	
	2	Partial Derivatives, The Chain Rule *(Chapter 13: Section 13.3, 13.5 of Text [1])*	
	3	Directional derivatives, Maxima and Minima of Functions of Two Variables *(Chapter 13: Sections 13.6, 13.7 of Text [1])*	
II		**Analytic functions**	**15**
	4	Complex Numbers and Their Geometric Representation *(Chapter 13: Section 13.1 of Text [2] (review only))*	
	5	Polar Form of Complex Numbers-Powers and Roots *(Chapter 13: Section 13.2 of Text [2]*	
	6	Derivative-Analytic Function, Cauchy–Riemann Equations Laplace's Equation *(Chapter 13: Section 13.3, 13.4 of Text [2])*	

Module	Unit	Contents	Hrs
III	**Cauchy's Integral Theorem**		**15**
	7	Line Integral in the Complex Plane and is properties (Except Existence of Complex Line integrals & ML Inequality) *(Chapter 14: Section 14.1 of Text [2])*	
	8	Cauchys Integral Theorems (without proof) Caucy's Integral Formula (without proof) Derivative of Analytic Functions *(Chapter 14: Sections 14.2, 14.3 of Text [2])*	
	9	Derivatives of Analytic Functions Lioville's Theorem and Morreras theorem (both without proof) *(Chapter 14: Section 14.4 of Text [2])*	
IV	**Conformal Mapping**		**12**
	10	Geometry of Analytic Functions, Conformal Mapping, Principle of Inverse Mapping *(Chapter 17: Section 17.1 of Text [2] all theorems without proof)*	
	11	Möbius Transformations, Extended Complex Plane, Fixed Points *(Chapter 17: Section 17.2 of Text [2] all theorems without proof)*	
	12	Special Linear Fractional Transformations, Mapping of Standard Domains *(Chapter 17: Section 17.3 of Text [2] all theorems without proof)*	

Textbooks

1. H Anton, I Bivens, S Davis, *Calculus*, 10th Edition, John Wiley and Sons, 2012.
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley Publishers, 10th Edition, 2018.

References

1. Anant R Shastri, *Basic Complex Analysis of One Variable*, Macmillan, 2010.
2. Edward B. Saff, Arthur David Snider, *Fundamentals of Complex Analysis with Applications to Engineering and Science*, 3rd Edition, Pearson Education India, 2017.
3. James Ward Brown and Ruel V Churchill, *Complex Variables And Applications*, Eighth Edition, McGraw Hill International Edition, 2001.
4. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12th Edition, Addison-Weseley Publishing Company, 2004.
5. John H Mathews and Russel W Howell, *Complex Analysis for Mathematics and Engineering*, Sixth Edition, Jones and Bartlett Publishers, 2012.
6. J Stewart, *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited, 2018.

7. G B Thomas, R L Finney, *Calculus*, 9th Edition, Addison-Weseley Publishing Company, 2004.

8. B S Tyagi, *Functions of A Complex Variable*, Kedar Nath Ram Nath, 2021.

E-resources

1. https://www.geogebra.org/m/VMa4z2RU

2. https://www.geogebra.org/m/wcjfy77h

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Define the concept of functions of two or more variables	PSO 1	U	F, C	L	
CO 2	Illustrate derivatives of multivariate functions	PSO 2, 4	Ap, An	P	L	
CO 3	Understand the algebraic operations of complex numbers, complex functions, limits, continuity, differentiablilty of complex functions and conformal mapping.	PSO 1	U	F, C	L	
CO 4	Able to find line integrals, integrals using Cauchy's integral formula	PSO 2, 4	Ap, An	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	2	1	-	-	-	3	-	-
CO2	-	-	3	3	-	-	2	1	-	-	-	3	-	-
CO3	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO4	-	3	3	-	-	-	-	3	2	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2MDCMAT100				
Course Title	Numerical Ability - II				
Type of Course	MDC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	3	3			3
Pre-requisites	Basic Arithmetic Operations				
Course Summary	This course is primarily meant for students who have not undergone a Mathematics course beyond their secondary school. The course is expected to equip the student tackle basic arithmetic problems. The student is further expected to form linear and quadratic equations from simple real world problems on their own and solve the same.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Series and Progression**	**11**
	1	Arithmetic Series, Geometric series, Arithmetic Series of different orders, Arithmetico-Geometric series, Geometrico-Arithmetic Series. Problems involving the above concepts *(Chapter 23 of Text [1])*	
	2	Arithmetic Progression, Geometric Progression, Harmonic Progression.Problems involving the above concepts *(Chapter 29 of Text)*	
II		**Interest Calculation**	**12**
	3	Simple Interest, Problems involving Simple Interest *(Chapter 17 of Text [1])*	

Module	Unit	Contents	Hrs
	4	Compound Interest, Problems involving Compound Interest *(Chapter 18 of Text [1])*	
	5	Types of Shares, Face value and market value of a share, Stocks and Brokerage, Income on a Stock, Market Value of a stock, Gain or Loss in Sale and Purchase of Stock, Change in income on Sale or Re-investment. Problems involving the above concepts. *(Chapter 20 of Text [1] (Debentures not included)*	
III		**Equations**	**11**
	6	Linear Equation in one variable, Linear equation in two variables, Solving two simultatneous linear equations. Consistent and inconsistent equations. *(Chapter 27 of Text [1])*	
	7	Quadratic Equation, Solution of a quadratic equation, Nature of roots, Relation between roots and coefficients, Formation of a quadratic equation with given roots. *(Chapter 28 of Text [1])*	
IV		**Permutations, Combinations, Probability**	**11**
	8	Fundamental principle of counting, Permutations, Permutations under restrictions, Combinations. *(Chapter 31 of Text [1])*	
	9	Terms and Concepts regarding Events, Probability, Odds, Fundamental theorems on probability, Independent Events *(Chapter 32 of Text [1])*	

Textbook

1. Dinesh Khattar, *Quantitative Aptitude for Competitive Examinations*, Fourth Edition, Pearson, 2016.

References

1. H Kruglak, JT Moore, RA Mata-Toledo, *Schaum's outline of theorey and problems of Basic Mathematics, with Applications to Science and Technology*, Second Edition, McGraw-Hill, 1998.

2. Rajesh Verma, *Fast Track Objective Arithmetic*, Arihant, 2018.

3. Steven T Karris, *Mathematics for Business, Science and Technology*, Third Edition, Orchard Publications, 2007.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand basic level mathematics used in real life situations	PSO1, PSO2, PSO3, PO1, PO2, PO5	U, An, E	C, P	L	
CO 2	Do maths problems quickly using ready to use formulae	PSO3, PO2	R, Ap	P	L	
CO 3	Converting real world problems to mathematical problems	PSO1, PSO2, PSO3, PSO5, PO1, PO2, PO5, PO6	U, An, E	C, P	L	
CO 3	Understand the concepts of probability and compute it	PSO1, PSO2, PSO3, PO1, PO2	U, An, E	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	-	-	-	3	2	-	-	2	-	-	-
CO2	-	-	3	-	-	-	-	2	-	-	-	-	-	-
CO3	2	3	2	-	2	-	3	2	-	-	2	2	-	-
CO4	2	3	2	-	-	-	3	2	-	-	-	-	-	-

(- -Nil, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		
CO2	✓			✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2MDCMAT101				
Course Title	Business Mathematics				
Type of Course	MDC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	3	3			3
Pre-requisites	Basic algebra				
Course Summary	The course covers methods for finding simple interest and compound interest using different period of compounding concepts like index numbers, time series, trend arc - introduced and different ways for finding these are dealt in detail.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Basic Mathematics of Finance**	**18**
	1	Nominal rate of Interest and effective rate of interest, Continuous Compounding, force of interest, compound interest calculations at varying rate of interest, present value, interest and discount, Nominal rate of discount, effective rate of discount, force of discount, Depreciation. (Chapter 8: Sections: 8.1, 8.2, 8.3, 8.4. 8.5, 8.6, 8.7, 8.9 of text [1])	

Module	Unit	Contents	Hrs
II	**Index Numbers**		**18**
	2	Definition, types of index numbers, methods of construction of price index numbers, Laspeyer's price index number, Paasche's price index number, Fisher ideal index number, advantages of index numbers, limitations of index numbers (Chapter 6 of Unit II of text [1] - Sections: 6.1, 6.3, 6.4, 6.5, 6.6, 6.8, 6.16, 6.17)	
III	**Time Series**		**9**
	3	Definition of Time Series, Components of Time Series, Analysis of Time Series, Measurement of Trend- Free hand Method, Semi Average Method, Method of Least Squares. (Chapter 7 of Unit II of text [1] - Sections: 7.1, 7.2, 7.4)	

Textbook

1. B M Agarwal, Business Mathematics and Statistics, Vikas Publishing House, New Delhi, 2009.

References

1. Alpha C Chiang, Kevin Wainwright, Fundamental methods of Mathematical Economics, 4th Edition, Mc-Graw Hill, 2005.

2. Qazi Zameeruddin, et al., Business Mathematics, Vikas Publishing House, New Delhi, 2009.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Define Index Numbers and find index numbers from a given data using various methods.	PSO1, PO1, 2, 3, 4, 5, 6, 7	U, E	L	C	
CO 2	Define Time Series, components of Time Series and related concepts.	PSO1, PO1, 2, 3, 4, 5, 6, 7	U	L	C	
CO 3	Solve problems related to simple and compound interest using varying periods of compounding.	PSO2, PO1, 2, 3, 4, 5, 6, 7	Ap, E	L	P	
CO 4	Use mathematical tools to analyse time series and measure trend	PSO2, PO1, 2, 3, 4, 5, 6, 7	E, Ap, An	L	P	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	1	2	1	2	3	1	2	1	2	1	-
CO2	3	2	2	1	2	1	2	1	1	3	1	1	1	-
CO3	2	3	2	2	1	1	2	3	1	1	1	2	-	-
CO4	1	3	2	1	1	1	2	3	1	1	1	2	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2MDCMAT102				
Course Title	Basic Operations Research				
Type of Course	MDC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	3	3			3
Pre-requisites	Basic mathematical operations				
Course Summary	This course covers the fundamentals of Operations Research including the historical background, mathematical formulation, graphical solution methods. It delves into the Transportation Problem and Assignment Problem, exploring various methods for obtaining initial basic feasible solutions and introducing algorithms for solving the Assignment Problem and travelling salesman problem.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Introduction to Operations Research**	**9**
	1	The History of Operations Research	
	2	Methodology of Operations Research	
	3	Applications and computer software of Operations Research	
		(Chapter 1: Section 1.2,1.9,1.13,1.15 of Text [1].)	
II		**Linear Programming**	**12**
	4	Structure of linear programming model	
	5	Mathematical model of an LPP	
	6	Graphical solution of LP problem	
	7	Special Cases in Linear Programming	

Module	Unit	Contents	Hrs
	(Chapter 2: Sections 2.2, 2.6,2.8.1, Chapter 3: sections 3.2, 3.3 (Examples 3, 5, 3.6, 3.7, 3.11) and section 3.4 of Text [1].)		
III	**Transportation Problem**		**14**
	8	Mathematical model of transportation problem	
	9	Initial feasible solution to Transportation Problem	
	10	The Optimal Solution by MODI method	
	(Chapter 9: Section 9.2, 9.4.1, 9.4.2, 9.4.3, 9.5.3, 9.5.4 of Text [1].)		
IV	**Assignment Problem**		**10**
	11	Mathematical model of Assignment problem	
	12	Hungarian Method for solving Assignment problem	
	13	Travelling Salesman Problem	
	(Chapter10: Section 10.2, 10.3.1, 10.4, 10.6 of Text [1].)		

Textbook

1. J. K. Sharma, Operations Research - Theory and Applications, Sixth Edition, 2016.

References

1. Goel B.S and Mittal S.K "Operations Research" Pragati Prakashan, Meerut ,1973.
2. Hardly G, "Linear Programming" Addison Wesley, Reading. Mass, 1962.
3. Kapoor V.K, "Operations Research" Sultan chand and sons, New Delhi 1985.
4. Nita H.Shah, Ravi M.Gor, Hardik Soni, "Operations Research", Prentice Hall of India, New Delhi, 2007.
5. Ravindran A, Don.T. Phillips, James.J.Solberg, "Operations research-Principles and Practice", Second edition, John Wiley and Sons, 2000.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand and apply the concept of mathematical modelling	PSO2, PSO3, PO2	R,U, Ap	F,P	L	
CO 2	Apply the techniques of LPP to solve problems	PSO3, PO2	Ap , E	P	L	
CO 3	Recognize and formulate a transportation problem	PSO2, PSO3, PO2	R, U	F	L	
CO 4	Solve a travelling salesman problem.	PSO3	Ap, E	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	3	2	-	-	-	-	2	-	-	-	-	-	-
CO2	-	-	3	-	-	-	-	3	-	-	-	-	-	-
CO3	-	3	3	-	-	-	-	2	-	-	-	-	-	-
CO4	-	-	3	-	-	-	-	-	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2MDCMAT103				
Course Title	Introduction to Modular Arithmetic and Cryptography				
Type of Course	MDC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	3	3			3
Pre-requisites	Basic properties of integers, divisibility, gcd Linear Diophantine equations, Unique factorization				
Course Summary	This is a short introduction to Cryptography using congruences.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Modular Arithmetic**	**12**
	1	Definition of congruence relation, Modular exponentiation, Divisibility tests, linear congruences, The Chinese remainder theorem (Chapter 5: Sections 5.1, 5.2, 5.3, 5.4, 5.5 of Text[1])	
II		**Three Classical Theorems**	**13**
	2	Fermat's theorem, Euler's theorem, Wilson's theorem (Chapter 6: Section 6.1, 6.2, 6.3 of Text[1])	
III		**Introduction to Cryptography**	**20**
	3	Shift and affine cipher, Vigenere ciphers, transposition ciphers, RSA, stream ciphers, block ciphers, secret sharing (Chapter 7: Sections 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8 of Text[1])	

Textbook

1. James S.Kraft, Lawrence C. Washington. Elementary Number Theory, CRC Press, 2015.

References

1. James S.Kraft, Lawrence C. Washington, An Introduction to Number Theory with Cryptography, CRC Press, 2014.
2. G A Jones, J M Jones, Elementary Number Theory, Springer, 1998.
3. Thomas Koshy, Elementary Number Theory with Applications, 2^{nd} Edition, Academic Press, 2007.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Describe the basic concept of Modular arithmetic	PSO1, PSO2	R	F,C	L	
CO 2	Apply congruence to solve various problems.	PSO3	U,Ap	P	L	
CO 3	Analyse the properties of integers using congruences via three milestone theorems	PSO3, PSO4	U,An	C	L	
CO 4	Apply congruence to cryptography	PSO3	R,U,An	C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	1	2	-	-	-	-	-	-	-	-	-	-
CO4	-	-	3	-	-	-	-	-	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4		✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK3DSCMAT200				
Course Title	Integral Calculus and Foundations of Vector Calculus				
Type of Course	DSC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4		1	5
Pre-requisites	1.Awareness of Differential Calculus and Integral Calculus				
	2. Knowledge of various co-ordinate systems in 2-dimension				
Course Summary	The course deal with identifying the applications of integration and vector valued functions				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Integral Calculus I**	**15**
	1	Area between two curves, Volume by Slicing, Volume by cylindrical shells. Chapter 5: Section 5.1, 5.2, 5.3 of Text [1]	
II		**Integral Calculus II**	**15**
	2	Length of the plane curve Area of surface of revolution Work(done by constant force in the direction of motion only) Chapter 5: Section 5.4, 5.5, 5.6 of Text [1]	
III		**Vector Valued Functions I**	**15**
	3	Rectangular Coordinates In 3-Space; Spheres; Cylindrical Surfaces, Vectors, Dot Product; Projections, Cross Product, Parametric equations of lines, Planes in 3- space, Cylindrical and spherical Coordinates. Chapter 11: Section 11.1 to 11.6, 11.8 of Text [1]	

Module	Unit	Contents	Hrs
IV	**Vector Valued Functions II**		**15**
	4	Introduction To Vector-Valued Functions, Calculus Of Vector-Valued Functions, Change Of Parameter; Arc Length, Unit Tangent, Normal, And Binormal Vectors, Curvature, Motion Along A Curve. Chapter 12: Section 12.1 to 12.6 of Text [1]	
Practical	Practical sessions can be given using suitable software like sagemath (not meant for examination purpose)		**15**

Textbook

1. H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons, 2012.

References

1. Joel Hass, Maurice D. Weir, Thomas' Calculus Early Transcendentals, 12th Edition, Addison-Weseley Publishing Company, 2004.
2. J Stewart, Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited, 2008.
3. G B Thomas, R L Finney, Calculus, 9th Edition, Addison-Weseley Publishing Company, 2004.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Demonstrate applications of Integration	PSO3, PO1, 2, 3, 4, 5, 6, 7, 8	U,E	F,P	L	
CO 2	Computing area and volume using Integration	PSO2, PO1, 2, 3, 4, 5, 7, 8	U,An	F, P		
CO 3	Analysing geometry of curves and surfaces using Vector Calculus	PSO2, PO1, 2, 3, 4, 5, 6, 7, 8	U, E	F, P		
CO 4	Distinguish cylindrical and spherical co-ordinates	PSO4, PO1, 2, 3, 4, 5, 6, 7, 8	R, An	F, P		

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1			3				3	3	2	2	1	2	2	1
CO2		3					3	3	1	1	2		2	1
CO3		3					3	2	1	1	2		2	1
CO4				3			3	2	1	1	1	2	3	1

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1		✓		
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics
Course Code	UK3DSCMAT201
Course Title	Differential Equations, Multiple Integrals and Vector Calculus
Type of Course	DSC
Semester	III
Academic Level	200-299

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Differential calculus 2. Vectors 3. Integration				
Course Summary	The course enable the students to find the solutions of certain differential equations, identifying the applications of multiple integrals and to get a brief idea of vector calculus.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**First Order Ordinary Differential Equations**	**20**
	1	Basic Concepts, solution, Initial Value Problem, Modelling	
	2	Separable ODE, reduction to separable form, exact ODEs and integrating factors, reducing to exact form	
	3	Homogeneous and non homogeneous linear ODEs	
	4	Special equations like Bernoulli equation	
	5	Homogeneous linear ODE of second order, initial value problem, basis, and general solutions, finding a basis if one solution is known, Reduction of order, homogeneous linear ODE with constant coefficients (various cases that arise depending on the characteristic equation)	
	6	Existence and uniqueness of solutions with respect to Wronskian, solving non-homogeneous ODE via the method of undetermined coefficients.	

Module	Unit	Contents	Hrs
	Chapter 1: Section 1.1, 1.3, 1.4, 1.5 (population dynamics not required), 2.1, 2.2, 2.6, 2.7 of Text [1]		
II	**Multiple Integrals**		**16**
	7	Double Integrals	
	8	Double integrals over non rectangular regions	
	9	Double integrals in polar coordinates	
	10	Triple integrals	
	11	Triple integrals in cylindrical and spherical coordinates	
	Chapter 14: Section 14.1, 14.2, 14.3, 14.5, 14.6 of Text [2]		
III	**Vector Calculus 1**		**12**
	12	Vector Fields, Inverse square field, Gradient field, Conservative fields and potential function, Divergence and Curl, ∇-operator, The Laplacian ∇^2	
	13	Integrating a function along a curve (line integrals), Integrating a vector field along a curve, defining work done as a line integral.	
	14	Line integrals along piece wise-smooth curves, integration of vector fields and independence of path,	
	15	Fundamental theorem of line integrals, line integrals along closed paths, test for conservative vector fields, *(excluding conservative vector fields in 3- Space, and conservation of Energy)* Green's theorem and applications(*without proof*).	
	Chapter 15: Section 15.1, 15.2, 15.3, 15.4 of Text [2]		
IV	**Vector Calculus- II**		**12**
	16	Defining and evaluating surface integrals, their applications	
	17	Orientation of surfaces, evaluating flux integrals	
	18	The divergence theorem	
	19	Gauss' Law, Stoke's theorem, applications of these theorems.	
	Chapter 15: Section 15.5, 15.6, 15.7, 15.8 of Text [2]		
Practical	Practical sessions can be given using suitable software like sagemath (not meant for examination purpose)		**15**

Textbooks

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10^{th} Edition Wiley, 2018.

2. Howard Anton, Irel Bivens, Stephens Davis, *Calculus* 10^{th} Edition Wiley, 2012.

References

1. Ian Sneddon, *Elements of Partial Differential Equations*, Mc Graw- Hill, 2013.
2. Peter. V. O Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007.
3. M. D. Raisinghaniya, *Ordinary and Partial Differential Equations*, S Chand 18^{th} Edition, 2008.
4. G. F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata McGraw-Hill, 2003.
5. G. B. Thomas, R. L. Finey, *Calculus*, 9^{th} Edition, Addison-Weseley Publishing Company, 2004.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concepts of ordinary differential equations, integration over multi variables geometric and physical interpretations of vector integration	PSO1, 2, PO3, 6, 7, 8	U, Ap	F,C	L	
CO 2	Analyze the solutions of ordinary differential equations, Multiple Integrals and Vector Integration	PSO 2,3, PO1, 2, 3, 6, 7, 8	U, An	C,P	L	
CO 3	Develop problem-solving skills and application skills	PSO 1, 2, 3, 4, PO1, 2, 3, 6, 7, 8	An, E	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1					3	-	1	-	-	2	1	1
CO2		3	1				1	1	3	-	-	2	1	1
CO3	1	3	2	3	2		1	3	3	-	-	3	1	1

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- End Semester Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	—-	—-	✓
CO2	✓	✓		✓
CO3	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK3DSCMAT202				
Course Title	Group Theory and Probability				
Type of Course	DSC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4	-		4
Pre-requisites	Sets, relations, functions, matrices				
Course Summary	This course provides a comprehensive idea about group theory and probability. We start the course with the concepts of groups and subgroups and then we go through permutation groups, cosets and their properties. After this we give an idea about basic probability theory, infact, random variables and its distributions namely binomial, normal and poisson				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Groups and Subgroups**	**15**
	1	Binary operations and isomorphic binary structures	
	2	Groups and Subgroups	
	3	Cyclic groups	
		The topics to be discussed in the module can be found in Chapter 1, Section 2, Section 3, Section 4, Section 5, Section 6 of the Text [2]. Theorem 6.14 statement only.	
II		**Permutation groups and Cosets**	**20**
	4	Groups of permutations	
	5	Orbits, cycles and alternating groups	
	6	Cosets and Lagrange theorem	

Module	Unit	Contents	Hrs
	The topics to be discussed in the module can be found in Chapter 2: Section 8, Section 9, Section 10 of the Text [2]. Theorem 9.15 statement only.		
III	**Probability and statistics**		**25**
	7	Probability and sample space: Definition and examples	
	8	Probability theorems	
	9	Random variables and continuous distributions	
	10	Binomial distribution, Normal distribution, Poisson distribution	
	The topics to be discussed in the module can be found in Chapter 15: Section 1, Section 2, Section 3, Section 5, Section 6, Section 7, Section 8, Section 9 of Text [1]		

Textbooks

1. M L Boas, Mathematical methods in physical sciences, 3rd Edn, John Wiley & Sons, 2006.

2. J B Fraleigh, A first course in abstract algebra, 7th Edn, Pearson, 2013.

References

1. Ian Sneddon, *Elements of Partial Differential Equations*, Mc Graw- Hill, 2013.

2. Peter. V. O Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007.

3. M. D. Raisinghaniya, *Ordinary and Partial Differential Equations*, S Chand 18^{th} Edition, 2008.

4. G. F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata McGraw-Hill, 2003.

5. G. B. Thomas, R. L. Finey, *Calculus*, 9^{th} Edition, Addison-Weseley Publishing Company, 2004.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understand the concepts of groups, subgroups and their properties.	PSO1, 2, PO1, 3	U	F,C	L, T	As
CO 2	Realise the concepts of permutation group, alternating group and cosets	PSO2, , PO2, 3	R, U	F, C	L, T	As
CO 3	Create an idea about basic probability theory and distributions	PSO2, PO2, 3	Ap, An	F,C	L, T	As
CO 4	Apply the knowledge to solve real world problems	PSO4, 5, 6, PO2, 3, 4	E	M	L, T	As

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2					2		1			
CO2		2	2						2	2		
CO3		2	2						2	2		
CO4				2	2	2			2	2	2	

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4		✓		

University of Kerala

Discipline	Mathematics				
Course Code	UK3DSCMAT203				
Course Title	Numerical Analysis				
Type of Course	DSC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Differentiation 2. Integration				
Course Summary	This course enable the students to gain a thourough understanding of various numerical methods used for solving mathematical problems				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Solution of Algebraic and Transcendental equations**	**15**
	1	Introduction, Bisection Method, Method of false position. Chapter 2: Section 2.1 to 2.3 of Text[1]	
	2	Iteration Method, Newton-Raphson method. Chapter 2: section 2.4 to 2.5 of Text[1]	
	3	Ramanujan's method, Secant method, Muller's method. Chapter 2: Section 2.6 to 2.8 of Text[1]	
II		**Interpolation**	**15**
	4	Finite differences. Chapter 3: Section 3.3	
	5	Newton's formulae for interpolation. Chapter 3: Section 3.6 of Text[1]	
	6	Interpolation with unevenly spaced points. Chapter 3: Section 3.9 of Text[1]	

Module	Unit	Contents	Hrs
	7	Divided differences and their properties. Chapter 3: Section 3.10 of Text[1]	
III	**Numerical Differentiation and Integration**		**15**
	8	Numerical differentiation. Chapter 6: Section 6.2 (excluding 6.2.1 and 6.2.2) of Text[1]	
	9	Maximum and Minimum values of a tabulated function. Chapter 6: Section 6.3 of Text[1]	
	10	Numerical integration Chapter 6: Section 6.4.1 to 6.4.4 of Text[1]	
IV	**Numerical Solution of Ordinary Differential equations**		**15**
	11	Solution by Taylor's series Chapter 8: Section 8.2 of Text[1]	
	12	Picard's method of Successive Approximations. Chapter 8: Section 8.3 of Text[1]	
	13	Euler's method Chapter 8: Section 8.4 of Text[1]	
	14	Runge- Kutta Methods.Chapter 8: Section 8.5 of Text[1]	
Practical	Practical sessions can be given using suitable software like sagemath (not meant for examination purpose)		**15**

Textbook

1. S.S. Sastry, *Introductory Methods of Numerical Analysis* , Fifth edition, PHI Learning Pvt. Ltd, 2012

References

1. A. C. Faul, *A Concise Introduction to Numerical Analysis* , CRC Press, 2016.
2. George A Anastassiou, Razvan A Mezei, *Numerical Analysis Using Sage*, Springer, 2015.
3. Richard L. Burden, J. Douglas Faires, *Numerical Analysis* , Ninth Edition, Cengage Learning, 2011.
4. Timo Heister, Leo G. Rebholz, Fei Xue, *Numerical Analysis An Introduction* , De Gruyter, 2019
5. Timothy Sauer, *Numerical Analysis*, Third Edition, Perason Education, 2018

E- resources

1. https://www.sagemath.org/help.html

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Find the solution of algebraic and transcendental equation using numerical methods	PO 2, PSO1, 2,3	U, Ap	F,C	L	
CO 2	Apply numerical techniques to interpolate data points effectively	PO1, PSO1, 2,3	U, Ap	F,C	L	
CO 3	Apply numerical techniques for differentiation and integration	PO2, PSO1, 2,3	U, Ap	F,C	L	
CO 4	Find the solution of ordinary differential equations using numerical methods	PO2, PSO1, 2,3	U, Ap	F,C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2					3						
CO2	3	3	2				3							
CO3	3	3	2					3						
CO4	3	3	2					3						

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam

- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK3DSCMAT204				
Course Title	Applications of Integration and Vector Calculus				
Type of Course	DSC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Integration 2. Differentiation 3. Vectors				
Course Summary	This course enable the students to get an idea about the applications of integration and vector calculus.				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Application of Integration**	**18**
	1	Area Between Two Curves, Volumes by Slicing; Disks and Washers *(Chapter 5: Sections 5.1, 5.2 of Text[1])*	
	2	Volumes by Cylindrical Shells *(Chapter 5: Section 5.3 of Text[1])*	
	3	Length of a Plane Curve, Area of revolution *(Chapter 5: Sections 5.4, 5.5 of Text[1])*	
II		**Work, Moments and Centroids**	**12**
	4	Work *(Chapter 5: Section 5.6 of Text[1])*	
	5	Moments, Centers of Gravity, and Centroids *(Chapter 5 Section 5.7 of Text[1])*	

Module	Unit	Contents	Hrs
III	**Vector Differentiation**		**12**
	6	Vector fields (Definition), inverse square fields, Gradient fields, Conservative Fields and potential functions, Divergence and Curl, the ∇ operator *(Chapter 15: Section 15.1 of Text[1])*	
IV	**Vector Integration**		**18**
	7	Line integrals, Integrating a vector field along a curve - Exercise Set 15.2- problems 15-30, 33-36, 41-46. *(Chapter 15 Section 15.2 of Text[1])*	
	8	Independence of Path; Conservative Vector Fields, Green's Theorem*(Chapter 15: Sections 15.3, 15.4 of Text[1])*	
	9	Surface integrals evaluating surface integrals, Flux, evaluation of flux integrals, The divergence theorem (without proof) using the divergence theorem to find flux. Stoke's the (all without proof) Relationships between Green's theorem and Stoke's theorem *(Chapter 15: Sections 15.5 to 15.8 of Text[1])*	
Practical	Practical sessions can be given using suitable software like sagemath (not meant for examination purpose)		**15**

Textbook

1. H Anton, I Bivens, S Davis, *Calculus*, 10^{th} Edition, John Wiley & Sons, 2012.

References

1. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12^{th} Edition, Addison-Weseley Publishing Company, 2004.

