22MA110	CALCULUS FOR ENGINEERS	Category	L	T	P	Credit(s)
		BSC	3	1	0	4

Preamble

This course aims to provide technical competence of modeling engineering problems using calculus. In this course, the calculus concepts are taught geometrically, numerically, algebraically and verbally. Students will apply the main tools for analyzing and describing the behavior of functions of single and multi-variables: limits, derivatives, integrals of single and multi-variables to model and solve complex engineering problems using analytical methods and MATLAB.

Prerequisite

- Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Cognize the concept of functions, limits and continuity	TPS2	75	70
CO2	Compute derivatives and apply them in solving engineering problems	TPS3	70	65
CO3	Employ partial derivatives to find maxima minima of functions of multi variables	TPS3	70	65
CO4	Demonstrate the techniques of integration to find the surface area of revolution of a curve.	TPS3	70	65
CO5	Utilize double integrals to evaluate area enclosed between two curves.	TPS3	70	65
CO6	Apply triple integrals to find volume enclosed between surfaces	TPS3	70	65

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	M	M	-	-	-	-	L	-	L	-	-	-
CO2	S	S	M	M	-	-	-	-	L	-	L	-	-	-
CO3	S	S	M	M	-	-	-	-	L	-	L	-	-	-
CO4	S	S	M	M	-	-	-	-	L	-	L	-	-	-
CO5	S	S	M	M	-	-	-	-	L	-	L	-	-	-
CO6	S	S	M	M	-	-	-	-	L	-	L	-	-	-

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)		Assessment 2 (%)		Terminal (%)			
	CAT 1	Assignment 1	CAT 1	Assignment 1				
TPS	1 / 2 / 3	1 / 2 / 3	1 / 2 / 3	1 / 2 / 3	1	2	3	Total
CO1	20		-	-	-	10	-	10
CO2	32	50	-	-	-	-	16	16
CO3	36		-	-	-	-	18	18
CO4	12	-	39		-	-	25	25
CO5	-	-	35	50	-	-	17	17
CO6	-	-	26		-	-	14	14
MATLAB	-	50	-	50	-	-	-	-
TOTAL	100	100	100	100	-	10	90	100

* Assignment 1: (i) Application Problems in CO1, CO2 and CO3 (50%)
(ii) MATLAB Onramp & Introduction to symbolic Math with MATLAB (50%).
**Assignment 2: (i) Application Problems in CO4, CO5 and CO6 (50%).
(ii) Application problems using MATLAB. (50%).
***Terminal examination should cover all Course Outcomes in the appropriate TPS Scale level.

Syllabus

DIFFERENTIAL CALCULUS
Functions - New functions from old functions - Limit of a function - Continuity - Limits at infinity - Derivative as a function - Maxima and Minima of functions of one variable – Mean value theorem - Effect of derivatives on the shape of a graph- Application problems in engineering using MATLAB.

FUNCTIONS OF SEVERAL VARIABLES:
Function of several variables- Level curves and level surfaces - Partial derivatives – Chain rule - Maxima and minima of functions of two variables –Method of Lagrange's Multipliers - Application problems in engineering using MATLAB.

INTEGRAL CALCULUS:
The definite integral – Fundamental theorem of Calculus – Indefinite integrals and the Net Change Theorem – Improper integrals – Area of surface of revolution - Volume of solid of revolution -Application problems in engineering using MATLAB.

MULTIPLE INTEGRALS:
Iterated integrals-Double integrals over general regions-Double integrals in polar coordinates-Applications of double integrals (density, mass, moments & moments of inertia problems only)- triple integrals- triple integrals in cylindrical coordinates- triple integrals in spherical coordinates-change of variables in multiple integrals - Application problems in engineering using MATLAB.

Text Book(s)

1. James Stewart, "Calculus Early Transcendentals", 9th Edition, Cengage Learning, New Delhi, 2019.
   a. DIFFERENTIAL CALCULUS: [Sections: 1.3, 2.2, 2.5, 2,6,2.8, 4.1, 4.2 and 4.3.]
   b. FUNCTIONS OF SEVERAL VARIABLES: [Sections: 14.1,14.3,14.5,14.7 and 14.8.]
   c. INTEGRAL CALCULUS: [Sections: 5.2, 5.3, 5.4, 7.8, 8.2 and 6.2.]
   d. MULTIPLE INTEGRAL: [Sections: 15.1-15.4, 15.6-15.9]

2. Lecture Notes on Calculus Through Engineering Application Problems and Solutions, Department of Mathematics, Thiagarajar College of Engineering, Madurai.

