Department of Mathematics

M.Sc. Mathematics
Curriculum and Syllabus

(Applicable to the students admitted from AY: 2023 onwards)

School of Engineering and Sciences
SRM University *AP*, Andhra Pradesh

Department Vision

To emerge as a world-class centre of excellence in the field of mathematics for teaching and research that will contribute to the well-being of society and foster collaborative research.

Department Mission

1. Create a vibrant mathematical atmosphere with strong undergraduate and graduate programs in mathematics as per the best universities in the world.
2. Create strong research groups with renowned researchers across the world in the field of mathematics.
3. Maintain high standards of teaching and research in various areas of pure, applied, and other areas of mathematics.

Program Educational Objectives (PEO)

1. Develop an in-depth theoretical understanding and provide practical training through the offering of advanced mathematics courses.
2. Equip students for academic research or industry readiness.
3. Empower students with the competence to tackle challenges in mathematics at both national and international levels.

Mission of the Department to Program Educational Objectives (PEO) Mapping

	PEO 1	PEO 2	PEO 3
Mission Statement 1	1	2	3
Mission Statement 2	3	2	3
Mission Statement 3	1	3	2

Program Specific Outcomes (PSO)

1. Express mathematical ideas using the formal language of mathematics and construct rigorous mathematical proofs.
2. Apply tools such as numerical analysis, optimization techniques, probability and statistics, and mathematical modelling to address real-world challenges in finance, engineering, and healthcare.
3. Demonstrate effective communication and collaboration skills, with multidisciplinary teams, facilitating the exchange of ideas and knowledge.

Mapping Program Educational Objectives (PEO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
PEOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
PEO 1	2	1	1	1	3	1	3	2	3	3	3	1	1	1	3
PEO 2	3	3	3	3	2	1	2	2	3	1	2	1	1	2	3
PEO 3	1	1	1	1	2	1	3	3	2	3	3	3	3	3	1

Category Wise Credit Distribution			
Course Sub-Category	**Sub-Category Credits**	**Category Credits**	**Learning Hours**
Ability Enhancement Courses (AEC)		3	90
University AEC	0		
School AEC	3		
Value Added Courses (VAC)		3	90
University VAC	0		
School VAC	3		
Skill Enhancement Courses (SEC)		6	180
School SEC	0		
Department SEC	6		
SEC Elective	0		
Foundation / Interdisciplinary courses (FIC)		9	270
School FIC	6		
Department FIC	3		
Core + Core Elective including Specialization (CC)		42	1260
Core	27		
Core Elective (Inc Specialization)	15		
Minor (MC) + Open Elective (OE)	0	0	0
Research / Design / Internship/ Project (RDIP)		19	570
Internship / Design Project / Startup / NGO	5		
Internship / Research / Thesis	14		
Total		**82**	**2460**

Semester wise Course Credit Distribution Under Various Categories						
Category	**Semester**					
	I	**II**	**III**	**IV**	**Total**	**%**
Ability Enhancement Courses - AEC	2	0	1	0	3	**4**
Value Added Courses - VAC	0	3	0	0	3	**4**
Skill Enhancement Courses - SEC	3	3	0	0	6	**7**
Foundation / Interdisciplinary Courses - FIC	3	3	3	0	9	**11**
CC / SE / CE / TE / DE / HSS	14	13	15	0	42	**51**
Minor / Open Elective - OE	0	0	0	0	0	**0**
(Research/ Design/ Industrial Practice/Project/Thesis/Internship) -RDIP	0	0	5	14	19	**23**
Grand Total	**22**	**22**	**24**	**14**	**82**	**100**

Note: L-T/D-P/Pr and the class allocation is as follows.

a) Learning Hours : 30 learning hours are equal to 1 credit.

b) Lecture/Tutorial : 15 contact hours (60 minutes each) per semester are equal to 1 credit.

c) Discussion : 30 contact hours (60 minutes each) per semester are equal to 1 credit.

d) Practical : 30 contact hours (60 minutes each) per semester are equal to 1 credit.

e) Project : 30 project hours (60 minutes each) per semester are equal to 1 credit.

SEMESTER - I								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 501	Community Engagement and Social Responsibility	0	0	1	1*
2	AEC	S AEC	AEC 501	Effective Communication for Impactful Interviews	2	0	0	2
3	SEC	D SEC	SEC 501	Introduction to R and Python	1	1	1	3
4	FIC	D FIC	FIC 501	Data Science for Beginners	3	0	0	3
5	Core	CC	MAT 501	Linear Algebra	3	0	0	3
6	Core	CC	MAT 502	Algebra	3	1	0	4
7	Core	CC	MAT 503	Real Analysis	3	1	0	4
8	Core	CC	MAT 504	Programming using C and Octave or MATLAB	2	0	1	3
				Semester Total	**17**	**3**	**3**	**22**

SEMESTER - II								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 502	Community Engagement and Social Responsibility	0	0	1	1
2	VAC	U VAC	VAC 503	Entrepreneurial Mindset	2	0	0	2
3	SEC	S SEC	SEC 105	Research Design and Methods	3	0	0	3
4	FIC	S FIC	FIC 108	Design Thinking	3	0	0	3
5	Core	CC	MAT 505	Ordinary Differential Equations	3	1	0	4
6	Core	CC	MAT 506	Probability and Statistics	3	0	0	3
7	Elective	CE		Core Elective	3	0	0	3
8	Elective	CE		Core Elective	3	0	0	3
				Semester Total	**20**	**1**	**1**	**22**

SEMESTER - III								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	AEC	S AEC	AEC 503	Research Seminar	0	0	**1**	1
2	FIC	S FIC	FIC 124	Psychology for Everyday Living	3	0	0	3
3	Core	CC	MAT 507	Numerical Methods and Analysis	3	0	0	3
4	Core	CC	MAT 508	Partial Differential Equations and Calculus of Variations	3	0	0	3
5	Elective	CE		Core Elective	3	0	0	3
6	Elective	CE		Core Elective	3	0	0	3
7	Elective	CE		Core Elective	3	0	0	3
8	RDIP	RDIP	MAT 510	Project - I	0	0	3	3
9	RDIP	RDIP	MAT 509	Summer Internship	0	0	2	2
				Semester Total	**18**	**0**	**6**	**24**

SEMESTER - IV								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	RDIP	RDIP	MAT 511	Project - II	0	0	14	14
				Semester Total	**0**	**0**	**14**	**14**

Pure Mathematics								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE	MAT 512	Functional Analysis	3	0	0	3
2	Elective	CE	MAT 520	General Topology	3	0	0	3
3	Elective	CE	MAT 529	Algebra -II	3	0	0	3
4	Elective	CE	MAT 587	Complex Analysis	3	0	0	3
5	Elective	CE	MAT 544	Algebraic Topology	3	0	0	3
6	Elective	CE	MAT 588	Operator Theory	3	0	0	3

Applied Mathematics								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE	MAT 530	Dynamical Systems	3	0	0	3
2	Elective	CE	MAT 534	Mathematics for Machine Learning	3	0	0	3
3	Elective	CE	MAT 548	Applied Statistics	3	0	0	3
4	Elective	CE	MAT 570	Tensor Calculus	3	0	0	3
5	Elective	CE	MAT 514	Optimization Techniques	3	0	0	3

Data Science and Industrial Mathematics								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE	MAT 515	Data Structures and Algorithms	3	0	0	3
2	Elective	CE	MAT 521	Industrial Mathematics	3	0	0	3
3	Elective	CE	MAT 534	Mathematics for Machine Learning	3	0	0	3
4	Elective	CE	MAT 540	DBMS with Data Lake and Warehousing	3	0	0	3
5	Elective	CE	MAT 548	Applied Statistics	3	0	0	3

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Effective Communication for Impactful Interviews

Course Code	AEC 501	**Course Category**	AEC	**L**	**T**	**P**	**C**
				2	0	0	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Literature & Languages	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. This course equips the learners for successful job hunting by fostering a comprehensive understanding and application of the KASB Model in professional communication, enhancing verbal communication skills to excel in interviews, mastering non-verbal communication for a positive first impression, and guiding them in customizing application materials to stand out from the crowd.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify key components of verbal and non-verbal communication and their significance in the interview process.	1	50%	50%
Outcome 2	Develop the skill to articulate thoughts clearly and concisely, using effective interview responses.	2	65%	60%
Outcome 3	Exhibit proficiency in the art of storytelling as a communication tool in interviews.	2	65%	60%
Outcome 4	Create personalized and tailored resumes, cover letters, and SOPs to align with specific job or educational opportunities.	3	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	1	1	1	3	1		3	2	3	2	3			
Outcome 2	2	3	3	1	3	1		3	2	3	3	3			
Outcome 3	2	1	3	2	3	2		3	2	3	3	3			
Outcome 4	2	3	3	2	3	3		3	2	3	3	3			
Average	**2**	**2**	**2.5**	**1.5**	**3**	**1.75**		**3**	**2**	**3**	**2.75**	**3**			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction: An Overview**	**9**		
	Types of interview	2	1	4
	Communication as a strategy	3	1	4,5
	The KASB Model	4	1	4
Unit 2	**Articulation Skills**	**8**		
	The 3 Vs of Communication	2	1	1,4
	Tone, Pitch and Modulation	4	2	4,5
	Practice session	4	2	
Unit 3	**Story Telling**	**6**		
	The Importance of story telling	2	3	6
	Creating stories around' Tell Me About Yourself'	2	3	6,7
	Group Discussion	2	3	8
Unit 4	**Written Strategy**	**10**		
	Resume	4	4	2,4
	Cover Letter	4	4	2,4
	SOP	2	4	2,4
Unit 5	Mock Interview Sessions	**12**	1,2,3.4	
	Total Hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (60%)**				**Interview Handling Process (40%)**
		CLA-1 15%	**Mid-1**	**CLA-2 15%**	**CLA-3 15%**	
Level 1	Remember	100%		30%	50%	20%
	Understand					
Level 2	Apply			70%	50%	50%
	Analyse					
Level 3	Evaluate					30%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Cialdini, R. B. (2021). Influence: The psychology of persuasion (Revised edition). Harper Perennial Modern Classics.
2. Dipboye, R. L., & Cole, C. H. (2019). Secrets of a hiring manager: How to land any job and win over any boss. HarperBusiness.
3. LaFare, M. (2013). Veritas: A game of lies. Penguin Books.
4. Mock, P., & Turner, L. (2019). The interview for dummies (6th edition). John Wiley & Sons.
5. Stone, D. D., Patton, B., & Heen, S. (2000). Difficult conversations: How to discuss what matters most (2nd edition). Viking.
6. Dolan, G. (2019). Storytelling for job interviews: How to use stories, nail an interview and land your dream job. BookBaby.
7. Pink, S. (2014). To sell is human: The science of persuasion. Penguin Books.
8. Lewis, V. J. (2018). Group discussion: A practical guide (7th edition). Kogan Page

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Introduction to R and Python

Course Code	SEC 501	**Course Category**	SEC	**L**	**T**	**P**	**C**
				1	1	1	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. In Python, identify and describe essential elements such as syntax, keywords, variables, indentation, data types, lists, tuples, sets, dictionaries, operators, control statements, and loops.
2. Understand the significance of built-in functions, user input-output, matrix computations, linear equations, and graphing curves and surfaces using Matplotlib and file handling in Python.
3. Implement R programming fundamentals, including objects, vectors, matrices, arrays, data manipulation techniques (subsetting, filtering, merging), and data frames, and create visualisations using ggplot2 in R.
4. Synthesise knowledge from Python and R to perform comprehensive data analysis and create reports that include descriptive statistics, linear regression, hypothesis testing, and time series forecasting.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate an understanding of Python programming fundamentals, including syntax, keywords, variables, data types, lists, tuples, sets, dictionaries, operators, and control statements.	2	80	70
Outcome 2	Grasp core programming concepts by comprehending the role of built-in functions, user input-output, file handling and graphing curves and surfaces using Matplotlib in Python.	3	75	70
Outcome 3	Apply programming skills in R by effectively using objects, vectors, matrices, arrays, and data frames, and will demonstrate the practical application of data manipulation techniques, including sub-setting, filtering, and merging, and create visualizations using ggplot2 in R.	4	75	70
Outcome 4	Integrate Python and R knowledge to perform sophisticated data analysis that incorporates descriptive statistics, linear regression, hypothesis testing, and time series forecasting, showcasing a synthesis of programming skills across both languages.	4	75	70
Outcome 5	Demonstrate an understanding of Python programming fundamentals, including syntax, keywords, variables, data types, lists, tuples, sets, dictionaries, operators, and control statements.	2	80	70

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	-	-	-	-	1	-	-	2	3	1	2
Outcome 2	3	3	3	2	1	-	-	-	2	-	-	2	3	2	2
Outcome 3	3	3	3	3	1	-	-	-	2	-	-	2	3	2	2
Outcome 4	3	3	3	3	3	-	-	-	3	-	-	2	3	2	2
Outcome 5	3	2	3	3	3	-	-	-	2	-	-	3	2	2	2
Average	**3**	**3**	**3**	**3**	**2**	-	-	-	**2**	-	-	**2**	**3**	**2**	**2**

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1		**6**		
	Introduction to data and its different types of scales.	3	1,2	1
	Summarising data, different types of descriptive statistics	3	1,2	1
Unit 2		**9**		
	Introduction to Vectors, matrices	3	2,3	1
	Recursive functions, Matrix computations and linear equations	3	2,3	1
	Solving system of Linear Equations. Consistency, transpose, determinants, inverses, trace,	3	2,3	1
Unit 3		**15**		
	Basic principles of probability, Random variables.	2	3,4	2
	The Binomial, Normal and other popular distributions.	2	3,4	2
	Inference for one or two samples means using the t-distribution, statistical power for comparing two groups	2	3,4	2
	Introduction to Correlation Analysis, Correlation coefficient for Categorical and Continuous data.	2	4	2
	Introduction to the logistics regression.	4	4	2
Total Contact Hours		**30**		

Course Unitization Plan Lab

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
1	Write a program to demonstrate the use of Python syntax, keywords, and variables.	2	1	1
2	Create a program that uses indentation and comments to improve code readability.	2	1	1
3	Implement a program that showcases different data types in Python (int, float, string, Boolean).	2	1	1
4	Write a program that manipulates lists (e.g., sorting, appending, slicing).	2	1	1
5	Create a program that demonstrates using tuples and sets in Python.	2	2	1
6	Implement a dictionary to store and retrieve information.		2	1
7	Write a program that uses different operators in Python (+, -, *, /, //, %, **).	2	2	1
8	Create a program that includes control statements (if-else, nested if-else, switch-case) and loops (for, while).	2	2	1
9	Write a program to create and manipulate objects in R.	2	3	2
10	Implement a program that demonstrates using vectors and matrices in R.	2	3	2
11	Create a program that works with arrays and lists in R.	2	3	2
12	Write a program to handle missing data in a data frame.	2	3	2
13	Implement a program that reads and writes data to CSV or text files.	2	4	2
14	Create a program that performs data manipulation tasks (subsetting, filtering, merging) on a data frame.	2	4	2
15	Write a program that uses ggplot2 to create a plot in R.	2	3,4	2
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)								End Semester Exam (40%)	
		CLA-1 20%		Mid-1 20%		CLA-2 10%		CLA-3 10%			
		Th	Pr	Th	Pr	Th	Pr	Th	Pr	Th	Pr
Level 1	Remember	35%	40%	20%	20%	30%	15%	25%		20%	15%
	Understand	35%	40%	20%	20%	30%	15%	25%		20%	15%
Level 2	Apply	15%	10%	20%	20%	20%	20%	25%		25%	25%
	Analyse	15%	10%	20%	20%	20%	20%	25%		25%	25%
Level 3	Evaluate			10%	10%		15%			5%	10%
	Create			10%	10%		15%			5%	10%
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Guido van Rossum and the Python development team Python Tutorial Release 3.7.0.
2. W. N. Venables, D. M. Smith and the R Core Team, An Introduction to R
3. R in Action, Robert L. Kabacoff, Second Edition, Paperback, Dreamtech Press
4. A Beginner's Guide to R, Alain F. Zuur, Elena N. Ieno, Erik H. W. G. Meesters, Springer New York.
5. The Absolute Beginner's Guide to Python Programming, A Step-by-Step Guide with Examples and Lab Exercises, Kevin Wilson, Apress Berkeley, CA
6. Python Programming Fundamentals, Kent D. Lee, Springer London