2. J Stewart, *Calculus with Early Transcendental Functions*, 7^{th} Edition, Cengage India Private Limited, 2008.

3. G B Thomas, R L Finney, *Calculus*, 9^{th} Edition, Addison-Weseley Publishing Company, 2004.

E-resourses

1. https://www.sagemath.org/help.html
2. https://www.geogebra.org/m/AzVR5uU7
3. https://www.geogebra.org/m/yyu2my9w
4. https://www.geogebra.org/m/zQzssykZ
5. https://www.geogebra.org/m/Bx8nFMNc

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Demonstrate various applications of integration	PSO 1, PO1, 6	U	F, C	L	
CO 2	Compute tangent lines to polar curves, arc length and area	PSO 2, 4, PO6	Ap, An	P	L	
CO 3	Describe the concepts Vector fields, Gradient fields, potential functions and vector integrals	PSO1, PO1, 6	U	F, C	L	
CO 4	Apply vector integrals to find areas	PSO 3, 4, PO1, 6	Ap, An	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	1	-	-	-	-	2	-	-
CO2	-	2	-	3	-	-	-	-	-	-	-	2	-	-
CO3	3	-	-	-	-	-	2	-	-	-	-	2	-	-
CO4	-	-	3	3	-	-	2	-	-	-	-	2	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam

- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK3DSCMAT205				
Course Title	Multivariate Calculus and Multiple Integrals				
Type of Course	DSC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Integration 2. Differentiation				
Course Summary	This course gives an insight to multi variable calculus, multiple integrals, vector calculus				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Multivariable Calculus**	**18**
	1	Functions of Two or More Variables, Limits and Continuity *(Chapter13: Sections 13.1, 13.2 of Text[1])*	
	2	Partial Derivatives, The Chain Rule *(Chapter 13 Section 13.3, 13.5 of Text[1])*	
	3	Directional derivatives, Maxima and Minima of Functions of Two Variables *(Chapter 13: Sections 13.6, 13.7 of Text[1])*	
II		**Multiple Integrals**	**12**
	4	Double Integrals, Double Integrals over Nonrectangular Regions *(Chapter 14: Section 14.1, 14.2 of Text[1]*	
	5	Double Integrals in Polar Coordinates *(Chapter 14: Section 14.3 of Text[1])*	
	6	Triple Integrals *(Chapter 14: Section 14.5 of Text[1])*	

Module	Unit	Contents	Hrs
III		**Vector Differentiation**	**10**
	7	Vector fields (Definition), inverse square fields, Gradient fields, Conservative Fields and potential functions, Divergence and Curl, the ∇ operator *(Chapter 15: Section 15.1 of Text[1])*	
IV		**Vector Integration**	**20**
	8	Line integrals, Integrating a vector field along a curve - Exercise Set 15.2- problems 15-30, 33-36, 41-46. *(Chapter 15: Section 15.2 of Text[1])*	
	9	Independence of Path; Conservative Vector Fields, Green's Theorem *(Chapter 15: Sections 15.3, 15.4 of Text[1])*	
	10	Surface integrals evaluating surface integrals, Flux, evaluation of flux integrals, The divergence theorem (without proof) using the divergence theorem to find flux. Stoke's the (all without proof) Relationships between Green's theorem and Stoke's theorem *(Chapter 15: Sections 15.5 to 15.8 of Text[1])*	
Practical		Practical sessions can be given using suitable software like sagemath (not meant for examination purpose)	**15**

Textbook

1. H Anton, I Bivens, S Davis, *Calculus*, 10^{th} Edition, John Wiley & Sons, 2012.

References

1. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12^{th} Edition, Addison-Weseley Publishing Company, 2004.

2. J Stewart, *Calculus with Early Transcendental Functions*, 7^{th} Edition, Cengage India Private Limited, 2008.

3. G B Thomas, R L Finney, *Calculus*, 9^{th} Edition, Addison-Weseley Publishing Company, 2004.

E-resourses

1. https://www.sagemath.org/help.html
2. https://www.geogebra.org/m/VMa4z2RU
3. https://www.geogebra.org/m/wcjfy77h
4. https://www.geogebra.org/m/g4xzgh8u
5. https://www.geogebra.org/m/Bp2mU8tk

6. https://www.geogebra.org/m/cu3yv7q8
7. https://www.geogebra.org/m/cqak5q98
8. https://www.geogebra.org/m/m7rzymub
9. https://www.geogebra.org/m/vm3jr9my
10. https://www.geogebra.org/m/wvxr8wxr
11. https://www.geogebra.org/m/zQzssykZ
12. https://www.geogebra.org/m/Bx8nFMNc

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Define the concept of functions of several variables, their limit, continuity and derivative	PSO 1, PO1, 2, 6	U	F, C	L	
CO 2	Illustrate various applications of multivariable calculus	PSO 2, 4, PO1, 2, 6	Ap, An	P	L	
CO 3	Describe the concepts Vector fields, Gradient fields, potential functions and vector integrals	PSO 1, PO1, 2, 6	U	F, C	L	
CO 4	Apply vector integrals to find areas	PSO 3, 4, PO1, 2, 6	Ap, An	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	2	1	-	-	-	3	-	-
CO2	-	-	3	3	-	-	2	1	-	-	-	3	-	-
CO3	3	-	-	-	-	-	1	1	-	-	-	2	-	-
CO4	-	-	3	3	-	-	2	1	-	-	-	3	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK3DSCMAT206				
Course Title	Complex Analysis				
Type of Course	DSC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4			4
Pre-requisites	Complex numbers, Partial derivatives				
Course Summary	Equips students with the fundamental knowledge and skills necessary to understand and apply complex analysis in various scientific and engineering disciplines. Students will be prepared for more advanced studies in complex analysis and its applications.				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Analytic functions**	**15**
	1	Complex Numbers and Their Geometric Representation *(Chapter 13: Section 13.1 of Text[1] (review only))*	
	2	Polar Form of Complex Numbers-Powers and Roots *(Chapter 13: Section 13.2 of Text[1])*	
	3	Derivative-Analytic Function, Cauchy–Riemann Equations Laplace's Equation *(Chapter 13: Section 13.3, 13.4 of Text[1])*	
II		**Cauchy's Integral Theorem**	**15**
	4	Line Integral in the Complex Plane and is properties (Except Existence of Complex Line integrals & ML Inequality) *(Chapter 14: Section 14.1 of Text[1])*	

Module	Unit	Contents	Hrs
	5	Cauchys Integral Theorems (without proof) Caucy's Integral Formula (without proof) Derivative of Analytic Functions *(Chapter 14: Sections 14.2, 14.3 of Text[1])*	
	6	Derivatives of Analytic Functions Liouville's Theorem and Morera's theorem (both without proof) *(Chapter 14: Section 14.4 of Text[1])*	
III		**Taylor and Maclaurian Series**	**12**
	7	Power Series Radius of Convergence, Taylor and Maclaurian Series *(Chapter 15: Section 15.2, 15.4 of Text[1])*	
	8	Laurents Series Singularities, Zeros - (exclude Riemann's Sphere) *(Chapter 16: Section 16.1, 16.2 of Text[1])*	
	9	Evaluation of an Integral by means of a Residue *(Chapter 16: Section 16.3 of Text[1])*	
IV		**Complex Integration**	**18**
	10	Evaluation of an Integral by Means of a Residue, Formulas for Residues, Residue Theorem, Application of the Residue Theorem, *(Chapter 16: Section 16.3 of Text[1])*	
	11	Residue Integration of Real Integrals, Another Kind of Improper Integral *(Chapter 16: Section 16.4 of Text[1])*	

Text books

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10^{th} Edition, Wiley Publishers, 2018

References

1. Anant R Shastri, *Basic Complex Analysis of One Variable*, Macmillan, 2010.

2. Edward B. Saff, Arthur David Snider, *Fundamentals of Complex Analysis with Applications to Engineering and Science*, 3^{rd} Edition, Pearson Education India, 2017.

3. James Ward Brown and Ruel V Churchill, *Complex Variables And Applications*, Eighth Edition, McGraw Hill International Edition, 2013.

4. John H Mathews and Russel W Howell, *Complex Analysis for Mathematics and Engineering*, Sixth Edition, Jones and Bartlett Publishers, 2012.

5. Murray R Spiegel, Seymour Lipschutz, Schaum's Outline Series, *Complex Variables*, 2009.

6. B S Tyagi, *Functions of A Complex Variable*, Kedar Nath Ram Nath, 2021.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand complex numbers, analytic functions, Series, Residues and conplex integration	PSO 1, PO1, 2	U	F, C	L	
CO 2	Apply Residue theory to find real integrals	PSO 2, 3, PO2	Ap, An	P	L	
CO 3	Explore applications of complex analysis in various fields	PSO 3, 4, PO2, 3	Ap, An	P	L	
CO 4	Develop problem soving skills	PSO 3, 4, 5, PO2, 3	Ap, An , E	P , M	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	3	3	-	-	-		-	-
CO2	-	3	3		-			3	-	-	-		-	-
CO3		-	3	3	-	-		3	3	-	-		-	-
CO4	-	-	3	3	3	-		2	2	-	-		-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics
Course Code	UK3DSCMAT207
Course Title	Applications of Integration, Special Functions and Fourier Series
Type of Course	DSC
Semester	III
Academic Level	200-299

Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4

Pre-requisites	1. Integration 2. Differentiation
Course Summary	This course provides applications of integration, beta and gamma functions and Fourier series

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Application of Integration**	**18**
	1	Area Between Two Curves, Volumes by Slicing; Disks and Washers *(Chapter 5: Sections 5.1, 5.2 of Text [1])*	
	2	Volumes by Cylindrical Shells *(Chapter 5: Section 5.3 of Text 1)*	
	3	Length of a Plane Curve, Area of revolution *(Chapter 5: Sections 5.4, 5.5 of Text [1])*	
II		**Work, Moments and Centroids**	**12**
	4	Work *(Chapter 5: Section 5.6 of Text [1])*	
	5	Moments, Centers of Gravity, and Centroids *(Chapter 5: Section 5.7 of Text [1])*	
III		**The Beta and Gammma Functions**	**10**
	6	The Factorial Function, Definition of the Gamma Function; Recursion Relation *(Chapter 11: Sections 11.1, 11.2, 11.3 of Text [3])*	

Module	Unit	Contents	Hrs
	7	The Gamma Function of Negative Numbers, Formulas Involving Gamma Functions *(Chapter 11: Sections 11.4, 11.5 of Text [3])*	
	8	Beta Functions, Beta Functions in Terms of Gamma Functions *(Chapter 11: Sections 11.6, 11.7 of Text [3])*	
IV		**Fourier Series**	**20**
	9	Basic Examples, Euler Formulas (proof is not required), Convergence and Sum of a Fourier Series, *(Chapter 11: Section 11.1 of Text [2])*	
	10	Arbitrary Period, Even and Odd Functions, Half-Range Expansions: From Period 2π to any Period $p = 2l$ Simplifications: Even and Odd Functions, Half Range Expansions*(Chapter 11: Section 11.2 of Text [2])*	

Textbooks

1. H Anton, I Bivens, S Davis, *Calculus*, 10$^{\text{th}}$ Edition, John Wiley & Sons, 2012.

2. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10$^{\text{th}}$ Edition, Wiley Publishers, 2018.

3. Mary L Boas, *Mathematical Methods in Physical Science*, 3$^{\text{rd}}$ Edition, 2006.

References

1. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12$^{\text{th}}$ Edition, Addison-Weseley Publishing Company, 2004.

2. Peter V. O. Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007.

3. J Stewart, *Calculus with Early Transcendental Functions*, 7$^{\text{th}}$ Edition, Cengage India Private Limited, 2008

4. G B Thomas, R L Finney, *Calculus*, 9$^{\text{th}}$ Edition, Addison-Weseley Publishing Company, 2004.

E-resourses

1. https://www.geogebra.org/m/AzVR5uU7

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Demonstrate various applications of integration	PSO 1, PO1, 6	U	F, C	L	
CO 2	Compute tangent lines to polar curves, arc length and area	PSO 2, 4, PO 6	Ap, An	P	L	
CO 3	Understand the concepts of factorial function, gamma function beta function and Fourier series	PSO 1, PO1, 6	U	F, C	L	
CO 4	Able to find Fourier series of different functions	PSO 3, 4, PO1, 2, 6	Ap, An	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	1	-	-	-	-	2	-	-
CO2	-	2	-	3	-	-	-	-	-	-	-	2	-	-
CO3	3	-	-	-	-	-	2	-	-	-	-	1	-	-
CO4	-	-	3	3	-	-	2	1	-	-	-	2	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar

- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Descipline	Mathematics				
Cours Code	UK3DSCMAT208				
Course Title	Geometry, Multivariate and Vector Calculus				
Type of Course	DSC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	1	5
Pre-requisites	1.Differentiation 2. Integration 3. Vectors				
Course Summary	This course enables the students to know the parametric and polar representation of curves, vector-valued functions , partial derivatives multiple integrals and vector fields				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Parametric and polar curves: Conic sections**		**10**
	1	Parametric equations: Tangent lines and arc length of parametric curves, Polar coordinates, Tangent lines, arc length and area of polar curves, Conic sections, Conic section in Polar coordinates.	
	Chapter 10: Section 10.1 ,10.2, 10.3, 10.4, 10.6 of Text[1]		
II	**Vector-valued functions**		**15**
	2	Introduction to vector-valued function, Calculus of vector-valued function, Change of parameter: Arc length, Unit tangent, normal and binomial vectors, curvature, motion along a curve	
	Chapter 12: Section 12.1, 12.2, 12.3, 12.4, 12.5, 12.6 of Text[1]		

Module	Unit	Contents	Hrs
III	**Partial derivatives**		**15**
	3	Functions of two or more variables, Limits and continuity, Partial derivatives, Differentiability, differentials and local linearity, Chain rule, Maxima and minima of functions of two variables	
	Chapter 13: Section 13.1, 13.2, 13.3, 13.4, 13.5, 13.8 of Text[1]		
IV	**Multiple integrals and vector fields**		**20**
	4	Double integrals, double integrals over non-rectangular region, Double integrals in polar coordinates, Surface area, Parametric surface, Triple integrals, triple integrals in cylindrical and spherical coordinates, Change of variables in multiple integrals, Jacobians, Vector fields, line integrals, Independence of paths, Conservative vector fields.	
	Chapter 14: Section 14.1, 14.2, 14.3, 14.4, 14.5, 14.6, 14.7, Chapter 15: Section 15.1, 15.2, 15.3 of Text[1]		
Practical	Practical sessions can be given using suitable software like sagemath (not meant for examination purpose)		**15**

Textbooks

1. H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons, 2012.

References

1. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12th Edition, Addison-Weseley Publishing Company, 2004.

2. J Stewart, *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited, 2008.

3. G B Thomas, R L Finney, *Calculus*, 9th Edition, Addison-Weseley Publishing Company, 2004.

E-resourses

1. https://www.geogebra.org/m/AzVR5uU7

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understands basic concepts of parametric and polar curves, conic section and vector-valued function	PSO1, 2, PO1	R,U	F,C	L,T	
CO 2	Evaluate multiple Integrals	PSO2, PO3, 4	An,Ap	F	L,T	
CO 3	Develop a concrete idea Partial derivatives	PSO1, PO2, 3	U,An	C	L,T	
CO 4	Apply multiple integrals to solve problems	PSO3, PO2	Ap,E	C,P	T	As

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1					3							
CO2		3							1	3				
CO3	2							2	2					
CO4			2					3						

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK3DSCMAT209				
Course Title	Mathematics in Social Sciences - III				
Type of Course	DSC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	Basic knowlegde of differential calculus				
Course Summary	This course include Integral calculus, Partial Differentiation and Differential equations.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Integral Calculus**		**18**
	1	Simple integration, Basic Definition, basic rule of integration, standard results	
	2	Methods of integration (substitution method only with simple problems), integration by parts (except trigonometeric functionss and logarithmic functions)	
	3	Definite integeal, properties of Definite integrals (without problems), Applications of definite integrals	
	Chapter 12: Sections 12.1, 12.2, 12.3, 12.4, 12.5 and 12.9 of Text[1], Chapter 13: Section 13.4 of Text[1]		
II	**Partial Differentiation**		**18**
	4	Partial derivatives. Technique of partial differentiation, partial differentiation of second order Cross partial differentiation	

Module	Unit	Contents	Hrs
	5	Partial derivatives of functions of more than two variables, Maxima and minima of a functions of two variables	
	6	Maxima and minima under given condition (Constrained extreme values) use of Lagrange multiplier first order condition	
	Chapter 8: Sections 8.2, 8.8 8.4, 8.5, 8.10, 8.12 of Text [1]		
III	**Differential Equations I**		**12**
	7	Definition, Kinds of differential equation. order of differential equation, degree of differential equation, solutions of differential equation of first order	
	8	Variable separable form, general first order differential equation, Lineal differential equation with constant Coefficients Chapter 14: Sections 14.1, 14.2, 14.3, 14.4, 14.5. 14.6. 14.10. 14.11 of Text[1].	
IV	**Differential Equations II**		**12**
	9	Second order lineal differential equations with constant coefficients	
	10	Rules for obtaining particular integral (involving e^x only)	
	11	Applications of differential equation: Harrold-Domar model, Domar model.	
	Chapter 14: Sections 14.12, Chapter 15: Section 15.3 (A and B) of Text[1]		

Textbook

1. B.C. Mehta, G.M.K. Madnani Mathematics for Economics. Sultan Chand & Sons, 2008.

References

1. Agarwal B.M, Business Mathematics and Statistics, Vikas Publishing House, New Delhi, 2009.

2. Allen, R.G.D., Mathematical Analysis for Economists. New Delhi: AITBS Publishers, 2008.

3. Yamane, Taro, Mathematics for Economists: An Elementary Survey. New Delhi: Prentice Hall of India, 2012.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concepts of integration, Definite integrals and partial derivatives	PSO1, PO1, 3, 8	U	F,C	L	
CO 2	Solve different types of differential equations	PSO3, PO1, 2, 3, 8	U,E	C,P	L	
CO 3	Applications of differential equations in Domar's models	PSO5, PO1, 2, 3, 4, 5, 6, 7, 8	Ap	C,M	L	
CO 4	Analyse different types of diferential equations	PSO2, PO1, 2, 3, 7	An	C, P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	3	-	1	-	-	-	-	1
CO2	-	3	3	-	-	-	1	3	3	-	-	-	-	1
CO3	-	-	-	-	3	-	2	3	2	2	3	2	1	3
CO4	-	3	-	-	-	-	2	2	3	-	-	-	1	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK3DSCMAT210				
Course Title	Integral Transforms				
Type of Course	DSC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4 Hours	-	-	4
Pre-requisites	1. Integral Calculus				
Course Summary	This course will equip with the knowledge and techniques to utilize the Laplace transform and Fourier Analysis for solving various problems.				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Laplace Transform**	**15**
	1	Definition, Transforms of Elementary function	
	2	Properties of Laplace Transform, Transform of Periodic Functions	
	3	Transforms of Derivatives, Transforms of Integrals, Multiplication by t^n, Division by t	
	4	Evaluation of Integrals by Laplace Transform.	
	Chapter 21: Sections 21.2, 21.3, 21.4, 21.5, 21.7, 21.8, 21.9, 21.10, 21.11of Text [1]		
II		**Inverse Laplace Transform**	**15**
	5	Inverse Transforms, Method of Partial Fractions, Other Methods of finding Inverse transforms, Convolution Theorem	
	6	Application to Differential Equation	

Module	Unit	Contents	Hrs
	Chapter 21: Sections 21.12, 21.13, 21.14, 21.15 of Text [1]		
III	**Fourier Series**		**15**
	7	Fourier Series, Basic Examples, Derivation of Euler Formulas, Convergence and Sum of a Fourier Series	
	8	Arbitrary Period, Even and Odd Functions, Half Range expansions from period 2π to any period $P = 2L$	
	9	Simplifications, Even and Odd functions, half range expansions.	
	Chapter 11: Sections 11.1, 11.2, 11.3 of Text [2]		
IV	**Fourier Integral and Transform**		**15**
	10	Fourier Integral, From Fourier series to Fourier Integral	
	11	Applications of Fourier Integrals, Fourier Cosine Integral and Fourier Sine Integral	
	12	Fourier Cosine and sine transforms, Linearity, Transforms of Derivatives,	
	13	Fourier Transform, Complex form of Fourier integral, Fourier transform and its inverse, linearity, Fourier transform of derivatives.	
	Chapter 11: Sections 11.7, 11.8, 11.9 (excluding physical interpretation of spectrum, convolution, DFT and FFT) of Text [2]		

Textbook

1. B. S. Grewal, *Higher Engineering Mathematics*, 42^{nd} Edition, Khanna Publishers, 2012.

2. E. Kreyszig, *Advanced Engineering Mathematics*, 10^{th} Edition Wiley, 2018.

References

1. M Greenberg, *Advanced Engineering Mathematics*, 2^{nd} Edition, Prentice Hall, 1998.

2. Peter. V. O Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand integral transforms and distinguish between different types of integral transforms, including Fourier transforms, Laplace transforms	PSO1, 2, PO1, 2, 3, 8	U, Ap	F,C	L	
CO 2	Solve differential equation using Laplace Transform	PSO 2, 3, PO1, 2, 3, 6	Ap, An	C,P	L	
CO 3	Analyse the properties of certain functions using Fourier Series	PSO 2, 3, PO1, 2, 3, 4, 5, 6	An, E	P	L	
CO 4	Equip students with a valuable mathematical tool that can be applied to analyze and solve problems arising in engineering, science and other disciplines	PSO 3, 4, PO1, 2, 3, 4, 5, 6	An, E	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	2	2	3	2	1	-	-			1
CO2	2	2	3	3	2	2	3	3	1	-	-	1		
CO3	3	3	3	3	3	3	3	3	3	1	1	3		
CO4	2	2	3	3	3	3	3	3	3	3	3	3		

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK3DSCMAT211				
Course Title	Discrete Mathematics				
Type of Course	DSC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4 hours	0	0	4
Pre-requisites	Knowledge of basic set theory				
Course Summary	This course includes Mathematical Logic, Predicate logic and Algebraic Structures				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Mathematical Logic**	**15**
	1	Proposition and Connectives, Conditional and bi-conditional, Equivalence of proposition *(These topics can be found in Chapter 1 of Text [2])*	
	2	Tautology and Contradiction, Logical implications well-formed formula, Algebra of proposition *(These topics can be found in Chapter 1 of Text [2])*	
	3	De Morgan's law, Duality theorem *(These topics can be found in Chapter 1 of Text [1])*	
II		**Proof Methods and Logic**	**15**
	4	Formal Proof, Propositional reasoning by contradiction, indirect method of proof *(These topics can be found in Chapter 1 of Text [2])*	