Reference Books & Web Resources

1. George B. Thomas, "Thomas Calculus: early Transcendentals", 14thedition, Pearson, New Delhi, 2018.
2. Howard Anton, Irl Bivens and Stephen Davis, "Calculus: Early Transcendentals", 12the, John Wiley & Sons, 2021.
3. Kuldeep Singh, "Engineering Mathematics Through Applications", 2nd edition, Blooms berry publishing, 2019.
4. Kuldip S. Rattan, Nathan W. Klingbeil, Introductory Mathematics for Engineering Applications, 2nd e John Wiley& Sons, 2021

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**DIFFERENTIAL CALCULUS**	
1.1	Functions and New functions from old functions	2
1.2	Limit of a function &Continuity of a function	1
	Tutorial	**1**
1.3	Limits at infinity	1
1.4	Derivative as a function	2
	Tutorial	**1**
1.5	Maxima and Minima of functions of single variable	2
1.6	The Mean value theorem and effect of derivatives on the shape of a graph of a function	1
	Tutorial	**1**
1.7	Application problems in engineering using MATLAB	1
2	**FUNCTIONS OF SEVERAL VARIABLES**	
2.1	Level curves and level surfaces	2
2.2	Partial derivatives – Chain rule	1
	Tutorial	**1**
2.3	Maxima and minima of functions of two variables	2
2.4	Method of Lagrange's Multipliers	1
	Tutorial	**1**
2.5	Application problems in engineering using MATLAB	1
3	**INTEGRAL CALCULUS**	
3.1	The definite integral	1
3.2	Fundamental theorem of Calculus	2
	Tutorial	**1**
3.3	Indefinite integrals and the Net Change Theorem	1
3.4	Improper integrals	2
	Tutorial	**1**
3.5	Area of surface of revolution	1

Module No.	Topic	No. of Periods
3.6	Volume of solid of revolution.	2
3.7	Application problems in engineering using MATLAB	1
4	**MULTIPLE INTEGRALS**	
4.1	Iterated integrals	1
4.2	Double integrals over general regions	2
	Tutorial	**1**
4.3	Double integrals in polar coordinates	1
4.4	Applications of double integrals (density, mass, moments & moments of inertia problems only)	2
	Tutorial	**1**
4.5	Triple integrals	1
4.6	Triple integrals in cylindrical coordinates	1
4.7	Triple integrals in spherical coordinates	1
	Tutorial	**1**
4.8	Change of variables in multiple integrals	1
4.9	Application problems in engineering using MATLAB	1
	Total	**48**

Course Designers:

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22MA310	ESSENTIALS OF MATRICES AND CALCULUS

Category	L	T	P	C	Terminal Exam Type
BSC	3	1	-	4	Theory

Preamble

This course aims to convey the process of finding the Eigen values and Eigen vectors of a matrix and hence the process of diagonalization of a matrix. It also demonstrates the techniques and sense of the utility of calculus using differentiation and integration of functions of single and several variables, enabling to solve complex engineering problems.

Prerequisite

- NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment
CO1	Utilize Eigen values and Eigen vectors of a matrix to diagonalize it.	TPS3	65	60
CO2	Model and solve extreme value problems of functions of single variable using their derivatives.	TPS3	65	60
CO3	Make use of partial derivative to model and solve extreme value problems of functions of several variables.	TPS3	65	60
CO4	Apply vector derivative to compute directional derivative and to identify solenoidal and irrotational vector fields.	TPS3	65	60
CO5	Demonstrate techniques of definite integrations of single variable functions.	TPS2	70	65
CO6	Compute mass and moments of given lamina using double integration in Cartesian coordinates.	TPS3	65	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L		L	L						L
CO2	S	M	L		L	L						L
CO3	S	M	L		L	L						L
CO4	S	M	L		L	L						L
CO5	S	M	L		L	L						L
CO6	S	M	L		L	L						L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Theory						Theory						Theory		
	Assessment-1						Assessment-2						Terminal Examination		
	Assignment-1			CAT-1			Assignment-2			CAT-2					
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	-	50	5	15	30	-	-	-	-	-	-	-	6	19
CO2	-	-	50	5	15	30	-	-	-	-	-	-	-	6	19
CO3	-	-	-	-	-	-	-	-	30	-	5	20	-	3	12
CO4	-	-	-	-	-	-	-	-	30	3	5	17	-	3	7
CO5	-	-	-	-	-	-	-	-	-	4	10	-	-	6	-
CO6	-	-	-	-	-	-	-	-	40	3	10	23	-	6	13

Syllabus

MATRIX EIGEN VALUE PROBLEMS [12Hrs]

The Matrix Eigen value Problem –Determination of Eigen values and Eigenvectors – Symmetric, Skew Symmetric and Orthogonal matrices – Eigen Bases – Diagonalization – Quadratic forms.