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Data Science for the Beginners

Course Code	FIC 501	**Course Category**	FIC	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. After completing this course, students will fully grasp different data types and representations. Also, they have a basic understanding of descriptive statistics for the given datasets.
2. Students will understand linear algebra concepts well, enabling them to manipulate vectors and matrices and solve linear systems efficiently.
3. Upon completing the course, students will be proficient in applying probability principles and conducting statistical inference, including point estimation, confidence intervals, and hypothesis testing for various scenarios.
4. Equip the Students with the knowledge and skills necessary to apply regression techniques for modelling numerical outcomes and logistic regression for classification tasks, both for numerical and categorical data.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain the different types of data and graphical representation of data.	2	70%	65%
Outcome 2	Compute descriptive statistics for any given dataset, such as different measures of central tendency and variation in the data.	2	70%	65%
Outcome 3	Interpret different definitions of probability and the different types of random variables. Illustrate the application of the central limit theorem. Draw inferences about the population parameters.	2	70%	65%
Outcome 4	Describe regression analysis using the concept of matrices and the solution of the system of equations.	2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	2	2	1	2	-	-	-	-	-	-	-	-	-
Outcome 2	1	2	2	2	1	-	-	-	-	-	-	-	-	-	-
Outcome 3	2	2	1	1	1	-	-	-	-	-	-	-	-	-	-
Outcome 4	2	2	2	1	2	3	-	-	-	-	-	-	-	-	-
Average	**2**	**2**	**2**	**1**	**1**	**2**	-	-	-	-	-	-	-	-	-

Course Unitization Plan

Unit	Unit Name	Required Contact hours	CLOs Addressed	Reference Used
	Unit-I: Data Representations	**9**		
1.	Introduction to data, data structures	1	1	1,3
2.	Variables and Basic data collection techniques	1	1	1,3
3.	Summarising data, Descriptive Statistics	2	1,2	1,3
4.	Graphics, Histograms, and Popular database software.	2	1,2	1,3
5.	A glimpse inside the mind of a data scientist	1	1	1,3
6.	Discussion and Tutorial-I	2	1	1,3
	Unit-II: Basics of Linear Algebra	**10**		
7.	Introduction to Vectors, matrices and linear systems,	1	4	1,2
8.	Solving system of Linear Equations. Consistency, transpose, determinants, inverses, trace,	1	4	2
9.	Vector space, subspaces,	1	4	2
10.	Independence of vectors, basis and dimension, dot product, inner product, Eigenvalues and Eigenvectors.	2	4	1,2
11.	Dot product, inner product and its application	2	4	2
12.	Eigenvalues and Eigenvectors.	1	4	2
13.	Discussion on Practical applications of vector spaces and Matrices.	2	2,4	1,2,4
	Unit-III: Probability Distributions and Inferential Statistics	**12**		
14.	Basic principles of probability, Different approaches for defining the probability.	1	3	1,3
15.	Random variables, Types of random Variables and their distribution.	1	3	1,3
16.	The Binomial, Normal and other popular distributions.	1	3	1,3
17.	Foundations for Statistical inference, Point and Interval Estimates.	1	3	1,3
18.	Discussion and Tutorial	1		1,3
19.	General ideas for statistical inference in estimating the population proportion, Central Limit theorem and its application.	2	3	1,3
20.	Inference for proportions and tables using the normal and chi-square distributions.	1	3	1,3
21.	Inference for categorical data,	1	3	1,3
22.	Inference for one or two samples means using the t-distribution, statistical power for comparing two groups	2	3	1,3
23.	Tutorial-III	1	3	1,3,4
	Unit-IV: Regression and Classification	**14**		
24.	Introduction to Correlation Analysis, Correlation coefficient for Categorical and Continuous data.	2	4	
25.	Introduction to linear regression, Scatter Plot.	1	4	1,4
26.	Regression for a numerical outcome with one predictor Variable,	2	4	1,4
27.	Brief Discussion about Model Adequacy, accuracy, and validation.	2	4	1,3,4
28.	Regression for numerical and categorical data using many Predictors,	1	4	1,4
29.	Logistic regression for classification,	2	4	1,4
30.	Tutorial and Doubt Clearing Session	1	4	1,4
31.	Practical applications of Regression and Classification in prediction and forecasting	2	4	1,4
32.	Tutorial-II	1	4	1,4
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-term (20%)		CLA-2 (10%)		CLA-3 (10%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	30%		25%		30%		20%		20%	
	Understand	30%		25%		30%		20%		30%	
Level 2	Apply	20%		25%		20%		30%		25%	
	Analyse	20%		25%		20%		30%		25%	
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. Openintro Statistics (4th edition), Diez David M Christopher D Barr and Çetinkaya, 2019.
2. Linear Algebra and its Applications, Gilbert Strang, Publisher Cengage India Private Limited, 2005.
3. First Course in Probability (11th Edition), Sheldon Ross, Academic Press, 2014.
4. An Introduction to Statistical Learning, with Applications in R, by James, Witten, Hastie and Tibshirani, Springer, 2013

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Linear Algebra

Course Code	MAT 501	**Course Category**		**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Develop a comprehensive set of skills and knowledge to solve complex systems of linear equations and utilizing matrix operations by introducing determinants, vector spaces, and their applications in real-world scenarios.
2. To gain proficiency in understanding and manipulating linear transformations, eigenvalues, and eigenvectors.
3. To apply the Gram-Schmidt process to find the orthonormal basis for the given subspaces.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Proficiently solve linear equations and perform matrix operations. Understand special matrix types.	1	75%	80%
Outcome 2	Define linear transformations and their matrix representations. Outline the equivalent conditions for the vector spaces to be isomorphic.	1	70%	75%
Outcome 3	Understand the elementary row operations in the system of equations and analyze the properties of the determinant of a square matrix.	2	75%	70%
Outcome 4	Summarize the concepts of eigenvalue, eigenvectors and diagonalization for both linear operators and matrices and derive some characterization for diagonalization.	1	75%	65%
Outcome 5	Ability to acquire the knowledge of orthonormal sets and orthogonal complement of the given subspace.	1	70%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	1	-	1	1	-	-	-	-	-	-	-	2	2	1
Outcome 2	1	1	1	1	1	-	-	-	-	-	-	-	3	3	1
Outcome 3	2	2	1	1	1	-	-	-	-	-	-	-	3	2	1
Outcome 4	2	2	2	1	2	-	-	-	-	-	-	-	3	2	1
Outcome 5	2	2	2	1	2	-	-	-	-	-	-	-	3	3	2
Average	**2**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Systems of Linear Equations, Algebraic Properties of Matrix Operations	2	1	1
	Special Types of Matrices, Echelon Form and Row reduced echelon of a Matrix	2	1	1
	Rank of a matrix, Solving Linear Systems, Elementary Matrices,	2	3	1,2
	Determinants, Properties of Determinants and finding matrix inverse	1	3	1
	Vectors in the Plane and in 3-Space, Vector Spaces	2	1	1,2
Unit 2	Vector spaces and Subspaces	2	2	1
	Linearly dependent and linearly independent	1	2	1
	Basis & Dimension	2	2	1
	Quotient spaces, Direct sums	2	2	1
	Maximum linearly independent subsets	2	2	1
Unit 3	Linear transformations, null spaces and ranges	2	3	2
	Matrix representation of a linear transformation	1	3	2
	Composition of Linear transformations and matrix multiplication	2	3	2
	Invertibility and Isomorphisms	2	3	2
	Change of coordinate matrix, Dual spaces	2	3	2
Unit 4	Eigenvalues and Eigenvectors	2	4	1,2
	Characteristic polynomial, Eigenspaces	2	4	1,2
	Diagonalization	2	4	1,2
	Some characterizations for diagonalizability	2	4	1,2
	Invariant subspaces	1	4	1,2
Unit 5	Inner product spaces and norms	2	5	1
	Orthogonal sets and orthonormal sets	2	5	1
	Gram Schmidt orthogonalization, Orthogonal complement	2	5	1
	Adjoint of a linear operator	1	5	1,2
	Normal and Self-adjoint operators	2	5	1,2

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 10%	Mid-1 20%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	40%	50%	60%	60%	60%
	Understand					
Level 2	Apply	60%	50%	40%	40%	40%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Linear Algebra (4th edition), Stephen H. Friedberg, Arnold J. Insel & Lawrence Spence, Pearson Education, 2010.
2. Linear Algebra- A Geometric Approach (3rd edition), S. Kumaresan, PHI Learning, 2001.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Algebra

Course Code	MAT 502	Course Category	CC	L	T	P	C
				3	1	0	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mathematics	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. The objective is to equip the students with the mathematical definitions, proofs, application, and connections with other areas of Mathematics
2. To introduce the basic algebraic structures especially groups, rings, and fields.
3. To construct substructures (subgroups and subrings).
4. To analyse a given algebraic structure in detail.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Categorize different kind of groups and understand various groups e.g. matrix groups, permutation groups.	2	80%	70%
Outcome 2	Understand subgroups, normal subgroups, homomorphism of groups and Isomorphism theorems and their applications.	2	70%	65%
Outcome 3	To understand the group actions and its various applications	2	70%	65%
Outcome 4	Understand the class equation and determine the class equation for permutation group, Cauchy's Theorem.	1	70%	65%
Outcome 5	Understand the Sylow theorems and calculate the number of p-subgroup of a group.	1	70%	60%
Outcome 6	Define a ring, subring, integral domain and field.	1	70%	70%
Outcome 7	Define ideal and understand prime ideals, maximal ideals, principal ideals and different properties of ideals	1	70%	60%
Outcome 8	Understand the homomorphism and isomorphism theorems of rings and their applications.	2	70%	60%
Outcome 9	Categorize integral domain into Euclidean Domain, Principal ideal Domain and Unique Factorization Domain	2	70%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	1	-	1	1	-	-	-	-	-	-	-	2	2	1
Outcome 2	1	1	1	1	1	-	-	-	-	-	-	-	3	3	1
Outcome 3	2	2	1	1	1	-	-	-	-	-	-	-	3	2	1
Outcome 4	2	2	2	1	2	-	-	-	-	-	-	-	3	2	1
Outcome 5	2	2	2	1	2	-	-	-	-	-	-	-	3	3	2
Outcome 6	3	3	3	2	2	-	-	-	-	-	-	-	2	3	3
Outcome 7	2	1	-	-	1	-	-	-	-	-	-	-	3	2	2
Outcome 8	2	1	1	-	1	-	-	-	-	-	-	-	3	3	1
Outcome 9	2	3	2	1	2	-	-	-	-	-	-	-	2	2	1
Average	**2**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Revision of the set theory, relation, equivalence relation, injective, surjective, and bijective function.	1	1	1
	Introduction to groups using examples of group of integers	1	2	1
	Permutation group and conjugacy classes in permutation group	1	4	1
	Lagrange Theorem and cosets	3	4	1
	Cayley Theorem	2	4	1
	Homomorphism of Groups, Examples	1	4	1
	Properties of Group Homomorphism, Normal Subgroups and Quotient Groups	3	3	1
	Isomorphism of Groups, Examples	1	4	1
	Isomorphism theorems	3	4	1
Unit 2	Group action and examples	1	4	1
	Orbit and Stabilizer of group action, examples and related theorems	3	4	1
	Introduction to the first Sylow Theorem for finite groups	1	4	1
	Second and third Sylow Theorem, Applications	3	4	1
Unit 3	Definition of a ring, Examples	2	2	1
	Basic theorems on rings	2	4	1
	Ring Homomorphisms, examples	2	4	1
	Kernel of a ring homomorphism and quotient ring	2	3	1
	Ring Isomorphism Theorems	2	4	1
	Correspondence Theorem	2	3	1
	Ideals, Prime Ideals	2	3	1
	Maximal Ideals	2	3	1
Unit 4	Integral Domain, examples, Theorems	3	3	1
	Field definitions, examples, Theorems	3	1	1
	Euclidean Norm	1	4	1
	Euclidean Domain definition and Examples	2	3,4	1
Unit 5	Principal Ideal domain: Definition	1	3,4	1
	Principal Ideal domain: Examples and Theorems	2	3,4	1
	Unique Factorization domain: Definitions	2	3,4	1
	Unique Factorization domain: Examples and Theorems	2	3,4	1
	Dedekind Hasse Norm	1	3,4	1
	Relations between ED, PID and UFD	3	1,4	1

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 10%	Mid-1 25%	CLA-2 10%	CLA-3 15%	
Level 1	Remember	60%	50%	60%	40%	20%
	Understand					
Level 2	Apply	40%	50%	40%	60%	80%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Abstract Algebra (3rd edition), David S. Dummit and Richard M. Foote, Wiley Publishers,2010.
2. Algebra (2nd edition), M. Artin, Pearson Publishers, 2010.
3. Basic Abstract Algebra (2nd edition), P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul,
4. Cambridge University Press, 2009.