Module	Unit	Contents	Hrs
	5	Boolean expressions, Normal forms - Disjunctive normal form, Conjunctive normal form, Principal Conjunctive Normal forms and principal disjunctive normal forms using truth table only *(These topics can be found in Chapter 1 of Text [2])*	
III		**Algebraic Structures**	**15**
	6	Algebra, DeMorgan's Law, Group, Subgroups examples and simple properties *(These topics can be found in Text [1])*	
	7	Communication Model - coding theory, error corrections, Hamming Codes (Avoid computer programs) *(These topics can be found in Text [1])*	
IV		**Predicate Logic**	**15**
	8	Quantifiers: Essential and Universal quantifier, Free and Bound Variables *(These topics can be found in Chapter 1 of Text [2])*	
	9	Rules of Specifications: Rule US, ES, UG, EG. Using these, convert a given statement into symbolic notation *(These topics can be found in Chapter 1 of Text [2])*	
	10	Derivation from Premises using truth table *(These topics can be found in Chapter 1 of Text [2])*	

Textbooks

1. R M Somasundaram, *Discrete Mathematical Structures*, Prentice Hall of India, 2003.

2. T. Veerarajan, *Discrete Mathematics with Graph Theory and Combinatorics*, Tata McGraw Hill, 2007.

References

1. C L Liu, D P Mohapatra, *Elements of Discrete Mathematics, A Computer oriented approach*, Tata McGraw-Hill, 2008

2. Rajendra Akerkar, Rupali Akerkar, *Discrete Mathematics*, Pearson Education, 2007.

3. B. V. Senthil Kumar and Hemen Dutta, *Discrete Mathematical Structures*, CRC Press, 2020

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Identify the concepts needed to test the logic of a programme	PSO 1, 2, PO1, 2, 4, 6	R, U	F, C	L	
CO 2	Explain the underline concepts and tools to solve problems	PSO 2, 3, PO1, 2, 3, 4, 6	U	F, C	L	
CO 3	Examine accurate and efficient use of algebraic techniques	PSO 4, PO1, 2, 3, 4, 6	An	C	L	
CO 4	Understand the basic rules of predicate logic	PSO 1, PO1, 2, 3, 4, 6	R, U	F,C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	-	-	-	-	2	1	-	2	-	1	-	-
CO2	-	3	3	-	-	-	3	3	2	1	-	2	-	-
CO3	-	-	3	-	-	-	3	2	2	1	-	2	-	-
CO4	3	-	-	-	-	-	3	2	2	1	-	2	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK3DSCMAT212				
Course Title	Vector Calculus				
Type of Course	DSC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Integration 2. Differentiation 3. Vectors				
Course Summary	This course in Vector Calculus provides students with a comprehensive understanding of parametric curves, vector-valued functions, differentiation and integration techniques, and their applications in analyzing motion, solving physical problems, and preparing for advanced studies.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Vector Valued Functions**		**15**
	1	Introduction to vector valued Functions, Parametric Curves in 3-Space - The parametric equations (introduction only) vector valued functions (introduction only) vector form of a line segment (introduction only) *(Chapter 12: Sections 12.1 of Text [1])*	
	2	Calculus of vector-valued Functions - Limits and Continuity, Geometric interpretations of limits, Derivatives, Geometric interpretation of the derivative, derivative rules Derivatives of dot and cross products (fundamentals only) Integrals of vector valued functions and integral rules (fundamentals only)*(Chapter 12: Section 12.2 of Text [1])*	

Module	Unit	Contents	Hrs
	3	Arc length parametrization *(Chapter 12: Section 12.3 of Text [1])*	
II	**Tangents and Curvature**		**10**
	4	Unit Tangent, Normal and Binormal vectors (introduction only) Normal and Tangential Components of Acceleration *(Chapter 12: Section 12.4 of Text [1])*	
	5	Curvature, radius of curvature, motion along a curve *(Chapter 12: Section 12.5, 12.6)*	
III	**Vector Differentiation**		**15**
	6	Vector fields (Definition), inverse square fields, Gradient fields, Conservative Fields and potential functions, Divergence and Curl, the ∇ operator *(Chapter 15: Section 15.1 of Text[1])*	
IV	**Vector Integration**		**20**
	7	Line integrals, Integrating a vector field along a curve - Exercise Set 15.2- problems 15-30, 33-36, 41-46. *(Chapter 15 Section 15.2 of Text[1])*	
	8	Independence of Path; Conservative Vector Fields, Green's Theorem*(Chapter 15: Sections 15.3, 15.4 of Text[1])*	
	9	Surface integrals evaluating surface integrals, Flux, evaluation of flux integrals, The divergence theorem (without proof) using the divergence theorem to find flux. Stoke's theorem (all without proof) Relationships between Green's theorem and Stoke's theorem *(Chapter 15: Sections 15.5 to 15.8 of Text[1])*	
Practical	Practical sessions can be given using suitable software like sagemath (not meant for examination purpose)		**15**

Textbook

1. H Anton, I Bivens, S Davis, *Calculus*, 10^{th} Edition, John Wiley & Sons, 2012.

References

1. Gregory V. Bard, William Stein, *Sage for Undergraduates*, American Mathematical Society, 2015.

2. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12^{th} Edition, Addison-Weseley Publishing Company, 2004.

3. J Stewart, *Calculus with Early Transcendental Functions*, 7^{th} Edition, Cengage India Private Limited, 2008.

4. G B Thomas, R L Finney, *Calculus*, 9^{th} Edition, Addison-Weseley Publishing Company, 2004.

E- resources

1. https://www.sagemath.org/help.html

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understanding of Vector-Valued Functions and Parametric Curves	PSO1	U	F, C	L	
CO 2	Ability to Parametrize Curves and Calculate Arc Length	PSO1, PSO2, PSO3, PSO4, PO1, PO2	R, U, E, Ap, An	P, C, F	L	
CO 3	Application of Line and Surface Integrals	PSO2, PSO3, PO1, PO2	U, Ap, E	P, F, C	L	
CO 4	Analyze and solve complex problems involving vector-valued functions and parametric curves in three-dimensional space.	PSO1, PSO2, PSO3, PSO4, PSO6, PO1, PO2, PO3	U, Ap, An, E, C	P, M	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	2	-	-	2	2	-	-	-	-	-	-
CO3	-	3	3	-	-	-	2	2	-	-	-	-	-	-
CO4	3	3	3	3	-	2	2	2	2	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK3DSEMAT200				
Course Title	Programming with LaTeX and Python				
Type of Course	DSE				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	3	0	2	5
Pre-requisites	1. Basic computer knowledge				
Course Summary	This course provides basic skill in LaTeX and python programming				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Basics of Type setting using LaTeX**	**20**
	1	Simple typesetting, Fonts, Type size Typesetting Mathematics,	
	2	Single Equations (equation, equation*, split) Group of Equations (gather, gather*, align, align*, cases) Matrices and Determinants (matrix, pmatrix, bmatrix, vmatrix) Putting one over another (frac, dfrac, int, lim, sum, prod). Chapter 1: Sections 8.1, 8.3.1, 8.3.2, 8.4.2 and 8.4.4 of Text [3].	
	3	Basics of typesetting Theorems and amsthm package (Sections 9.1 to 9.2.1 of Text [1]). Do Exercise questions 4, 5, 6 and 7 of Chapter 9 of Text [2].	
II		**Tables, Figures and Presentation**	**20**
	4	Typesetting basic tables. Merge cells using $\backslash multicolumn$ (Chapter 7: Section 7.2 of Text [3], except the portion using $\backslash renewcommand$)	

Module	Unit	Contents	Hrs
	5	Inserting pictures using Graphicx package (Chapter 12: Section 12.1.1 to 12.1.3 of Text [1], except the portion on pstricks)	
	6	Creating Floating Figures (Chapter 11: Section 11.1.1 of Text [3])	
	7	Beamer Presentation, Thinking in terms of frames. Set up a Beamer document, Enhance a Beamer presentation. (Chapter 11: Sections 11.1 to 11.4 of Text [2], except the portion using pstricks)	
III		**The Essentials of Python**	**20**
	8	Absolute Basics - Lists, tuples and sets - Strings - Control Flow - Functions - Reading and writing files (Chapter 4, 5 (Sections 5.6, 5.8 need not be discussed), 6 (Section 6.5 to 6.9 need not be discussed),8, 9.1 to 9.5 (Section 9.3 need not be discussed) and 13.1 to 13.4 of Text [4])	
IV		**Working with numbers**	**15**
	9	Basic Mathematical Operations - Working with different kinds of numbers - Getting user input - Math Programmes - The Programming challenges mentioned in Chapter 1 of Text [1]	

Textbooks

1. Amit Saha, Doing Math with Python, No Starch Press, 2015.

2. Donald Binder and Martin Erickson, A student's guide to the study, practice and tools of modern mathematics, CRC Press, 2010.

3. E. Krishnan, The LaTeX Tutorial: A Primer, by The Tutorial Team, Indian TeX Users Group, Sayahna Foundation, http://www.sayahna.org, 2020.

4. Naomi Ceder, The Quick Python Book, Manning, 2018.

References

1. E Balagurusamy, Introduction to computing and problem solving using Python, Mc Graw Hill Education, 2017.

2. Dilip Datta, LaTeXin 24 Hours, A Practical Guide for Scientific Writing, Springer, 2017.

3. Hubert Partl, Irene Hyna and Elisabeth Schlegl, The Not So Short Introduction to LaTeX2ϵ, Tobias Oetiker, Version 6.4, 09 March 2021.

4. Kenneth A Lambert, Fundamentals of Python, First Programs, 2nd Edition, Cengage, 2019.

E- resources

1. https: //www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes
2. https://www.python.org/

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the basics of LaTeX and python	PSO1, PO7	U	F,C	L	P
CO 2	Create documents and programs	PSO5, PO3	Ap,C	P	L	P
CO 3	Create good quality presentations	PSO5, PO3, 4	Ap, C	P	L	P
CO 4	Apply to the subject and get more insight to the mathematical concepts	PSO2	Ap	M	L	P

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1												3	
CO2					3				2					
CO3			-	-	3				3	3				
CO4		3												

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar

- Midterm Exam
- Programming Assignments
- Final Exam (Theory and Practical)

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		
CO4		✓		

University of Kerala

Discipline	Mathematics				
Course Code	UK3DSEMAT201				
Course Title	Numerical Analysis				
Type of Course	DSE				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Differentiation 2. Integration 3. Solution of system of equations				
Course Summary	This course enable the students to gain a thourough understanding of various numerical methods used for solving mathematical problems				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Solution of Algebraic and Transcendental equations**	**15**
	1	Introduction, Bisection Method, Method of false position. Chapter 2: Section 2.1 to 2.3 of Text[1]	
	2	Iteration Method, Newton-Raphson method. Chapter 2: section 2.4 to 2.5 of Text[1]	
	3	Ramanujan's method, Secant method, Muller's method. Chapter 2: Section 2.6 to 2.8 of Text[1]	
II		**Interpolation**	**15**
	4	Finite differences. Chapter 3: Section 3.3	
	5	Newton's formulae for interpolation, Central difference interpolation formulae, Chapter 3: Section 3.6, 3.7 of Text[1]	
	6	Interpolation with unevenly spaced points. Chapter 3: Section 3.9 of Text[1]	

Module	Unit	Contents	Hrs
	7	Divided differences and their properties. Chapter 3: Section 3.10 of Text[1]	
III	**Numerical Differentiation and Integration**		**15**
	8	Numerical differentiation. Chapter 6: Section 6.2 (excluding 6.2.1 and 6.2.2) of Text[1]	
	9	Maximum and Minimum values of a tabulated function. Chapter 6: Section 6.3 of Text[1]	
	10	Numerical integration Chapter 6: Section 6.4.1 to 6.4.4 of Text[1]	
IV	**Numerical Solution of Ordinary Differential equations**		**15**
	11	Solution by Taylor's series Chapter 8: Section 8.2 of Text[1]	
	12	Picard's method of Successive Approximations. Chapter 8: Section 8.3 of Text[1]	
	13	Euler's method Chapter 8: Section 8.4 of Text[1]	
	14	Runge- Kutta Methods.Chapter 8: Section 8.5 of Text[1]	
Practical	Practical sessions can be given using suitable software like sagemath (not meant for examination purpose)		**15**

Textbook

1. S.S. Sastry, *Introductory Methods of Numerical Analysis*, Fifth edition, PHI Learning Pvt. Ltd, 2012

References

1. A. C. Faul, *A Concise Introduction to Numerical Analysis* , CRC Press, 2016.

2. Richard L. Burden, J. Douglas Faires,*Numerical Analysis* , Ninth Edition, Cengage Learning, 2011.

3. Timo Heister, Leo G. Rebholz, Fei Xue, *Numerical Analysis An Introduction* , De Gruyter, 2019.

4. Timothy Sauer, *Numerical Analysis*, Third Edition, Perason Education, 2018.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Calculate the solution of algebraic and transcendental equation using numerical methods	PO 2, PSO1, 2,3	U, Ap	F,C	L	
CO 2	Apply numerical techniques to interpolate data points effectively	PO1, PSO1, 2,3	U, Ap	F,C	L	
CO 3	Apply numerical techniques for differentiation and integration	PO2, PSO1, 2,3	U, Ap	F,C	L	
CO 4	Calculate the solution of ordinary differential equations using numerical methods	PO2, PSO1, 2,3	U, Ap	F,C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	-	-	-	-	3	-	-	-	-	-	-
CO2	3	3	2	-	-	-	3	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	3	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	3	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam

- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK3DSEMAT202				
Course Title	Discrete Mathematics				
Type of Course	DSE				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	Basic understanding of algebra and mathematical reasoning				
Course Summary	This course serves as an introduction to the fundamental concepts and techniques of discrete mathematics, focusing on topics relevant to computer science, mathematics, and related fields.				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Mathematical Logic**	**15**
	1	Propositions, Connectives, Order of Precedence for Logical Connectives, Conditional and Biconditional Propositions, Tautology and Contradiction, Equivalence of Propositions *(These topics can be found in Chapter 1 of Text [1])*	
	2	Duality Law, Duality Theorem, Algebra of Propositions, Tautological Implication *(These topics can be found in Chapter 1 of Text [1])*	
	3	Normal Forms, Disjunctive and Conjunctive Normal Forms, Principal Disjunctive and Principal Conjunctive Normal Forms *(These topics can be found in Chapter 1 of Text [1])*	
II		**Predicate Logic**	**15**
	4	Theory of Inference, Truth Table Technique, Rules of Inference, Form of Argument *(These topics can be found in Chapter 1 of Text [1])*	

Module	Unit	Contents	Hrs
	5	Rule of Conditional Proof, Inconsistent Premises, Indirect Method of Proof *(These topics can be found in Chapter 1 of Text [1])*	
	6	Predicate Logic *(These topic can be found in Chapter 1 of Text [1])*	
III		**Combinatorics**	**12**
	7	Pigeonhole Principle, Generalisation of the Pigeonhole Principle *(These topics can be found in Chapter 2 of Text [1])*	
	8	Principle of Inclusion-Exclusion, Mathematical Induction *(These topics can be found in Chapter 2 of Text [1])*	
	9	Recurrence Relations, Particular Solutions, Solution of Recurrence Relations by using Generating Functions *(These topics can be found in Chapter 2 of Text [1])*	
IV		**Lattices and Algebra**	**18**
	10	Lattices, Principle of Duality, Properties of Lattices *(These topics can be found in Chapter 5 of Text [1])*	
	11	Lattice as Algebraic System, Sublattices, Lattice Homomorphism, Some Special Lattices *(These topics can be found in Chapter 5 of Text [1])*	
	12	Boolean Algebra, Additional Properties of Boolean Algebra, Dual and Principle of Duality, Principle of Duality, Subalgebra, Boolean Homomorphism, Isomorphic Boolean Algebras, Boolean Expressions and Boolean Functions *(These topics can be found in Chapter 5 of Text [1])*	

Textbook

1. T. Veerarajan, *Discrete Mathematics*, Tata McGraw Hill, 2019.

References

1. C L Liu, D P Mohapatra, *Elements of Discrete Mathematics, A Computer oriented approach*, Tata McGraw-Hill, 2008

2. Rajendra Akerkar, Rupali Akerkar, *Discrete Mathematics*, Perason Education, 2007.

3. B. V. Senthil Kumar and Hemen Dutta, *Discrete Mathematical Structures*, CRC Press, 2020.

4. R M Somasundaram, *Discrete Mathematical Structures*, Prentice Hall of India, 2003.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	A solid understanding of fundamental concepts in discrete mathematics, including propositional and predicate logic, relations and combinatorics.	PSO1, PO1, 6	U	F, C		
CO 2	Develop problem-solving skills through the application of various proof techniques	PSO 2, 4, PO1, 2, 6	R, U	P		
CO 3	Develop critical thinking skills and creativity in approaching mathematical problems, exploring alternative approaches, and synthesizing solutions using discrete mathematical concepts.	PSO 2, 3, 4, PO1, 2, 6	An, C	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	-	-	-	-	-	1	-	-	-	-	2	-	-
CO2	-	3	-	3	-	-	1	1	-	-	-	2	-	-
CO3	-	3	2	3	-	-	2	1	-	-	-	2	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	-		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics
Course Code	UK3DSEMAT203
Course Title	Probability Theory
Type of Course	DSE
Semester	III
Academic Level	200-299

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4			4

Pre-requisites	Sets, limit and continuity of functions
Course Summary	This course provides a comprehensive idea on basic probability theory and some standard distributions

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Introduction to probability**	**15**
	1	Basic terminology	
	2	Probability	
	3	Axiomatic approach to probability	
	Chapter 3: Sections 3.3, 3.4, 3.5, 3.8 of Text [1]		
II		**Random variables and distribution functions**	**15**
	4	Distribution function	
	5	Discrete random variable	
	6	Continuous random variable	
	Chapter 5: Sections 5.1, 5.2, 5.3, 5.4 of Text [1]		
III		**Mathematical Expectation**	**10**
	7	Expected value of a random variable	
	8	Expected value of function of a random variable	
	9	Properties of expectation and variance, covariance	

Module	Unit	Contents	Hrs
	Chapter 6: Section 6.1, 6.2, 6.3, 6.4, 6.5, 6.6(only the concept of covariance) of the Text [1]. Topics from section 6.6.1 onwards are not included		
IV	**Standard Distributions**		**20**
	10	Discrete uniform distribution, Bernoulli distribution	
	11	Binomial distribution, Poisson distribution	
	12	Normal, Gamma and Beta distributions	
	Chapter 8: Sections 8.1,8.2, 8.3, 8.4 (subsections 8.4.1 to 8.4.8), Section 8.5 (subsections 8.5.2 to 8.5.6) and in Chapter 9: Sections 9.2 (subsections 9.2.1 to 9.2.5), Sections 9.5, 9.6 of the Text [1]		

Textbook

1. S C Gupta and V K Kapoor, Fundamentals of Mathematical statistics, 4th Edition, Sultan Chand and Sons, 2005.

References

1. R J Larsen and M L Marx, An introduction to Mathematical Statistics and its Applications, 6th edition, Pearson, 2011.
2. V K Rohatgi and A K Md Ehsanes Saleh, An Introduction to Probability and Statistics, 2nd edition, John-Wiley, 2001.
3. Sheldon Ross, A first course in probability, 5th Edn, Prentice Hall, 1998.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understand the different approaches to probability and their properties	PSO1, 2	U	F,C	L, T	As
CO 2	Develop the idea of random variables, distribution functions and their expectations	PSO2, 3	U, Ap	C, P	L, T	As
CO 3	Create a concrete idea of some standard distributions	PSO2, 3	Ap, An	C, P	L, T	As
CO 4	Apply the knowledge to solve real world problems	PSO4, 5, 6	C	M	L, T	As

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2					2		1					
CO2		2	2				2		2					
CO3		2	2					2		2				
CO4				2	2	2		2			2	2		

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4		✓		

University of Kerala

Discipline	Mathematics				
Course Code	UK3VACMAT200				
Course Title	Introduction to Actuarial Mathematics				
Type of Course	VAC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	3	3		0	3
Pre-requisites	1. Basics of Probability Theory, including basic concepts like probabilities, events, random variables, expected values, and variance. 2. Fundamentals of algebra, especially for solving equations and manipulating mathematical expressions.				
Course Summary	This course provides a comprehensive overview of key concepts in actuarial mathematics, including probability theory, financial mathematics and insurance principles. Through exploration of topics such as probabilities, interest calculations, life insurance premiums, and annuities, students develop the analytical skills necessary for careers in insurance, finance, and risk management.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Probability**		**10**
	1	Probabilities and events	
	2	Conditional probability Δ and E	
	3	Random variables	
	4	Expected values	
	5	Variance	
	Chapter 1 of Text [3]		

Module	Unit	Contents	Hrs
II	**The Theory of Interest**		**10**
	6	Simple interest and compound interest	
	7	Continuously compounded interest	
	8	Present value of future payments	
	9	Rate of return	
	10	Continuously varying interest rates	
	Chapter 1 of Text [1]		
III	**Annuity**		**15**
	11	Introduction to annuity	
	12	Types of Annuities	
	13	Amortization	
	14	Sinking Fund	
	Chapter 9 of Text [4]		
IV	**Life insurance**		**10**
	15	Calculating life insurance premiums	
	16	Types of life insurance	
	17	Combined insurance–annuity benefits	
	18	Insurances viewed as annuities	
	19	General insurance–annuity identity	
	Chapter 5 of Text [2]		

Textbooks

1. Buchanan, J. R., An undergraduate introduction to financial mathematics, 2012.

2. Promislow, S. D. . Fundamentals of actuarial mathematics. John Wiley Sons, 2014.

3. Ross, S. M., An elementary introduction to mathematical finance. Cambridge University Press, 2011.

4. Trivedi, K., Business mathematics. Pearson Education India, 2011.

References

1. Bowers et al., Actuarial Mathematics, Society of Actuaries, 1997.

2. Samuel A. Broverman, Mathematics of Investment and Credit, Actex Learning, 2017.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Examine interest calculations, including simple, compound, and continuously compounded interests, and rate of return evaluations	PSO1, 2	R, U, Ap	F, C		
CO 2	Compare various annuities and apply amortization and sinking funds principles.	PSO-5,6	R, U ,An	P		
CO 3	Develop methods for calculating life insurance premiums and disting-uishing between different insurance types.	PSO-1,3	U, An	M		
CO 4	Solve practical problems using statistical and mathematical methods in actuarial contexts.	PSO-3,4	C,E	C, P		
CO 5	Apply knowledge to analyze insurance-annuity benefits and explore insurance-annuity identities.	PSO-6	C,Ap.An	P		

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3					1	3	3					
CO2					3	3								
CO3	2	3							3					
CO4			3	3										
CO5						3								

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4		✓		✓
CO5		✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK3VACMAT201				
Course Title	Project Management and Game Theory				
Type of Course	VAC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	3	3			3
Pre-requisites	Matrix theory				
Course Summary	After completing the course student get the clear ides of the following , minimizing some measure of performance of a system such as the total completion time for the project, overall cost and so on, types of game theory, Mathematic required for solving game theory, Technique of solving for different types of games.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Critical Path Analysis**	**11**
	1	Network Components and Precedence Relationships	
	2	Critical Path Analysis	
	Chapter 13: Sections 13.4 and 13.5 of Text [1]		
II		**PERT**	**11**
	3	Project Scheduling with uncertain Activity Time *(probability not included)*	
	4	Basic Difference Between PERT and CPM	
	Chapter 13: Sections 13.6 and 13.2 of Text [1]		
III		**Games with Saddle Point**	**11**
	5	Introduction	

Module	Unit	Contents	Hrs
	6	Two Person Zero Sum Games	
	7	Pure Strategies	
	Chapter 12: Sections 12.1, 12,2 and 12.3 of Text [1]		
IV	**Games without Saddle Point**		**12**
	8	Rules of Dominance	
	9	Solution Methods of Games without Saddle Point *(Arithmetic Method, Matrix Method,Graphical Method)*	
	Chapter 13: Sections 12.5 and 12.6 of Text [1]		

Textbook

1. J K Sharma, Operations Research - Theory and Applications, Sixth Edition, 2016.

References

1. Hamdy A Taha, Operations Research an Introduction, Tenth edition, Pearson, 2016.
2. Kanti Swarup, P.K.Gupta, Man Mohan, Operations Research, Sultan Chand and Sons, 2005.
3. G Srinivasan, Operations Research, Principle and Applications, Second Edition, PHI Learning, 2010.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understant concepts in various Mathematical modelling	PSO1, 2, PO4, 5	U	F, C		
CO 2	Evaluate project completion time in different Network	PSO2, 3, PO1, 2, 3, 5	U, E	F, P		
CO 3	To find solutions of problems in Game theory	PSO3, 5, PO3	Ap, E	F, P		
CO 4	Apply techniques in Game theory to solve problems Game theory	PSO4, 5	Ap, E	F, P		

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1			2						2	4			
CO2	2		4	1			2	2	3		1			
CO3			3	-	3				3					
CO3			-	3	3									

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK4DSCMAT200				
Course Title	Introduction to Real Analysis and Multiple Integrals				
Type of Course	DSC				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4			4
Pre-requisites	1. Knowledge of number systems				
	2. Awareness of Calculus				
Course Summary	This course includes introductary Real Analysis and Multiple Integrals				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Real Numbers**	**15**
	1	The Algebraic and Order Properties of $\mathbb{R}$, Absolute Value and the Real Line, The Completeness Property of $\mathbb{R}$, Applications of the Supremum Property Intervals (Chapter 2: Sections 2.1, 2.2, 2.3, 2.4, 2.5 (subsections 2.5.1 to 2.5.4) of Text [1])	
II		**Sequences**	**15**
	2	Sequences and their Limits, Limit Theorems, Monotone Sequences (Chapter 3: Sections 3.1, 3.2, 3.3 (subsections 3.3.1 to 3.3.4) of Text [1]) Subsequences and the Bolzano-Weierstrass Theorem (Chapter 3: Section 3.4 (subsections 3.4.1 to 3.4.9), The Cauchy Criterion (Chapter 3: Section 3.5 (subsections 3.5.1 to 3.5.6) of Text [1])	

Module	Unit	Contents	Hrs
III		**Multiple Integral I**	**15**
	3	Double Integrals, Double Integrals over Non-rectangular Regions, Double Integrals In Polar Coordinates, Surface Area, Parametric Surfaces. (Chapter 14: Sections 14.1 to 14.4 of Text [2])	
IV		**Multiple Integral II**	**15**
	4	Triple Integrals, Triple Integrals In Cylindrical And Spherical Coordinates, Change Of Variables In Multiple Integrals, Jacobians, Centers of Gravity using Multiple Integrals. (Chapter 14: Sections 14.5 to 14.8 of text [2])	

Textbook

1. R. G. Bartle, Donald R. Sherbert, Introduction to Real Analysis, Fourth Edition, John Wiley & Sons, Inc., 2010.

2. Howard Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons, 2012.

References

1. Joel Hass, Maurice D. Weir, Thomas' Calculus Early Transcendentals, 12th Edition, Addison-Weseley Publishing Company, 2004.