DIFFERENTIAL CALCULUS AND ITS APPLICATIONS [12Hrs]

The Limit of a function – Continuity of a function– The derivative as a function – Maximum and Minimum values – The Mean value theorem.

PARTIAL DIFFERENTIATION AND ITS APPLICATIONS [12Hrs]

Partial derivatives – The Chain rule – Maximum and Minimum Values – Directional derivatives and the Gradient vector – Curl and Divergence.

TECHNIQUES OF INTEGRATION AND ITS APPLICATIONS [12Hrs]

Definite Integrals – Properties of Definite integrals – Fundamental Theorem of Calculus – Double integrals over rectangles - Double integrals over general regions - Applications of double integrals in Cartesian coordinates (Density, Mass, Moments & Moments of Inertia problems only).

Textbook (s)

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley, 2017.
2. James Stewart, Daniel Clegg and Saleem Watson "Calculus Early Transcendentals", 9e, Cengage Learning, New Delhi, 2019.
3. Lecture Notes on Calculus Through Engineering Application Problems and Solutions, Department of Mathematics, Thiagarajar College of Engineering, Madurai.

Reference Books & Web Resources

1. Kuldeep Singh, "Engineering Mathematics Through Applications",2e, Palgrave Macmillan, 2011, Great Britan.
2. KuldeepS.Rattan, Nathan W.Klingbeil, “Introductory Mathematics for Engineering Applications”,Wiley, 2015.
3. 3) George B. Thomas, "Thomas Calculus: Early transcendentals ", Pearson, New Delhi, 2013.

Course Contents and Lecture Schedule

No.	Topic	No. of Periods
1.	**MATRIX EIGEN VALUE PROBLEMS**	
1.1	The Matrix Eigen value Problem	1
1.2	Determination of Eigenvalues and Eigenvectors	2
	Tutorial	1
1.3	Symmetric, Skew Symmetric and Orthogonal matrices	2
	Tutorial	1
1.4	Eigen Bases, Diagonalization	2
1.5	Quadratic forms.	2

No.	Topic	No. of Periods
	Tutorial	1
2	**DIFFERENTIAL CALCULUS AND ITS APPLICATIONS**	
2.1	The Limit of a function	2
2.2	Continuity of a function	1
	Tutorial	1
2.3	The derivative as a function	2
2.4	Maximum and Minimum values of a function of single variable.	2
	Tutorial	1
2.5	The Mean value theorem	2
	Tutorial	1
3	**PARTIAL DIFFERENTIATION AND ITS APPLICATIONS**	
3.1	Partial derivatives	1
3.2	The Chain rule	2
	Tutorial	1
3.3	Maximum and Minimum Values of a function of two variables	2
	Tutorial	1
3.4	Directional derivative and the Gradient vector	2
3.5	Curl and Divergence	2
	Tutorial	1
4	**TECHNIQUES OF INTEGRATION AND ITS APPLICATIONS**	
4.1	Definite Integrals- Properties of Definite integrals.	1
4.2	Fundamental Theorem of Calculus	2
	Tutorial	1
4.3	Double integrals over rectangles	2
4.4	Double integrals over general regions	2
	Tutorial	1
4.5	Applications of double integrals in Cartesian coordinates(Density, Mass, Moments &Moments of Inertia problems only).	2
	Tutorial	1
	Total No. of Hours	48

Course Designers

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22MAFA0	ALGORITHMIC GRAPH THEORY

Category	L	T	P	C	Terminal Exam Type
BS	3	0	-	3	Theory

Preamble

Overview and objectives of the course.

Graph Theory has wide range of applications in Networks, computer architecture, artificial intelligence, software engineering, expert systems, storage methods etc. This course is concerned with studying properties of graphs and digraphs from an algorithmic perspective. This course focuses on understanding basic properties of graphs that can be used to design efficient algorithms.