Other Resources

1. https://ysharifi.wordpress.com/
2. https://www.youtube.com/watch?v=uYsrCAr4PUo&list=PLBY4G2o7DhF0JCgapYKrqibGaJuvV4Gkb

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Real Analysis

Course Code	MAT 503	**Course Category**	CC		**L**	**T**	**P**	**C**
					3	1	0	4
Pre-Requisite Course(s)	Calculus	**Co-Requisite Course(s)**	Linear Algebra	**Progressive Course(s)**				
Course Offering Department	Mathematics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To achieve knowledge and understanding of sets, continuity, differentiability, integrability, finiteness and connected-ness, and their various properties and capabilities to solve wide range of problems in science
2. To demonstrate the capability to use a range of established techniques and a reasonable level of skill in calculation and manipulation of the material to solve problems in the following areas: uniform continuity of functions, sequences of functions, uniform convergences, series, power series, Riemann integration, functions of several variables, differentiation of functions of several variables.
3. To apply the concepts and principles in mathematical analysis in well-defined contexts beyond those in which they were first studied, showing the ability to evaluate critically the appropriateness of different tools and techniques
4. To demonstrate skills in constructing rigorous mathematical arguments.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the notion of countable, uncountable sets, metric space, open sets and interior of sets.	1	75%	80%
Outcome 2	State and Prove the Cantor's intersection theorem, Finite Intersection property, and Baire's category theorem.	**3**	70%	75%
Outcome 3	Outline equivalent conditions for the function to be continuous	**2**	70%	70%
Outcome 4	Summarize the concepts of compact metrics space and derive equivalent characterization for compactness and recognize the concepts of connected metric space and contraction mapping	**1**	70%	70%
Outcome 5	Able to understand the deep notion behind Riemann Integrations and their applications and its generalization by Lebesgue criterion.	**2**	70%	70%
Outcome 6	Ability to acquire knowledge of pointwise and uniform convergence of sequence and series.	**2**	75%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	1	-	1	1	-	-	-	-	-	-	-	2	2	1
Outcome 2	1	1	1	1	1	-	-	-	-	-	-	-	3	3	1
Outcome 3	2	2	1	1	1	-	-	-	-	-	-	-	3	2	1
Outcome 4	2	2	2	1	2	-	-	-	-	-	-	-	3	2	1
Outcome 5	2	2	2	1	2	-	-	-	-	-	-	-	3	3	2
Outcome 6	3	3	3	2	2	-	-	-	-	-	-	-	2	3	3
Average	**2**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Real line and Completeness property	3	1	1
	Limit and continuity	3	1	1
	Countable and Uncountable sets, Cantor sets	3	1	1
	Monotone Functions	3	1	1
Unit 2	Metric Spaces, examples, the relative metric	3	1	1
	Interior and limit points, open and closed sets, bounded sets	3	1	1
	Complete metric spaces, Continuous functions and homeomorphisms.	3	2 & 3	1
	Convergence in metric spaces, and Nested set theorem, Baire category Theorem.	3	2	1
Unit 3	Compactness, totally bounded sets	3	4	1
	Characterizations of compactness, Finite intersection property,	3	4	1
	Continuous functions on compact sets, Uniform continuity	3	4	1
	Connectedness and its properties, Continuous functions	3	4	1
Unit 4	Riemann Integration	3	5	1
	Fundamental theorem of calculus	3	5	1
	Set of measure zero, Lebesgue's Criterion	3	5	1
	Cantor set, Integrable Functions.	3	5	1
Unit 5	Convergence of sequence and series of functions: Pointwise and uniform convergence of functions	3	6	1
	Series of functions, Power series	3	6	1
	Dini's theorem, Ascoli's theorem,	3	6	1
	Nowhere-differentiable Continuous functions, Weierstrass approximation theorem.	3	6	1

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 10%	Mid-1 25%	CLA-2 10%	CLA-3 15%	
Level 1	Remember	40%	60%	40%	50%	60%
	Understand					
Level 2	Apply	60%	40%	60%	50%	40%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Real analysis. Carothers, N. L. Cambridge University Press, Cambridge, 2000.
2. Elements of Real Analysis, Charles G. Denlinger, Johns & Bartlett Learning, 2011

Other Resources

1. Principles of Mathematical Analysis, Rudin, Walter, McGraw-Hill, New York, 1976
2. Mathematical analysis (2nd edition), Apostol T.M., Addison-Wesley Publishing Co., Reading, Mass-London-Don Mills, Ont., 1974.

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Programming using C and MATLAB / Octave

Course Code	MAT 504	**Course Category**	CC	**L**	**T**	**P**	**C**
				2	0	2	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Master fundamental C programming concepts including variables, operators, loops, and functions.
2. Apply advanced techniques like recursion, linked lists, and file operations to solve complex problems.
3. Develop proficiency in project organization and compilation using Make for efficient software development.
4. Gain practical skills in scientific computing, data analysis, and visualization for real-world applications.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Analyse and evaluate C programming code to identify errors and inefficiencies	2	60%	90%
Outcome 2	Design and implement algorithms using advanced C programming techniques such as recursion and linked lists.	2	75%	70%
Outcome 3	Demonstrate proficiency in organizing C projects and compiling them using Make, ensuring efficient project management.	2	75%	70%
Outcome 4	Apply C programming skills to solve real-world problems in scientific computing, data analysis, and visualization, showcasing practical application of learned concepts.	2	50%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	-	-	-	-	1	-	-	2	3	1	2
Outcome 2	3	3	3	2	1	-	-	-	2	-	-	2	3	2	2
Outcome 3	3	3	3	3	1	-	-	-	2	-	-	2	3	2	2
Outcome 4	3	3	3	3	3	-	-	-	3	-	-	2	3	2	2
Average	**3**	**3**	**3**	**3**	**2**	-	-	-	**2**	-	-	**2**	**3**	**2**	**2**

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction to C programming language, history, and features	1	1,2	1
	Variables and data types	1	1,2	1
	Operators and expressions	1	1,2	1
	Control structures: conditions and loops	2	1,2	1
	Functions: definition, declaration, and usage	1	1,2	1
Unit 2	Arrays: one-dimensional arrays and pointers	2	2,3	1
	Multi-dimensional arrays and dynamic memory allocation	2	2,3	1
	Pointers and memory management	2	2,3	1
	Recursion: principles and examples	1	2,3	1
	Introduction to linked lists	1	2,3	1
	Operating on files: file handling in C	2		
	Organizing C projects and Makefile compilation	2	3,4	2
	Project Work and Application : Project presentation and review, troubleshooting, and advanced topics review	6	3,4	2
Unit 3	Matrices and vector operations	2	3,4	2
	Vectorization of code for performance optimization	1	3,4	2
	Import and export of data in C	1	4	2
	Plotting curves and surfaces	1	4	2
	Introduction to fractals and their implementation	1	4	2

Course Unitization Plan Lab

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Write a program to print "Hello, World!" to the console	2	1	1
Unit 2	Write a program to perform arithmetic operations on different types of variables	2	1	1
Unit 3	Implement a program with if-else statements based on user input	2	1	1
Unit 4	Write a program with multiple functions for mathematical operations	2	1	1
Unit 5	Implement operations on one-dimensional arrays and demonstrate pointer arithmetic	2	2	1
Unit 6	Read data from a file, perform operations, and write results to another file	2	2	1
Unit 7	Implement basic linked list operations like insertion, deletion, and traversal	2	2	1
Unit 8	Work on guided projects involving computational tasks like simulations or data analysis	2	2	1
Unit 9	Work on guided projects involving tasks like data visualization or image processing	2	3	2
Unit 10	Perform arithmetic operations and plot basic graphs using MATLAB	2	3	2
Unit 11	Plot various graphs using sample datasets	2	3	2
Unit 12	Perform matrix addition, subtraction, multiplication, and inversion operations	2	3	2
Unit 13	Write MATLAB functions for mathematical operations and create a script to execute them	2	4	2
Unit 14	Perform operations like grayscale conversion, edge detection, and image enhancement	2	4	2
Unit 15	Generate and plot various signals, perform operations like filtering and Fourier transform	2	3,4	2

Learning Assessment Theory

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 10%	Mid-1 15%	CLA-2 10%	CLA-3 15%	
Level 1	Remember	40%	40%	50%	60%	60%
	Understand					
Level 2	Apply	60%	60%	50%	40%	40%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Mark Lutz : Learning Python , O'Reilly Media Inc.
2. GNU/Octave Documentation: http://docs.octave.org

Other Resources

1. C Programming Absolute Beginner's Guide" by Greg Perry and Dean Miller
2. Website: GeeksforGeeks (https://www.geeksforgeeks.org/) - for Both C Programming and MATLAB/Octave
3. Online Course: "MATLAB Programming for Beginners" on Coursera.

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

COMMUNITY SERVICE AND SOCIAL RESPONSIBILITY

Course Code	VAC 502	**Course Category**	VAC	**L**	**T**	**P**	**C**
				0	0	2	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CEL	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Encourage initiatives that address local needs, foster self-sufficiency, and promote environmental sustainability within the community.
2. Equip participants with a deeper understanding of social issues and a sense of responsibility towards marginalized communities.
3. Inspire active participation in community service programs and foster a culture of giving back among individuals and organizations.
4. Develop and implement programs that contribute to skill development, economic empowerment, and equal opportunities for underprivileged sections of society.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Develop effective strategies for identifying and addressing community needs.	3	80%	80%
Outcome 2	Demonstrate empathy and cultural sensitivity when engaging with diverse community groups.	4	80%	75%
Outcome 3	Implement sustainable solutions and evaluate their impact on social well-being.	5	90%	85%
Outcome 4	Collaborate effectively within teams to design and lead community service projects.	6	90%	80%

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments 50%				End Semester Exam 50%
		CLA-1 20%	Mid-1 20%	CLA-2 20%	CLA-3 20%	
Level 1	Remember	10%	10%			20%
	Understand					
Level 2	Apply		10%	10%		20%
	Analyse					
Level 3	Evaluate				10%	10%
	Create					
Total		**10%**	**20%**	**10%**	**10%**	**50%**

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Entrepreneurial Mindset

Course Code	VAC 503	**Course Category**	Foundation Course	**L**	**T**	**P**	**C**
				2	0	0	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Management	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To develop a foundation in innovation and entrepreneurship among the students.
2. To enhance analytical skills of students for practical application of their ideas.
3. To make students proficient in designing solutions.
4. To introduce students to different phases of entrepreneurship.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe and classify the basic concepts of Innovation and Entrepreneurship	2	90%	80%
Outcome 2	Discuss the concept of Design Thinking and prototyping	2	80%	70%
Outcome 3	Apply design thinking to generate innovative ideas and strategize implementation plan	3	65%	60%
Outcome 4	Prepare a business plan by assessing customer segment, market validation and product development	4	60%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Management Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Strategic Thinking and Logical Reasoning	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	1	-	-	-	-	-	-	-	-	2	3	2
Outcome 2	2	2	2	-	2		2	-	-	-	-	3	2	2
Outcome 3	1	3	3	2	-	-	-	3	-	3	3	-	3	2
Outcome 4	2	3	3	2	-	-	-	3	2	3	3	3		3
Average	**2**	**2**	**3**	**2**	**1**	**0**	**1**	**2**	**1**	**2**	**2**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Entrepreneurship & Inventions**	**5**		
	Entrepreneurship and Types of Entrepreneurship	2	1	3,4
	Entrepreneurs and their Characteristics	1	1	3,4
	Innovation & its Types	2	1	1
Unit 2	**Exploration & Summarizing Facts**	**3**		
	Structured exploration and quantifying the data	2	3,4	3,4
	Analysing the data	1	3,4	3,4
Unit 3	**Reflection, Synthesizing and ideating**	**3**		
	Summarizing facts and designing a workable model	3	3,4	3,4
Unit 4	**Prototyping**	**8**		
	Definition and Basics of Prototyping	2	2,3,4	2
	Types and methods of Prototyping	4	2,3,4	2
	Innovations in prototyping	2	2,3,4	2
Unit 5	**Concept Ideation & Design Thinking**	**8**		
	Importance of Idea	1	3,4	1,2
	Idea Generation Techniques	1	3,4	1,2
	Validating the idea	1	3,4	1,2
	Definition and Basics of Design Thinking	2	2	5
	Stages of Design Thinking	3	2	5
Unit 6	**Market Validation**	**5**		
	Concept of Market Validation and its importance	2	3,4	3,4
	Customer survey	1	3,4	3,4,5
	Feedback and modifying the idea	2	3,4	3,4,5
Unit 7	**Segmentation of the potential users/ customers**	**3**		
	Customer segment and its types	2	4	3,4
	Understanding niche customer segment	1	4	3,4
	Reaching the real customers	1	4	3,4
Unit 8	**Industry Validation**	**2**		
	Industry validation and mentoring	2	3,4	3,4,5
Unit 9	**Solution Design**	**8**		
	Generate an Innovative Idea	3	3,4	1,2,5
	Develop a Business Plan	5	4	3,4
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 10%	Mid-1 20%	CLA-2 20%	CLA-3 %	
Level 1	Remember	90%	60%	50%		40%
	Understand					
Level 2	Apply	10%	40%	50%		60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Larry Keeley Brian Quinn Ryan Pikkel. Ten types of innovation -the discipline of building breakthroughs, John Wiley& Sons, Inc; 2013
2. Eric Ries. The lean startup how constant innovation creates radically successful businesses, Penguin Books
3. Bruce R. Barringer, R. Duane Ireland. Entrepreneurship Successfully Launching New Ventures, Pearson; 2020
4. Robert D. Hasrich, Dean A. Shepherd, Michael P. Peters, Entrepreneurship, McGraw Hill, 2020
5. Siva Prasad N. Design Thinking : Techniques And Approaches, Ane Books, New Delhi; 2023

Other Resources

Course Designers

1. Mr Udayan Bakshi, Assistant Professor, Paari School of Business, SRM University, A.P.

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Research Design and Methods

Course Code	SEC 105	Course Category	FIC	L	T	P	C
				3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Chemistry	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand and apply various research designs and methodologies.
2. Equip students with the practical skills necessary to conduct research independently.
3. Foster an understanding of ethical considerations in research.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Students will be able to identify a research problem	2	85%	80%
Outcome 2	Students will develop the ability to critically evaluate and compare different research designs and methodologies.	3	80%	75%
Outcome 3	Students will demonstrate an understanding of ethical considerations in research.	5	80%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	2	3	-	3	2	3	3	3	-	2	1	3
Outcome 2	2	1	2	2	1	-	2	2	1	2	3	-	3	2	2
Outcome 3	3	3	3	3	2	-	2	1	2	2	1	-	1	3	1
Average	**3**	**2**	**3**	**2**	**2**	-	**2**	**2**	**2**	**2**	**2**	-	**2**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Research Design and Methods**	**10**	**1**	**1,2**
	Overview of research: Definition, significance, purpose, and types.	4		
	Types of Research: Basic and applied research.	4		
	Google scholar, ResearchGate, Citations, h-index, i10 index Bibliography, Reference manager	2		
Unit 2	**Formulating Research Questions and Hypotheses**	**10**	**2**	**1,3**
	Developing clear and focused research questions	2		
	Literature survey, various sources of research information	2		
	Methodology of research	2		
	Importance of research design	2		
	Steps in conducting research	2		
Unit 3	**Introduction to scientific ethics**	**10**	3	**1,2,3**
	Key ethical principles: Honesty, integrity, transparency.	4		
	The role of ethics in experimental design	2		
	Ethical considerations in data collection and analysis.	2		
	Human and animal research ethics.	2		
Unit 4	**Report your findings**	**10**	3	**1,2,3**
	Writing reports, Structuring reports	2		
	Writing journal articles,	3		
	Writing research proposals	3		
	Producing oral presentations	2		
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 10%	Mid-1 15%	CLA-2 15%	CLA-3 10%	
Level 1	Remember	40%	60%	40%	60%	30%
	Understand					
Level 2	Apply	60%	40%	60%	40%	70%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Bordens K.S. and Abbott, B.b.: Research Design and Methods, McGraw Hill, 2008.
2. John W. Creswell and J. David Creswell Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" SAGE Publications, 2017
3. Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, Joseph Bizup and William T. FitzGerald, The Craft of Research, Fourth Edition, University of Chicago Press, 2016