2. W. Rudin, Principles of Mathematical Analysis, Second Edition, McGraw-Hill, 1964.

3. Stephen Abbot, Understanding Analysis, 2nd Edition, Springer, 2015.

4. J Stewart, Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited, 2008.

5. Terrence Tao, Analysis I, Hindustan Book Agency, 2022.

6. G B Thomas, R L Finney, Calculus, 9th Edition, Addison-Weseley Publishing Company, 2004.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understanding fundamental properties of real numbers that contributes to formal development of Real Analysis	PSO1, PO1, 2, 3, 4, 5, 6, 7	R, U	F,C	L	
CO 2	Demonstrates and understand the concept of sequence of real numbers and categorize them into convergent and divergent sequence	PSO1, PO1, 2, 3, 4, 5, 6, 7	U,An	F,C	L	
CO 3	Describe the concepts of multiple integration	PSO2, PO1, 2, 3, 4, 5, 6, 7	U, E	C, P	L	
CO 4	Apply double and triple integrals to solve real life problems	PSO3, PO1, 2, 3, 4, 5, 6, 7	Ap	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	2	2	1	1	2	1	3	1	2	1	
CO2	3	2	1	2	2	1	2	2	2	3	1	2	1	
CO3	2	3	1	2	1	1	2	2	2	3	1	2	2	
CO4	2	2	3	2	1	1	2	3	2	2	1	2	2	

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK4DSCMAT201				
Course Title	Partial Differentiation and Introduction to Abstract Algebra				
Type of Course	DSC				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4		1	5
Pre-requisites	Awareness of Differential Calculus and Set theory				
Course Summary	This course includes Partial differentiation and basic Abstract Algebra				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Partial Differentiation I**	**12**
	1	Functions of two or more variables, Limits And Continuity, Partial Derivatives, Differentiability, Differentials, And Local Linearity, The Chain Rule.	
	Chapter 13: Section 13.1, 13.2, 13.3, 13.4, 13.5 of Text [2]		
II		**Partial Differentiation II**	**12**
	2	Directional Derivatives And Gradients, Tangent Planes And Normal Vectors, Maxima And Minima Of Functions Of Two Variables, Lagrange Multipliers.	
	Chapter 13: Section 13.6, 13.7, 13.8, 13.9 of Text [2]		
III		**Groups**	**18**
	3	Binary Operations, Groups, Abelian Examples, Subgroups, Cyclic Groups.	

Module	Unit	Contents	Hrs
	Chapter 1 : Sections 1, 2, 3, 5, 6 of Text [1]		
IV		**Cosets**	**18**
	4	Non-abelian Examples, Groups of Permutations, Cosets and Theorem of Lagrange.	
	Chapter 1 : Section 4, Chapter 2 : Sections 8 and 10 of Text[1]		
Practical	Practicals and assignments can be given using Sagemath for solving the problems in the above modules. Chapters 3, 4, 5, 6 of Text [3] (not meant for examination)		**15**

Textbooks

1. J. B. Fraleigh, Neal.E.Brand A First Course in Abstract Algebra, Eighth Edition, Pearson Education Inc, 2022

2. Howard Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons, 2012.

3. Thomas. W. Judson, Stephen. F. Austin *Abstract Algebra Theory and Applications*, State University, Robert A Beezer, *Sage Exercises for Abstract Algebra* , University of Puget Sound, 2020.

References

1. I. N. Herstein, Topics in Algebra, Second Edition, Wiley, 2006.

2. Joel Hass, Maurice D. Weir, Thomas' Calculus Early Transcendentals, 12th Edition, Addison-Weseley Publishing Company, 2004.

3. Joseph. A. Gallian, Contemporary Abstract Algebra, Eighth Edition, Brooks Cole Cengage Learning, 2012.

4. Michael Artin, *Algebra*, Second Edition, Pearson Education, 2023.

5. J Stewart, Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited, 2008.

6. G B Thomas, R L Finney, Calculus, 9th Edition, Addison-Weseley Publishing Company, 2004.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Define multivariable functions and relate it to single variable functions	PSO5, PO1, 2, 3, 4, 5, 6, 7	R, U	F,C	L	
CO 2	Describe limits, continuity and partial derivatives	PSO1, PO1, 2, 3, 4, 5, 6, 7	U,E	P	L	
CO 3	Solve maximization and minimization problems using partial derivatives	PSO2, PO1, 2, 3, 4, 5, 6, 7	Ap	P	L	
CO 4	Explain the concepts of binary operations and groups and classify the groups as abelian, non-abelian and cycle groups	PSO4, PO1, 2, 3, 4, 5, 6, 7	U,An	F,C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	1	1	3	1	2	2	1	3	1	2	2	
CO2	3	2	2	2	2	1	2	3	2	2	1	2	1	
CO3	2	3	2	2	2	1	2	3	2	2	1	2	1	
CO4	2	2	2	3	2	1	3	2	2	2	1	2	1	

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK4DSEMAT200				
Course Title	Elementary Graph Theory				
Type of Course	DSE				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4	0	1	5
Pre-requisites	Fundamental concepts in set theory, Algebra and Geometry				
Course Summary	This course is intended to motivate the students to study Graph Theory as a branch of Discrete Mathematics and prepare them to learn more advanced concepts in Graph Theory				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Basic concepts of Counting**		**16**
	1	Events	
	2	Union of events	
	3	One-to-one correspondence and infinite set	
	4	Arrangement problem	
	5	Selections	
	6	Binomial Theorem and its Applications	
	Chapter 5: Sections 5.1, 5.2, 5.3, 5.4, 5.5, 5.6 of Text [2]		
II	**Introduction to Graphs**		**16**
	7	What is a graph?	
	8	Application of graphs	
	9	Finite and Infinite graphs	

Module	Unit	Contents	Hrs
	10	Incidence and Degree	
	11	Isolated Vertex, Pendant Vertex, and Null Graph	
	Chapter 1: Sections 1.1, 1.2, 1.3, 1.4, 1.5 of Text [1]		
III	**Paths and Circuits**		**16**
	12	Isomorphism	
	13	Sub-graphs	
	14	Walks, Paths, and Circuits	
	15	Connected Graphs, Disconnected Graphs, and Components	
	Chapter 2: Sections 2.1, 2.2, 2.3, 2.4, 2.5 of Text [1]		
IV	**Euler Graphs and Hamiltonian Graphs**		**12**
	16	Euler Graphs	
	17	Operations On Graphs	
	18	More on Euler Graphs	
	19	Hamiltonian Paths and Circuits	
	20	The Traveling Salesman Problem	
	Chapter 2: Sections 2.6, 2.7, 2.8, 2.9, 2.10 of Text [1]		
Practical	Practicals and assignments can be given using suitable software (like sagemath, scilab etc) to familiarize the concepts studied in this course. (not meant for examinations)		**15**

Textbooks

1. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Dover Publications Inc. Mineola, New York, 2017.

2. W. D. Wallis, A Beginner's Guide to Discrete Mathematics, Second Edition, Birkhauser, Springer International Edition, 2012.

References

1. A. Bondy, U. S. R. Murthy, Graph Theory with Applications, Macmillan Press, London, 1976.

2. M. Joan and R. J. Wilson, Graphs and Applications: An Introductory Approach, Springer Indian Reprint, 2007.

3. Jonathan L. Gross, Jay Yellen, Mark Anderson, Graph Theory and Its Applications, CRC Press, 2018.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Students get motivated to study Graph Theory	PSO 1, 2	R,U	F,C	L	
CO 2	Students develop basic understanding of the concepts in Graph Theory	PSO 1, 2, 3	R,U	F,C	L, T	
CO 3	Students develop skill in solving various problems containing concepts in Graph Theory.	PSO 3, 4, 5	Ap, An, E	F,C, P, M	T	
CO 4	Students apply the knowledge and skills in new situations	PSO 3, 4, 5, 6	Ap, An, E	F,C, P, M	T	P

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	1	0	1	1	1	1	2	2	3	0	1
CO2	2	3	3	2	2	1	2	2	2	3	3	2	1	2
CO3	1	3	3	3	4	3	3	3	2	2	2	2	1	1
CO4	1	1	3	3	3	3	3	3	3	3	3	3	2	2

(0 - Nill, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓	✓	✓
CO4	✓	✓	✓	✓

University of Kerala

Discipline	Mathematics				
Course Code	UK4DSEMAT201				
Course Title	Introduction to Operations Research				
Type of Course	DSE				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4			4
Pre-requisites	Matrix Theory				
Course Summary	At the end of the course student get the clear ides of using technique in algebra that uses linear equations to determine how to arrive at the optimal situation (maximum or minimum) as an answer to a mathematical problem, assuming the finiteness of resources and the quantifiable nature of the end optimization goal.				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Linear Algebra**	**15**
	1	Simultaneous linear equations-Gaussian Elimination, Rules of Rank, Homogeneous linear equations (review only)	
	2	Lines and hyper plane	
	3	Convex sets	
	4	Convex hull	
	5	Basic results in linear programming (statement of the theorems only)	
		Chapter 5: Sections 5.2, 5.4 and 5.6, Chapter 6: 6.4, 6.5 and 6.7 of Text [1]	

Module	Unit	Contents	Hrs
II	**Introduction to Linear Programming**		**15**
	6	History of Operations Research	
	7	Definitions of Operations Research	
	8	Structure of Linear Programming Model	
	9	Advantages and limitations of Linear Programming	
	10	Linear Programming Model formulation	
	11	Examples of Linear Programming Model formulation	
	Chapter 1: Sections 1.2, 1.3 , Chapter 2: Sections 2.2, 2.3, 2.7, 2.8 of Text[2]		
III	**Graphical and Simplex Method**		**15**
	12	Important Definitions	
	13	Graphical Solution	
	14	Special Cases in Linear Programming	
	15	Standard form of an LPP	
	16	Simplex Algorithm *(Maximization case)*	
	17	Simplex Algorithm *(Minimization case)*	
	Chapter 3: Sections 3.2, 3.3 , 3.4, Chapter 4: Sections 4.2 and 4.3 of Text [2]		
IV	**Two-phase and Big-M Method**		**15**
	18	Two phase Method	
	19	Big-M Method	
	Chapter 4: Sections 4.4 of Text[2]		

Textbooks

1. G. Hadley: Linear Algebra, Narosa, Reprint, 2002.
2. J K Sharma, Operations Research - Theory and Applications, Laxmi Publications, Sixth Edition, 2016.

References

1. Hamdy A Taha, Operations Research an Introduction, Tenth edition, Pearson, 2021.
2. I.N Herstein, Linear Algebra, Wiley Eastern, 2006.
3. Kanti Swarup, P.K.Gupta, Man Mohan, Operations Research, Sultan Chand and Sons, 2005.
4. Kenneth Hoffman and Ray Kunze, Linear Algebra, Prentice Hall, 1981.
5. S. Kumaresan, Linear Algebra, Prentice Hall, 2000.
6. G Srinivasan, Operations Research - Principle and Applications, Second Edition, PHI Learning, 2010.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand and apply the concept of mathematical modelling	PSO2, PSO3, PO2	R,U, Ap	F,P	L	
CO 2	Formulate LPP	PSO3, PO2	Ap , E	P	L	
CO 3	Solve LPP using Simplex Method	PSO2, PSO3, PO2	An, Ap	P	L	
CO 4	Solve LPP using Two-phase and Big M Method .	PSO2, PSO3, PO2	Ap,An	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	3	2	-	-	-	-	2	-	-	-	-	-	-
CO2	-	-	3	-	-	-	-	3	-	-	-	-	-	-
CO3	-	3	3	-	-	-	-	2	-	-	-	-	-	-
CO4	-	3	3	-	-	-	-	2	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK4DSEMAT202				
Course Title	Data Analysis using Python				
Type of Course	DSE				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	3		2	5
Pre-requisites	Basics of python, Descriptive Statistics, Statistical plotting, Testing of hypothesis, simple linear regression and correlation				
Course Summary	This course in Data Visualization and Statistical Analysis using Python equips students with the skills to visualize data through various plots and graphs, obtain statistical measures, conduct hypothesis tests, and perform correlation and regression analysis, all within the Python programming environment.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Data Visualization using python**		**15**
	1	Plotting and interpreting bar diagram, subdivided bar diagram, multiple bar diagram, line chart, histogram, box plot, Normality plot, scatter plot.	
	Chapter 9 of Text [4], Chapter 4 of Text [3], Chapter 4 of Text [1].		
II	**Descriptive Statistical Measures**		**20**
	2	Measures of central tendency (mean, median, mode), measures of dispersion (range, quartile deviation, standard deviation)– Practical using Python.	
	3	Correlation and regression: Fitting a simple linear regression model, Karl Pearson's coefficient of correlation, Spearman's rank correlation coefficient – Practical using Python	

Module	Unit	Contents	Hrs
	Chapter 2, Chapter 6 of Text [3] , Chapter 5 of Text [2] and Chapter 5 of Text [1].		
III	**Tests of Hypothesis**		**20**
	4	Parametric and non-parametric tests, Data assumptions for parametric tests, checking normality and variance assumptions, Parametric tests: one sample and two sample tests for mean – Z-tests, t-tests, tests of proportions, test of equality of variance- F-test, Analysis of variance- One-way. – Practical using Python	
	Chapter 2 of Text [3], Chapter 3, Chapter 4 of Text [1]		
IV	**Non-Parametric Tests**		**20**
	5	Need for non-parametric tests, Shapiro Wilk test for normality, Levene test for equality of variance, Chi-square test for goodness of fit, Kolmogorov-Smirnov test, Chi-square test for independence of attributes, Mann-Whitney U test for equality of means or medians of two independent samples, Wilcoxon test for paired samples, Kruskal-Wallis H test for equality of means of independent samples– Practical using Python.	
	Chapter 2 of Text [3], Chapter 5 of Text [1]		

Textbooks

1. Huy Hoang Nguyen, Paul N Adams, Stuart J Miller, Building Statistical Models in Python, Packt Publishing, 2023.

2. Joel Grus, Data Science from Scratch: First Principles with Python,second edition, O'Reilly, 2019.

3. Samir Madhavan, Mastering Python for Data Science, Packt Publishing, 2015

4. Wes McKinney, Python for data analysis, third edition, O'Reilly, 2022.

References

1. Allen B. Downey, Think Stats: Probability and Statistics for Programmers; 2^{nd} Edition, O'Reilly Media, 2014

2. Wes McKinney, Python for Data Analysis, 2nd Edition; O'Reilly Media, 2017.

3. William Mendenhall, Robert J. Beaver, and Barbara M. Beaver ; Introduction to Probability and Statistics, 15^{th} Edition, Cengage Learning, 2016.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the basics of Python.	PSO2, PSO4, PO1	U, E	L	C	P
CO 2	Able to present a data by suitable diagrams and graphs using Python.	PSO1, PSO2, PSO4, PO1, PO3	U	L	C	P
CO 3	Describe relations between two variables using correlation and regression.	PSO3, PO3	Ap, E	L	P	P
CO 4	Check the validity of statistical hypothesis' by parametric and non-parametric tests.	PSO1, PSO2, PSO5, PO6	E, Ap, An	L	P	P

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	3	-	3	-	-	2	-	-	-	-	-	-	-
CO2	3	3	-	2	-	-	2	-	2	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-	2	-	-	-	-	-
CO4	3	3	-	-	2	-	-	-	-	-	-	2	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓	✓	✓
CO3	✓	✓	✓	✓
CO4	✓	✓	✓	✓

University of Kerala

Discipline	Mathematics				
Course Code	UK4SECMAT200				
Course Title	Typesetting Documents with LaTeX				
Type of Course	SEC				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	3	2	-	2	4
Pre-requisites	Basic computer knowledge				
Course Summary	This course provides the basics of LaTeX programs which enable the students to create good quality scientific documents and presentations				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Basics of LaTeX**		**10**
	1	What is LaTeX, Simple typesetting, Fonts, Type size (Chapter 1 of Text [2])	
II	**Typesetting Mathematics**		**20**
	2	Basics of typesetting (Section 8.1 complete) Single Equations (equation, equation*, split) Group of Equations (gather, gather*, align, align*, cases) Matrices and Determinants (matrix, pmatrix, bmatrix, vmatrix) Putting one over another (frac, dfrac, int, lim, sum, prod) The above topics can be found in 8.1, 8.3.1, 8.3.2, 8.4.2 and 8.4.4 of Text [2]. Basics of typesetting Theorems and amsthm package (9.1 to 9.2.1 of Text [2]) Do Exercise questions 4, 5, 6 and 7 of Chapter 9 of Text [1].	

Module	Unit	Contents	Hrs
III	**Tables and Figures**		**15**
	3	Typesetting basic tables. Merge cells using $\backslash multicolumn$ (7.2 of Text [2], except the portion using $\backslash renewcommand$) Inserting pictures using Graphicx package (12.1.1 to 12.1.3 of Text [2], except the portion on pstricks), Creating Floating Figures (11.1.1 of Text [2])	
IV	**Beamer Presentation:**		**15**
	4	What is Beamer. Thinking in terms of frames. Set up a Beamer document. Enhance a Beamer presentation. (11.1 to 11.4 of Text [1], except the portion using pstricks)	

Textbooks

1. Donald Binder, Martin Erickson, A student's guide to the study, practice and tools of modern mathematics, CRC Press, 2010.

2. E. Krishnan, The LaTeX Tutorial: A Primer, by The Tutorial Team, Indian TeX Users Group, Sayahna Foundation, http://www.sayahna.org, 2020.

References

1. Dilip Datta, LaTeXin 24 Hours, A Practical Guide for Scientific Writing, Springer, 2017.

2. Hubert Partl, Irene Hyna and Elisabeth Schlegl, The Not So Short Introduction to LaTeX2ϵ, Tobias Oetiker, Version 6.4, 09 March 2021.

E- resources

1. https: //www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the basics of LaTeX programs	PSO1, PO7	U	F,C	L	P
CO 2	Create good quality scientific documents	PSO5, PO3	Ap,C	P	L	P
CO 3	Create good quality presentations	PSO5, PO3, 4	Ap, C	P	L	P

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1												3	
CO2					3				2					
CO3			-	-	3				3	3				

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓	✓	✓
CO3	✓	✓	✓	✓

University of Kerala

Discipline	Mathematics				
Course Code	UK4SECMAT201				
Course Title	Numerical Methods				
Type of Course	SEC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Differentiation 2. Integration				
Course Summary	This course enable the students to gain a thourough understanding of various numerical methods used for solving mathematical problems				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Solution of Algebraic and Transcendental equations**	**15**
	1	Introduction, Bisection Method, Method of false position. Chapter 2: Section 2.1 to 2.3 of Text	
	2	Iteration Method, Newton-Raphson method. Chapter 2: section 2.4 to 2.5 of Text	
	3	Ramanujan's method, Secant method, Muller's method. Chapter 2: Section 2.6 to 2.8 of Text	
II		**Interpolation**	**15**
	4	Finite differences. Chapter 3: Section 3.3 (excluding 3.3.4)	
	5	Newton's formulae for interpolation. Chapter 3: Section 3.6 of Text	
	6	Interpolation with unevenly spaced points. Chapter 3: Section 3.9 of Text	

Module	Unit	Contents	Hrs
	7	Divided differences and their properties. Chapter 3: Section 3.10 of Text	
III		**Numerical Differentiation and Integration**	**15**
	8	Numerical differentiation. Chapter 6: Section 6.2 (excluding 6.2.1 and 6.2.2) of Text	
	9	Maximum and Minimum values of a tabulated function. Chapter 6: Section 6.3 of Text[1]	
	10	Numerical integration Chapter 6: Section 6.4.1 to 6.4.3 of Text	
Practical	Practical sessions can be given using suitable software like sagemath (not meant for examination purpose)		**15**

Textbook

1. S.S. Sastry, *Introductory Methods of Numerical Analysis* , Fifth edition, PHI Learning Pvt. Ltd, 2012

References

1. A. C. Faul, *A Concise Introduction to Numerical Analysis* , CRC Press, 2016.
2. Richard L. Burden, J. Douglas Faires,*Numerical Analysis* , Ninth Edition, Cengage Learning, 2011.
3. Timo Heister, Leo G. Rebholz, Fei Xue, *Numerical Analysis- An Introduction* , De Gruyter, 2019.
4. Timothy Sauer, *Numerical Analysis*, Third Edition, Perason Education, 2018.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Find the solution of algebraic and transcendental equation using numerical methods	PO 2, PSO1, 2,3	U, Ap	F,C	L	
CO 2	Apply numerical techniques to interpolate data points effectively	PO1, PSO1, 2,3	U, Ap	F,C	L	
CO 3	Apply numerical techniques for differentiation	PO2, PSO1, 2,3	U, Ap	F,C	L	
CO 4	Apply numerical techniques for integration	PO2, PSO1, 2,3	U, Ap	F,C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2					3						
CO2	3	3	2				3							
CO3	3	3	2					3						
CO4	3	3	2					3						

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam

- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK4VACMAT200				
Course Title	Introduction to Mathematical Modeling				
Type of Course	VAC				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	3	3	-	-	3
Pre-requisites	Basic School Mathematics and basic calculus				
Course Summary	This course is designed for enhancing students to work with data from the real world by formulating mathematical questions and drawing conclusions based on the analysis of that data using different mathematical tools				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Data and Functions**		**12**
	1	A basic introduction to data along with problems on mean,median and quartiles,Representing functions with graph,formulas and tables,Behaviour of functions such as increasing,decreasing,concavity:inflection points and periodicity, Domain and Range of a function with example, Mathematical models.	
	Chapter 1: Section 1.1 (Topics only prescribed above), Chapter 2: Sections 2.1, 2.2, 2.3, 2.4 of Text [1]		

Module	Unit	Contents	Hrs
II		**Modeling with Linear functions**	**15**
	2	Fundamental concepts of Linear functions, Slope, Point-Slope Formula, Modeling with Linear functions, Linear Regression, Correlation Coefficient, Virtual Laboratory: Bradford Analysis for Protein Concentrations and Hooke's Law on the Elongation of a Spring.	
		Chapter 3: Sections: 3.1 (not included for examination), 3.2, 3.3 (z-values excluded), 3.4 of Text [1]	
III		**Modeling with Logarithmic and Polynomial functions**	**18**
	3	Exponential growth functions,Applicatons,Domain and Range,Exponential decay functions,Half- Life,Radioactive decay,Fitting Exponential Functions to Data,Modeling with Logarithmic functions,Fitting Logarithmic functions to Data,Behaviour and Applications of Power function,Fitting Power functions to data. Polynomial functions,Zeros of a polynomial and Roots of an equation,Behaviour of Polynomial functions,Modeling with polynomial functions,Path of a Projectile,Fitting polynomials to data.	
		Chapter 5: Sections 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7 (Topics from Potential problems when fitting power functions to data excluded for examination), 5.8 (not included for examination), 6.1, 6.2 (6.1 and 6.2 are not included for examination), 6.3 (Deriving Regression Equations excluded)	

Textbook

1. Sheldon P. Gordon and Florence S. Gordon. Functions, Data and Models , The Mathematical Association of America, 2010.

References

1. Edward A Bender, An introduction to mathematical modeling, Dover Books, 1978.
2. Majid Jaberi, Douraki, Seyed M Moghadas, Mathematical modeling - a graduate text book, Wiely, 2018.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understand the concept of mathematical modeling	PSO1,2, PO1	U	F,C	L,T	
CO 2	Analyse various data using mathemtical models	PSO2, PO3, 4	An	F	L,T	
CO 3	Apply various mathematical functions for modeling	PSO1,3, PO2, 3	Ap	C	L,T	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1					3							
CO2		2							1	3				
CO3	2		3					2	2					

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK4VACMAT201				
Course Title	Mathematics in Nature				
Type of Course	VAC				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	3	3			3
Pre-requisites	Basic concepts in Mathematics				
Course Summary	This course explores two fascinating mathematical concepts: the golden ratio and fractals. Both concepts are prevalent in various fields, including mathematics, art, architecture, and nature. Through this course students will be able to gain a deeper appreciation for the beauty and complexity inherent in mathematical patterns and structures.				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Introduction to Golden Ratio**	**10**
	1	Introduction - Chapter 1 of Text [1].	
	2	Basic Properties of Golden Ratio - Chapter 2 of Text [1]	
II		**Golden Ratio and Fibonacci Numbers**	**13**
	3	Fibonacci Numbers - Chapter 5 of Text [1].	
	4	Lucas numbers and generalized Fibonacci numbers- Chapter 6 of Text [1].	
	5	Continued Fractions and Rational Approximations - Chapter 7 of Text [1].	

Module	Unit	Contents	Hrs
III		**Fractals**	**10**
	6	Introduction - Section 11.0 of Text [2]	
	7	Countable and Uncountable Sets - Section 11.1 of Text [2]	
	8	Cantor Sets - Section 11.2 of Text [2]	
IV		**Different Dimensions**	**12**
	9	Dimension of Self-similar Fractals - Section 11.3 of Text 2	
	10	Box Dimension - Section 11.4 of Text [2]	
	11	Pointwise and Correlation Dimension - Section 11.5 of Text [2]	

Textbooks

1. Richard A, Dunlap, *The Golden Ratio and Fibonacci Numbers*, World Scientific Publishing Co. Pte. Ltd. 5 Toh Tuck Link, Singapore, 2003.