Prerequisite

- Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment
CO1	Explain the fundamental concepts such as types of graphs, connectedness, Matrix representation of graphs and Directed graphs	TPS2	70	70
CO2	Illustrate the working of Havel - Hakimi Algorithm on degree sequence and explain graph isomorphism, Eulerian and Hamiltonian graphs.	TPS3	75	70
CO3	Estimate the co-trees and blocks for connected graph	TPS2	80	75
CO4	Illustrate the working of Prim's and Kruskal's algorithms for computing minimum cost spanning tree and Depth First search, Berth First search algorithms for computing spanning tree	TPS3	75	70
CO5	Compute a maximum matching using Hungarian algorithm for a connected graph	TPS3	75	70
CO6	Explain the vertex color and edge color problems and construct the chromatic polynomial for the given graph	TPS3	75	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L		L	L						L
CO2	S	M	L		L	L						L
CO3	S	M	L		L	L						L
CO4	S	M	L		L	L						L
CO5	S	M	L		L	L						L
CO6	S	M	L		L	L						L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Theory Assessment-1						Theory Assessment-2						Theory Terminal Examination		
	CAT-1			Assignment-1			CAT-2			Assignment-2					
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	3	20	-	-	-	-	-	-	-	-	-	-	-	10	-
CO2	4	-	37	-	-	70	-	-	-	-	-	-	-	5	15
CO3	3	10	-	-	-	-	-	-	-	-	-	-	-	5	-
CO4	-	-	23	-	-	30	3	10	10	-	-	20	-	-	20
CO5	-	-	-	-	-	-	3	10	25	-	-	40	-	5	20
CO6	-	-	-	-	-	-	4	10	25	-	-	40	-	5	15
Total	**10**	**30**	**60**	**-**	**-**	**100**	**10**	**30**	**60**	**-**	**-**	**100**	**-**	**30**	**70**

Syllabus

Basic terminologies: Graphs and subgraphs – Degree of a vertex –Graph isomorphism- special types of graphs –Paths, Cycles, Complete graphs, Bipartite graphs–Degree Sequence-Havel - Hakimi Algorithm-Connected graphs and Distances-Matrix representation of graphs -Eulerian graphs - Hamiltonian graphs - Directed graphs with applications.
Trees and Connectivity: Properties of Trees - Fundamental Cycles - Co-trees and Bonds - Spanning tree – Prim's Algorithm– Kruskal's Algorithm -Blocks – vertex connectivity – edge connectivity- Depth First Search Algorithm -Berth First Search Algorithm.
Alternating Path and Matching: Introduction to Matching – Maximum matching – Alternating path – Augmenting path –Berge Theorem –Halls marriage problem - Hungarian Algorithm - Perfect matching and 1- factorizations.
Graph Coloring and Planarity: Vertex Coloring – Chromatic number - Chromatic Polynomial – Edge Coloring-**:** Planar Graphs- properties - Euler's formula

Text Book

1. Graphs, Algorithms and Optimization, William Kocay, Donald L. Kreher ,CRC Press 2013.
2. Graphs and Digraphs, Gary Chartrand, Linda Lesniak, Ping Zhang, Fifth edition, CRC Press 2011.

Reference Books

1. Introduction *to Graph Theory* Robin J.Wilson, *Pearson publications, 5th Edition, 2010*
2. Introduction to Graph Theory, Douglas B.West , Second Edition Pearson publications 2015.
3. Applied and Algorithmic Graph Theory , Gary Chartrand, Ortrud R. Oellermann, McGraw-Hill, 1993.

Course Contents and Lecture Schedule

No.	Topic	No. of Periods
1	**Basic terminologies**	
1.1	Graphs and subgraphs	1
1.2	Degree of a vertex –Graph isomorphism	2
1.3	Special types of graphs - Paths, Cycles, Complete graphs and Bipartite graphs	2
1.4	Degree sequence- Havel - Hakimi Algorithm	2
1.5	Connected graphs and Distances	1
1.6	Matrix representation of graphs	1
1.7	Eulerian graphs - Hamiltonian graphs	2
1.8	Directed graphs with applications.	1
2	**Trees and Connectivity**	
2.1	Properties of Trees - Fundamental Cycles	2
2.2	Co-trees and Bonds	1
2.3	Spanning tree - Prim's Algorithm, Kruskal's Algorithm	2
2.4	Blocks	1
2.5	vertex connectivity – edge connectivity	1
2.6	Depth First Search Algorithm, Berth First Search Algorithm	3
3	**Alternating Path and Matching**	
3.1	Introduction toMatching - Maximum matching	2
3.2	Alternating path – Augmenting path	1
3.3	Berge Theorem - Halls marriage problem	2
3.4	Hungarian Algorithm	1
3.5	Perfect matching and 1- factorizations.	1
4	**Graph Coloring and Planarity**	
4.1	Vertex Coloring - Chromatic number	2
4.2	Chromatic Polynomial	2
4.3	Edge Coloring	1
4.4	Planar Graphs – properties	1
4.5	Euler's formula.	1
	Total	36