Other Resources

Course Designers

1. Dr. Rajapandiyan J P, Assistant Professor, Department of Chemistry, SRM University AP

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Design Thinking

Course Code	FIC 108	**Course Category**	FIC	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Management	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Familiarize with the principles of Design Thinking
2. Learn to apply the principles of Design Thinking
3. Apply Design Thinking to solve problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Importance of Design Thinking	1	75%	90%
Outcome 2	Grasp the Concepts and process of Design Thinking	3	75%	90%
Outcome 3	Learn the process of Design Thinking	2	85%	90%
Outcome 4	Solve a problem using Design Thinking Principles	3	75%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	-	-	-	-	-	-	-	-	-	-	-	3	3	3
Outcome 2	3	-	-	-	-	-	-	-	-	-	-	1	3	1	3
Outcome 3	3	-	-	-	-	-	-	-	3	-	-	2	3	2	3
Outcome 4	3	3	3	3	-	-	-	-	3	3	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**2**	3	2	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	An Introduction to the innovation Process	15		1,2
	Understanding of Design Thinking & its Importance, Pillars of Design Thinking		2	1,2
Unit 2	Process – Understanding the Stages of Design Thinking	15	2	1,2
Unit 3	Identifying Opportunity Areas: Problem Framing & Definition	10	2	1,2,3
Unit 4	Idea Generation and Concept Development	10	2	1,2,3
Unit 5	Implementation and Managing Innovation	10	4	1,2,3

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)			End Semester Exam (50%)	
		CLA-1 20%	CLA-2 15%	CLA-3 15%		
Level 1	Remember	60%	60%	40%	30%	
	Understand					
Level 2	Apply	40%	40%	60%	40%	30%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**70%**	**30%**

Recommended Resources

1. Design Thinking – Techniques and Approaches, N. Siva Prasad
2. Design Thinking, Nigel Cross , BERG Publishing
3. Design Thinking- Integrating Innovation, Customer Experience and Brand Value, Thomas Lockwood , De-sign Management Institute, 2009

Other Resources

1. HBS – Online – Design Thinking & Innovation – course material
2. Case studies

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Ordinary Differential Equations

Course Code	MAT 505	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand and apply solution methods for ordinary differential equations, including both first and second-order equations. Explore advanced techniques such as power series methods, Bessel functions, and Legendre polynomials.
2. To understand the concepts of existence and uniqueness of initial value problems, essential for modeling dynamic systems in diverse fields. Learn theorems like Picard's and Peano's, Gronwall's inequality, and explore the continuous dependence of solutions.
3. Gain expertise in higher-order linear equations and systems, matrix exponential solutions, and phase space analysis. Delve into the study of asymptotic behavior, stability analysis, and boundary value problems with a focus on applications in physics, engineering, and other scientific domains.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Apply diverse solution methods, including power series and specialized functions, to solve ordinary differential equations, addressing real-world challenges in physics and engineering.	1,2	75%	80%
Outcome 2	Demonstrate comprehension of the existence and uniqueness of initial value problems, utilizing theorems such as Picard's and Peano's to analyze solutions' continuity.	1,2	70%	65%
Outcome 3	Master higher-order linear equations, matrix solutions, and phase space analysis for a nuanced understanding of dynamic systems' behavior.	2	75%	70%
Outcome 4	Develop skills in predicting the asymptotic behavior of solutions through stability analysis and Lyapunov methods.	3	70%	65%
Outcome 5	Solve boundary value and eigenvalue problems for second order differential equations such as heat equations, wave equations etc.	2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	2	2	1	-	-	-	-	-	-	-	3	3	3
Outcome 2	1	2	2	2	1	-	-	-	-	-	-	-	3	1	3
Outcome 3	2	2	1	1	1	-	-	-	-	-	-	-	3	2	3
Outcome 4	2	2	2	1	2	-	-	-	-	-	-	-	3	2	3
Outcome 5	2	2	2	1	2	-	-	-	-	-	-	-	3	2	3
Average	**2**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Review of Solution Methods**	**12 Hours**		
	Introduction to ODEs	1	**CO 1**	1
	Solution Methods for First-Order Equations	2	**CO 1**	1
	Tutorial	1	**CO 1**	1
	Solution Methods for Second-Order Equations	2	**CO 1**	1
	Power Series Methods	1	**CO 1**	1
	Tutorial	1	**CO 1**	1
	Bessel Functions	1	**CO 1**	1
	Legendre Polynomials	2	**CO 1**	1
	Tutorial	1	**CO1**	1
Unit 2	**Existence and Uniqueness of Initial Value Problems**	**12 Hours**		
	Picard's Theorem	1	**CO 2**	1,3
	Peano's Theorem	2	**CO 2**	1,3
	Tutorial	1	**CO 2**	1,3
	Gronwall's inequality	1	**CO 2**	1,3
	Continuation of solutions	2	**CO 2**	1,3
	Tutorial	1	**CO 2**	1,3
	Maximal interval of existence	1	**CO 2**	1,3
	Continuous dependence	2	**CO 2**	1,3
	Tutorial	1	**CO 2**	1,3
Unit 3	**Higher Order Linear Equations and linear Systems**	**12 Hours**		
	Fundamental solutions	1	**CO 3**	1
	Wronskian, Variation of constants	2	**CO 3**	1
	Tutorial	1	**CO 3**	1
	Matrix exponential solution	2	**CO 3**	2
	Behavior of solutions	1	**CO 3**	2
	Tutorial	1	**CO 3**	2
	Two Dimensional Autonomous Systems	1	**CO 3**	2
	Phase Space Analysis	2	**CO 3**	2
	Tutorial	1	**CO 3**	2
Unit 4	**Asymptotic Behavior**	**12 Hours**		
	Asymptotic Behavior and Stability	3	**CO 4**	1,2
	Tutorial	1	**CO 4**	1,2
	Linearized Stability	2	**CO 4**	1,2
	Lyapunov Methods	2	**CO 4**	1,2
	Simple critical points of nonlinear system	2	**CO 4**	1,2
	Tutorial	2	**CO 4**	1,2
Unit 5	**Boundary Value Problems for Second Order Equations**	**12 Hours**		
	Green's function	2	**CO 5**	1
	Sturm comparison theorems and oscillations	3	**CO 5**	1
	Tutorial	2	**CO 5**	1
	Eigenvalue Problems	2	**CO 5**	1
	Regular Sturm Liouville Problems	2	**CO 5**	1
	Tutorial	1	**CO 5**	1
Total		**60**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 10%	Mid-1 20%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	50%	50%	60%	40%	30%
	Understand					
Level 2	Apply	40%	40%	40%	60%	60%
	Analyse					
Level 3	Evaluate	10%	10%			10%
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Differential Equations with Applications and Historical Notes, G.F. Simmons, New York: McGrawHill, 1991.
2. Differential Equations, Dynamical Systems and Introduction to Chaos, M. Hirsch, S. Smale and R. Deveney, Academic Press, 2004.
3. Differential Equations and Dynamical Systems, Texts in Applied Mathematics (Vol. 7, 2nd Edition), Perko, Springer Verlag, New York, 1998.

Other Resources

1. Ordinary Differential Equations: Modern Perspective, Mohan C. Joshi, Narosa Publishing House, 2006.
2. Ordinary Differential Equations: Principles and Applications, A. K. Nandakumaran, P. S. Datti, Raju K. George, Cambridge IISc Series, Cambridge University Press, 2017.
3. Text book of ordinary differential equations ,V Raghavendra, V Lakshmikantam, S Deo, Tata McGrawHill Education, 2008.
4. Ordinary Differential Equations and Stability Theory: An Introduction, D. A. Sanchez, Dover Publ. Inc., New York, 1968.

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Probability and Statistics

Course Code	MAT 506	**Course Category**	FIC		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Mathematics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the concept of probability through Kolmogorov's Axioms and understand the difference be-tween the different approaches to defining probability. Apply conditional probability and Bayes' Rule to solve problems.
2. Define and analyze random variables and their properties. Evaluate cumulative distribution functions and their significance. Investigate the distribution function of a random variable. Examine special distributions such as Binomial, Poisson, Multinomial, Normal, Exponential, Gamma, and other important distributions.
3. Analyze the expectation, moments, and moment-generating functions. Introduce the concept of the multi-dimensional random variable and explore joint distributions and marginal and conditional distributions. Ex-plore the laws of large numbers (weak and strong) and the Central Limit Theorem.
4. Utilize descriptive statistics for data representation and analysis. Analyze the measure of central tendency and measure of variation. Understand the concept of population and sample and investigate the sampling distribution of statistics and their importance.
5. Introduction to statistical inference. Learn the different methods of point estimation. Assess the properties of unbiasedness and consistency for the point estimators. Understand and apply hypothesis testing, Neyman-Pearson fundamental lemma, and P-value.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand and apply basic combinatorics principles in probability calculations. Describe classical and axiomatic definitions of probability and their significance. Demonstrate proficiency in properties of probability functions, including conditional probability, Bayes' Rule, and the multiplication rule.	1,2	80%	75%
Outcome 2	Define and interpret random variables, cumulative distribution functions, and their properties. Analyze and compute moments, expectations, and moment-generating functions for random variables. Explain the concepts of the Laws of Large Numbers and the Central Limit Theorem. Apply these limit theorems in practical scenarios.	2,3	70%	65%
Outcome 3	Use descriptive statistics to represent and summarize data, including measures of location, variability, skewness, and kurtosis. Define and understand population and sample parameters. Analyze sampling distributions of statistics, including t, F, and χ^2 distributions and their relationships.	2,3	70%	65%
Outcome 4	Apply point estimation techniques, including moments and maximum likelihood estimation. Evaluate the properties of estimators, such as unbiasedness and consistency. Able to construct large samples and exact confidence intervals for means and proportions. Conduct hypothesis testing using Neyman-Pearson fundamental lemma and likelihood ratio tests for normal populations.	1,2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	2	2	1	-	-	-	-	-	-	-	3	1	2
Outcome 2	1	2	2	2	1	-	-	-	-	-	-	-	2	2	3
Outcome 3	2	2	1	1	1	-	-	-	-	-	-	-	3	2	1
Outcome 4	2	2	2	1	2	-	-	-	-	-	-	-	3	3	2
Average	**2**	**2**	**2**	**1**	**1**	-	-	-	-	-	-	-	3	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1		**5**		
	Basic Combinatorics, Classical and Axiomatic definitions of probability.	2	1	1,3
	Properties of Probability function. Conditional probability,	1	1	1,3
	Bayes Rule. Independence of Events and multiplication rule.	1	1	1,3
	Discussion and Tutorial-I	1	1	1,3
Unit 2		**5**		
	Random variables and their properties, different types of random variables.	2	1,2	1,3
	Cumulative distribution function and its properties.	1	1,2	1,3
	Probability mass and Probability density functions and their properties.	1	1,2	1,3
	Discussion on practical applications of random variables and tutorial.	1	1,2	1,3
Unit 3		**7**		
	Expectation, moments and probability generating function, moment generating function and characteristic generating function and their importance and drawbacks.	2	1,2	1,2
	The distribution function of a random variable. Markov and Chebyshev inequality.	2	1,2	1,2
	Joint distributions, marginal and conditional distributions	1	2	1,2
	Problem-solving and discussion.	2	2	
Unit 4		**8**		
	Functions of random variables and their distributions. Independence of random variables, covariance and correlation. Joint distributions, marginal and conditional distributions.	2	2	1,2
	Special distributions such as Multinomial distributions. Bivariate normal distributions and their properties.	2	2	1,2
	Laws of large numbers	2	2	1,2
	Central limit theorem and their applications.	1	2	1,2,4
	Tutorial-II	1	2	
Unit 5		**8**		
	Descriptive statistics, Graphical representation of the data, histogram, and relative frequency histogram	2	3	1,3
	Measures of location, variability, skewness and kurtosis.	1	3	3
	Population, sample parameters. Random sample and different types of sampling	2	3	2,3
	Sampling distributions of a statistic.	1	3	2
	Discussion of sampling distribution such as t, F and χ^2 and their interrelations.	2	3	1,2,3
Unit 6		**12**		
	Discussion of statistical inference, Point estimation method of moments and maximum likelihood estimator.	2	4	1,2
	Properties of point estimators. Unbiased estimates and Information inequality.	2	4	1,2
	Sufficient statistics, Factorization theorem. Convex loss and Rao-Blackwell theorem	1	4	1,2
	Interval estimation, large sample and exact confidence intervals for mean and proportions.	2	4	1,2
	Fundamental of the testing of hypothesis	1	4	1,2
	Neyman Pearson's fundamental lemma	1	4	1,2
	Likelihood ratio tests for one sample and two sample problems for normal populations.	1	4	1,2
	Chi-square test of goodness of fit.	1	4	1,2
	Tutorial and discussion	1	4	1,2

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 10%	Mid-1 20%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	60%	50%	60%	40%	30%
	Understand					
Level 2	Apply	40%	50%	30%	50%	60%
	Analyse					
Level 3	Evaluate			10%	10%	10%
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. An Introduction to Probability and Statistics (Second Edition), V.K Rohatgi and A.K. Md. Ehsanes Saleh, Publisher - Wiley
2. Statistical Inference, George Casella and Roger L. Berger, Publisher – Duxbury Advanced Series
3. A First Course in Probability (11th Edition), Sheldon Ross, Academic Press, 2014.
4. Introduction to the Theory of Probability and its Applications, (Vols. 1 & 2), W. Feller, Publisher - Wiley

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Numerical Methods and Analysis

Course Code	MAT 507	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Real Analysis, Linear Algebra	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Develop a comprehensive understanding of fundamental concepts and techniques in scientific computing and numerical methods.
2. Acquire proficiency in applying numerical techniques to solve real-world problems in various scientific disciplines using computational tools like MATLAB.
3. Foster the ability to critically evaluate numerical methods, including assessing accuracy, stability, and convergence properties, and proposing strategies for improvement
4. Enhance communication skills and teamwork abilities through discussions, presentations, and collaborative projects, enabling effective sharing of ideas and problem-solving in multidisciplinary contexts.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate proficiency in fundamental numerical methods including interpolation, differentiation, integration, and solving linear and nonlinear equations.	1,2	80	65
Outcome 2	Apply computational tools such as MATLAB to implement algorithms, analyze data, and solve mathematical problems encountered in scientific and engineering contexts.	1,2	90	90
Outcome 3	Critically evaluate numerical algorithms to assess accuracy, stability, and convergence properties, and make informed decisions regarding their suitability for solving specific mathematical problems.	1,2	70	70
Outcome 4	Communicate findings and insights clearly, both orally and in writing, and collaborate effectively with peers to solve computational problems and present results in a collaborative learning environment.	2,3	90	60