2. Steven H. Strogatz, *Nonlinear Dynamics and Chaos - With Applications to Physics, Chemistry, Biology and Engineering*, Second Edition, CRC Press Taylor and Francis Group 6000 Broken Sound Parkway, 2018.

References

1. Barnsley M F, *Fractals Everywhere* , Dover Publication, Newyork,3rd Edition, 2012.

2. Coxetcr H.S.M., *Introduction to Geometry*, Witey, New York, 1961.

3. Falconer K.J, *The Geometry of Fractal Sets* ,Cambridge University Press, Cambridge, 1986.

4. Holden, A. 1971 *Shapes, Space and Symmetry*, Columbia University Press, New York, 1971.

5. Kenneth Falconer, *Fractal Geometry Mathematical Foundation and Application*, Third edition, Wiley, 2014.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concept of Golden ratio	PSO1	U	F, C	L	
CO 2	Understand the concept of Fractals	PSO1	U	F , C	L	
CO 3	Identify instances of the Golden Ratio and fractals in natural and man-made phenomena	PSO3, PSO4, PSO6, PO6	Ap, An, E, C	F, C, M	L	
CO 4	Construct mathematical models of phenomena exhibiting the Golden Ratio and fractal patterns	PSO3, PSO4, PSO6, PO6	Ap, An, E, C	F, C, M	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	3	-	2	-	-	-	-	-	2	-	-
CO4	-	-	3	3	-	2	-	-	-	-	-	2	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam

- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓			✓

University of Kerala

Discipline	Mathematics				
Course Code	UK5DSCMAT300				
Course Title	Differential Equations and Vector Calculus				
Type of Course	DSC				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4 Hours	-	1	5
Pre-requisites	1. Differential Calculus 2. Integral Calculus 3. Vector Calculus				
Course Summary	This course will introduce the fundamental concepts of ODE, different techniques for solving these ODE's and gives fundamental concepts of Vector Calculus including Vector Field, Line Integrals, Surface Integrals and Volume Integrals. Also it explains the physical interpretation of Green's Theorem, Stoke's Theorem and Divergence Theorem.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**First Order Ordinary Differential Equations**		**18**
	1	Basic Concepts, solution, Initial Value Problem, Modelling	
	2	Separable ODE, reduction to separable form, exact ODEs and integrating factors, reducing to exact form	
	3	Homogeneous and non homogeneous linear ODEs	
	4	Special equations like Bernoulli equation, orthogonal trajectories, understanding the existence and uniqueness of solutions theorem.	
	Chapter 1: Section 1.1, 1.3, 1.4, 1.5, 1.6, 1.7 of Text [1]		

Module	Unit	Contents	Hrs
II		**Higher Order Ordinary Differential Equations**	**18**
	5	Homogeneous linear ODE of second order, initial value problem, basis, and general solutions, finding a basis if one solution is known, Reduction of order, homogeneous linear ODE with constant coefficients (various cases that arise depending on the characteristic equation)	
	6	Differential operators, Euler-Cauchy Equations	
	7	Existence and uniqueness of solutions w.r. to Wronskian, solving non-homogeneous ODE via the method of undetermined coefficients.	
	8	Applications of techniques, solution by variation of parameters.	
		Chapter 2: Section 2.1, 2.2, 2.3, 2.5, 2.6, 2.7, 2.10 of Text [1]	
III		**Vector Calculus 1**	**12**
	9	Vector Fields, Inverse square field, Gradient field, Conservative fields and potential function, Divergence and Curl, ∇-operator, The Laplacian ∇^2	
	10	Integrating a function along a curve (line integrals), Integrating a vector field along a curve, defining work done as a line integral.	
	11	Line integrals along piece wise-smooth curves, integration of vector fields and independence of path,	
	12	Fundamental theorem of line integrals, line integrals along closed paths, test for conservative vector fields, *(excluding conservative vector fields in 3- Space, and conservation of Energy)* Green's theorem and applications(*without proof*).	
		Chapter 15: Section 15.1, 15.2, 15.3, 15.4 of Text [2]	
IV		**Vector Calculus- II**	**12**
	13	Defining and evaluating surface integrals, their applications	
	14	Orientation of surfaces, evaluating flux integrals	
	15	The divergence theorem	
	16	Gauss' Law, Stoke's theorem, applications of these theorems.	
		Chapter 15: Section 15.5, 15.6, 15.7, 15.8 of Text [2]	
Practical		Practical sessions can be given using suitable software like sagemath (not meant for examination purpose)	**15**

Textbooks

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10^{th} Edition Wiley, 2018.
2. Howard Anton, Irel Bivens, Stephens Davis, *Calculus* 10^{th} Edition Wiley, 2012.

References

1. Ian Sneddon, *Elements of Partial Differential Equations*, Mc Graw- Hill, 2013.
2. Peter. V. O Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007.
3. M. D. Raisinghaniya, *Ordinary and Partial Differential Equations*, S Chand 18^{th} Edition, 2008.
4. G. F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata McGraw-Hill, 2003.
5. G. B. Thomas, R. L. Finey, *Calculus*, 9^{th} Edition, Addison-Weseley Publishing Company, 2004.

Course Outcomes

CO No.	**Upon completion of the course the graduate will be able to**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture(L) Tutorial (T)**	**Practical (P)**
CO 1	Classify ordinary differential equations based on their order, linearity, and homogeneity.	PSO1, 2	U, Ap	F,C	L	
CO 2	Analyze the behavior of solutions to differential equations	PSO 2,3	U, An	C,P	L	
CO 3	Develop problem-solving skills through solving a variety of vector integration problems	PSO 1,2,3,4	An, E	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	3	3	3	2	1	-	-	1		
CO2	3	3	3	3	3	2	3	3	2	-	-	1		
CO3	3	3	3	3	2	3	3	3	2	-	-	1		

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK5DSCMAT301				
Course Title	Fundamentals of Real Analysis - I				
Type of Course	DSC				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4 hours			4
Pre-requisites	1. Functions 2. sequences, 3. Convergence of sequences				
Course Summary	This course provides basics of real analysis				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Series**	**12**
	1	Introduction to Infinite Series	
	2	Absolute Convergence	
	3	Tests for Absolute Convergence	
	Chapter 3: Section 3.7 of Text [1]		
II		**Limits**	**18**
	4	Limits of Functions	
	5	Limit Theorems	
	6	Some Extensions of the Limit Concept	
	Chapter 4 of Text [1]		
III		**Continuous Functions**	**18**
	7	Continuous Functions	
	8	Combinations of Continuous Functions	

Module	Unit	Contents	Hrs
	9	Continuous Functions on Intervals	
	10	Monotone and Inverse Functions	
	Chapter 5: Section 5.1, 5.2, 5.3, 5.6(Sub-section 5.6.1-5.6.5) of Text [1]		
IV	**Differentiation**		**12**
	11	The Derivative	
	12	The Mean Value Theorem	
	13	L'Hospital's Rule	
	14	Taylor's Theorem	
	Chapter 6: Section 6.1, 6.2, 6.3, 6.4 (Sub-section 6.4.1-6.4.4) of Text [1]		

Textbook

1. Robert G. Bartle, Donald R. Sherbert, Introduction to Real Analysis, Fourth Edition, John Wiley & Sons, Inc, 2011.

References

1. H Anton, I Bivens, S Davis, Calculus, 10^{th} Edition, John Wiley & Sons, 2015.

2. W. Rudin, Principles of Mathematical Analysis, Second Edition, McGraw-Hill, 2017.

3. Stephen Abbot, Understanding Analysis, 2^{nd} Edition, Springer, 2015.

4. Terrence Tao, Analysis I, Hindustan Book Agency, 2015.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Define the theory of real series and apply the theory to check the convergence or divergence of series.	,6 PSO1, PSO2, PSO4, PSO5, PSO6, PO1	R, U, Ap, An, E, C	F, C	L	
CO 2	Describe the concepts related to the limit of functions.	PO 1,6 PSO1, PSO2, PSO4, PSO5, PSO6	R, U, Ap, An, E, C	F, C	L	
CO 3	Understand the concepts of continuity and differentiability more rigorously than what we have done in the previous courses.	PSO1, PSO2, PSO4, PSO5, PSO6, PO1, PO6	R, U, Ap, An, E, C	F, C	L	
CO 4	Understand the fundamental properties of continuous functions on intervals and monotone functions.	PSO1, PSO4, PSO5, PO1	R, U, An	F, C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3		2	2	1	3					2		
CO2	3	3		2	3	1	3					1		
CO3	3	3		3	2	2	3					2		
CO4	3			1	2		3							

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓			✓

University of Kerala

Discipline	Mathematics				
Course Code	UK5DSCMAT302				
Course Title	Abstract Algebra				
Type of Course	DSC				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	1	5
Pre-requisites	Groups and Subgroups				
Course Summary	The course delves into the fundamental concepts of homomorphism and factor groups . It covers the definition of Rings, fields and Integral Domains along with the field of quotients of an integral domain, rings of polynomials and factorization of polynomials over a field, factor rings and prime and maximal ideals				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Homomorphisms and Factor Groups**		**10**
	1	Factor Groups, Factor Group Computations and Simple Groups. (Proof of theorems in the sections 'Simple Groups and Commutator Subgroups' can be excluded)	
	Chapter 3: Sections 12,13 of Text [1]		
II	**Rings and Fields**		**20**
	2	Rings and Fields, Integral Domains, Fermat's and Euler's Theorems	
	Chapter 5: Sections 22, 23, 24 of Text [1]		

Module	Unit	Contents	Hrs
III	**Constructing Rings and Fields**		**20**
	3	The field of quotients of an integral domain, Rings of polynomials, factorization of polynomials over a Field. (The part 'our basic goal' in section 27 and proof of theorem 28.16 in section 28 of Text [1] are excluded)	
	Chapter 6: Sections 26, 27, 28 of Text [1]		
IV	**Homomorphisms and Factor Rings**		**10**
	4	Homomorphisms and factor rings, Prime and Maximal Ideals. (The part 'A preview of our basic goal' In section 31 can be excluded)	
	Chapter 6: Sections 30,31 of Text [1]		
Practical	Assignments can be given using Sagemath for finding the problems in the above modules. (Sections 10,11,16,17,18 of Text [2])(not meant for examination purpose)		**15**

Textbooks

1. John B. Fraleigh, Neal.E.Brand *A First Course in Abstract Algebra*, Eighth Edition, Pearson Education, Inc., 2022.

2. Thomas.W. Judson, Stephen. F. Austin *Abstract Algebra Theory and Applications*, State University, Robert A Beezer, *Sage Exercises for Abstract Algebra* , University of Puget Sound, 2020.

References

1. I. N. Herstein, *Topics in Algebra*, Second Edition, Wiley, 2006.

2. Joseph. A. Gallian, *Contemporary Abstract Algebra*, Eighth Edition, Brroks/cole Cengage Learning, 2012.

3. Michael Artin, *Algebra*, Second Edition, Pearson Education, 2023.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the fundamental algebraic structures and their properties	PSO 1,2, PO1, 3, 6, 7, 8	U	F, C		
CO 2	Explore the relationship between different structures	PSO 4, 5, PO1, 2, 3, 6, 7, 8	Ap	C, P		
CO 3	Develop new structures based on given structures	PSO 3, 4, PO1, 2, 3, 6, 7, 8	C	P, M		
CO 4	Apply the concept of algebraic structures to solve problems	PSO 1, 3, 6, PO1, 2, 3, 6, 7, 8	Ap	P, M		

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	2	2	3	3	3	-	1	-	-	2	1	1
CO2	1	3	1	2	1	1	1	1	3	-	-	2	1	1
CO3	1	3	2	3	2	3	1	3	3	-	-	3	1	1
CO4	1	1	3	3	2	1	1	3	3	-	-	3	1	1

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- End Semester Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	—-		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK5DSCMAT303				
Course Title	Advanced Mathematics for Social Sciences				
Type of Course	DSC				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	Knowledge of Matrices, Calculus and Basics of Linear Programming				
Course Summary	This course includes Determinants and Matrices, Differential and integral Calculus, Differential and Difference Equations, Linear Programming				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Determinants and Matrices**		**15**
	1	Determinants and their properties, Evaluation of higher order Determinant- Laplace method, Hessian determinant	
	2	Inverse of 3x3 matrix, rank of a matrix, Solution of simultaneous equations by Cramer's rule and inverse method	
	3	Uses of matrices- Input- output models(static and dynamic, open and closed models)- Hawkin- Simon condition	
	Topics of this section can be found in Chapter 11: Sections 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 11.7, 11.8 and 11.9. Chapter 12: Sections 12.2 and 12.6 of Text [2], Section 5.7 of Text [1]		
II	**Differential and integral Calculus**		**15**
	4	Derivatives of multivariable functions, unconstrained optimization, constrained optimization by Lagrange method	

Module	Unit	Contents	Hrs
	5	Uses of derivatives in economics- slope, concavity and convexity of economic functions, elasticity of demand, equilibrium of the consumer and the firm, monopoly and discriminating monopoly.	
	6	Rules of integration, definite integrals and their properties. Uses of integrals in Economics- the stock of capital, consumer's and producer's surplus	
	Topics of this section can be found in Chapter 5: Sections 5.1, 5.2, 5.3, 5.4, 5.5. Chapter 4: Sections 4.1,4.2,4.3, Chapter 14: Sections 14.1, 14.2, 14.3, 14.5, 14.6, Chapter 15: Sections 15.1, 15.2, 15.3, 15.4, and 15.8 of Text [2]		
III	**Differential and Difference Equations**		**15**
	7	Concept of differential equations , First order linear differential equations and their solutions	
	8	Concept of difference equations, solution of first order linear difference equations	
	9	Uses of these equations in economics-dynamic stability, lagged income determination model, Harrod and Cobweb models.	
	Topics of this section can be found in Chapter 16: Sections 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, Chapter 17: Sections 17.1, 17.2, 17.3, 17.4, 17.5, 17.6 of Text [2]		
IV	**Linear Programming**		**15**
	10	Basic concepts, Formulation of a linear programming problem, basic LP theorem	
	11	Solution of linear programming problems by graphical and simplex methods, degenerate problem	
	12	Duality theorem and its interpretation, shadow prices and their uses	
	Topics of this section can be found in Chapter 2: Sections 2.1, 2.2, Chapter 3: Sections 3.1, 3.3, 3.4 (Subsection 3.4.1 and 3.5.1), Chapter 4: Sections 4.1, 4.2 (Subsection 4.2.2, 4.2.3, 4.2.4), 4.3 (Subsection4.3.1, 4.3.2) of text [3]		

Textbooks

1. Chiang, A.C., Fundamental Methods of Mathematical Economics, McGraw Hill, NewYork, 2008.

2. Dowling, E.T., Introduction to mathematical Economics, Schaum's Outline Series, McGraw Hill, 2007.

3. Taha, H.A., Operations Research- An introduction, Prentice hall of India, New Delhi, 2008

References

1. Allen, R.G.D., Mathematical Analysis for Economists. New Delhi: AITBS Publishers, 2008.
2. Archibald, G.C and Lipsey, R.G (), Introduction to mathematical Treatment of Economics, Wiedenfeld Nicholson, London, 1984.
3. Baumol, W.J., Economic Theory and Operations Analysis, Prentice Hall, Englewood Cliffs, New Jersey, 2003.
4. Michael Hoy and L. John, Mathematics for Economics, PHI, New Delhi, 2004.
5. Musthafi, C.K., Operations Research: Methods and Practice, Wiley Eastern, New Delhi, 2011.
6. Taro Yamane, Mathematics for Economists : An Elementary Survey: Prentice Hall of India Pvt. Ltd., New Delhi, 2001.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concepts of determinanats and matrices	PSO1, PO1, 4	U	F,C	L	
CO 2	Analyse and solve Different types of differential equations and difference equations	PSO2, 3, PO2	An, U	C,P	L	
CO 3	Applications of matrices, determinanats, differential and integral calculus	PSO5, PO2, 3	Ap	C,M	L	
CO 4	Solving LPP graphically	PSO3, PO3	E	C, P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	3	2	2	3	1	-	1	2
CO2	-	3	3	-	-	-	2	3	2	-	-	1	-	2
CO3	-	-	-	-	3	-	2	3	3	-	-	-	1	1
CO4	-	-	3	-	-	-	2	2	3	2	-	1	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Descipline	Mathematics				
Cours Code	UK5DSEMAT300				
Course Title	Intermediate Graph Theory				
Type of Course	DSE				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4	0	1	5
Pre-requisites	Basic concepts in Graph Theory				
Course Summary	This course is developed to prepare the students studying graph theory to develop a clear understanding of Graph Theoretic concepts				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Trees**	**16**
	1	Trees	
	2	Cut Edges and Bonds	
	3	Cut Vertices	
	4	Cayley's Formulae - Applications (Chapter 2: Section 2.1, 2.2, 2.3, 2.4 of Text [1])	
II		**Connectivity**	**16**
	5	Connectivity	
	6	Blocks - Applications	
	7	Construction of Reliable Communication Networks (Chapter 3: Section 3.1, 3.2, 3.3 of Text [1])	
III		**Matching**	**16**
	8	Matchings	
	9	Matchings and Coverings in Bipartite Graph	

Module	Unit	Contents	Hrs
	10	Perfect Matchings - Applications (Chapter 5: Section 5.1, 5.2, 5.3 of Text [1])	
IV	**Edge Coloring**		**12**
	11	Edge Chromatic Number	
	12	Vizing's Theorem, Application	
	13	The Time Tabling Problem (Chapter 6: Section 6.1, 6.2, 6.3 of Text [1])	
Practical	Using suitable software familiarize the students with the concepts studied in this course		**15**

Textbook

1. J. A. Bondy and U. S. R. Murty, Graph Theory with Applications, London, McMillan Press, 1976.

References

1. V. K. Balakrishnan, Schaum's Outline of Graph Theory, McGraw Hill, 1997

2. Douglas Brent West, Introduction to Graph Theory, Pearson, 2018

3. John Clark, Derek Allan Holton, A First Look at Graph Theory, World Scientific, 1995

4. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Dover Publications Inc. Mineola, New York, 2017

E- resources

1. https://www.sagemath.org/help.html

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Students get motivated to study the concept of trees, connectivity, matching and edge coloring	PSO 1, 2	R,U	F,C	L	
CO 2	Students develop basic understanding of the concept of trees, connectivity, matching and edge coloring	PSO 1, 2, 3	R,U	F,C	L, T	
CO 3	Students develop skill in solving various problems containing the concept of trees, connectivity, matching and edge coloring	PSO 3, 4, 5	Ap, An, E	F,C, P, M	T	
CO 4	Students apply the acquired knowledge and skills in new situations	PSO 3, 4, 5, 6	Ap, An, E	F,C, P, M	T	P

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	1	0	1	1	1	1	2	2	3	0	1
CO2	2	3	3	2	2	1	2	2	2	3	3	2	1	2
CO3	1	3	3	3	3	3	3	3	2	2	2	2	1	1
CO4	1	1	3	3	3	3	3	3	3	3	3	3	2	2

(0 - Nill, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam

- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK5DSEMAT301				
Course Title	Advanced Python Programming				
Type of Course	DSE				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	3		2	5
Pre-requisites	1. Basic knowledge of mathematics, including algebra and calculus. 2. Familiarity with programming concepts and Python programming language. 3. Some exposure in signal processing concepts.				
Course Summary	This course comprehensively explores computational methods and tools for data analysis and visualization. Students will gain practical skills to tackle real-world challenges by covering modules on SciPy for mathematical problem-solving, signal processing, Pandas for data manipulation, and advanced visualization techniques. Through hands-on exercises and projects, learners will develop proficiency in solving complex problems, analyzing diverse datasets, and creating compelling visualizations to communicate insights effectively.				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Introduction to SciPy**	**15**
	1	SciPy Introduction	
	2	SciPy for solving Linear Algebraic problems	
	3	SciPy differentiation and integration (including numerical integration)	

Module	Unit	Contents	Hrs
	4	Interpolation	
	5	SciPy Clustering- including Vector quantization, k-means, and Hierarchical clustering.	
	Chapter 1: SciPy Introduction, Chapter 3: SciPy for linear algebra, Chapter 4 SciPy for Data Mining (Interpolation, integration and Ordinary differential equations only) Chapter 6 SciPy for Data Mining (Clustering section only), of Text [1]		
II		**SciPy for Signal Processing**	**20**
	6	Discrete Fourier Transforms	
	7	Signal construction	
	8	Filters.	
	Chapter 5: SciPy for Signal Processing of Text [1]		
III		**Pandas data frame and data-frame related operations**	**20**
	9	Reading and writing csv and Excel files	
	10	Exploratory data analysis	
	11	Data preparation and preprocessing.	
	Chapter 1: Empowering data analysis with pandas, Data cleansing, and Data operations of Text [2]		
IV		**Advanced Visualization**	**20**
	12	Controlling the properties of a plot	
	13	Combining multiple plots	
	14	Styling your plots	
	15	Creating various advanced visualizations.	
	Chapter 4: Making Sense of Data through Advanced Visualization of Text [2]		

Textbooks

1. Blanco-Silva, F. J., Learning SciPy for numerical and scientific computing, Packt Pub, 2013

2. Madhavan, S., Mastering python for data science. Packt Publishing Ltd, 2015

References

1. David Beazley, Brian K. Jones, Python Cookbook, O'Reilly, 2013.

2. Wes McKinney, Python for data Analysis, O'Reilly, 2013.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the basics of SciPy	PSO1, PO7	U	F,C	L	P
CO 2	Create useful application programs	PSO5, PO3	Ap,C	P	L	P
CO 3	Create different plots for data visualisations	PSO2, PO7	Ap,An	C	L	P

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1												3	
CO2					3				3					
CO3		3	-	-										

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam (Theory and Practicals)

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3		✓		

University of Kerala

Discipline	Mathematics				
Course Code	UK5DSEMAT302				
Course Title	Special Functions				
Type of Course	DSE				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4 Hours	-	-	4
Pre-requisites	1.Derivatives 2. Integral Calculus 3. Linear Differential Equations				
Course Summary	This course will enable the students to understand the properties of special functions like Legendre Function, Bessel's Function etc.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Beta and Gamma Functions**		**12**
	1	Factorial function, Gamma Function, Recursion relation	
	2	Gamma function of negative numbers, some important formulas involving gamma functions	
	3	Beta functions, Beta functions in terms of Gamma functions	
	Chapter 11: Sections 1, 2, 3, 4, 5, 6, 7 of Text [2]		
II	**Series Solutions of Ordinary Differential Equations**		**18**
	4	Power series method	
	5	Legendre's Equation, Legendre Polynomials	
	6	Frobenius Method, Indicial equation, Indicating the form of solutions, Typical applications	
	Chapter 5: Sections 5.1, 5.3, 5.4 of Text [1]		

Module	Unit	Contents	Hrs
III	**Bessel's Function- I**		**18**
	7	Bessel's Equation, Bessel's Function, Bessel's functions for any $v \geq 0$, General Solution for non-integer v	
	8	Discovery of properties from series	
	Chapter 5: Sections 5.5 of Text [1]		
IV	**Bessel's Function- II**		**12**
	9	Bessel Functions of the second kind	
	10	Sturm-Liouville Problems, Orthogonal Functions	
	Chapter 5: Sections 5.6, 5.7 of Text [1]		

Textbooks

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 9^{th} Edition Wiley, 2014.

2. Mary L Boas, *Mathematical Methods in the Physical Sciences*, 3^{rd} Edition, Wiley, 2006.

References

1. M. D. Raisinghaniya, *Ordinary and Partial Differential Equations*, S Chand 18^{th} Edition, 2008.

2. G. F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata McGraw-Hill, 2003.

Course Outcomes

CO No.	**Upon completion of the course the graduate will be able to**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture(L) Tutorial (T)**	**Practical (P)**
CO 1	Explain the concepts behind Beta Gamma Function, Bessel's Differential Equations and Legendre Differential equations.	PSO1, 2	U, Ap	F,C	L	
CO 2	Interpret the physical significance of Bessel Functions and Legendre polynomials.	PSO 2,3,4	Ap, An	C,P	L	
CO 3	Analyse the properties of special functions	PSO 3,4	An, E	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)

(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	3	3	3	2	2	3	3	2	-	-	1		
CO2	2	3	3	3	2	2	3	3	1	-	-	-		
CO3	1	3	3	3	2	2	3	3	3	-	-	-		

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK5DSEMAT303				
Course Title	Optimization Techniques				
Type of Course	DSE				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4			4
Pre-requisites	Probability Distributions *(Poisson and Exponential)*				
Course Summary	At the end of the course student get the clear ideas of the following, minimizing some measure of performance of a system such as the total completion time for the project, overall cost and so on, how lines form, how they function, and why they malfunction. He can also examines every component of waiting in line, including the arrival process and the number of customers in a waiting line, a systematic procedure in assigning priorities to waiting jobs thereby determining the sequence in which jobs will be processed and decomposing a multistage problem into a sequence of interrelated one-stage problems and hence finding an optimal solution				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Network Scheduling by PERT/CPM**	**15**
	1	Network and Basic Components	
	2	Logical Sequencing	
	3	Rules of Network Construction	

Module	Unit	Contents	Hrs
	4	Critical Path Analysis	
	5	Probability Consideration in PERT	
	Chapter 21: Sections 21.1, 21.2, 21.3, 21.4, 21.5 and 21.6 of Text [1]		
II	**Queueing Theory**		**15**
	6	Queueing system	
	7	Elements of queueing system-characteristics of queueing system	
	8	Probability distributions in queueing system	
	9	Pure Birth death process	
	10	Pure Birth death process	
	11	Poisson queueing system	
	Chapter 20: Sections 20.2,20.3,20.5,20.6 to 21.6 and 20.8 of Text [1]		
III	**Sequencing Problem**		**15**
	12	Problem of Sequencing	
	13	Basic terms	
	14	Processing n jobs through two machines	
	15	Processing 2 jobs through k machines	
	16	Maintenance crew scheduling	
	Chapter 12: Sections 12.2, 12.3, 12.4, 12.5, 12.6 and 12.7 of Text [1]		
IV	**Dynamic Programming**		**15**
	17	Minimum path problem	
	18	Single additive constraint additively separable return	
	19	Single multiplicative constraint additively separable return	
	20	Single additive constraint multiplicatively separable return	
	Chapter 10: Sections 2, 3, 4 and 5 of Text [2]		

Textbooks

1. Manmohan, PK Gupta and Kanti Swarup – Operations research 11^{th} Edition, Sultan Chand & Sons, 2007

2. K V Mital and C Mohan, Optimization methods in Operations research and system analysis 3^{rd} edition, New Age International, 1996.