Course Designers:

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3. Dr. P.Krishnapriya pkamar@tce.edu

22MAFB0	**FUZZY SETS AND SYSTEMS**

Category	L	T	P	C	Terminal Exam Type
BS	3	-	-	3	Theory

Preamble

Fuzzy set theory provides a major newer paradigm in modeling and reasoning with uncertainty. Evolution of fuzzy mathematics has added promising new dimensions to the development of research and technology. The main objective of this course is to introduce the basic concepts of fuzzy sets which include representations and operations of fuzzy set, fuzzy numbers, fuzzy logic, fuzzy relations and fuzzy systems. These topics have wide range of applications in engineering, Machine learning, etc.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcomes	TCE Proficiency Scale	Expected Proficiency	Expected Attainment
CO1	Understand the basic ideas of fuzzy sets, fuzzy numbers, operations and properties of fuzzy sets	TPS2	75	70
CO2	Apply the concept of fuzzy sets to determine $\alpha - cuts$ and strong $\alpha - cuts$.	TPS3	70	65
CO3	Construct fuzzy relations using membership functions.	TPS3	70	65
CO4	Apply the basic concepts of membership functions, fuzzification process, defuzzification process in decision making problems.	TPS3	70	65
CO5	Apply the fuzzy logic and inference to construct the fuzzy model systems.	TPS3	70	65
CO6	Understand the concepts of various membership value assignments.	TPS2	75	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M									L	
CO2	S	M									L	
CO3	S	M									L	
CO4	S	M									L	
CO5	S	M									L	
CO6	S	M									L	

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Scale CO	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I (%)			CAT – II (%)			Assg. II (%)					
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	3	20	-	-	-	-	-	-	-	-	-	-	-	9	-
CO2	3	-	20	-	-	40	-	-	-	-	-	-	-	-	14
CO3	4	10	40	-	-	60	-	-	-	-	-	-	-	3	25
CO4	-	-	-	-	-	-	4	10	34	-	-	60	-	6	16
CO5	-	-	-	-	-	-	3	-	26	-	-	40	-	-	15
CO6	-	-	-	-	-	-	3	20	-	-	-	-	-	12	-
Total	**10**	**30**	**60**	**-**	**-**	**100**	**10**	**30**	**60**	**-**	**-**	**100**	**-**	**30**	**70**

Syllabus

Fuzzy Sets: Operations and properties of classical sets, Mapping of classical sets to the functions. Fuzzy sets - Membership functions, Fuzzy set operations, Properties of fuzzy sets– α-Cuts –Representations of Fuzzy Sets - Fuzzy Numbers – Arithmetic operations on Fuzzy numbers.

Fuzzy relations: Cartesian product, crisp relations-cardinality, operations and properties of crisp relations. Fuzzy relations-cardinality, operations, properties of fuzzy relations, fuzzy Cartesian product and composition, Projections and Cylindrical extensions, Fuzzy tolerance and equivalence relations, value assignments and other format of the composition operation.

Fuzzification and Defuzzification: Features of the membership functions, various forms, fuzzification, defuzzification to crisp sets, λ- cuts for fuzzy relations, Defuzzification to scalars, other forms of the implication operation.

Fuzzy Logic and Fuzzy Systems: Classic logic - Fuzzy logic - Natural language, Linguistic hedges, Fuzzy (Rule based) System, Aggregation of fuzzy rules, Graphical techniques of inference, Membership value assignments: Intuition, Inference, rank ordering.

Text Books

1. Timothy J.Ross - Fuzzy logic with engineering applications, 4th edition, Wiley,2017.
2. J. KlirBo Yuan - Fuzzy sets and Fuzzy logic theory and Applications, PHI, New Delhi,1995.