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2	-	-	-	2	2	-	-	2	2	2
Outcome 2	3	3	3	3	2	-	-	-	2	2	-	-	3	3	3
Outcome 3	3	3	3	3	2	-	-	-	2	2	-	-	3	3	3
Outcome 4	3	3	3	3	2	-	-	-	2	2	-	-	3	3	3
Average	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction to Scientific Computing	**1**	**1**	**1,2**
	MATLAB Introduction and Basic Operations	**1**	**1**	**1,2**
	Floating-Point Approximation and Errors	1	1	**1,2**
	Loss of Significance and Error Propagation	1	1	**1,2**
	Stability in Numerical Computation	1	1	**1,2**
Unit 2	Gaussian Elimination	1	2	**1,2**
	Gaussian Elimination with Pivoting Strategy	**1**	**2**	**1,2**
	LU Factorization	1	2	**1,2**
	Residual Corrector Method	1	2	**1,2**
	Iterative Methods: Jacobi Iteration	1	2	**1,2**
	Iterative Methods: Gauss-Seidel Iteration	1	2	**1,2**
	Convergence Analysis of Iterative Methods	1	2,3	**1,2**
	Matrix Norms and Error Analysis	1	2,3	**1,2**
	Eigenvalue Problem: Introduction	1	2	**1,2**
	Power Method for Eigenvalue Approximation	1	2	**1,2**
	Gershgorin's Theorem	1	2	**1,2**
Unit 3	Bisection Method for Root Finding	1	2,3	**1,2**
	Fixed-Point Iteration Method	1	2	**1,2**
	Secant Method for Root Finding	1	2	**1,2**
	Newton's Method for Root Finding	1	**2**	**1,2**
	Rate of Convergence Analysis	1	2,3	**1,2**
	Solution of Systems of Nonlinear Equations	1	2	**1,2**
	Unconstrained Optimization: Introduction	1	1	**1,2**
Unit 4	Lagrange Interpolation	1	1,2	**1,2**
	Error Analysis in Interpolation	1	3	**1,2**
	Piecewise Linear Interpolation	1	2	**1,2**
	Cubic Spline Interpolation	1	2	**1,2**
	Trigonometric Interpolation	1	2	**1,2**
Unit 5	Data Fitting: Introduction	1	**1**	**1,2**
	Least-Squares Approximation Problem	**1**	**2**	**1,2**
Unit 6	Difference Formulae for Differentiation	1	1	**1,2**
	Basic Rules of Integration	1	1	**1,2**
	Adaptive Quadratures	1	2	**1,2**
	Gaussian Quadrature Rules	1	2	**1,2**
	Composite Quadrature Rules	1	2	**1,2**
	Error Formulas in Integration	1	3	**1,2**
Unit 7	Euler Method for Ordinary Differential Equations (ODEs)	1	2,3	**1,2**
	Runge-Kutta Methods for ODEs	1	2,3	**1,2**
	Multistep Methods for ODEs	1	3	**1,2**
	Predictor-Corrector Methods for ODEs	1	3,4	**1,2**
	Introduction to Two-Point Boundary Value Problems	1	3,4	**1,2**
	Shooting method	1	**2**	**1,2**
	Implicit schemes	1	**2**	**1,2**
	Project presentations	2	**4**	**1,2**

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 20%	Mid-1 20%	CLA-2 20%	CLA-3 20%	
Level 1	Remember	30%	30%	30%		30%
	Understand					
Level 2	Apply	70%	70%	70%	100%	70%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. An Introduction to Numerical Analysis (2nd Edition), K. E. Atkinson, Wiley-India, 1989.
2. Elementary Numerical Analysis -An Algorithmic Approach (3rd Edition), S. D. Conte and C. de Boor, McGraw-Hill, 1981

Other Resources

1. Applied Numerical Methods with MATLAB for Engineers and Scientists, Steve C Chapra, McGraw-Hill Science En-gineering.
2. Numerical Analysis (7th Edition), R. L. Burden and J. D. Faires, Thomson, 2001
3. Elements of Numerical Analysis, R.S. Gupta, Macmillan India Ltd. New Delhi, 2009.

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Partial Differential Equations and Calculus of Variations

Course Code	MAT 508	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Ordinary Differential Equations, Multivariable calculus	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Develop proficiency in solving first and second-order partial differential equations using methods such as the method of characteristics, separation of variables, and D'Alembert solution, gaining insight into the behaviour of so-lutions through maximum and minimum principles.
2. Gain a deep understanding of fundamental properties of solutions to Laplace's equation, including the maximum and minimum principles, Green's identity, and the concept of invariance, enabling the application of these principles to solve boundary value problems.
3. Explore variational methods in calculus of variations, including deriving and applying Euler's equation, under-standing geodesics, and solving variational problems with moving boundaries, providing a foundation for optimizing functionals and understanding Hamilton's principle.
4. Apply mathematical concepts to real-world problems, such as modelling heat transfer and wave propagation, by solving time-dependent boundary value problems, understanding uniqueness and continuous dependence, and utilizing Duhamel's principle, fostering critical thinking and problem-solving skills.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Proficient Problem Solving: Students will solve various partial differential equations using advanced techniques, demonstrating analytical prowess.	3	75%	70%
Outcome 2	Advanced Understanding of Mathematical Properties: Students will deeply understand properties of solutions to Laplace's equation, applying them effectively.	3	75%	70%
Outcome 3	Application of Variational Methods: Students will use variational methods to solve optimization problems, enabling real-world applications.	2	75%	70%
Outcome 4	Critical Thinking and Analytical Skills: Students will develop critical thinking and analytical abilities through problem-solving exercises and real-world applications.	3	75%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	2	2	2	-	-	-	-	-	-	3	3	2	2
Outcome 2	2	2	2	3	3	-	-	-	-	-	-	3	2	3	3
Outcome 3	2	2	2	2	2	-	-	-	-	-	-	2	2	3	3
Outcome 4	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
Average	**2**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction to PDEs and Classification	2	1	**1,2**
	Solution Techniques for First Order Hyperbolic Equations (Method of Characteristics)	2	1	**1,2**
	Classification and Normal Forms of Second Order PDEs	2	1	**1,2**
	The Heat Equation - Maximum and Minimum Principles	2	1,2	**1,2**
	The Heat Equation - Uniqueness, Continuous Dependence, and Separation of Variables	4	2	**1,2**
	Applications of the Heat Equation (e.g., diffusion problems)	2	2	**1,2**
Unit 2	The Wave Equation - Introduction and D'Alembert Solution	2	2	**3,4**
	The Wave Equation - Boundary Value Problems	1	2	**3,4**
	Laplace Equation - Basic Properties and Maximum/Minimum Principle	2	2	**3,4**
	Laplace Equation - Green's Identity and Separation of Variables	2	2	**3,4**
	Advanced Topics in PDEs (e.g., inhomogeneous wave equation, boundary conditions)	2	2	**3,4**
Unit 3	Introduction to Calculus of Variations	2	3	**5,6**
	Derivation and Applications of Euler's Equation	2	3	**5,6**
	Variational Problems in Parametric Form	1	3	**5,6**
	Variational Problems of General Type	2	3	**5,6**
	Invariance of Euler's Equation and Isoperimetric Problem	2	3	**5,6**
Unit 4	Variational Problems with Moving Boundaries	2		**5,6**
	Variational Methods for Boundary Value Problems in ODEs and PDEs	4	3	**5,6**
	Hamilton's Principle and Variational Principle of Least Action	2	3	**5,6**
	Applications of Variational Methods (e.g., physics, engineering)	2	4	**5,6**
	Review, Applications, and Advanced Topics in Calculus of Variations	3	4	**5,6**

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 10%	Mid-1 15%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	60%	60%	60%		60%
	Understand					
Level 2	Apply	40%	40%	40%	100%	40%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Partial Differential Equations, E. DiBenedetto, Birkhaüser, 1995.
2. Partial Differential Equations, L.C. Evans, Graduate Studies in Math- ematics, Vol.19, American Mathematical Society, 1998.
3. Partial Differential Equations (3rd edition), F. John, Narosa, 1979.
4. Partial Differential Equations of Applied Mathematics (2nd Edition), Zauderer, John Wiley and Sons, 1989.
5. Applied Calculus of Variations for Engineers, (2nd Edition) Louis Komzsik, CRC Press.
6. Calculus of Variations, I. M. Gelfand, S. V. Fomin translated and edited by Richard A. Sil-verman, 1963.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Project I

Course Code	MAT 510	**Course Category**	Other courses (P)	**L**	**T**	**P**	**C**
				0	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Gain a comprehensive understanding of research processes.
2. Foster creativity and effective ideation skills.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Outline the phases involved in the ideation process.	2	70%	65%
Outcome 2	Conduct a comprehensive literature survey.	3	70%	65%
Outcome 3	Analyse the feasibility of a research project	3	70%	65%
Outcome 4	Prepare a short report.	2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	-	-	-	2	-	1	2	3	2	1	3	2	2	3
Outcome 2	2	3	2	3	3	1	1	3	3	3	2	3	2	2	3
Outcome 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
Outcome 4	-	1	-	-	-	3	3	3	-	-	3	3	2	2	3
Average	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Explore personal interests to generate a project idea.	6	1	1
	Conduct a feasibility assessment for the proposed project.	4	1	1
Unit 2	Conduct a literature survey to gather relevant information. Submit an abstract outlining the conceptualized idea.	40	2	1
	Write an abstract of the proposed idea	20	3	1
Unit 3	Collaboratively write a report based on the results	20	4	1

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (100%)		
		Record / Observation Note (10%)	**Report Review (60%)**	**Viva+ Presentation (30%)**
Level 1	Remember			
	Understand			
Level 2	Apply	60%	80%	80%
	Analyse			
Level 3	Evaluate	40%	20%	20%
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. As recommended by Advisor pertaining to student research interest.

Other Resources

Course Designers

Project II

Course Code	MAT 511	**Course Category**	RDIP	**L**	**T**	**P**	**C**
				0	0	14	14
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Gain a comprehensive understanding of research processes.
2. Foster creativity and effective ideation skills.
3. Acquire skills in devising and implementing project plans.
4. Learn to prevent plagiarism and contribute ethically to the research community through effective publication practices.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Outline the phases involved in the ideation process.	2	70%	65%
Outcome 2	Conduct a comprehensive literature survey.	3	70%	65%
Outcome 3	Develop an idea tailored to address the specified problem.	3	70%	65%
Outcome 4	Describe the significance of the idea.	2	70%	65%
Outcome 5	Prepare a report intended for peer review.	2	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	3	3	-	-	-	-	-	-	-	3	1	3
Outcome 2	3	3	3	3	3	-	-	-	-	-	-	-	3	2	3
Outcome 3	3	3	3	3	3	-	-	-	-	-	-	-	3	2	3
Outcome 4	3	3	2	3	3	-	-	-	-	-	-	-	2	3	3
Outcome 5	3	2	1	3	3	-	-	-	-	-	-	-	3	2	3
Average	**3**	**3**	**2**	**3**	**3**	-	-	-	-	-	-	-	**3**	**2**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Project Ideation**	**65**		
	Explore personal interests to generate a project idea.	30	1,4	1
	Conduct a feasibility assessment for the proposed project.	35	1,4	1
Unit 2	**Conceptualization and Abstract Development**	**75**		
	Conduct a literature survey to gather relevant information. Submit an abstract outlining the conceptualized idea.	55	2	1
	Write an abstract of the proposed idea	20	2	1
Unit 3	**Develop an idea**	**136**		
	Formulate an idea.	86	3	1
	Establish a timeline for executing different project modules.	50	3	1
Unit 4	**Execution Planning**	**72**		
	Create a detailed timeline for the project's module execution. Conduct numerical analysis to validate the model if applicable.	72	4	1
Unit 5	**Results Analysis and Report Writing**	**72**		
	Analyze the results obtained from the project modules.	36	3	1
	Collaboratively write a report based on the results	36	5	1,2
	Total	**420**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)			End Semester Exam (50%)
		Experiments (20%)	**Record / Observation Note (10%)**	**Viva + Model (20%)**	
Level 1	Remember				
	Understand				
Level 2	Apply	50%	70%	50%	70%
	Analyse				
Level 3	Evaluate	50%	30%	50%	30%
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. As recommended by the Advisor pertaining to students' research interest.
2. Research Methodology

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

General Topology

Course Code	MAT 520	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	MAT 104	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the student to elementary properties of topological spaces and structures defined on them.
2. To introduce the student to maps between topological spaces, as well as to the interplay of product and subspace topologies.
3. To develop the student's ability to handle abstract ideas of Mathematics and Mathematical proofs.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Define the concept of topological spaces and continuous functions, and prove and apply a selection of related theorems.	1	80	70
Outcome 2	Describe the concept of product topology and subspace topology.	1	80	70
Outcome 3	Understand connectedness and compactness,and prove and apply a selection of related theorems.	1,2	80	70
Outcome 4	Analyse the concepts of the separation axioms	1,2	80	70

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	3	2	1	-	-	-	-	-	-	-	3	2	1
Outcome 2	2	3	2	3	1	-	-	-	-	-	-	-	2	2	1
Outcome 3	3	2	3	2	2	-	-	-	-	-	-	-	2	3	2
Outcome 4	2	2	2	3	2	-	-	-	-	-	-	-	2	3	2
Average	**2**	**2**	**3**	**3**	**2**	-	-	-	-	-	-	-	**2**	**3**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Topological Spaces**	10	1,2	1,2
	Basic set theory (Finite, Countable, Uncountable sets)	2	1,2	1,2
	Topological space, Closed sets and limit points	3	1,2	1,2
	Basis for a topology	3	1,2	1,2
	Product topology, Subspace topology	2	1,2	1,2
Unit 2	**Continuity**	10	1,2	1,2
	Continuity of a function	3	1,2	1,2
	Homeomorphism, Constructing continuous functions	3	1,2	1,2
	Metric topology	4	1,2	1,2
Unit 3	**Connectedness**	8	1,3	1,2
	Connected Space	2	1,3	1,2
	Connected subspace of the real line	3	1,3	1,2
	Components and Local Connectedness	3	1,3	1,2
Unit 4	**Compactness**	10	1,3	1,2
	Compact topological space	3	1,3	1,2
	Limit Point Compactness	4	1,3	1,2
	Local Compactness	3	1,3	1,2
Unit 5	**Separation Axioms**	7	1,4	1,2
	Regular space, Normal space	2	1,4	1,2
	The Urysohn Lemma	2	1,4	1,2
	The Urysohn Metrization Theorem	2	1,4	1,2
	The Tietze Extension Theorem	1	1,4	1,2
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 15%	Mid-1 25%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	60%	55%	40%	50%	55%
	Understand					
Level 2	Apply	40%	45%	60%	50%	45%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. James R. Munkres, Topology, 2nd edition, Prentice Hall, 1976
2. Simmons, George F., Introduction to Topology and Modern Analysis, Published by Krieger Pub Co. (1982)