References

1. Humdy A Taha, Operations Research an Introduction, 10^{th} edition -Pearson, 2021.

2. J K Sharma, Operations Research - Theory and Applications, 6^{th} Edition, 2016.

3. G Srinivasan, Operations Research - Principle and Applications, 2^{nd} Edition, PHI Learning, 2010.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Evaluate project completion time in different Network problems	PSO1, 2	U,E	F,P		
CO 2	Distinguish between various models in Queues	PSO3 ,4	U,An	F,P		
CO 3	To find optimal sequences in various sequencing problems	PSO4	U,E	F,P		
CO 4	Apply Techniques of D.P to solve problems	PSO3	R,An	F,P		

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1			2				2		1				
CO2	2				3	3				2				
CO3		3	-	1							3			
CO4			2				2					3		

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓

University of Kerala

Discipline	Mathematics				
Course Code	UK5DSEMAT304				
Course Title	Difference Equations and Z-Transforms				
Type of Course	DSE				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4			4
Pre-requisites	Sequences, Series and their Limits				
Course Summary	This paper explores the relationship between difference equations and Z transforms, two fundamental concepts in discrete-time signal processing and system analysis. Difference equations are recurrence relations that describe the behavior of discrete-time systems, recurrence relations that describe the behavior of discrete-time systems, while Z transforms provide a powerful tool for analyzing such systems in the frequency domain.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**The Difference Calculus**		**15**
	1	Definitions	
	2	Operators Δ and E	
	3	Elementary Difference Operators	
	Chapter 1: Section 1.2, 1.5, 1.6 of Text		

Module	Unit	Contents	Hrs
II	**Solution of Linear Homogeneous Difference Equations**		**15**
	4	Introduction	
	5	Homogeneous Equations	
	6	Construction of a Difference Equation having Specified Solutions	
	7	Relationship Between Linear Difference and Differential Equations	
	Chapter 4: Section 4.1, 4.2, 4.3, 4.4 of Text		
III	**Inhomogeneous Equations**		**15**
	8	Methods of Undetermined Coefficients	
	9	Operator Methods	
	Chapter 4: Section 4.5, 4.6 of Text		
IV	**Z-transforms**		**15**
	10	Z-transforms Method	
	Chapter 4: Section 4.7 of Text		

Textbook

1. Ronald E Mickens, *Difference Equations, Theory, Applications and Advanced Topics*, Third Edition, CRC Press, New York, 2015.

References

1. S Goldberg, *Introduction to Difference Equations*, Firs, Dover Publications, 1986.

2. V Lakshmikantham, Donato Trigiante, *Theory of Difference Equations: Numerical Methods and Applications*, Second Edition, Marcel Dekker, Inc, New York, 2002.

3. Saber N Elaydi, *An Introduction to Difference Equations*, Third Edition, Springer International Edition, New Delhi, 2008.

4. Sudhir K Pundir, Rimple Pundir, *Difference Equations*, Pragati Prakashan, First Edition, Meerut, 2006.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concept of difference calculus	PSO1, 2, PO1	U	F,C	L	
CO 2	Know to classify difference equations	PSO3, PO2	R, U	E	L	
CO 3	Learn to solve linear difference equations with constant coefficients	PSO4, 5, 6, PO6	Ap	C, P, E	L	
CO 4	Understand the concept of Z-transform	PSO1, 2, PO6	R, U	C, E	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2					2							
CO2			2					2						
CO3				3	3	2						2		
CO4	2	2										2		

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK5SECMAT300				
Course Title	Programming with Python				
Type of Course	SEC				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	3	2	-	2	4
Pre-requisites	Basic computer programming skill				
Course Summary	This course offers basics of python programming				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Introduction to Python**	**10**
	1	Installing Python - Basic Interactive Mode - IDLE - Quick Python Review (Chapter 2,3 of Text 2)	
II		**The Essentials of Python**	**20**
	2	Absolute Basics - Lists, tuples and sets - Strings - Control Flow - Functions - Reading and writing files (Chapter 4,5 (except 5.6, 5.8),6 (except 6.5-6.9),8, 9.1-9.5 (except 9.3) and 13.1-13.4 of Text 2)	
III		**Working with numbers**	**15**
	3	Basic Mathematical Operations - Working with different kinds of numbers - Getting user input - Math Programmes - The Programming challenges mentioned in Chapter 1 of Text 1	

Module	Unit	Contents	Hrs
IV		**Visualising Data with Graphs:**	**15**
	4	Working with Lists and Tuples - Creating Graphs with Matplotlib (Chapter 2 of Text 1 except "Plotting with Formula")	

Textbooks

1. Amit Saha, Doing Math with Python, No Starch Press, 2015.
2. Naomi Ceder, The Quick Python Book, Manning, 2018.

References

1. E Balagurusamy, Introduction to computing and problem solving using Python, Mc Graw Hill Education, 2017.
2. Kenneth A Lambert, Fundamentals of Python, First Programs, 2nd Edition, Cengage, 2019.

E- resources

1. https://www.python.org/

Course Outcomes

CO No.	**Upon completion of the course the graduate will be able to**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture(L) Tutorial (T)**	**Practical (P)**
CO 1	Understand the basics of python programming	PSO1, PO7	U	F,C	L	P
CO 2	Create useful python programs	PSO5, PO3	Ap,C	P	L	P
CO 3	Apply to the subject and get more insight to the mathematical concepts	PSO2	Ap	M	L	P

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1												3	
CO2					3				2					
CO3		3	-	-										

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam (Theory and Practical)

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3		✓		

University of Kerala

<table>
<tr><td>Descipline</td><td colspan="5">Mathematics</td></tr>
<tr><td>Cours Code</td><td colspan="5">UK5SECMAT301</td></tr>
<tr><td>Course Title</td><td colspan="5">Programming with Scilab</td></tr>
<tr><td>Type of Course</td><td colspan="5">SEC</td></tr>
<tr><td>Semester</td><td colspan="5">V</td></tr>
<tr><td>Academic Level</td><td colspan="5">300-399</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours per week</td></tr>
<tr><td>3</td><td>2</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">Basic computer knowledge</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides an introduction to programming in Scilab, focusing on data manipulation, analysis, and visualization.</td></tr>
</table>

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Matrices and Vectors**	**15**
	1	Creating matrices, type of matrices, matrix operations (Section 1.1 to 1.5 of Text [1])	
	2	Vector Algebra: basic vector operations – addition, scalar multiplication, dot product and cross product (Section 1.5 of Text 1)	
	3	Applications: Changing Cartesian to cylindrical and spherical, Orthogonal vectors, center of mass of a system (Sub sections 1.6.1 to 1.6.4 of Text [1])	
II		**Creating plots**	**15**
	4	Formatting the plot: axes, lines and markers, Legend, (Sections 2.1 to 2.6 of Text [1])	
	5	Applications: Trajectory of a projectile, Superposition of collinear harmonic oscillations, Beats (Subsections 2.7.1 to 2.7.3 of Text [1])	

Module	Unit	Contents	Hrs
III	**Least square curve fitting**		**15**
	6	Fitting Linear data (Section 3.2 of Text [1])	
	7	Fitting Non-linear data (Section 3.3 of Text [1])	
	8	The datafit function (Section 3.5 of Text [1])	
	9	Applications: Refractive index and spring constant (Subsections 3.6.1 and 3.6.2 of Text [1])	
IV	**Integration and differentiation**		**15**
	10	The scilab functions *intg* and *integrate*, Trapezoidal rule (Section 5.2 of Text [1])	
	11	Simpson's 1/3 and 3/8 rule (Section 5.4 and 5.5 of Text [1])	
	12	Applications: Integration in cylindrical coordinates (Sub section 5.7.1 of Text [1])	

Textbook

1. Jain, Chetana, Computing in Scilab. Cambridge University Press, 2023.

References

1. Bunks, Carey, Chancelier, J. P., Delebecque, F., Goursat, M., Nikoukhah, R., and Steer, S. Engineering and scientific computing with Scilab. Springer Science & Business Media, 2012.

2. Nagar, Sandeep, and Sandeep Nagar. Introduction to Scilab. Apress, 2017.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the syntax and use of scilab.	PSO2, PSO4 PO7	U	F,C	L	P
CO 2	Create charts and plots using scilab.	PSO2, PSO5	R, U	P	L	P
CO 3	Apply scilab for curve fitting	PSO3 PO6	C	P	L	P
CO 4	Apply scilab for integration and differentiation.	PSO1	A	M	L	P

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1		3		2									3
CO2		3			3								
CO3			3									3	
CO4	3												

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam (Theory and Practical)

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK6DSCMAT300				
Course Title	Real Analysis - II				
Type of Course	DSC				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4 hours			4
Pre-requisites	1. Limits 2. Continuity 3. Differentiation				
Course Summary	This course includes Reimann Integral, Fundamental Theorems, Metric spaces and the concepts Interior, closure and boundary of sets				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Riemann Integral**	**18**
	1	Riemann Integral	
	2	Riemann Integrable Functions	
	3	The Additivity Theorem	
	Chapter 7: Sections 7.1, 7.2 of Text [1]		
II		**The Fundamental Theorem**	**12**
	4	Fundamental Theorem of Calculus (First Form)	
	5	Fundamental Theorem of Calculus (Second Form)	
	6	Lebesgue's Integrability Criterion	
	Chapter 7: Section 7.3 of Text [1]		
III		**Metric Space**	**18**
	7	The Definition and Some Examples	
	8	Open Sets in Metric Spaces	

Module	Unit	Contents	Hrs
	9	Closed Sets in Metric Spaces	
	Chapter 3: Sections 3.1, 3.2 of Text [2]. More examples can be found in Reference Text [4]		
IV	**Interior, Closure and Boundary**		**12**
	10	Interior of a Set	
	11	Closure of a Set	
	12	Boundary of a Set	
	Chapter 3: Sections 3.3 of Text [2]. More examples can be found in Reference Text [4]		

Textbooks

1. R. G. Bartle, Donald R. Sherbert, Introduction to Real Analysis, Fourth Edition, John Wiley & Sons, Inc., 2011

2. Fred H. Croom, Principles of Topology, Dover Publication, 2016

References

1. James R. Munkres, Topology, PHI Learning Private Limited, Second Edition, 2009.

2. K. D. Joshi, Introduction to general topology, New Age International (P) Limited, First Edition, 1983.

3. S. Kumaresan, Topology of Metric Spaces, Alpha Science International Ltd., 2005.

4. W. Rudin, Principles of Mathematical Analysis, Third Edition, McGraw-Hill, 2017.

5. Sheldon W. Davis, Topology, Tata Mc Graw-Hill Edition, 2006.

6. G.F. Simmons, Topology and Modern Analysis, Mc Graw-Hill, New York, 13th reprint, 2010.

7. Stephen Abbot, Understanding Analysis, 2nd Edition, Springer, 2015

8. Terrence Tao, Analysis I, Hindustan Book Agency, 2015.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concept of integrability deeper than what we done in the previous courses.	PO 1,6 PSO 1,2,4,5, 6	R, U, Ap, An, E, C	F, C	L	
CO 2	Get an exposure to the fundamental theorem of calculus.	PO 1,6 PSO 1,4,5	R, U, An	F, C	L	
CO 3	Understand the concept of metric space as an extension of real analysis.	PO 1,6 PSO 1,2,4,5, 6	R, U, Ap, An, E, C	F, C	L	
CO 4	To develop the student's ability to handle abstract ideas of mathematics and mathematical proofs.	PO 1,6 PSO 1,4,5	U, An, C	F, C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3		2	2	1	3					2		
CO2	3			2	1		3					1		
CO3	3	3		3	3	2	3					2		
CO4	3			3	3		3					3		

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓	✓	✓
CO2	✓			✓
CO3	✓	✓	✓	✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK6DSCMAT301				
Course Title	Complex Analysis I				
Type of Course	DSC				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4	0	0	4
Pre-requisites	1. Complex Numbers 2. Differentiation 3. Integration				
Course Summary	This course deals with the study of analytic functions and helps the students to evaluate complex integrals				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Complex numbers, Complex planes and Complex functions**		**14**
	1	Complex numbers, their properties, Complex planes (Chapter 1: Section 1.1, 1.2 of Text [1])	
	2	Polar form of complex numbers, Powers and roots, Set of points in the complex plane (Chapter 1: Section 1.3, 1.4 and 1.5 of Text [1])	
	3	Complex functions, Limits and continuity (Chapter 2: Section 2.1, 2.2 (upto common parametric curves in the complex plane line, line segment, ray and circle), 2.6.1, 2.6.2 – upto bounding property of Text [1]	
II	**Analytic and Harmonic functions**		**14**
	4	Differentiability and analyticity (Chapter 3: Section 3.1)	
	5	Cauchy Riemann Equations (Chapter 3: Section 3.2)	

Module	Unit	Contents	Hrs
	6	Harmonic functions (Chapter 3: Section 3.3)	
III		**Elementary functions**	**12**
	7	Exponential and Logarithmic functions (Chapter 4: Section 4.1), (Exponential mapping, logarithmic mapping and other branches of $\ln z$ are not included)	
	8	Complex powers (Chapter 4: Section 4.2)	
	9	Trigonometric and Hyperbolic functions (Chapter 4: Section 4.3)excluding the subsection trigonometric mapping, analyticity and algebraic properties (mapping is not included)	
IV		**Complex integration**	**20**
	10	Real integrals (Chapter 5: Section 5.1),Complex integrals (Chapter 5: Section 5.2 (excluding the proof theorem 5.3)	
	11	Cauchy Goursat Theorem (5.3 (proof Cauchy's theorem is not included)	
	12	Independence of path (Chapter 5: Section 5.4 upto theorem 5.7 including examples)	
	13	Cauchy's integral formulae and their consequences (Chapter 5: Section 5.5 proof of theorems 5.9, 5.10 are not included)	

Textbook

1. Dennis G Zill, Patric D Shanahan, A First Course in Complex Analysis with Applications, Jones and Bartnett Publishers, 2003.

References

1. Anant R Shastri, *Basic Complex Analysis of One Variable*, Macmillan, 2010.

2. Edward B. Saff, Arthur David Snider, *Fundamentals of Complex Analysis with applications to Engineering and Science*, 3^{rd} Edition, Pearson Education India, 2017.

3. Erwin Kreyszig, *Advanced Engineering Mathematics* 10^{th} Edition, Wiley-India, 2018.

4. James Ward Brown and Ruel V Churchill, *Complex Variables and Applications*, 8^{th} Edition, McGraw Hill International Edition, 2008.

5. John H Mathews and Russel W Howell, *Complex Analysis for Mathematics and Engineering* Sixth Edition, Jones and Bartlett Publishers, 2011.

6. B.S Tyagi, *Functions of a Complex Variable*,Kedar Nath Ram Nath, 2021.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand algebraic operations of complex numbers and complex functions	PSO1, PO1	U,R	C	L	
CO 2	Understand limits, continuity and differentiability of complex functions	PSO1,2, PO1, 2	U,R	C	L	
CO 3	Analyse analytic functions and other elementary functions	PSO 1,2, PO2	U,R, An	P	L	
CO 4	Apply contour integration, Cauchy's theorem and Cauch's Integral formula to calculate integrals	PSO 3, PO2	Ap, E	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1						2							
CO2	2	2					2	2						
CO3	3	3	-	-				2						
CO4			3					2						

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓			✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK6DSCMAT302				
Course Title	Linear Algebra				
Type of Course	DSC				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	1. Matrix operations & its algebraic properties 2. Singular and Non-singular Matrices 3. Matrix inverses and their properties				
Course Summary	The primary purpose of this course is to explore the concepts of vector spaces, linear transformation on vector spaces and the relationship between linear transformation and matrices.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Vector Space Properties of $\mathbb{R}^n$**	**15**
	1	Vector space properties of $\mathbb{R}^n$ and examples of subspaces	
	2	Bases for Subspaces and dimension	
	3	Orthogonal Bases for Subspaces.	
		The topics to be discussed in the module can be found in Chapter 3: Sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 of Text [2]	
II		**Eigenvalues and Eigenvectors**	**15**
	4	The Eigenvalue Problem for matrices, Determinants and the Eigenvalue	
	5	Eigenvalues and the Characteristic Polynomial, Eigenvectors and Eigenspaces	

Module	Unit	Contents	Hrs
	6	Complex Eigenvalues and Eigenvectors	
	7	Similarity Transformations and Diagonalization.	
	The topics to be discussed in the module can be found in Chapter 4: Sections 4.1, 4.2, 4.4, 4.5, 4.6, 4.7 of Text [2]		
III	**Linear Transformation**		**15**
	8	Linear Transformations from $\mathbb{R}^n$ to $\mathbb{R}^m$	
	9	Operations with Linear Transformations	
	10	Matrix Representations for Linear Transformations, Change of Basis.	
	The topics to be discussed in the module can be found in Chapter 3: Section 3.7 and Chapter 5: Sections 5.7, 5.8, 5.9, 5.10 of Text [2]		
IV	**Generalised Vector Spaces**		**15**
	11	Definition and Examples, Subspaces	
	12	Bases and Dimension, Co-ordinates.	
	The topics to be discussed in the module can be found in Chapter 2: Sections 2.1, 2.2, 2.3, 2.4 Text [1]		

Textbooks

1. K. Hoffman & R. Kunze, Linear Algebra, Second Edition, Pearson Education, 2005.
2. Lee W. Johnson et.al., Introduction to Linear Algebra, 5th Edition, Addition Wesley, 2001.

References

1. T S Blyth, E F Robertson, Linear Algebra, Springer, Second edition, 2013.
2. David C. Lay, Linear Algebra, Addison Wesley, 2012.
3. Gilbert Strang, Introduction to Linear Algebra, Fifth edition, Pearson, 2005
4. Seymour Lipschutz, Marc Lars Lipson, Linear Algebra, Schaums outlines, McGraw Hill, 2018.
5. Thamban Nair, Arindama Singh, Linear Algebra, Springer, 2018.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understand the concepts of vector spaces, subspaces and their properties	PSO1, 2, PO1, 2	U	F,C	L, T	As
CO 2	Realise the concepts of eigenvalues, eigenvectors and diagonalization of matrices	PSO2, 3, PO1, 2, 3	R, U	C, P	L, T	As
CO 3	Create a comprehensive idea about linear transformation on finite dimensional vector spaces and its matrix representation	PSO2, 3, PO1, 2, 3	An, E	C, P	L, T	As
CO 4	Develop a concrete idea about generalised vector spaces, subspaces and its properties	PSO2, 3, PO1	Ap, An	C, P	L, T	As
CO 5	Apply the knowledge to many fields in engineering, statistics, computer science, etc.	PSO4, 5, 6 PO2	Ap	M		As

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2					2	1						
CO2		2	2				2	1	1					
CO3		2	3				2	2	2					
CO4		2	2				2	1						
CO5				3	2	2		2						

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		

University of Kerala

Descipline	Mathematics				
Cours Code	UK6DSEMAT300				
Course Title	Advanced Linear Programming				
Type of Course	DSE				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4			4
Pre-requisites	Linear Programming Problems				
Course Summary	At the end of the course student get a clear picture of following: assign a dual variable for each primal constraint, construct a dual constraint for each primal variable, finding the solution of the primal from the dual,locate a basic feasible solution of a transportation problem by various methods and a minimum transportation schedule by MODI method, determine the optimal solutions of assignment problems using the Hungarian method; , types of game theory, Mathematics required for solving game theory, Techniques of solving for different types of games.				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Duality in Linear Programming**	**15**
	1	Formulation of dual linear programming problem	
	2	Standard Results on Duality	
	3	Advantages of Duality	
	Chapter 5: Sections 5.1,5.2 and 5.5 of Text [1]		
II		**Transportation Problem**	**15**
	4	Mathematical Model of Transportation Problem	
	5	Transportation Problem Algorithm	

Module	Unit	Contents	Hrs
	6	Methods of finding initial solution	
	7	Test for optimality	
	Chapter 9: Sections 9.2,9.3,9.4 and 9.5 of Text [1]		
III	**Assignment Problem**		**15**
	8	Mathematical Model of Assignment Problem	
	9	Solution methods of Assignment problem	
	10	Travelling salesman problem	
	Chapter 10: Sections 10.2,10.3 and 10.6 of Text [1]		
IV	**Theory of Games**		**15**
	11	Introduction	
	12	Two person zero sum games	
	13	Games with saddle points	
	14	Games without saddle points	
	15	Rules of dominance	
	16	Solution methods of Games without saddle points (algebraic method, arithmetic method, matrix method, graphical method)	
	Chapter 12: Sections 12.1, 12.2, 12.3, 12.4, 12.5 and 12.6 of Text [1]		

Textbook

1. J K Sharma, Operations Research, Theory and Applications, Sixth Edition, 2016

References

1. Hamdy A Taha, Operations Research an Introduction, Tenth edition, Pearson, 2021.

2. Kanti Swarup, P.K.Gupta, Man Mohan, Operations Research, Sultan Chand and Sons, 2005.

3. G Srinivasan, Operations Research Principle and Applications, Second Edition, PHI Learning, 2010.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understant concepts in various Mathematical modelling	PSO1, 2, PO2	U	F,C		
CO 2	Apply techniques in transportation model to solve problems	PSO3, PO2, 6	R, Ap	F,P		
CO 3	Distinguish between transportation model and Assignment model	PSO4, PO3	U,An,	F,P		
CO 4	To find solutions of problems in Game theory	PSO3, PO3, 5	Ap,E	F,P		

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1							2						
CO2	2		3	2		1		1				2		
CO3		3	2	3							3			
CO4									2		2			

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			
CO2	✓			✓
CO3	✓			
CO4	✓			

University of Kerala

Discipline	Mathematics				
Course Code	UK6DSEMAT301				
Course Title	Partial Differential Equations				
Type of Course	DSE				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4 Hours	-	-	4
Pre-requisites	1. Differential Calculus 2. Integral Calculus 3. Differential equations				
Course Summary	This course will introduce the fundamental concepts of PDE and different techniques for solving these PDE's.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Partial Differential Equations of First Order**	**12**
	1	Formation of Partial Differential Equations, Solutions of a PDE	
	2	Equations solvable by direct integration, Linear Equations of first order	
	Chapter 17: 17.1, 17.2, 17.3, 17.4, 17.5 of Text [1]		
II		**Non-Linear Partial Differential Equations**	**12**
	3	Non-linear Equations of first order	
	4	Charpit's Method	
	Chapter 17: 17.6, 17.7 of Text [1]		
III		**Homogeneous and Non Homogeneous PDE**	**24**
	5	Homogeneous Linear Equations with constant coefficient.	
	6	Rules for finding complementary function	

Module	**Unit**	**Contents**	Hrs
	7	Rules for finding particular integral, working procedure to solve the equation	
	8	Non Homogeneous Linear Equations, Non- Linear Equations of Second order.	
	Chapter 17: 17.8, 17.9, 17.10, 17.11, 17.12, 17.13 of Text [1]		
IV		**Application of PDE**	**12**
	9	Method of separation of Variables	
	10	Vibration of a Stretched String - Wave Equation	
	11	One Dimensional Heat Flow	
	Chapter 18: 18.1, 18.2, 18.4 of Text [1]		

Textbook

1. B. S. Grewal, *Higher Engineering Mathematics*, 42^{nd} Edition, Khanna Publishers, 2012.

References

1. Ian Sneddon, Elements of Partial Differential Equations ,Mc Graw- Hill, 2013.
2. Phoolan Prasad, Renuka Raveendran: *Partial Differential Equations*, Wiley Eastern, 1985.
3. M. D. Raisinghaniya, *Ordinary and Partial Differential Equations*, S Chand 18^{th} Edition, 2008.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Solve PDE using different solution techniques	PSO1, 2, PO1, 2, 3, 6	U, Ap	P	L	
CO 2	Develop a mathematical model using Partial Differential Equations	PSO 3,4, PO1, 2, 3, 4, 6	E, C	P	L	
CO 3	Utilize the boundary condition to reflect real world constraint in the modelled system.	PSO 3, 4, PO1, 2, 3, 6	U, E, C	C, P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	3	3	3	3	3	3	1	-	-	1		
CO2	3	3	3	3	3	3	3	3	3	2	-	1		
CO3	3	3	3	3	3	3	3	3	3	-	-	2		

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam

- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK6DSEMAT302				
Course Title	Stochastic Processes				
Type of Course	DSE				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	1. Probability distributions 2. Matrix algebra				
Course Summary	This course on stochastic processes provides students with a deep understanding of randomness and its applications in various fields, equipping them with valuable tools for analyzing and modeling uncertain systems.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Probability and Stochastic process**	**15**
	1	Definition of Stochastic Processes, specification of Stochastic processes	
	2	Stationary processes, Markov Chains: definition and examples, higher transition probabilities,	
	3	Generalization of Independent Bernoulli trails, classification of states and chains.	
	Chapter 2: Sections 2.1, 2.2, 2.3, Chapter 3: Sections 3.1, 3.2, 3.3, 3.4 of Text [1]		
II		**Markov Processes with Discrete State Space:**	**15**
	4	Poisson process, Poisson process and related distributions	
	5	Properties of Poisson process, Generalizations of Poisson Processes	

Module	Unit	Contents	Hrs
	6	Birth and death processes, Continuous time Markov Chains.	
	Chapter 4: Sections 4.1, 4.2, 4.3, 4.4, 4.5 of Text [1]		
III	**Markov Processes with continuous state space:**		**15**
	7	Brownian motion Wiener Process	
	8	Differential equations for a Wiener process, Kolmogorov equations first passage time distribution for Wiener process,	
	9	Ornstein-Uhlenbech process.	
	Chapter 5: Sections 5.1, 5.2, 5.3, 5.4, 5.5, 5.6 of Text [1]		
IV	**Stochastic process in queueing and reliability**		**15**
	10	Queueing Process,Notations, Steady state distribution	
	11	Littles formula, M/M/1 queueing model and steady state solution	
	12	Waiting time distribution, Queue with limited waiting space.	
	Chapter 10: Sections 10.1, 10.2, 10.3 of Text [1]		