Reference Books & Web Resources

1. H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers Limited, New Delhi, 1991.
2. Guanrong Chen and Trung Tat Pham, Introduction to Fuzzy sets, Fuzzy Logic and Fuzzy contro systems, CRC Press, New York, 2001.
3. https://nptel.ac.in/courses/108104157

Course Contents and Lecture Schedule

No.	Topic	No. of Periods	CO
1.	**Fuzzy Sets**		
1.1	Operations and properties of classical sets	1	CO1
1.2	Mapping of classical sets to the functions	1	CO1
1.3	Fuzzy sets - Membership functions, Fuzzy set operations	2	CO1
1.4	Properties of fuzzy sets– α-Cuts - Representations of Fuzzy Sets	2	CO2
1.5	Fuzzy Numbers – Arithmetic operations on Fuzzy numbers	2	CO2
2.	**Fuzzy Relations**		
2.1	Cartesian product, crisp relations-cardinality, operations and properties of crisp relations	2	CO3
2.2	Fuzzy relations-cardinality, operations, properties of fuzzy relations, fuzzy Cartesian product and composition	2	CO3
2.3	Projections and Cylindrical extensions	2	CO3
2.4	Fuzzy tolerance and equivalence relations	2	CO3
2.5	Value assignments	1	CO3
2.6	Other format of the composition operation.	1	CO3
3	**Fuzzification and Defuzzification**		
3.1	Features of the membership functions, various forms	1	CO4
3.2	Fuzzification	1	CO4
3.3	Defuzzification to crisp sets	2	CO4
3.4	λ- cuts for fuzzy relations	2	CO4
3.5	Defuzzification to scalars	1	CO4
3.6	Other forms of the implication operation	1	CO4
4	**Fuzzy Logic and Fuzzy Systems**		
4.1	Classic logic	1	CO5
4.2	Fuzzy logic	2	CO5
4.3	Natural language, Linguistic hedges	1	CO5
4.4	Fuzzy (Rule based) System, Aggregation of fuzzy rules	1	CO5
4.5	Graphical techniques of inference	2	CO6
4.6	Membership value assignments: Intuition	1	CO6
4.7	Inference	1	CO6
4.8	Rank Ordering	1	CO6
	Total	36	

Course Designers:

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22MAFD0	NUMERICAL CALCULUS	Category	L	T	P	Credit
		BS	3	0	0	3

Preamble

Mathematical models can be solved analytically and numerically. Models which do not have an analytical solution can be solved using numerical methods. This course aims at giving a thorough knowledge on methods of numerical differentiation and numerical integration and use them to solve ordinary differential equations and partial differential equations.

Prerequisite

- 22MA110 : Calculus for Engineers

Course Outcomes

On the successful completion of the course, students will be able to

	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Construct the matrix from the given linear transformation	TPS 3	75	70
CO2	Calculate the solution of the given linear system of equations	TPS 3	75	70
CO3	Compute the derivative of the polynomial fitting the given data set.	TPS 3	75	70
CO4	Compute the integral of the given function using the quadrature methods	TPS 3	75	70
CO5	Compute the solution to the given ODE using different order Runge-Kutta methods	TPS 3	75	70
CO6	Compute the solution of the given PDE using finite difference methods.	TPS 3	75	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L	-	-	-	-	-	-	-	S	S
CO2	S	M	L	-	-	-	-	-	-	-	S	S
CO3	S	M	L	-	-	-	-	-	-	-	S	S
CO4	S	M	L	-	-	-	-	-	-	-	S	S
CO5	S	M	L	-	-	-	-	-	-	-	S	S
CO6	S	M	L	-	-	-	-	-	-	-	S	S
CO7	S	M	L	-	-	-	-	-	-	-	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Scale CO	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I (%)			CAT – II (%)			Assg. II (%)					
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	-	10	10	-	-		-	-	-	-	-	-	-	6	6
CO2	3	10	26	-	-	100	-	-	-	-	-	-	-	6	13
CO3	7	-	34	-	-		-	-	-	-	-	-	-	6	13
CO4	-	-	-	-	-	-	3	10	14	-	-		-	3	11
CO5	-	-	-	-	-	-	3	10	18	-	-	100	-	6	11
CO6	-	-	-	-	-	-	4	-	38	-	-		-	3	16
Total	**10**	**20**	**70**	**-**	**-**	**100**	**10**	**20**	**70**	**-**	**-**	**100**	**-**	**30**	**70**

Syllabus

Linear Transformations: Definition and examples, Matrix representation of linear transformations. [4 hours]

Numerical solutions to system of equations: Gauss Elimination method, Gauss Jordan method, Crout's method, Gauss-Seidal method, Gauss Jacobi method, Least square method. [7 hours]

Numerical Differentiation: Finite Difference Operators, Numerical differentiation using Lagrange's polynomial, numerical differentiation using Newton's forward and backward difference polynomial, numerical differentiation using finite difference method. [7 hours]