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Industrial Mathematics

Course Code	MAT 521	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Calculus, Ordinary Differential Equation	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Formulate a given problem with mathematical definitions.
2. Apply the appropriate mathematical and computational tools.
3. Give oral presentations and write technical reports.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Formulate the mathematical equations for physical problems	2	70%	75%
Outcome 2	Industrial extension of via typical applications.	3	75%	80%
Outcome 3	Demonstrate the power of interweaving analytic with computing methods during problem solving.	3	72%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2	-	-	-	-	2	-	-	3	2	2
Outcome 2	2	3	3	3	3	-	-	-	-	3	-	-	2	3	3
Outcome 3	2	3	3	3	3	3	-	-	-	2	-	-	2	3	3
Average	**2**	**3**	**3**	**3**	**3**	**3**	-	-	-	**2**	-	-	**2**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	**(Statistical Reasoning & Regression)**	**8**		
	Random Variables	1	CO 1	1
	Binomial distribution, Poisson distribution, Uniform distribution, and Normal distribution	2	CO 1	1
	Project-1 (Staffing Problem and Newsboy Problem)	1	CO 3	1
	Best Fit to Discrete Data	2	CO 2	1
	Least square fir with Fourier and Chebyshev functions	2	CO 1	1
Unit II	**(Discrete Fourier Transform & Linear Programming)**	**9**		
	Discrete Fourier Transforms and Fast Fourier Transform	3	CO 1, 2	1
	Project-2 (Application of FFT: Image Processing)	1	CO 3	1
	Optimization and the diet problem	3	CO 2	1
	Simplex Algorithm	2	CO 1	1
Unit III	**(Differential Equations)**	**11**		
	Newton's method and Hamilton equations for modelling.	2	CO 1, 2	1
	System of Equations: Mass-Spring model	2	CO 3	1,2
	Frequency-Domian Method: Plants in Cascade	3	CO 3	1
	Project-3 (Nyquist Analysis)	1	CO 3	1
	Six Big PDEs: Application to undersea telegraph cables and traffic flow	3	CO 1, 3	1
Unit IV	**(Divided Differences and Splines)**	**7**		
	Finite difference: Lotka-Volterra equations and Heat equation	3	CO 1, 2	1
	Project-4 (three body problem)	1	CO 3	1, 2
	Cubic splines	3	CO 1	1
Unit V	**(Galerkin's Method)**	**10**		
	Galerkin requirement	3	CO 1	1
	Eigenvalue problems	3	CO 1	1
	Steady Problem and Unsteady problem	3	CO 1, 2	1
	Course end technical report writing and final presentation	1	CO 3	1

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 15%	Mid-1 25%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	40%	50%	50%	50%	50%
	Understand					
Level 2	Apply	40%	50%	40%	40%	50%
	Analyse					
Level 3	Evaluate	20%		10%	10%	
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Charles R. MacCluer: Industrial Mathematics. Modeling in Industry, Science, and Government. Prentice Hall, 2000.
2. J N Kapur, Mathematical Modeling, Wiley Eastern Limited, 1998.
3. Ahsan Zafar, Differential Equations and their Applications, PHI learning Pvt. Ltd., 2016.
4. Wang Hao, Mathematical Modeling I: Preliminary, Bookbon.com, The e-book Company, 2012.
5. T Veerarajan, Probability, Statistics and Random Processes, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2008.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Algebra-II

Course Code	MAT 529	**Course Category**	Core	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Algebra	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand and apply advanced algebraic structures such as groups, rings, fields, and modules.
2. Apply Galois theory to analyze polynomial solvability by radicals.
3. Master module and vector space theory for problem-solving in algebra and related areas.
4. Develop systematic problem-solving skills through theoretical and computational exercises in abstract algebra.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand and apply groups, rings, fields, and modules effectively.	2	80%	65%
Outcome 2	Apply Galois theory to analyze polynomial solvability and assess field extensions.	2	90%	90%
Outcome 3	Demonstrate proficiency in module and vector space theory, including linear transformations.	1,2	70%	70%
Outcome 4	Develop strong problem-solving abilities through theoretical and computational exercises.	1,2	90%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	-	2	-	-	-	2	2	-	-	2	2	2
Outcome 2	3	3	3	-	2	-	-	-	2	2	-	-	3	3	3
Outcome 3	3	3	3	-	2	-	-	-	2	2	-	-	3	3	3
Outcome 4	3	3	3	-	2	-	-	-	2	2	-	-	3	3	3
Average	**3**	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Foundations of Algebraic Structures**	12	1	1,2
	Introduction to Algebraic Structures	1	1	1,2
	Overview of groups, rings, and fields Basic definitions and examples	2	1	1,2
	Group Theory I: Basics	1	1	1,2
	Definitions and properties of groups Subgroups, cosets, and Lagrange's theorem	2	1	1,2
	Group Theory II: Advanced Topics		1	1,2
	Normal subgroups, quotient groups Group homomorphisms and isomorphism theorems	2	1	1,2
	Ring Theory: Introduction	2	2	1,2
	Definitions and examples of rings Properties of ring elements and operations	2	2	1,2
Unit 2	**Further Explorations in Ring Theory**	**12**		1,2
	Ring Theory II: Ideals and Factorization	3	2	1,2
	Ideals and quotient rings Prime and maximal ideals, integral domains Ring Theory III: Polynomial Rings	3	2	1,2
	Definitions and properties of polynomial rings	3	2	1,2
	Factorization in polynomial rings, Euclidean domains	3	2	1,2
Unit 3	**Field Theory I:**	**6**		1,2
	Field Extensions	2	3	1,2
	Field extensions and algebraic elements	2	3	1,2
	Splitting fields and algebraic closures	2		1,2
Unit 4	**Field Theory II:**	7		1,2
	Galois Theory	2	3	1,2
	Fundamental concepts of Galois theory Galois groups, solvability by radicals	2	3	1,2
	Module Theory	1	3	1,2
	Definitions and examples of modules Module homomorphisms, direct sums	2	3	1,2
Unit 5	**Applications and Review**	**12**		1,2
	Vector Spaces	3	4	1,2
	Definitions and properties of vector spaces Linear transformations and matrix representations	3	4	1,2
	Applications of Algebra	3	4	1,2
	Selected applications in algebra and beyond Review and problem-solving sessions	3	4	1,2
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 15%	Mid-1 25%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	60%	50%	40%	50%	55%
	Understand					
Level 2	Apply	40%	50%	60%	50%	45%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Abstract Algebra by David S. Dummit and Richard M. Foote, 3rd Edition.
2. Algebra by Michael Artin, 2nd Edition.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Dynamical Systems

Course Code	MAT 530	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand key dynamical systems concepts, including topology, continuity, and root finding
2. Master fixed-point theorems, attraction-repulsion dynamics, and key bifurcations like saddlenode and period doubling
3. Explore quadratic family dynamics, Cantor set, and period doubling, focusing on chaos transition through orbit diagrams
4. Study symbolic dynamics, itineraries, and Sharkovsky's theorem linking period 3, chaos, critical points, and basin of attraction.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate a thorough understanding of fundamental dynamical systems concepts, including topology and root finding.	2	80%	50%
Outcome 2	Exhibit proficiency in applying fixed-point theorems, understanding attraction-repulsion dynamics, and analyzing saddle-node and period-doubling bifurcations.	3	70%	50%
Outcome 3	Identify and analyze chaotic behavior in dynamical systems, specifically within the quadratic family and period-doubling scenarios, using orbit diagrams and numerical methods.	4	60%	40%
Outcome 4	Apply symbolic dynamics principles, including itineraries and the shift map, and comprehend the implications of Sharkovsky's theorem, establishing connections between period 3, chaos, critical points, and basin of attraction.	3	50%	20%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	2	3	-	2	-	2	2	-	3	3	2	2
Outcome 2	3	3	3	2	3	-	-	-	-	1	-	2	3	2	2
Outcome 3	3	3	3	2	3	2	1	-	-	2	-	1	2	3	2
Outcome 4	2	3	3	3	3	-	-	-	-	-	-	2	1	3	3
Average	**3**	**3**	**3**	**2**	**3**	**1**	**1**	**-**	**2**	**2**	**-**	**2**	**3**	**3**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Dynamical Systems**	**12**		**1**
	A brief history of dynamical systems.	2	1	
	Orbits, Iterations, the doubling of functions.	2	1	
	Examples from biology, and finance.	2	1	
	Mathematical preliminaries: topological concepts, closed set, open sets, continuous functions, Root finding	2	1	
	Graphical Analysis: Phase portrait, Orbit analysis	4	1	
Unit 2	**Fixed Points and Bifurcation**	**10**		1
	A fixed-point theorem,	2	1	
	Attraction & Repulsion	1	2	
	Calculus of fixed points,, periodic points	2	**2**	
	Introduction to bifurcation;	2	1	
	dynamics of quadratic map Saddle node bifurcation,	2	2	
	Period doubling bifurcation	1	2	
Unit 3	**Quadratic family & Transition to Chaos**	**7**		1,2
	Introduction to quadratic family,	1	1,2	
	Cantor middle-thirds set	2	2	
	Orbit diagram,	2	**2**	
	period doubling	2	2,3	
Unit 4	**Symbolic Dynamics & Chaos**	**9**		1,3
	Itineraries,	2	3	
	the sequence space,	1	3	
	the shift map,	1	2,3	
	conjugacy	1	3	
	Three properties of chaotic map,	1	3,4	
	Manifestation of chaos,	2	4	
	Other chaotic systems	1	4	
Unit 5	**Sharkovsky's theorem**	**7**		2,3
	Period 3 implies chaos,	2	4	
	Sharkovsky's theorem,	2	4	
	Critical points	1	2,3,4	
	Basin of Attraction	2	3,4	
	Total	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 15%	Mid-1 25%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	60%	50%	40%	50%	55%
	Understand					
Level 2	Apply	40%	50%	60%	50%	45%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Robert L. Devaney, A First Course in Chaotic Dynamical Systems, CRC Press, Chapman & Hall, 2nd Edition, 2020.
2. Strogatz, Steven H. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Westview Press, 2014.
3. R. K. Nagle, E. B. Saff, and A. D. Snider. Fundamentals of Differential Equations and Boundary Value Problems, 7th edition, ISBN: 9780321977175, Pearson, 2017.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Mathematics for Machine Learning

Course Code	MAT 534	**Course Category**	Core	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	Probability and Statistics, Python, Linear Algebra	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand essential mathematical concepts like linear algebra, calculus, and probability theory to analyze and implement machine learning algorithms effectively.
2. Learn statistical tools and techniques for analyzing data, evaluating model performance, and making informed decisions in machine learning tasks.
3. Master optimization techniques essential for training and fine-tuning machine learning models to achieve optimal performance.
4. Gain insights into neural network architectures, training algorithms, and their applications in modern machine learning scenarios.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate proficiency in applying mathematical concepts such as linear algebra, calculus, and probability theory to analyze and solve machine learning problems.	1.2	80%	65%
Outcome 2	Apply statistical methods including descriptive statistics, hypothesis testing, and Bayesian inference to evaluate and interpret machine learning models and their results.	2	90%	90%
Outcome 3	Utilize optimization techniques to train machine learning algorithms effectively, including gradient-based optimization methods and advanced optimization algorithms.	1,2	70%	70%
Outcome 4	Implement artificial neural networks (ANNs) and deep learning architectures for various machine learning tasks, including image classification, sequence prediction, and generative modeling.	1,2	90%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2	-	-	-	2	-	-	-	2	2	2
Outcome 2	3	3	3	3	2	-	-	-	2	-	-	-	3	3	3
Outcome 3	3	3	3	3	2	-	-	-	2	-	-	-	3	3	3
Outcome 4	3	3	3	3	2	-	-	-	2	-	-	-	3	3	3
Average	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Mathematical Foundations for Machine Learning**	**15**		**1**
	Introduction to mathematical notation and its importance in machine learning.	2	1	**1**
	Algebraic concepts in machine learning: variables, equations, and functions.	2	1	**1**
	Basics of calculus: derivatives and their role in optimization.	2	1	1
	Further calculus concepts: integration and its application in probability.	2	1	1
	Introduction to linear algebra: vectors and matrices.	2	1	1
	Matrix operations and their applications in machine learning.	1	1	1
	Eigenvalues and eigenvectors in machine learning.	1	1	1
	Introduction to linear regression and its mathematical foundation.	1	1	1
	Principal Component Analysis (PCA) for dimensionality reduction.	1	1	1
	Review and Q&A session.	1	1	1
Unit 2	**Probability and Statistics in Machine Learning**	**18**		**2**
	Introduction to probability fundamentals in machine learning, Probability distributions and their applications, Descriptive statistics: mean, variance, and covariance.	3	2	2
	Statistical inference techniques: hypothesis testing and confidence intervals.	3	2	2
	Bayesian statistics in machine learning: concepts and applications.	3	2	2
	Model evaluation metrics in machine learning.	2	2	2
	Feature selection techniques based on statistical analysis.	2	2	2
	Uncertainty estimation using Bayesian inference.	2	2	2
	Applications of probability and statistics in machine learning: case studies.	2	2	2
	Review and Q&A session.	1		2
Unit 3	**Optimization Methods for Machine Learning**	**13**		3
	Introduction to optimization: objectives, constraints, and optimality conditions.	2	3	3
	Gradient-based optimization techniques: gradient descent and its variants.	2	3	3
	Advanced optimization algorithms: momentum, AdaGrad, Adam.	1	3	3
	Challenges in convex and non-convex optimization in machine learning.	2	3	**3**
	Training neural networks using gradient descent.	2	3	**3**
	Hyperparameter tuning techniques: grid search and Bayesian optimization.	1	2,3	**3**
	Model selection criteria and techniques.	1	2,3	**3**
	Applications of optimization methods in machine learning: case studies.	1	3,4	**3**
	Review and Q&A session.	1		**3**
Unit 4	**Artificial Neural Networks (ANNs) and Deep Learning**	**14**		**4**
	Introduction to Artificial Neural Networks (ANNs): architecture and components.	1	4	**4**
	Activation functions and their role in ANNs.	1	4	**4**

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
	Training ANNs: backpropagation algorithm and loss functions.	1	4	**4**
	Optimizing ANNs using various optimization algorithms.	2	4	**4**
	Introduction to Convolutional Neural Networks (CNNs) and their architecture.	2	4	**4**
	Applications of CNNs in image classification tasks.	2	4	**4**
	Introduction to Recurrent Neural Networks (RNNs) and their architecture.	1	4	**4**
	Applications of RNNs in sequence prediction tasks.	1	4	**4**
	Advanced topics in deep learning: attention mechanisms, GANs.	1	4	**4**
	Applications of ANNs and deep learning in machine learning: case studies.	1	**4**	**4**
	Review and Q&A session.	1		**4**
Total Contact Hours		**60**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 15%	Mid-1 25%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	50%	50%	55%	50%	50%
	Understand					
Level 2	Apply	50%	50%	45%	50%	50%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. "Pattern Recognition and Machine Learning" by Christopher M. Bishop.
2. "Introduction to Statistical Learning: with Applications in R" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani.
3. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
4. "Convex Optimization" by Stephen Boyd and Lieven Vandenberghe.

Other Resources

1. "Mathematics for Machine Learning" by Marc Peter Deisenroth, A Aldo Faisal, and Cheng Soon Ong.
2. "Bayesian Data Analysis" by Andrew Gelman, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari, and Donald B. Rubin.
3. "Numerical Optimization" by Jorge Nocedal and Stephen Wright.
4. "Neural Networks and Deep Learning: A Textbook" by Charu C. Aggarwal.