Textbook

1. Jyotiprasad Medhi, Stochastic Processes, New Age International, 1994.

References

1. Erhan Cinlar, Introduction to Stochastic Processess, Dover Publications, Inc, 2013.
2. Robert G. Gallager, Stochastic Processess, Cambridge University Press, 2013.
3. Sheldon Ross, Introduction to Probability Models, Cambridge University Press, 2003.
4. Sheldon Ross, Stochastic Processess, John Wiely, 1996.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the basic definitions of stochastic process	PSO1	U	F,C	L	P
CO 2	Understand the basics of queueing theory	PSO1, PO1	U	F, C	L	P
CO 3	Modelling a real life situation as a queueing model	PSO2, 3, PO1, 2	Ap	P	L	P
CO 4	Solving a queueing model	PSO3, PO2	Ap, An	P	L	P

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	3												
CO2	2	3					2							
CO3		3	3	-			3	3						
CO4			3					3						

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓			✓
CO3	✓	✓	✓	✓
CO4	✓	✓	✓	✓

University of Kerala

Descipline	Mathematics				
Cours Code	UK6DSEMAT303				
Course Title	Foundations of Computational Mathematics with SageMath				
Type of Course	DSE				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	3		2	5
Pre-requisites	Basic knowledge of algebra, calculus, and basic programming concepts, Familiarity with mathematical topics like matrices, derivatives, integrals, and number theory, Basic knowledge of programming fundamentals such as variables, loops, and control structures.				
Course Summary	This course provides a comprehensive introduction to computational mathematics using SageMath, covering topics ranging from basic arithmetic operations to advanced calculus, matrix algebra, and programming techniques. Students will learn to leverage the power of computational tools for mathematical exploration, problem-solving, and visualization, equipping them with essential skills for mathematical analysis in various fields.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Introduction to SageMath Cloud, Calculations and Visualization**		**15**
	1	Starting SageMath using a browser, how to use the sage cell server https://sagecell. sagemath.org/, how to use SageMathCloud, creating and saving a sage worksheet, saving the worksheet, moving it and re-opening it in another computer system;	

Module	Unit	Contents	Hrs
	2	Using SageMath as a calculator, basic functions (square root, logarithm, numeric value, exponential, trigonometric, conversion between degrees and radians, etc.), integrating functions, definite and indefinite integrals	
	3	Plotting: simple plots of known functions, controlling range of plots, controlling axes, labels, gridlines, drawing multiple plots on a single picture, adding plots, polar plotting, plotting implicit functions, contour plots, level sets, parametric 2D plotting, vector fields plotting, gradients;	
	Unit 1: The SageMathCloud, https://cloud.sagemath.com/ Unit 2: Chapter 1 of Text [1] (excluding section 1.5) Unit 3: Chapter 3 of Text [1]		
II		**Matrix algebra and solving polynomial equations**	**20**
	4	Matrix Algebra: Adding, multiplying two matrices, row reduced echelon forms to solve linear system of equations, finding inverses of square matrices, determinants, exponentiation of matrices, computing the kernel of a matrix.	
	5	Defining own functions and using it, composing functions, multivariate functions; Polynomials: Defining polynomials, operations on them like multiplication and division, expanding a product, factorizing a polynomial, finding gcd.	
	6	Solving single-variable equations, Bisection Method, Newton–Raphson's Method, FixedPoint Iteration.	
	Unit 4: Chapter 1, section 1.5, Chapter 4. sections 4.4 and 4.16 Unit 5: Chapter 1.6, 1.7, 1.8, 1.9, Chapter 4, section 4.1. Unit 6: Chapter 2 section 2.1, 2.2 and 2.4 of Text [2]		
III		**Numerical Differentiation and Integration**	**20**
	7	Numerical Differentiation-Derivative Formulae Using Taylor Series	
	8	Numerical Integration-Trapezoidal Rule, Simpson's Rule	
	Unit 7: Chapter 4 of Text 2 Unit 8: Chapter 5 section 5.1, 5.2 of Text [2]		
IV		**Introduction to Programming in Sage**	**20**
	9	Repetition without Boredom: The for Loop	
	10	Writing Subroutines	
	11	Styling your plots	
	12	Loops and Newton's Method	
	13	An Introduction to Control Flow	
	14	while Loops versus for Loops	
	Chapter 5 of Text [1]		

Textbooks

1. The SageMathCloud, https://cloud.sagemath.com/

2. Bard, G. V., Sage for undergraduates (Vol. 87). American Mathematical Soc., 2015

References

1. Anastassiou, G. A., Mezei, R. A. Numerical analysis using sage, Springer, 2015.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Solve both definite and indefinite integrals efficiently.	PSO1, 2, PO1	U, E	L	C	P
CO 2	Evaluate various plotting methods in SageMath for effective data visualization and analysis.	PSO5, 6, PO1, 3	U	L	C	P
CO 3	Analyse matrix algebra operations such as addition, multiplication, and inversion for solving linear equations.	PSO2, 3, PO3	Ap, E	L	P	P
CO 4	Compare and contrast different numerical methods for solving mathematical problems, such as polynomial equations and differential equations.	PSO1, 2, 5, PO5, 6	E, Ap, An	L	P	P
CO 5	Develop proficiency in programming with SageMath by writing loops, control flow statements, and implementing numerical algorithms.	PSO1, 2, 5, PO5, 6	E, Ap, An	L	P	P
CO 6	Apply numerical differentiation techniques, such as Taylor Series expansions, for approximating derivatives in mathematical calculations.	PSO1, 2, 5, PO5, 6	E, Ap, An	L	P	P

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	3	-	3	-	-	2	-	-	-	-	-	-	
CO2	3	3	-	2	-	-	2	-	2	-	-	-	-	
CO3	-	-	3	-	-	-	-	-	2	-	-	-	-	
CO4	3	3	-	-	2	-	-	-	-	-	2	-	-	
CO5	3	3	-	-	2	-	-	-	-	-	2	-	-	
CO6	3	3	-	-	2	-	-	-	-	-	2	-	-	

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam (Theory and Practical)

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓	✓	✓
CO3	✓	✓	✓	✓
CO4	✓	✓	✓	✓
CO5	✓	✓		✓
CO6	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK6DSEMAT304				
Course Title	Integral Transforms				
Type of Course	DSE				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4 Hours	-	-	4
Pre-requisites	Integral Calculus				
Course Summary	This course will equip with knowledge and techniques to utilize the Laplace transform and Fourier Analysis for solving various problems.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Laplace Transform**		**18**
	1	Definition, Transforms of Elementary function	
	2	Properties of Laplace Transform, Transform of Periodic Functions	
	3	Transforms of Derivatives, Transforms of Integrals, Multiplication by t^n, Division by t	
	4	Evaluation of Integrals by Laplace Transform.	
	Chapter 21: Section 21.2, 21.3, 21.4, 21.5, 21.7, 21.8, 21.9, 21.10, 21.11 of Text [1]		
II	**Inverse Laplace Transform**		**12**
	5	Method of Partial Fractions, Other Methods of finding Inverse transforms, Convolution Theorem	
	6	Application to Differential Equation	

Module	Unit	Contents	Hrs
	7	Unit Step Function, Unit Impulse Function.	
	Chapter 21: Sections 21.12, 21.13, 21.14, 21.15, 21.17, 21.18 of Text [1]		
III	**Fourier Series**		**12**
	8	Basic Examples, Derivation of Euler Formulas, Convergence and Sum of a Fourier Series	
	9	Arbitrary Period, Even and Odd Functions, Half Range expansions from period 2π to any period $P = 2L$	
	10	Simplifications, Even and Odd functions, half range expansions.	
	Chapter 11: Sections 11.1, 11.2, 11.3 of Text [2]		
IV	**Fourier Integral and Transform**		**18**
	11	Fourier Integral, From Fourier series to Fourier Integral	
	12	Applications of Fourier Integrals, Fourier Cosine Integral and Fourier Sine Integral	
	13	Fourier Cosine and sine transforms, Linearity, Transforms of Derivatives,	
	14	Fourier Transform, Complex form of Fourier integral, Fourier transform and its inverse, linearity, Fourier transform of derivatives, convolution.	
	Chapter 11: Sections 11.7, 11.8, 11.9(excluding Physical interpretation of spectrum, DFT and FFT) of Text [2]		

Textbooks

1. B. S. Grewal, *Higher Engineering Mathematics*, 42^{nd} Edition, Khanna Publishers, 2012

2. E. Kreyszig, *Advanced Engineering Mathematics*, 10^{th} Edition Wiley, 2018.

References

1. M Greenberg, *Advanced Engineering Mathematics*, 2^{nd} Edition, Prentice Hall, 1998.

2. Peter. V. O Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand integral transforms and distinguish between different types of integral transforms, including Fourier transforms, Laplace transforms	PSO1, 2	U, Ap	F,C	L	
CO 2	Solve differential equation using Laplace Transform	PSO 2,3	Ap, An	C,P	L	
CO 3	Analyse the properties of certain functions using Fourier Series	PSO 2,3	An, E	P	L	
CO 4	Equip students with a valuable mathematical tool that can be applied to analyze and solve problems arising in engineering, science and other disciplines	PSO 3,4	An, E	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2	3	2	1	-	-	1
CO2	2	2	3	3	2	2	3	3	1	-	-	1
CO3	3	3	3	3	3	3	3	3	3	1	1	3
CO4	2	2	3	3	3	3	3	3	3	3	3	3

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments

- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK6DSEMAT305				
Course Title	Fuzzy Mathematics				
Type of Course	DSE				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	Sets, Operations and Functions				
Course Summary	This course will introduce the fundamental concepts of fuzzy set theory, fuzzy logic, fuzzy arithmetic and fuzzy relations. Through this course students will be able to apply these concepts to model real-world problems where there is inherent uncertainty in data or decision making.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Fuzzy sets**		**15**
	1	Crisp Sets and Fuzzy sets	
	2	α cuts and properties	
	3	Representation of Fuzzy sets.	
	Chapter 1: Sections 1.1, 1.2, 1.3, 1.4, Chapter 2: Sections 2.1 and 2.2 of Text [1]		
II	**Operations on Fuzzy sets**		**15**
	4	Fuzzy complement	
	5	Fuzzy intersection	
	6	Fuzzy Union	

Module	Unit	Contents	Hrs
	Chapter 3: Sections 3.1, 3.2, 3.3, 3.4 of Text [1]		
III	**Fuzzy Arithmetic**		**15**
	7	Fuzzy Numbers	
	8	Linguistic variables	
	9	Arithmetic Operations on Intervals	
	10	Arithmetic Operations on Fuzzy Numbers	
	Chapter 4: Sections 4.1, 4.2, 4.3, 4.4 of Text [1]		
IV	**Fuzzy Relations**		**15**
	11	Crisp and Fuzzy Relations	
	12	Projections and Cylindric Extensions	
	13	Binary Fuzzy Relations	
	14	Fuzzy Equivalence Relations	
	Chapter 5: Sections 5.1, 5.2, 5.3, 5.4, 5.5 of Text [1]		

Textbook

1. George J Klir and Yuan: Fuzzy sets and fuzzy logic: Theory and applications, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.

References

1. Dubois D and Prade H: Fuzzy Sets and Systems: Theory and Applications, Ac.Press, NY, 1988.

2. Klir G J and T Folger: Fuzzy sets, Uncertainty and Information, PHI Pvt.Ltd., New Delhi, 1998

3. H J Zimmerman: Fuzzy Set Theory and its Applications, Allied Publishers, 1996.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the basic concepts of fuzzy set theory and fuzzy logic.	PSO1 PSO2	R,U	F,C	L	
CO 2	Apply membership functions to represent uncertainty in data.	PSO2 PSO3	U,Ap	F, C	L	
CO 3	Apply fuzzy arithmetic techniques to solve problems with imprecise data.	PSO2 PSO3	U,Ap	F, C	L	
CO 4	Analyze real-world scenarios where fuzzy mathematics can be beneficial.	PSO2 PSO4 PSO5	U, An, C,E	C, M	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	3	-	-	-	-	-	-	-	-			-
CO3	-	3	3	-	-	-	-	-	-	-	-			-
CO4	-	3	-	3	2	-	-	-	-	-	-			-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK6SECMAT300				
Course Title	Programming with R				
Type of Course	SEC				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	3	2	0	2	4
Pre-requisites	Basic Programming skill				
Course Summary	This course provides an introduction to programming in R, focusing on data manipulation, analysis, and visualization. Students will learn how to write R scripts, understand basic data structures like vectors, lists, and data frames, and perform data analysis, graphical data representation and solve some statistical problems.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Introduction to R**	**15**
	1	Basic arithmetic operations, and data types such as vectors, matrices, data frames etc (Chapter2: Section 2.1 and 2.2 of Text [1])	
	2	Built-in functions, logical vectors and relational operations (Chapter2: Section 2.3 and 2.4 or Text [1])	
	3	Data input and output, dump() and source(), saving and retrieving image files, Data frames and read.table function and lists (Chapter2: Sections 2.5 of Text [1])	

Module	Unit	Contents	Hrs
II	**Creating charts and plots**		**15**
	4	Creating bar, dot chars, pie chars, histograms, box plots, scatter plots and QQ plots (Chapter3: Section 3.1 of Text [1])	
III	**Control statements**		**15**
	5	Control statements and loops, repeat, break and next statements (Chapter4: Section 4.1 of Text [1])	
IV	**Simulation of random numbers**		**15**
	6	Monte Carlo simulation, Generation of psudorandom numbers (Chapter5: Section 5.1 and 5.2 of Text [1])	
	7	Generation of Bernoulli, Binomial, Poisson, Exponential and Normal random variables (Chapter5: Section 5.3 or Text [1])	
	8	Monte Carlo integration (Chapter5: Section 5.4) of Text [1]	

Textbook

1. Braun, W. John, and Duncan J. Murdoch. A first course in statistical programming with R. Cambridge University Press, 2021.

References

1. Cotton, Richard, *Learning R: A step-by-step function guide to data analysis*, O'Reilly Media, Inc., 2013.

2. Matloff, Norman, *The art of R programming: A tour of statistical software design*. No Starch Press, 2011.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the syntax and use of R.	PSO2, PSO4 PO7	U	F,C	L	P
CO 2	Create charts and plots using R.	PSO2, PSO5	R, U	P	L	P
CO 3	Write complex R programs using control statements.	PSO3 PO6	C	P	L	P
CO 4	Apply Monte Carlo method for integration.	PSO1	A	M	L	P

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		3		2									3	
CO2		3			3									
CO3			3									3		
CO4	3													

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓	✓	✓
CO2	✓	✓	✓	✓
CO3	✓	✓	✓	✓
CO4	✓	✓	✓	✓

University of Kerala

Discipline	Mathematics
Course Code	UK7DSCMAT400
Course Title	Topology
Type of Course	DSC
Semester	VII
Academic Level	400-499

Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4

Pre-requisites	Metric Space : Definition and examples
Course Summary	This course provides important concepts in metric spaces and point set topology. We begin the course by continuous functions on metric spaces. Then we introduce the concept of topological spaces and its properties. Also the topological properties such as connectedness, compactness and related concepts are also discussed.

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Continuous Functions & Metric Spaces**		**15**
	1	Continuous Functions	
	2	Equivalence of metric spaces	
	3	Complete metric spaces.	
	The topics to be discussed in the module can be found in Chapter 3: Section 3.4, 3.5, 3.7, $C(X, \mathbb{R})$ is a complete metric space and Cantor's Intersection Theorem		
II	**Topological Spaces**		**20**
	4	Definition and examples	
	5	Interior, Closure and Boundary	
	6	Basis and sub-basis	
	7	Continuity and topological equivalence, Subspaces.	

Module	Unit	Contents	Hrs
	The topics to be discussed in the module can be found in Chapter 4: Section 4.1, 4.2 (Theorem 4.5 Statement only), Section 4.3, Section 4.4 (Theorem 4.11 Statement only), Section 4.5 (Theorem 4.16 Statement only, Example 4.5.4 need not be discussed)		
III		**Connectedness**	**12**
	8	Connected and disconnected spaces	
	9	Connected subsets of the real line	
	10	Applications of Connectedness.	
	The topics to be discussed in the module can be found in Chapter 5: Section 5.1, 5.2 (Theorem 5.2 ,5.3 proof is not required), 5.3, 5.4		
IV		**Compactness**	**13**
	11	Compact spaces and subspaces	
	12	Compactness and continuity	
	13	Properties related to compactness.	
	The topics to be discussed in the module can be found in Chapter 6: Section 6.1, 6.2, 6.3 (the proof of the first Lemma in this section is not required) The topics in Section 6.3 will be covered upto Example 6.31		

Textbook

1. Fred. H. Croom, Principles of Topology, Dover Publications, 2002

References

1. K D Joshi, Introduction To General Topology, New Age Publishers, 2017.
2. S Lipschutz, General Topology, Tata Mc Graw Hill, 1998.
3. J Munkers, Topology: A First Course, PHI, 2002.
4. G F Simmons, Introduction to Topology and Modern Analysis, 8^{th} Edition, Mc Graw Hill, 1983.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understand the concepts of continuous functions on metric spaces, topological equivalence, complete metrics spaces	PSO1, 2, PO1, 3	U	F,C	L, T	As
CO 2	Realise the structure of topological spaces using continuous functions and homeomorphisms	PSO2, 3, PO1, 3	U, Ap	C, P	L, T	As
CO 3	Develop the concepts of connectedness and related properties	PSO1, 2 , PO1, 3	U, An	F, C	L, T	As
CO 4	Realise the concepts of compactness and related properties	PSO1, 2 , PO1, 3	U, An	F, C	L, T	As
CO 5	Enable the students to apply the knowledge of topology to solve real world problems	PSO4, 5, 6 , PO3, 4	C	M		As

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	1				2		1					
CO2	2	2	1				2		2					
CO3	2	2	1				2		1					
CO4	2	2	1				2		1					
CO5	3	3	3	3	2	2			3	2				

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	

University of Kerala

Discipline	Mathematics				
Course Code	UK7DSCMAT401				
Course Title	Complex Analysis - II				
Type of Course	DSC				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4	-	-	4
Pre-requisites	1. Analytic Functions 2. Integration				
Course Summary	The course deals with the study of power series, conformal mapping and helps the student to evaluate certain real and improper integrals				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Power Series**	**16**
	1	Sequences and series	
	2	Taylor Series	
	3	Laurent Series	
	4	Zeroes and poles	
	Chapter 6: Sections 6.1, 6.2, 6.3, 6.4 of Text [1]		
II		**Residues and Residue Theorem**	**16**
	5	Residues	
	6	Cauchy's Residue Theorem	
	7	Argument Principle and Rouche's theorem	
	Chapter 6: Sections 6.5, 6.6 (subsection 6.6.4) of Text [1]		
III		**Evaluation of Real Integrals**	**16**
	8	Evaluation of Real Trigonometric Integrals	

Module	Unit	Contents	Hrs
	9	Evaluation of Real Improper Integrals	
	Chapter 6: Section 6.6(subsections 6.6.1, 6.6.2) of Text [1]		
IV	**Conformal Mapping and Linear fractional Transformation**		**12**
	10	Conformal mapping , Mapping $z^2, z^n, z+\frac{1}{z}, e^z$	
	11	Linear fractional transformation	
	12	Special linear fractional transformation	
	Chapter 17: Sections 17.1, 17.2, 17.3 of Text [2]		

Textbooks

1. Dennis G Zill, Patric D Shanahan, *A First Course in Complex Analysis with Applications*, Jones and Bartnett Publishers, 2003.

2. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10^{th} edition, Wiley-India, 2011.

References

1. Anant R Shastri, *Basic Complex Variables of One Variable*, Macmillan, 2010.

2. Edward B.Saff, Arthur David Snider, *Fundamentals of Complex Analysis with applications to Engineering and Science*, 3^{rd} Edition,Pearson Education India, 2017.

3. James Ward Brown and Ruel V Churchill,*Complex Variables and Applications*, 8^{th} Edition, McGraw Hill International Edition, 2013.

4. John H Mathews and Russel W Howell,*Complex Analysis for Mathematics and Engineering* Sixth Edition, Jones and Bartlett Publishers, 2012.

5. B.S Tyagi, *Functions of a Complex Variable*,Kedar Nath Ram Nath, 2021.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand sequence, series and represent a given complex function as a power series	PSO1, 2, PO1	U, Ap	F,C	L	
CO 2	Understand the concept of residue and evaluate integrals along the given contour using Residue theorem	PSO1, 2, PO2	U,R,Ap	F,C	L	
CO 3	Evaluate real integrals	PSO 2, PO2	Ap	F,C	L	
CO 4	Understand conformal mapping and linear fractional transformation	PSO1, 3, PO1	U,Ap	F,C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3					2							
CO2	3	3						3						
CO3		3	-	-				3						
CO4			2				2							

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			
CO2	✓			✓
CO3	✓			
CO4	✓			

University of Kerala

Descipline	Mathematics				
Cours Code	UK7DSEMAT400				
Course Title	Advanced Graph Theory				
Type of Course	DSE				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4	-	-	4
Pre-requisites	Basic of concepts in Graph Theory				
Course Summary	This course is intended to prepare the students for more advanced level leading to research in Graph Theory				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Vertex Coloring**	**16**
	1	Chromatic Number	
	2	Brook's Theorem	
	3	Hajo's Conjecture	
	4	Chromatic Polynomial	
	Chapter 8: Sections 8.1, 8.2, 8.3, 8.4 of Text [1]		
II		**Planar Graphs**	**16**
	5	Plane and Planar Graphs	
	6	9Dual Graphs	
	7	Euler's Formula	
	8	Bridges	
	9	Kuratowski's Theorem (Statement Only)	

Module	Unit	Contents	Hrs
	Chapter 9: Sections 9.1, 9.2, 9.3, 9.4, 9.5 of Text [1]		
III	**Directed Graphs**		**16**
	10	Directed Graph	
	11	Directed Path	
	12	Directed Cycles	
	13	Applications - Job Scheduling Problem	
	Chapter 10: Sections 10.1, 10.2, 10.3, 10.4 of text [1]		
IV	**Networks**		**12**
	14	Flows	
	15	Cuts	
	16	The Max - Flow Min - Cut Theorem	
	Chapter 11: Sections 11.1, 11.2, 11.3 of Text [1]		
	Using suitable software familiarize the students with the concepts studied in this course		

Textbook

1. J. A. Bondy and U. S. R. Murty, Graph Theory with Applications, London, McMillan Press, 1976.

References

1. V. K. Balakrishnan, Schaum's Outline of Graph Theory, McGraw Hill, 1997.
2. Douglas Brent West, Introduction to Graph Theory, Pearson, 2018.
3. John Clark, Derek Allan Holton, A First Look at Graph Theory, World Scientific, 1995.
4. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Dover Publications Inc. Mineola, New York, 2017.
5. Reinhard Diestel, Graph Theory, 5th edition, Springer-Verlag, 2017.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Students get motivated to study the concept of trees, connectivity, matching and edge coloring	PSO1, 2, PO1, 2, 3, 4, 5, 6, 7, 8	R,U	F,C	L	
CO 2	Students develop basic understanding of the concept of trees, connectivity, matching and edge coloring	PSO 1, 2, 3, PO1, 2, 3, 4, 5, 6, 7, 8	R,U	F,C	L, T	
CO 3	Students develop skill in solving various problems containing the concept of trees, connectivity, matching and edge coloring	PSO 3, 4, 5, PO1, 2, 3, 4, 5, 6, 7, 8	Ap, An, E	F,C, P, M	T	
CO 4	Students apply the acquired knowledge and skills in new situations	PSO 3, 4, 5, 6, PO1, 2, 3, 4, 5, 6, 7, 8	Ap, An, E	F,C, P, M	T	P

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2			0		1	1	1	2	2	3	0	1
CO2	2	3	3				2	2	2	3	3	2	1	2
CO3			3	3	3		3	3	2	2	2	2	1	1
CO4				3	3	3	3	3	3	3	3	3	2	2

(0 - Nill, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓	✓	✓
CO4	✓	✓	✓	✓

University of Kerala

<table>
<tr><td>Discipline</td><td colspan="5">Mathematics</td></tr>
<tr><td>Course Code</td><td colspan="5">UK7DSEMAT401</td></tr>
<tr><td>Course Title</td><td colspan="5">Functional Analysis</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSE</td></tr>
<tr><td>Semester</td><td colspan="5">VII</td></tr>
<tr><td>Academic Level</td><td colspan="5">400-499</td></tr>
<tr><td>Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical</td><td>Total Hours per week</td></tr>
<tr><td></td><td>4</td><td>4</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">A quick review on : Metric spaces and continuous functions</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course explores the interplay between algebraic structures and distance structures. Students will gain a comprehensive idea on Banach and Hilbert spaces and bounded operators on them.</td></tr>
</table>

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Normed Spaces and continuous linear map**	**15**
	1	Normed space, examples, finite dimensional normed spaces, subspaces, quotient space, Riesz lemma	
	2	Continuity of linear maps, bounded linear maps on normed spaces.	
		The topics to be discussed in this module can be found in Chapter II : Section 5(All results in Section 5 except 5.1(c), 5.1(d) and Section 6(6.1, 6.2, 6.3, 6.4, 6.5(a), 6.5(b), 6.6, 6.7(a)) of Text [1]	
	3	Examples of continuous linear maps.	
II		**Banach spaces, Bounded linear maps and its spectrum**	**15**
	4	Hahn-Banach theorems, Banach spaces, examples and related results.	