Numerical Integration: Trapezoidal rule, Simpson's rules for numerical integration, Gaussian quadrature - two point and three-point method. [5 hours]

Numerical solution to ODE: Introduction to ODE, Euler' method – Modified Euler's method, Adam's and Milne's Predictor–Corrector methods, Runge-Kutta Method order four for First order ODE. [6 hours]

Numerical solution to PDE: Introduction to PDE, numerical solution of Elliptic equations, numerical solution of Parabolic equations, numerical solution to Hyperbolic equations. [7 hours]

Text Book

1. Steven J. Leon, "Linear Algebra with Applications", 8th edition, Pearson, 2010
2. S. R. K. Iyengar, R. K. Jain, Mahinder Kumar Jain, "Numerical methods for Scientific and Engineering Computations", New Age International publishers, 6th Edition, 2012.
3. Steven C. Chapra, Raymond P. Canale, "Numerical Methods for Engineers", McGraw Hill Higher Education, 2016.
4. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, New Delhi, 2018.

Reference Books& web resources

1. ParvizMoin, "Fundamentals of engineering numerical analysis", Cambridge, 2010.
2. Joe D Hoffman "Numerical methods for engineers and scientists", McGraw Hill, 2001

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods	COs
1	**Linear Transformations**		
1.1	Definition and examples	2	CO1
1.2	Matrix representation of linear transformations	2	CO1
2	**Numerical solutions to system of equations**		
2.1	Gauss Elimination method	1	CO2
2.2	Gauss Jordan method	2	CO2
2.3	Crout's method	1	CO2
2.4	Gauss-Seidal method	1	CO2
2.5	Gauss Jacobi method	1	CO2
2.6	Least squares method	1	CO2
3	**Numerical Differentiation**		
3.1	Finite Difference Operators	1	CO3
3.2	Numerical differentiation using Lagrange's polynomial	1	CO3
3.3	Numerical differentiation using Newton's forward and backward difference polynomial	3	CO3
3.4	Numerical differentiation using finite difference method	2	CO3
4	**Numerical Integration**		
4.1	Trapezoidal rule	1	CO4
4.2	Simpson's rules for numerical integration	2	CO4
4.3	Gaussian quadrature-two point and three point method	2	CO4
5	**Numerical solution to ODE**		
5.1	Introduction to ODE	1	CO5
5.2	Euler' method	1	CO5
5.3	Modified Euler's method	1	CO5
5.4	Adam's and Milne's Predictor –Corrector methods	1	CO5
5.5	Runge-Kutta Method order four for First order ODE	2	CO5
6	**Numerical solution to PDE**		
6.1	Introduction to PDE	1	CO6

Module No.	Topic	No. of Periods	COs
6.2	Numerical solution of Elliptic equations	2	CO6
6.3	Numerical solution of Parabolic equations	2	CO6
6.4	Numerical solution to Hyperbolic equations	2	CO6
	Total	36	

Course Designer(s):

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22MAFF0	MATHEMATICS FOR MACHINE LEARNING

Category	L	T	P	Credit
BS	3	0	0	3

Preamble

Machine learning focuses on the development of computer program that can access data and use it to learn for themselves. This course elaborates the geometrical aspect of machine learning. First, it demonstrates modelling and analysis of data by means of vectors. Then it develops the concept of distance and hence least square distance in the field of data. Finally, it presents the least square technique for data fitting, feature engineering, regression, classification and clustering.

Prerequisite

- NIL

Course Outcomes

On the successful completion of the course, students will be able to

Cos	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Summarize the concept and model of Machine Learning	TPS2	75	70
CO2	Model data as vectors and manipulate by means of vector operations	TPS3	75	70
CO3	Construct norm, average, standard deviation and correlation	TPS3	75	70
CO4	Apply least square distance to fit regression lines and perform feature engineering	TPS3	75	70
CO5	Classify data by means of least square classifiers	TPS3	70	65
CO6	Cluster the data into k-groups of similar data	TPS3	70	65