Course Designers

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Database management systems with Data lake and Warehousing concepts

Course Code	MAT 540	**Course Category**	Core	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Master Database Fundamentals by understanding the principles of database management systems, including relational and NoSQL databases, database design, and SQL querying.
2. Apply normalization techniques to design efficient relational database schemas and optimize database performance using indexing strategies.
3. Develop skills in designing and implementing data warehouses using dimensional modeling and performing ETL processes for data integration.
4. Gain proficiency in utilizing NoSQL databases and data lakes to manage unstructured and semi-structured data, and integrate them into modern data architectures.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand Fundamental Concepts: Students will demonstrate a thorough understanding of fundamental concepts in database management systems, including relational and NoSQL databases, database design principles, and SQL query language.	2	70%	65%
Outcome 2	Apply Database Design Principles: Students will be able to apply database design principles to create normalized relational database schemas, optimize database performance through indexing, and implement transaction management strategies to ensure data integrity.	2	70%	70%
Outcome 3	Utilize Data Warehousing Techniques: Students will learn how to design and implement data warehouses using dimensional modeling techniques, perform Extract, Transform, Load (ETL) processes, and understand the role of data warehousing in decision support systems.	1,2	70%	70%
Outcome 4	Integrate NoSQL Databases and Data Lakes: Students will gain an understanding of NoSQL database concepts, including data modeling, querying, and scalability, and learn how to integrate NoSQL databases and data lakes into modern data architectures for managing diverse and large-scale datasets.	1,2	60%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3	3	2	3	-	-	2	-	-	2	2	2	2
Outcome 2	2	3	3	3	2	3	-	-	2	-	-	3	3	3	3
Outcome 3	2	3	3	3	2	3	-	-	2	-	-	3	3	3	3
Outcome 4	2	3	3	3	2	3	-	-	2	-	-	3	3	3	3
Average	**2**	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**2**	**-**	**-**	**3**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Foundations of Database Management Systems**	14		1
	Introduction to Databases and Data Management	2	1	1
	Types of Databases (Relational)	1	1	1
	Types of Databases (NoSQL)	1	1	1
	Data Models	2	1	1
	Introduction to SQL	4	1	1
	SQL Practice Session	4	1	1
Unit 2	**Relational Database Design and Normalization**	10		2
	Relational Database Design	2	2	2
	Normalization	3	2	2
	Indexes and Performance Tuning	5	2	2
Unit 3	**Advanced SQL, Transaction Management, and Data Warehousing Concepts**	13		3
	Advanced SQL Queries	2	2,3	3
	Aggregate Functions and Grouping	1	3	3
	Transaction Management	2	3	3
	Concurrency Control	2	2,3	3
	Introduction to Data Warehousing	2	3	3
	Dimensional Modeling	2	3	3
	ETL Processes	2	3	3
Unit 4	**NoSQL Databases, Data Lake Concepts, Integration, Case Studies, and Project Work**	8		4
	Introduction to NoSQL Databases	2	4	4
	NoSQL Data Models	2	4	4
	Data Lake Concepts and Architecture	2	4	4
	Data Lake Integration, Case Studies, and Project Overview	2	1,2,3,4	4
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 10%	Mid-1 20%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	60%	55%	40%	50%	55%
	Understand					
Level 2	Apply	40%	45%	60%	50%	45%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. "Database Management Systems" by Raghu Ramakrishnan and Johannes Gehrke.
2. "Database Systems: The Complete Book" by Hector Garcia-Molina, Jeffrey D. Ullman, and Jennifer Widom.
3. Advanced SQL, Transaction Management, and Data Warehousing Concepts
   Textbook: "SQL Performance Explained" by Markus Winand.
4. NoSQL Databases, Data Lake Concepts, Integration, Case Studies, and Project Work
   Textbook: "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence" by Martin Fowler and Pramod J. Sadalage.

Other Resources

1. Ramakrishnan, R., & Gehrke, J. (2002). "Database Management Systems." McGraw-Hill Education.
2. Date, C. J. (2003). "An Introduction to Database Systems." Addison Wesley.
3. Garcia-Molina, H., Ullman, J. D., & Widom, J. (2008). "Database Systems: The Complete Book." Pearson.
4. Winand, M. (2012). "SQL Performance Explained." Markus Winand.
5. Kimball, R., & Ross, M. (2013). "The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling." Wiley.
6. Sadalage, P. J., & Fowler, M. (2012). "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence." Addison-Wesley Professional.

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Algebraic Topology

Course Code	MAT 544	**Course Category**		**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Topology, Algebra-1, 2, Analysis-1, 2.	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Gain basic understanding of paths, covering spaces, universal cover and lifting theorems along with applications in different settings.
2. Develop deep understanding of fundamental groups of different objects, especially the circle group, along with applications and consequences of related results such as the Seifert-van Kampen theorem.
3. Obtain proficiency in simplicial homology theory, including simplicial, chain and CW complexes along with computation of simplicial homology groups and their applications.
4. Gain basic understanding of singular homology theory, including the interplay between singular, cellular and simplicial homologies, Mayer-Vietoris sequence and chain homotopy.
5. Develop overall grasp on advanced topics in cohomology theory, including different products of cohomology groups, relative cohomology and Poincaré duality.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe basic aspects of Algebraic Topology such as paths, covers and fundamental groups, among others.	1,2	90%	80%
Outcome 2	Analyse important results related to fundamental groups and apply them in different settings.	2	80%	75%
Outcome 3	Demonstrate the concepts and applications of simplicial and singular homology theory.	2	80%	70%
Outcome 4	Understand the basics of cohomology theory along with certain advanced topics such as Poincaré duality and relative cohomology.	1,2	80%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2	3	-	-	-	1	-	-	-	2	2	2
Outcome 2	3	1	3	2	3	-	-	-	1	-	-	-	3	3	3
Outcome 3	3	2	3	3	2	-	-	-	-	-	-	-	3	3	3
Outcome 4	3	2	2	3	3	-	-	-	-	-	-	-	3	3	3
Average	**3**	**2**	**2**	**3**	**3**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Basic Topological Notions**	**9**	1	1, 2, 4
	Homotopy of maps.	2	1	1, 2, 4
	paths and path connectedness, quotient topology revisited, examples and applications.	3	1	1, 2, 4
	covering spaces, lifting theorems.	4	1	1, 2, 4
Unit 2	**Fundamental Groups**	**9**		1, 2, 3
	Multiplication of paths, the fundamental group.	3	2	1, 2, 3
	Induced homomorphisms, fundamental group of the circle.	3	2	1, 2, 3
	Seifert-van Kampen theorem, applications, universal cover.	3	2	1, 2, 3
Unit 3	**Simplicial Homology**	**10**		1, 2
	Simplicial complexes, chain complexes.	3	3	1, 2
	Definition and computation of simplicial homology groups.	3	3	1, 2
	Properties of homology groups and their applications.	2	3	1, 2
	CW complex	2	3	1, 2
Unit 4	**Singular Homology**	**8**		1, 2
	Singular homology, comparison with simplical and cellular homology (statements).	2	3	1, 2
	Excision, Mayer-Vietoris sequence.	3	3	1, 2
	Chain homotopy.	1	3	1, 2
	Homology with coefficients, Universal coefficient theorem (statement).	2	3	1, 2
Unit 5	**Cohomology**	**9**		1, 2, 3
	Cohomology groups, relative cohomology.	2	4	1, 2, 3
	Cup and Cap products, Examples.	2	4	1, 2, 3
	Orientation on manifolds	2	4	1, 2, 3
	Poincaré duality	2	4	1, 2, 3
	Review	1	4	1, 2, 3
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 15%	Mid-1 25%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	60%	55%	40%	50%	55%
	Understand					
Level 2	Apply	40%	45%	60%	50%	45%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Algebraic topology, A, Hatcher, Algebraic Topology, Cambridge Univ. Press, 2002
2. Elements of Algebraic Topology, Munkres, JM Addison-Wesiley, 1984.
3. Lectures notes on elementary Topology and Geometry, I.M, Singer and J.A. Thorpe
4. Armstrong, M.A., Basic Topology, Springer (India), 2004.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Applied Statistics

Course Code	MAT 548	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Basic Statistics	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the notion of statistical analysis like quality control time series, statistical design etc.
2. To apply the concepts to real life problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand what is quality control	1,2	75%	70%
Outcome 2	Describe the basics of time series	2	75%	70%
Outcome 3	Demonstrate statistical designs	2	75%	70%
Outcome 4	Apply anova and index numbers	1,2	75%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	2	2	-	-	-	-	-	-	-	-	3	2	2
Outcome 2	2	2	2	3	-	-	-	-	-	-	-	-	2	3	3
Outcome 3	2	2	2	2	-	-	-	-	-	-	-	-	2	3	3
Outcome 4	3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
Average	**2**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Statistical quality control (SQC)**	**8**		
	Introduction and basics of SQC	1	1	1
	Control charts for attributes and variables	4	1	1
	natural tolerance limits, acceptance sampling plan	3	1	1
Unit 2	**Time series**	**8**		
	Introduction and components of time series	2	2	**3,4**
	analysis of time series, trends, cyclic variations	3	2	**3,4**
	auto regression, auto-correlation random component in a time series.	3	2	**3,4**
Unit 3	**Index Numbers**	**8**	**3**	
	Basics of index numbers	2	3	**1,2**
	Construction of index numbers	2	3	**1,2**
	Classification of index numbers	2	3	**1,2**
	base shifting splicing and deflation of index numbers	1	3	**1,2**
	use and limitation of index numbers	1	3	**1,2**
Unit 4	**Design of experiments**	**14**		
	Introduction	1	4	**1,2**
	CRD, RBD, LSD	1	4	**1,2**
	ANCOVA	3	4	**1,2**
	Factorial experiments,	2	4	**1,2**
	Confounding,	4	4	**1,2**
	Fractional factorial	2	4	**1,2**
	Split Plot and BIBD	1	4	**1,2**
Unit 5	**Anova**	**7**		2
	One and two way anova	4	3,4	**1,2**
	Revision	3		
Total Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 15%	Mid-1 25%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	60%	55%	40%	50%	55%
	Understand					
Level 2	Apply	40%	45%	60%	50%	45%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. S.C. Gupta, V.K. Kapoor (2013) - Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand & Sons.
2. Eugene L. Grant Richard S. Leavenworth, Statistical Quality Control,7 edition, McGraw Hill Education, India, 2017
3. Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulahci, Introduction to Time Series Analysis and Forecasting, Second Ed., Wiley, 2016.
4. George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung, Time Series
5. Analysis: Forecasting and Control, Fifth Ed., Wiley, 2016.

Other Resources

Course Designers

Tensor calculus

Course Code	MAT 570	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Real Analysis, Linear Algebra, Multivariable calculus	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Master the art of algebra with tensors and apply tensor calculus for solving continuum mechanics problems.
2. Understand motion descriptions, strain, stress tensors, and deformation analysis
3. Apply conservation laws, momentum balances, and thermodynamics principles to analyze mechanical and thermodynamic systems.
4. Grasp the necessity and application of constitutive equations for modeling elastic solids and fluids.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Apply tensor calculus proficiently in continuum mechanics problem solving.	2	75%	70%
Outcome 2	Analyze material motion, strain, stress tensors, and transformations accurately.	2	75%	70%
Outcome 3	Apply balance laws effectively to complex systems.	2	75%	70%
Outcome 4	Understand and apply constitutive principles to predict material behavior accurately.	2	75%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	2	2	2	-	-	-	-	-	-	3	3	2	2
Outcome 2	2	2	2	3	3	-	-	-	-	-	-	3	2	3	3
Outcome 3	2	2	2	2	2	-	-	-	-	-	-	2	2	3	3
Outcome 4	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
Average	**2**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Tensor Algebra and Tensor Calculus**	**10**		
	Introduction to vectors and tensors	2	1	1
	Index notation and operations	1	1	1
	Properties of tensors	1	1	1
	Tensor products and contractions	1	1	1
	Introduction to tensor calculus	1	1	1
	Derivatives of tensors	1	1	1
	Gradient, divergence, and curl operations	2	1	1
	Applications of tensor calculus in continuum mechanics	1	1	1
Unit 2	**Kinematics Principles and Balance Laws**	**10**		
	Lagrangian and Eulerian descriptions	2	2	1
	Deformation analysis: strain tensors	1	2	1
	Motion analysis: velocity and acceleration fields	1	2	1
	Area and volume transformations	1	2	1
	Conservation of mass	1	2	1
	Linear momentum balance	1	2	1
	Angular momentum balance	2	2	1
	Introduction to thermodynamics principles	1	2	1
Unit 3	**Constitutive Relations: Elastic Solids and Fluids**	**11**		
	Necessity of constitutive equations	1	3	1
	Material frame-indifference	1	3	1
	Linear elasticity theory	2	3	1
	Applications of constitutive equations in solid mechanics	2	3	1
	Thermomechanics of fluids	2	3	1
	Viscous-heat conduction fluids	1	3	1
	Incompressible fluid mechanics	1	3	1
	Applications of constitutive equations in fluid dynamics	1	3	1
Unit 4	**Advanced Topics in Tensor Algebra and Tensor Calculus**	**14**		
	High-order tensors	1	4	1
	Principal invariants	1	4	1
	Eigenvalues and eigenvectors	2	4	1
	Orthogonal and symmetric tensors	2	4	1
	Gateaux and Frechet derivatives	2	4	1
	Time derivatives and integral theorems	4	4	1
	Polar decomposition of tensors	1	4	1
	Isotropic functions and their applications	1	4	1
Total hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (40%)
		CLA-1 10%	Mid-1 15%	CLA-2 10%	CLA-3 15%	
Level 1	Remember	60%	60%	60%	60%	60%
	Understand					
Level 2	Apply	40%	40%	40%	40%	40%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. NPTEL Course on Continuum Mechanics, https://nptel.ac.in/courses/112/103/112103167/
2. C. S. Jog, Continuum Mechanics: Foundations and Applications of Mechanics, Volume I, Third edition, 2015, Cambridge University Press.
3. M. E. Gurtin, An Introduction to Continuum Mechanics, 1981, Academic Press, New York.
4. M. E. Gurtin, E. Fried and L. Anand, The Mechanics and Thermodynamics of Continua, 2010, Cambridge University Press, New York.

Other Resources

1. P. Chadwick, Continuum Mechanics: Concise Theory and Problems, 1999, Dover Publications, Inc., New York.
2. I-S. Liu, Continuum Mechanics, 2002, Springer, Berlin.
3. J. Bonet and R. D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, 1997, Cam-bridge University Press, Cambridge.
4. Z. Martinec, Lecture Notes on Continuum Mechanics (Link: http://geo.mff.cuni.cz/vyuka/Martinec-ContinuumMechanics.pdf)
5. D. S. Chandrasekharaiah and L. Debnath, Continuum Mechanics, 1994, Academic Press Inc., London.
6. E. B. Tadmor, R. E. Miller and R. S. Elliott, Continuum Mechanics and Thermody-namics from Fundamental Concepts to Governing Equations, 2012, Cambridge Uni-versity Press, UK.