Module	Unit	Contents	Hrs
	5	Closed graph and Open mapping theorems, Bounded inverse theorem, Invertibility of a bounded linear operator, spectrum of a bounded linear operator, classification of spectrum.	
	The topics to be discussed in this module can be found in Chapter II : Section 7(Statements only), Section 8(8.1, 8.2 Statement only, 8.3 Statement only, 8.4, Chapter III : Section 10(10.1, 10.2, 10.3 Statement only, 10.4 Statement only, 10.5 Statement only, 10.6), Section 11.1, Section 12(12.1, 12.2, 12.3, 12.5, 12.6, 12.7(a), 12.8 (Statement only) of Text [1]		
III	**Geometry of Hilbert space**		**15**
	6	Definition and examples, Polarization identity, Schwarz inequality, parallelogram law.	
	7	Pythagoras theorem, Gram-Schmidt orthonormalization and its examples, Bessel's inequality, Riesz-Fischer theorem, Fourier expansion, parseval formula, examples, separability of Hilbert space.	
	The topics to be discussed in this module can be found in Chapter VI : Section 21(21.1, 21.2, 21.3(a), 21.3(b), Section 22 (22.1, 22.2, 22.3(a), 22.3(b), 22.4, 22.5, 22.6 Statement only, 22.7 Statement only, 22.8(a), 22.9) of Text [1]		
IV	**Approximation and Riesz Representation theorem**		**15**
	8	Best approximation- Definition and properties, Projection Theorem and Riesz Representation theorem.	
	9	Adjoint of an operator, Normal, unitary, self-adjoint operators.	
	The topics to be discussed in this module can be found in Chapter Chapter VI : Section 23(Theorem 23.1, Theorem 23.5), Section 24(24.1, 24.2, 24.3, 24.4, 24.5, 24.6 Statement only), Section 25(25.2, 25.3), Section 26(26.1, 26.2, 26.3) of Text [1]		

Textbooks

1. B. V. Limaye, Functional Analysis, Third Edition, New Age International Publishers, New Delhi, 2009

References

1. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons, 1978.

2. V. K. Krishnan, Textbook of Functional Analysis, PHI, Second Edition, 2004.

3. S. Kumaresan & D Sukumar, Functional Analysis: A First Course, Narosa, India, 2020.

4. W. Rudin, Functional Analysis Mc Graw Hill.Inc., Second edition, 1991.

5. M. Thamban Nair, Functional Analysis, A first course: PHI, 2022.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understand the concept of normed spaces and inner product spaces and their properties	PSO1, 2, PO1	U	F,C	L, T	As
CO 2	Realise different types of convergences in normed spaces	PSO1, 2, 3, PO1, 2	R, An	C	L, T	As
CO 3	Develop basic concepts of bounded operators and their spectrum	PSO1, 2, PO1, 2, 3	Ap, An	F, C	L, T	As
CO 4	Create an idea about geometric structure to a linear space	PSO3, PO1, 2, 3	Ap, E	C, P	T	As
CO 5	Apply the knowledge of functional analysis to solve mathematical problems	PSO5, 6, PO3	Ap, C	M		

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M - Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2					2							
CO2	2	3	2				2	1						
CO3	3	3					2	1	2					
CO4			3				3	3	2					
CO5					2	2			3			3		

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4		✓		✓
CO5			✓	

University of Kerala

Descipline	Mathematics				
Cours Code	UK7DSEMAT402				
Course Title	Advanced Linear Algebra				
Type of Course	DSE				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4			4
Pre-requisites	1. Vector spaces 2. Subspaces 3. Bases and dimension				
Course Summary	This course provides a comprehensive idea about the mathematical concepts of linear algebra in an advanced level				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Linear Transformations**	**15**
	1	Linear transformations, Algebra of linear transformations	
	2	Isomorphism and representation of transformations by matrices	
	The topics to be discussed in the module can be found in Chapter 3, Sections 3.1, 3.2, 3.3, 3.4 of Text[1]		
II		**Diagonalizable operators**	**15**
	3	Introduction, characteristic values	
	4	Annihilating polynomials, Invariant subspaces	
	The topics to be discussed in the module can be found in Chapter 6, Sections 6.1, 6.2, 6.3, 6.4 of Text[1]		
III		**The Primary Decomposition Theorem**	**15**
	5	Simultaneous diagonalization, Direct-sum decompositions	
	6	Invariant direct sums, Primary decomposition theorem	

Module	Unit	Contents	Hrs
	The topics to be discussed in the module can be found in Chapter 6, Sections 6.5, 6.6, 6.7, 6.8 of Text[1]		
IV	**Rational and Jordan Forms**		**15**
	7	Cyclic subspaces and annihilators	
	8	Cyclic decompositions and the rational form	
	9	The Jordan form	
	The topics to be discussed in the module can be found in Chapter 7, Sections 7.1, 7.2, 7.3 of Text[1]		

Textbook

1. K. Hoffman, R. Kunze, Linear Algebra, Second Edition, Pearson Education, 2005

References

1. K. B. Datta, Matrix and Linear Algebra, Prentice Hall of India, 2004.
2. I. N. Herstein, Topics in Algebra, Wiley Eastern, 2006.
3. S. Kumaresan, Linear Algebra, Prentice Hal, 2000.
4. S. Roman, Advanced Linear Algebra, Second Edition, Springer, 2008.
5. Sheldon Axler, Linear Algebra Done Right 2nd Edition, Springer, 1997.
6. M. Thamban Nair & A. Singh, Linear Algebra, Springer, 2018.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understand the properties of linear transformation and its matrix representation	PSO1, 2 , PO1, 3	U	F,C	L, T	As
CO 2	Develop the idea of computing characteristic values and minimal polynomial of a linear operator and their properties	PSO2, 3, PO2, 3	R, U	C, P	L, T	As
CO 3	Realise the concept of diagonalizable linear operator and its various properties	PSO3, 4, , PO3, 4	Ap, An	C, P	L, T	As
CO 4	Solve the applied problems using the ideas discussed in the course	PSO5, 6, , PO4, 6	C	M		As

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2					2		2					
CO2		2	2					1	2					
CO3		3		3					3	1				
CO4						2				3		2		

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4		✓	✓	

University of Kerala

Descipline	Mathematics				
Cours Code	UK7DSEMAT403				
Course Title	Advanced Abstract Algebra				
Type of Course	DSE				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	1	5
Pre-requisites	1. Groups 2. Rings and Fields				
Course Summary	The Course covers advanced topics in group theory like Sylow theorems, Isomorphism theorems and Series of groups. Commutative algebra delves into Unique factorization domains, Euclidean domains. Finally, explore the topics Extension Fields, Algebraic Extensions and Finite Fields				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Advanced Group Theory - I**	**10**
	1	Isomorphism Theorems (Chapter IV - Sections 16 of Text [1])	
II		**Advanced Group Theory - II**	**12**
	2	Sylow Theorems, Series of Groups (Chapter IV - Sections 17, 18 of Text [1])	
III		**Commutative Algebra**	**18**
	3	Unique factorization domains, Euclidean domains, Number theory (Chapter VII - Sections 34, 35, 36 of Text [1])	

Module	Unit	Contents	Hrs
IV	**Extension Fields**		**20**
	4	Introduction to Extension Fields, Algebraic Extensions, Finite Fields (Chapter VIII - Sections 39, 40, 42 of Text [1])	
Practical	Practical and assignments can be given using Sagemath for solving the problems in the above modules. (Chapter 15, 18, 21, 22 of Text [2]) (not meant for examination purpose)		**15**

Textbooks

1. John B. Fraleigh, Neal.E.Brand *A First Course in Abstract Algebra*, Eighth Edition, Pearson Education, Inc, 2022.

2. Thomas.W.Judson, Stephen.F.Austin *Abstract Algebra Theory and Applications*, State University, Robert A Beezer, *Sage Exercises for Abstract Algebra* , University of Puget Sound, 2020.

References

1. I. N. Herstein, *Topics in Algebra*, Second Edition, Wiley, 2006.

2. Joseph. A. Gallian, *Contemporary Abstract Algebra*, Eighth Edition, Brooks/Cole Cengage Learning, 2012.

3. Michael Artin, *Algebra*, Second Edition, Pearson Education, 2023.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the fundamental properties of different algebraic structures	PSO 1,2, , PO1, 6, 7, 8	U	F, C		
CO 2	Investigate the connection between different structures	PSO 4, 5, PO1, 2, 3, 6, 7, 8	An	C, P		
CO 3	Develop Proficiency in constructing proofs	PSO 3, 4, PO1, 2, 3, 6, 7, 8	C	P, M		
CO 4	Apply techniques to solve problems	PSO 1,3,6, PO1, 2, 3, 6, 7, 8	Ap	C, P		

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	2	2	3	3	3	-	1	-	-	2	1	1
CO2	1	3	1	2	1	1	1	1	3	-	-	2	1	1
CO3	1	3	2	3	2	3	1	3	3	-	-	3	1	1
CO4	1	1	3	3	2	1	1	3	3	-	-	3	1	1

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- End Semester Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	—-	✓	✓
CO2	✓	✓	✓	✓
CO3	✓	✓	✓	✓
CO4	✓	✓	—-	✓

University of Kerala

Discipline	Mathematics				
Course Code	UK7DSEMAT404				
Course Title	Semigroups				
Type of Course	DSE				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4	-		4
Pre-requisites	Basic concepts from elementary group theory such as the definition of groups, cosets, factor groups, homomorphism.				
Course Summary	This course provides an elementary idea about semigroup theory. We begin the course by elementary concepts on semigroup theory such as generators, subsemigroups, binary relations, lattices, homomorphisms, sub-direct products, actions and Cayley graph. Then we give the green's relations to understand the structure of semigroups. After this we go through regular semigroups, inverse semigroups and related concepts.				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Elementary concepts on semigroup theory**	**15**
	1	Basic concepts and examples, Generators and subsemigroups, Binary relations, Orders and lattices	
	2	Homomorphisms, Congruences and quotients, Generating equivalences and congruences	
	3	Subdirect products, Actions, Cayley graphs	
	The topics to be discussed in the module can be found in Chapter 1 of the Text		

Module	Unit	Contents	Hrs
II	**Structure of semigroups**		**15**
	4	Green's relations, Simple and 0-simple semigroups	
	5	D-class structure, Inverses and D-classes	
	6	Schützenberger groups	
	The topics to be discussed in the module can be found in Chapter 3 of the Text		
III	**Regular semigroups**		**15**
	7	Completely 0-simple semigroups, Ideals and completely 0-simple semigroups	
	8	Completely simple semigroups, Completely regular semigroups	
	9	Left and right groups, Homomorphisms	
	The topics to be discussed in the module can be found in Chapter 4 of the Text		
IV	**Inverse semigroups**		**15**
	10	Equivalent characterizations, Vagner-Preston theorem	
	11	The natural partial order	
	12	Clifford semigroups	
	The topics to be discussed in the module can be found in Chapter 5 of the Text, except free inverse semigroup		

Textbook

1. Alan J. Cain, Nine Chapters on Semigroup Art, Porto & Lisbon, 2020.

References

1. P. A. Grillet, *Semigroups: An Introduction to the Structure Theory*, Marcel Dekker, New York, 1995.

2. J. M. Howie, *Fundamentals of Semigroup Theory*, Clarendon Press, Oxford, 1995.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understand the basic concepts on semigroup theory	PSO1, 2	U	F,C	L, T	As
CO 2	Create an idea about structure of semigroups	PSO2, 3	U, Ap	C, P	L, T	As
CO 3	Develop the idea about regular semigroups and inverse semigroups	PSO2, 3	Ap, An	C, P	L, T	As
CO 4	Apply the knowledge in the advanced level of semigroup theory	PSO4, 5, 6	E	M	L, T	As

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2					2		2			
CO2		2	2				2	1	2			
CO3		2	2				2	2	2	1		
CO4				2	2	2	2	2	2	2	2	2

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4		✓		

University of Kerala

Discipline	Mathematics				
Course Code	UK7DSEMAT405				
Course Title	Ordinary and Partial Differential Equations				
Type of Course	DSE				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4 Hours	-	-	4
Pre-requisites	1. Differential Equations				
Course Summary	This course aims to teach the basic concepts of ODE and PDE, and different techniques for solving these ODE's and PDE's. Also this will discuss the physical applications in Physics and Engineering fields.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Ordinary Differential Equations - I**		**15**
	1	Solving Second Order Linear Equations.	
	2	Method of Undetermined Coefficients	
	3	Method of Variation of Parameters	
	4	Method of Successive Approximations and Picard's Theorem	
	Chapter 3: Section 18, 19 Chapter 11: Section 55, 56, 57 of Text [2]		
II	**Ordinary Differential Equations - II**		**15**
	5	Series solution of First order equations.	
	6	Ordinary point, Regular singular point	

Module	Unit	Contents	Hrs
	7	Gauss Hypergeometric Equations	
	8	Point at Infinity, Chebychev Polynomials.	
	Chapter 5: Section 25, 26, 27, 28, 29, 30, 31 and Appendix: D excluding min max property of Text [2].		
III	**First order Partial Differential Equations**		**18**
	9	First order PDE, curves and surfaces	
	10	Genesis of First order	
	11	Classification of Integrals	
	12	Linear Equation of First order	
	13	Charpits Equations, Jacobi's Method	
	Chapter 1: Sections 1.1, 1.2, 1.3, 1.4, 1.7, 1.8 of Text [1]		
IV	**Second order Partial Differential Equations**		**12**
	14	Second order PDE, Classification of Second order PDE	
	15	One Dimensional Wave Equation, Vibration of Infinite String	
	16	Laplace Equations, Boundary value Problem, Maximum Minimum principles.	
	Chapter 2: Sections 2.1, 2.2, 2.3.1, 2.4.1, 2.4.2 of Text [1]		

Textbooks

1. T. Amarnath, *An Elementary Course in Partial Differential Equations*, Narosa, 2009.

2. G. F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata McGraw-Hill, 2003.

References

1. G. Birkhoff and G. C. Rota, *Ordinary Differential Equations Wiley and Sons*, Third Edition, 1978.

2. Earl A Coddington, Noeman Levinson, *Theory of Ordinary Differential Equations*, Tata Mc Graw-Hil, 1955.

3. Ian Sneddon: *Elements of Partial Differential Equations* Mc Graw- Hill, 2013.

4. Phoolan Prasad, Renuka Raveendran: *Partial Differential Equations*, Wiley Eastern, 1985.

5. M Rama Mohana Rao, *Ordinary Differential Equations and Theory and Applications*, E Arnold, 1981.

6. Zahir Ahsan, *Differential Equations and their Applications*, Prentice Hall,1999.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Analyze the behavior of solutions to differential equations	PSO2, 4	Ap, An	C	L	
CO 2	Interpret mathematical relationship between a PDE and its solutions.	PSO 2,5	U, Ap	C,P	L	
CO 3	Assess the physical implication of different boundary conditions on heat transfers or wave propogation.	PSO 3,4,5	An, E	C, P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	3	3	2	2	-	-	1		
CO2	2	3	3	3	3	3	3	3	1	-	-	2		
CO3	2	2	3	3	3	3	3	3	3	-	-	1		

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK7DSEMAT406				
Course Title	Coding Theory				
Type of Course	DSE				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	Basic Linear Algebra				
Course Summary	Linear codes involve encoding data into a sequence of bits using mathematical operations to correct errors during transmission. Cyclic codes are special type of linear codes facilitating efficient encoding and decoding.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Introduction to Coding theory**	**13**
	1	Error Detection and Correction	
	2	Maximum likelihood decoding and Nearest neighbour decoding	
	3	Basics of Finite Fields and Vectorspace	
	Chapters 1, 2 and 3 (Sections 3.1, 3.2 , 3.3) of Text		
II		**Linear codes**	**20**
	4	Linear codes and Hamming weight	
	5	Generator matrix and parity-check matrix	
	6	Equivalence of linear codes	
	7	Decoding of linear codes	
	Chapter 4 of Text		

Module	Unit	Contents	Hrs
III	**Cyclic codes**		**14**
	8	Generator polynomials	
	9	Decoding of cyclic codes	
	10	Burst-error-correcting codes	
	Chapter 7 of Text		
IV	**Some special codes**		**13**
	11	q-ary Hamming codes	
	12	Golay codes	
	13	Reed-Solomon codes	
	14	Reed-Muller codes	
	Chapter 5: Sections 5.3.1, 5.3.2, 5.3.3, Chapter 6: Section 6.2, Chapter 8: Section 8.2 of Text		

Textbook

1. San Ling and Chaoping Xing,Coding Theory, A First Course, Cambridge University Press, 2004.

References

1. R. Lidl and H.Neiderreiter, Introduction to Finite Fields and their Applications, Cambridge University Press, 1983.
2. F.J.MacWilliams and N.J.A.Sloane, The Theory of Error Correcting Codes, North Holland, Amsterdam, 1998.
3. Shu Lin and Daniel J.Costello, Error Control Coding -Fundamentals and Applications, Pearson Education India, 2011.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand error detection in Coding Theory	PSO1, PSO2	R, U	F,C	L	
CO 2	Able to build linear codes	PO 3 PSO1 PSO2 PSO3, PSO4, PSO6	R, U, An, Ap,C	F ,C , P	L	
CO 3	Able to design cyclic codes	PO 3 PSO1 PSO2 PSO3, PSO4, PSO6	R, U, An, Ap,C	F, C, P	L	
CO 4	Compare different types of linear and cyclic codes	PO 2 PSO2, PSO3, PSO4	R,U,Ap,E	C, P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	3	3	-	-	2	-	-	-	-
CO3	3	3	3	3	3	-	-	2	-	-	-	-
CO4	-	3	3	3	-	-	-	2	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK7DSEMAT407				
Course Title	Measure Theory				
Type of Course	DSE				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	4			4
Pre-requisites	Sequence and series of real numbers and their limits, Limit of functions, Continuity and uniform continuity of functions, Sequence and series of functions and their limits, Riemann Integration.				
Course Summary	This course provides a comprehensive idea about Lebesgue measure, measurable functions and integration of measurable functions.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Lebesgue Measure**		**15**
	1	Lebesgue outer measure, Lebesgue Measurable sets	
	The topics to be discussed in the module can be found in Chapter 2, Section 2.1, Section 2.2 of the text book		
II	**Measure on arbitrary σ-algebra**		**15**
	2	Lebesgue Measure on $\mathbb{R}^k$, Generated σ-algebra and Borel σ-algebra, Restrictions of σ-algebras and measures, Complete measure space and the completion, General outer measure and the induced measure, Some properties of measure	
	The topics to be discussed in the module can be found in Chapter 3, Section 3.1, Section 3.2 of the text book		

Module	Unit	Contents	Hrs
III	**Measurable Functions**		**15**
	3	Probability space and probability distribution, Further properties of measurable functions, Sequence and limits of measurable functions, Almost everywhere properties, Simple measurable functions, Measurability using simple measurable function, Incompleteness of Borel σ-algebra.	
	The topics to be discussed in the module can be found in Chapter 3, Section 3.3, Section 3.4		
IV	**Integral of Measurable Functions**		**15**
	4	Integral of simple measurable functions, Integral of positive measurable functions, Riemann integral as Lebesgue integral, Monotone convergence theorem, Radon-Nikodym Theorem.	
	The topics to be discussed in the module can be found in Chapter 4, Section 4.1, Section 4.2		

Textbook

1. M. Thamban Nair, Measure and Integration , A first Course, CRC Press 2023

References

1. P R Halmos, Measure Theory, Springer, 2016.
2. G de Barra, Measure Theory and Integration, New Age International Publishers, Second Edition 2013.
3. H L Royden, P M Fitzpatrik, Real Analysis, Fourth Edition, Pearson, 2017.
4. Terence Tao, An Introduction to Measure Theory, AMS, 2016.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understand the basic concepts Lebesgue measurable and Lebesgue measure sets	PSO1, 2	U	F, C	L	As
CO 2	Realise the concepts of measurable and simple measurable functions	PSO2, 3	R, U	F, C	L	As
CO 3	Create a concrete idea on integrable functions and realising the importance of convergence theorems	PSO3, 4	Ap, An	C, P	L, T	As
CO 4	Applying the concepts of measure and integration in various branches of analysis	PSO4, 5, 6	C	M		As

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2					2		1					
CO2		2	2				2		2					
CO3			2	2			3	1	2	4				
CO4				2	2	2	3	2	3	2		6		

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4		✓		

University of Kerala

Discipline	Mathematics				
Course Code	UK7DSEMAT408				
Course Title	Queueing Theory				
Type of Course	DSE				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	3	-	2	5
Pre-requisites	1. Probability distributions 2. Matrix algebra				
Course Summary	This course on stochastic processes provides students with a deep understanding of randomness and its applications in various fields, equipping them with valuable tools for analyzing and modeling uncertain systems.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**ElementaryQueueingTheory**	**15**
	1	Introduction and Basic definitions	
	2	Arrivals and service	
	3	Poisson Arrivals and Exporential service	
	4	Scheduling desciplines	
	5	Kendall's Notation	
	6	Performance measures	
	Chapter 11: Section 11.1, Subsections 11.1.1, 11.1.2, 11.1.3, 11.1.5 of Text [1]		
II		**Birth-Death Processes: The M/M/1 Queue**	**20**
	7	Description and Steady-State Solution	
	8	Various Performance Measures	

Module	Unit	Contents	Hrs
	9	Transient Behavior	
	Chapter 11: Section 11.2, Subsections 11.2.1, 11.2.2, 11.2.3 of Text [1]		
III	**General Birth-Death Processes**		**20**
	10	Derivation of the State Equations	
	11	Steady-State Solution	
	12	Matrix formulation of Birth Death Process	
	13	Multi Server System	
	Chapter 11: Section 11.3, Subsections 11.3.1, 11.3.2, Section 11.4, Subsection 11.4.1 of Text [1]		
IV	**Matrix Geometric Method**		**20**
	14	Quasi-Birth-Death case	
	15	Algorithm for solving QBD Process	
	Chapter 10: Section 10.6, Subsection 10.6.1 of Text [1].		
Practical	Use any programming software to perform the solving method. It is not meant for examination. A sample matlab code is given in Example 10.27 of Text [1]		

Textbook

1. William J. Stewart, Probability, Markov chains, queues and simulation: the mathematical basis of performance modeling, Princeton University Press, 2009.

References

1. D. Gross and C. M. Harris. Fundamentals of Queueing Theory, John Wiley and Sons, New York, 1974.

2. L. Kleinrock, Queueing Systems, Vol. 1: Theory. John Wiley and Sons, New York, 1975.

3. M. F. Neuts. Matrix Geometric Solutions in Stochastic Models—An Algorithmic Approach. Johns, Hopkins University Press, Baltimore, MD, 1981. 2003

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand basic definitions of Queueing Theory	PSO1	U	F,C	L	P
CO 2	Understand the basics of Birth Death Processess	PSO1, PO1	U	F, C	L	P
CO 3	Modelling a real life situation as a queueing model	PSO2, 3, PO1, 2	Ap	P	L	P
CO 4	Solving a queueing model	PSO3, PO2	Ap, An	P	L	P

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	3												
CO2	2	3					2							
CO3		3	3	-			3	3						
CO4			3					3						

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK7DSEMAT409				
Course Title	Machine Learning using Python				
Type of Course	DSE				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	3		2	5
Pre-requisites	Basics of Python				
Course Summary	An introduction to supervised and unsupervised machine learning algorithms using python.				

Detailed Syllabus

Module	**Unit**	**Contents**	Hrs
I		**Introduction to Machine Learning**	**15**
	1	Machine learning, basic concepts of supervised learning, unsupervised learning and reinforcement learning, Machine learning applications- classification, regression, clustering, association rule mining, reinforcement learning, Essential libraries and tools in python for machine learning, training data and testing data for supervised learning, splitting data into training and test sets using python.	
	Chapter 1 of Text[1] and Chapter 1 of Text[2]		

<table>
<tr><th>Module</th><th>Unit</th><th>Contents</th><th>Hrs</th></tr>
<tr><td>II</td><td colspan="2">Basic concepts for Supervised Learning</td><td>15</td></tr>
<tr><td rowspan="2"></td><td>2</td><td>Overview of classification and regression, generalization, overfitting and underfitting, Evaluation metrics and scoring, Metrics for binary classification, metrics for multiclass classification and regression metrics, Preprocessing and scaling, different kinds of preprocessing, applying data transformations, scaling training and test data the same way, the effect of preprocessing on supervised learning, Encoding categorical variables.</td><td></td></tr>
<tr><td colspan="3">Chapter 2, 3, 5 of Text[2]</td></tr>
<tr><td>III</td><td colspan="2">Supervised Machine Learning</td><td>25</td></tr>
<tr><td rowspan="2"></td><td>3</td><td>Supervised machine learning algorithms: k- Nearest neighbors, Naïve Bayes classifiers, Linear models, Kernelized Support vector machines, decision tree, ensembles of decision trees, neural networks (deep learning)- Practical using python for obtaining models and corresponding evaluation metrics using the algorithms.</td><td></td></tr>
<tr><td colspan="3">Chapter 2 of Text[2]</td></tr>
<tr><td>IV</td><td colspan="2">Unsupervised Machine Learning</td><td>20</td></tr>
<tr><td rowspan="2"></td><td>4</td><td>Unsupervised learning: Types of unsupervised learning, dimensionality reduction, feature extraction and manifold learning, clustering: k-Means clustering, agglomerative clustering, DBSCAN- practical using Python.</td><td></td></tr>
<tr><td colspan="3">Chapter 3 of Text[2]</td></tr>
</table>

Textbooks

1. Alpaydin E, Introduction to machine learning, MIT press, 2009.
2. Andreas C. Muller and Sarah Guido, Introduction to machine learning with Python: A guide for data scientists, O'Reilly, 2017.

References

1. Daniel T. Larose, Data Mining: Methods and Models, John Wiley and sons, 2006
2. Jerome, F., Trevor, H. and Robert, T. ,The elements of statistical learning: Data mining, inference and prediction, second edition, Springer, 2008.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Describe the applications and basic concepts of machine learning	PSO3, PSO6	R, U	F, C	L, T	
CO 2	Apply and evaluate supervised machine learning algorithms for classification	PSO2, PSO4	E, Ap	P	T	
CO 3	Apply clustering algorithms to find clusters in a data	PSO2, PSO4	Ap	P	T	
CO 4	Apply and evaluate supervised machine learning algorithms for regression	PSO2, PSO4	Ap	P	T	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	1	2	-	-	-	-	-	-	-	-	-	-
CO4	-	-	3	-	-	-	-	-	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam (Theory and Practical)

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

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University of Kerala

May 2024

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