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	M	L			M			L	M	L		M
CO2	S	M	L		M	L		L	M	L		M
CO3	S	M	L		M			L	M	L		M
CO4	S	M	L		M	L		L	M	L		M
CO5	S	M	L		M	L		L	M	L		M
CO6	S	M	L		M	L		L	M	L		M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Scale CO	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I (%)			CAT – II (%)			Assg. II (%)					
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	4	5	15	-	-		-	-	-	-	-	-	-	10	-
CO2	3	10	15	-	-	100	-	-	-	-	-	-	-	2	14
CO3	3	10	15	-	-		-	-	-	-	-	-	-	3	14
CO4	-	5	15	-	-		7	10	20	-	-		-	10	14
CO5	-	-	-	-	-	-	-	10	20	-	-	100	-	-	14
CO6	-	-	-	-	-	-	3	10	20	-	-		-	5	14
Total	**10**	**30**	**60**	**-**	**-**	**100**	**10**	**30**	**60**	**-**	**-**	**100**	**-**	**30**	**70**

*Terminal examination should cover all Course Outcomes in the appropriate TPS Scale level.

Syllabus

Machine Learning: Introduction to Machine learning, Supervised learning, Unsupervised learning, Some basic concepts in machine learning.

Vectors: Vectors in R^n, Modelling of data, Manipulation of data using vector addition in R^n, Manipulation of data using Scalar-vector multiplication in R^n, Manipulation of data using Inner product in R^n.

Norm and distance: Norm in R^n and application in the domain of data, Distance in R^n and application in the domain of data, Standard deviation in R^n and application in the domain of data, Angle in R^n and application in the domain of data.

Least squares: Least squares problem, Solution, Solving least squares problems, Examples, Least squares data fitting, Fitting univariate functions, Regression, Log transform of dependent variable, Feature engineering.

Least squares classification: Classification, Least square classifier,Iris flower classification, Handwritten digit classification, Receiver operating characteristic.

Clustering: Clustering, A clustering objective, The k-means algorithm, Examples.

Text Books

1. Kevin P. Murphy, The MIT Press Cambridge, Massachusetts London, England, "Machine Learning A Probabilistic Perspective", © Massachusetts Institute of Technology, 2012.
2. Stephen Boyd Department of Electrical Engineering Stanford University, LievenVandenberghe , Department of Electrical and Computer Engineering, University of California, Los Angeles, " Introduction to Applied Linear Algebra", © Cambridge University Press, 2018.

Reference Books & web resources

1. Jean Gallier and Jocelyn Quaintance, Department of Computer and Information Science University of Pennsylvania Philadelphia," Linear Algebra for Computer Vision, Robotics, and Machine Learning", Jean Gallier August 7, 2019
2. Marc Peter Deisenroth , A. Aldo Faisal, Cheng Soon Ong," Mathematics for Machine Learning ",To be published by Cambridge University,2019.
3. Steven J. Leon, "Linear Algebra with Applications", Macmillan publishing company, New York, 1990.
4. S. Kumaresan, "Linear Algebra a geometrical approach", PHI Learning Pvt. Ltd., 2014.
5. https://www.coursera.org/lecture/linear-algebra-machine-learning/summary-L0jsftowardsdatascience.com

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Machine Learning**:		
1.1	Introduction to Machine learning	1	CO1
1.2	Supervised learning	1	CO1
1.3	Unsupervised learning	1	CO1
1.4	Some basic concepts in machine learning	1	CO1
2	**Vectors**:		
2.1	Vectors in R^n, Modelling of data	1	CO2
2.2	Manipulation of data using Vector addition in R^n	1	CO2
2.3	Manipulation of data using Scalar-vector multiplication in R^n	1	CO2
2.4	Manipulation of data using Inner product in R^n	2	CO2
3	**Norm and distance:**		
3.1	Norm in R^n and application in the domain of data	1	CO3
3.2	Distance in R^n and application in the domain of data	1	CO3
3.3	Standard deviation in R^n and application in the domain of data	2	CO3
3.4	Angle in R^n and application in the domain of data	1	CO3
4	**Least squares**		
4.1	Least squares problem	1	CO4
4.2	Solution	1	CO4
4.3	Solving least squares problems	2	CO4
4.4	Examples	1	CO4
4.5	Least squares data fitting	1	CO4
4.6	Fitting univariate functions, Regression	2	CO4
4.7	Log transform of dependent variable	1	CO4
4.8	Feature engineering	2	CO4
5	**Least squares classification**		
5.1	Classification	1	CO5
5.2	Least square classifier	1	CO5
5.3	Iris flower classification	1	CO5
5.4	Handwritten digit classification	1	CO5
5.5	Receiver operating characteristic	1	CO5
6	**Clustering**		
6.1	Clustering	2	CO6
6.2	A clustering objective	2	CO6
6.3	The k-means algorithm, Examples	2	CO6
	Total Hours	**36**	

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