Course Designers

Operator Theory

Course Code	MAT 588	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Real Analysis, Linear Algebra, Complex Analysis	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To get the properties of various types of operators.
2. To gain the knowledge of bounded linear operators and the properties of their respective spectrums.
3. To grasp the generalized concepts of Banach Algebra and C^* Algebra.
4. To learn specialized knowledge like weak convergence, strong convergence of compact linear operators on Hilbert space. Furthermore, to become familiar with numerical range, numerical radius, convexity of numeri-cal range of the respective operators.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand various types of bounded linear operators and their properties.	1,2	70%	60%
Outcome 2	Demonstrate the concept of bounded linear operators in their associated spectrums.	2	70%	60%
Outcome 3	Describe bounded linear operators in the context of Banach Algebra and C^* Algebra to obtain the well known results like Mazur's theorem, Gel'fand spectrum, Gel'fand transform, Symmetric involutions, BochnerRaikov theorem.	1,2	70%	65%
Outcome 4	Understand the fundamental concepts of weak and strong convergence, numerical range, numerical radius, convexity of numerical range of various types of bounded linear operators.	2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	3	2	3	-	-	-	-	-	-	-	2	2	2
Outcome 2	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
Outcome 3	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
Outcome 4	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	-	-	-	-	-	-	-	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Topologies and the related concepts.	2	1	1,2
	Special classes of operators self-adjoint, normal, unitary operators.	1	1	1,2
	Isometries, projection and its properties.	1	2	1,2
	Square root of a positive operator.	1	1	1,2
	Polar decomposition, Singular value decomposition.	1	1	1,2
Unit 2	Regular value, spectrum and spectral radius of a bounded linear operator, resolvent set, properties of spectrum of bounded linear operator and compact operator.	3	1,2	2
	Spectral mapping theorem (self-adjoint, normal, unitary operators), Spectrum on a complex Banach space.	2	2	2
Unit 3	Banach algebra, symbolic calculus, invertible element of a Banach algebra.	3	3	5, 6
	Lomonosov's invariant subspace theorem, convergence of an infinite series on a Banach algebra, Mazur's theorem on a Banach field.	3	3	5, 6
	The Gel'fand spectrum and Gel'fand transform, homomorphism on a Banach algebra and its properties.	4	3	5, 6
	Symmetric involutions, Bochner Raikov theorem, introduction to C^* algebra.	2	3	5, 6
Unit 4	Compact linear operator, sequence of compact operators.	1	3,4	2, 5, 6
	Weak convergence, range of compact operator.	1	4	2, 5, 6
	Adjoint of a compact operator, eigenvalues of a compact operators.	3	4	2, 5, 6
	Sum, product and compositions of compact operator.	2	4	2, 5, 6
	Operator equation involving compact operators, unbounded linear operator in Hilbert space.	2	4	2, 5, 6
	Spectral properties of compact operator, Hellinger-Toeplitz theorem.	2	4	2, 5, 6
	Wecken's lemma, Bishop-Phelps theorem.	1		2, 5, 6
Unit 5	Numerical range, numerical radius, convexity of numerical range.	3	4	4, 6, 7, 8
	Toeplitz- theorem, numerical radius for 2 by 2 matrix, numerical radius norm.	2	4	4, 6, 7, 8
	Numerical radius orthogonality, numerical radius for operator matrix.	2	4	4, 6, 7, 8
	Joint numerical range, C-numerical range, K-numerical range.	2	4	4, 6, 7, 8
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 10%	Mid-1 20%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	60%	55%	40%	50%	55%
	Understand					
Level 2	Apply	40%	45%	60%	50%	45%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Introductory Functional Analysis with applications - Erwin Kreyszig
2. Operator Theory- Barry Simon
3. Functional Analysis- Bachman, Narici
4. Matrix Analysis- Horn and Hohnson
5. An invitation to C^*-algebra- W. Arveson
6. A course in Operator theory- John B. Conway
7. Numerical Range- Gustafson and Rao
8. Inequalities for numerical radius of bounded linear operator-Dragomir

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Optimization Techniques

Course Code	MAT 514	**Course Category**	CE		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	Analysis and Linear Algebra	**Co-Requisite Course(s)**	Multivariable Calculus	**Progressive Course(s)**				
Course Offering Department	Mathematics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Designing mathematical programming problems requires acquiring a comprehensive set of skills and knowledge. It is equally important to analyze the model problem and develop a fully analytical behavior of both the problem and the solution.
2. To gain proficiency in understanding and solving the model problem and solution spaces, enabling analysis and interpretation of diverse mathematical models. To study numerical algorithms to solve model problems.
3. The objective is to analyze and create numerical algorithms that can solve both linear and nonlinear optimization problems.
4. To solve convex optimization problems, apply the Karush-Kuhn-Tucker conditions.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand problems as mathematical programming problems. Classification of optimization problems, Optimization techniques – classical and advanced techniques.	1	75%	80%
Outcome 2	Apply Linear Programming problems, Graphical solution method, Unbounded solutions, Infeasible solutions, Maximization – Simplex Algorithm, Big-M method, Two-phase method, Duality in linear programming, Integer linear programming.	2	70%	65%
Outcome 3	Describe Transportation (TP) and Assignment (TP) Problems: Balanced TP, Unbalanced TP, North-West Corner Rule, Vogel's Approximation, Stepping Stone Method, Modified Distribution Method. Hungarian Method for AP.	1,2	75%	70%
Outcome 4	Understand Convex function, Constrained-Unconstrained Problems, Lagrange Multipliers, Karush-Kuhn-Tucker Conditions, Gradient-descent method.	1,2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	2	2	2	-	-	-	-	-	-	3	3	2	2
Outcome 2	2	2	2	3	3	-	-	-	-	-	-	3	2	3	3
Outcome 3	2	2	2	2	2	-	-	-	-	-	-	2	2	3	3
Outcome 4	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
Average	**2**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction: History and formulation of design problems as mathematical programming problems.**	**12 Hours**		
	History of optimization problems	1	CO 1	1,2
	Study of optimization problems	1	CO 1	1,2
	Formulation of design problems as mathematical programming problems.	2	CO 1	1,2
	Classification of optimization problems	1	CO 1	1,2
	Explore classical and advanced techniques for solving optimization problems	2	CO 1	1,2
	Writing code for efficient algorithms for programming problems.	2	CO 1	1,2
	Implement of efficient algorithms for real world model problem.	2	CO 1	1,2
	Quizzes and presentations	1	CO 1	1,2
Unit 2	**Linear Programming Problems.**	**12 Hours**		
	Formulation of Linear Programming problems	1	CO1, 2	1,2
	Classification of solution for Linear Programming problems.	2	CO1, 2	1,2
	Maximal & minimal solution for Linear Programming problems.	1	CO1, 2	1,2
	Simplex Algorithm	2	CO1, 2	1,2
	Big-M method, Two-phase method	2	CO1, 2	1,2
	Duality in linear programming	2	CO1, 2	1,2
	Integer linear programming	2	CO1, 2	1,2
Unit 3	**Transportation (TP) and Assignment (TP) Problems**	**9 Hours**		
	Balanced TP, Unbalanced TP	2	CO 3	1,2
	North-West Corner Rule	1	CO 3	1,2
	Vogel's Approximation	2	CO 3	1,2
	Stepping Stone Method	2	CO 3	1,2
	Modified Distribution Method, Hungarian Method for AP.	2	CO 3	1,2
Unit 4	**Nonlinear optimization problem**	**12 Hours**		
	Formulation of nonlinear programming problems	1	CO1, 4	1,2
	Classification of nonlinear optimization problems	1	CO1, 4	1,2
	Constrained-Unconstrained Problems	2	CO 4	1,2
	Lagrange Multipliers,	1	CO 4	1,2
	Gradient-descent methods.	2	CO 4	1,2
	Karush-Kuhn-Tucker Conditions	2	CO 4	1,2
	Efficient techniques for Quadratic problems	2	CO 4	1,2
	Class Assessment	1	CO 4	1,2
Total		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 15%	Mid-1 25%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	60%	55%	40%	50%	55%
	Understand					
Level 2	Apply	40%	45%	60%	50%	45%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Mokhtar S. Bazaraa, John J. Jarvis, Hanif D. Sherali: Linear Programming and Network Flows. John Wiley & Sons,
2. Hamdy A. Taha: Operations Research, an Introduction. Pearson Education.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Data Structures and Algorithms

Course Code	MAT 515	Course Category	CE	L	T	P	C
				3	0	0	3
Pre-Requisite Course(s)	C++ or Python	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mathematics	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To comprehend the notion of an algorithm and to gain knowledge on their role in computing with mathematical notations
2. To implement searching algorithms like Linear search, Binary search, Hashing and
3. Sorting algorithms like Bubble sort, Merge sort, Heapsort, Quicksort, Lower Bounds for sorting,
4. Counting sort, Radix sort, Bucket sort.
5. To comprehend and implement various algorithmic design paradigms.
6. To gain knowledge on Representations of graphs, Trees, and Hash Tables.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Comprehend the notion of an algorithm and to gain knowledge on their role in computing with mathematical notations.	2	80%	65%
Outcome 2	Implement searching algorithms like Linear search, Binary search, Hashing and Sorting algorithms like Bubble sort	2,3	90%	50%
Outcome 3	Implement various algorithmic design paradigms.	2,3	70%	50%
Outcome 4	Analyse Representations of graphs, Trees, and Hash Tables	2	90%	40%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2	-	-	-	-	-	-	-	2	2	2
Outcome 2	3	3	3	3	2	-	-	-	-	-	-	-	3	3	3
Outcome 3	3	3	3	3	2	-	-	-	-	-	-	-	3	3	3
Outcome 4	3	3	3	3	2	-	-	-	-	-	-	-	3	3	3
Average	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	**Introduction to Data Structures and Algorithms, Algorithm Analysis**	**8**		**1,2**
	Overview of data structures and algorithms, Importance in computer science and software development	2	1	
	Basic terminology and concepts	1	1	
	Time and space complexity analysis with the help of Insert sort	3	1	
	Asymptotic notation (Big-O, Omega, Theta) Best, average, and worst-case analysis	2	1	
Unit II	**Sorting and Searching Algorithms**	**12**		**1,2**
	Comparison-based sorting algorithms - Bubble Sort, Insert Sort, Selection Sort	3		
	Comparison-based sorting algorithms - Merge Sort, QuickSort	3	2,3	
	Non-comparison sorting algorithms - Counting Sort, Radix Sort	3	2,3	
	Searching algorithms - Binary Search, Hashing	3	2,3	
Unit III	**Fundamental Data Structures and Advanced Data Structures**	**16**		**2,3**
	Arrays, Linked Lists, and their variations,	2	2,4	
	Stacks and Queues,	3	2,4	
	Trees and Binary Trees,	3	2,4	
	Heaps and Priority Queues,	3	2,4	
	Hash Tables and Hashing techniques,	3	2,4	
	Graphs and their representations	2	2,4	
	Trees- Binary tree, Binary search tree, Hash tables, Heaps		2,4	
Unit IV	**Algorithm Design Paradigms**	**9**		**1,2**
	Divide and Conquer,	3	3	
	Greedy Algorithms,	3	3	
	Dynamic Programming	3	3	
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 15%	Mid-1 25%	CLA-2 10%	CLA-3 10%	
Level 1	Remember	60%	50%	40%	40%	50%
	Understand					
Level 2	Apply	30%	40%	60%	40%	40%
	Analyse					
Level 3	Evaluate	10%	10%		20%	10%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. T.H. Cormen, C.E. Leiserson, R.L. Rivest, and C. Stein, Introduction to Algorithms, 3rd Edn, PHI, New Delhi, 2009.
2. "Algorithms" by Robert Sedgewick and Kevin Wayne
3. "Data Structures and Algorithms in Python" by Michael T. Goodrich, Roberto Tamassia, and Michael H. Goldwas-ser.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Functional Analysis

Course Code	MAT 512	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Metric Space & Real Anal-ysis	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. The objectives include mastering vector spaces and their applications in solving linear algebraic problems, comprehending normed linear spaces with proficiency in using norms.
2. The objectives of basic functional analysis include building a strong foundation in vector spaces, norms, and linear operators. Emphasis is placed on developing practical skills to apply mathematical analysis concepts in diverse contexts.
3. To proficiently apply a diverse set of established techniques and develop a reasonable level of skill in calculations and material manipulation. Emphasizing problem-solving across various areas of study.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Define vector operations and norms in normed linear spaces, demonstrating competence in continuity and convergence. Also, analyse and work with bounded and continuous linear operators.	1	75%	80%
Outcome 2	Understand the theory of Hilbert spaces, grasping the properties and applications of inner product spaces with a focus on completeness.	1	75%	75%
Outcome 3	Describe the significance and applications of Zorn's lemma in establishing existence and maximality in partially ordered sets. Furthermore, students will extend linear functional and appreciate their applications in functional analysis.	2	75%	80%
Outcome 4	Develop a comprehensive and advanced skill set, enabling them to navigate intricate problems in functional analysis and linear algebra with confidence.	2	75%	75%
Outcome 5	Understand key fixed-point theorems and will extend it to broader mappings and spaces.	1	75%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	3	2	3	-	-	-	-	-	-	-	2	2	2
Outcome 2	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
Outcome 3	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
Outcome 4	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
Outcome 5	2	2	3	2	3	-	-	-	-	-	-	-	2	2	2
Average	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	Vector space, normed linear space	2	CO 1	1,2
	Holder, Minkowski's inequality,	2	CO 1	1,2
	compactness and finite dimension, bounded and continuous linear operator	3	CO 1	1,2
	linear functional, dual space, Completeness	3	CO 1	1,2
Unit II	Inner Product Space, Hilbert space	2	CO 2	1,3
	Cauchy-Schwartz inequality, Bessel's inequality	2	CO 2	1,3
	Parallelogram identity, Apollonius identity, Polarization identity, Parseval identity	2	CO 2	1,3
	Riesz representation theorem, Hilbert adjoint operator	3	CO 2	1,3
	Projections, bounded linear functional on Hilbert space.	2	CO 2	1,3
Unit III	Zorn's lemma, Hamel basis, Hahn-Banach theorem and its consequences,	2	CO 3	1,3
	Geometric form, applications,	2	CO 3	1,3
	Baire Category theorem, Uniform Boundedness theorem,	2	CO 3	1,3
	strong and weak convergence,	2	CO 4	1,3
	Open mapping theorem, Closed graph theorem.	2	CO 4	1,3
Unit IV	Reflexive space, separability of dual space, best approximations, strict and uniform convexity	2	CO 5	3
	Frechet Differentiability, Gateaux Differentiability, smoothness, extreme point, Haar uniqueness theorem	2	CO 5	3
	Chebysev polynomial, compact convex sets, seminorm and local convexity,	2	CO 5	3
	Banach Alaoglu theorem, Banach -Steinhaus theorem, Banach Mazur theorem, Generalized Stone-Weierstrass theorem.	2	CO 5	3
Unit V	Banach fixed point theorem, Contraction theorem	2	CO 6	1,3
	Brouwer fixed point theorem, Kakutani's fixed point theorem,	2	CO 6	1,3
	Schauder fixed point theorem. Picard's theorem.	2	CO 6	1,3
Total		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 20%	Mid-1 20%	CLA-2 20%	CLA-3 20%	
Level 1	Remember	60%	55%	65%	60%	50%
	Understand					
Level 2	Apply	40%	45%	35%	40%	50%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, India, 2006.
2. M. Schechter, Principles of Functional Analysis, Second Edition, American Mathematical Society, 2001.
3. Rudin, W., 1991. Functional analysis, mcgrawhill. Inc, New York.

Other Resources

Course Designers