Department of Mathematics

B.Sc. (Hons.) 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. Offer foundational and advanced courses in undergraduate mathematics by active researchers in the field.
2. Prepare students to pursue higher mathematics and conduct research.
3. Develop competencies to apply mathematical knowledge in practical problems, which will help them to shine in their chosen fields, including Education, IT, Banking, etc.

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

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

Program Specific Outcomes (PSO)

1. Express mathematical ideas in the formal language of mathematics.
2. Construct a mathematical proof with analytical thinking, following logical rules of inference.
3. Extrapolate, deduce, formulate, and solve complex mathematical problems with available information.

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	3	3	1	1	2	1	-	-	1	-	-	-	1	2	2
PEO 2	3	2	1	1	3	2	-	2	1	1	-	2	2	3	3
PEO 3	2	3	3	2	1	3	2	1	2	1	2	2	3	2	3

Category Wise Credit Distribution			
Course Sub-Category	**Sub-Category Credits**	**Category Credits**	**Learning Hours**
Ability Enhancement Courses (AEC)		8	240
University AEC	4		
School AEC	4		
Value Added Courses (VAC)		8	240
University VAC	8		
School VAC	0		
Skill Enhancement Courses (SEC)		15	450
School SEC	7		
Department SEC	2		
SEC Elective	6		
Foundation/ Interdisciplinary courses (FIC)		17	510
School FIC	14		
Department FIC	3		
Core + Core Elective including Specialization (CC)		80	2400
Core	52		
Core Elective (Inc Specialization)	28		
Minor (MC) + Open Elective (OE)	15	15	450
Research / Design / Internship/ Project (RDIP)		17	510
Internship / Design Project / Startup / NGO	5		
Internship / Research / Thesis	12		
	Total	**160**	**4800**

Semester wise Course Credit Distribution Under Various Categories										
Category	**Semester**									
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**	**%**
Ability Enhancement Courses - AEC	2	2	2	2	0	0	0	0	8	**5**
Value Added Courses - VAC	2	2	0	0	0	4	0	0	8	**5**
Skill Enhancement Courses - SEC	3	2	2	2	3	3	0	0	15	**9**
Foundation / Interdisciplinary Courses - FIC	11	6	0	0	0	0	0	0	17	**11**
CC / SE / CE / TE / DE / HSS	0	8	16	12	16	16	12	0	80	**50**
Minor / Open Elective - OE	0	0	3	3	3	3	3	0	15	**9**
(Research/ Design/ Industrial Practice/Project/Thesis/Internship) -RDIP	0	0	0	0	0	0	5	12	17	**11**
Grand Total	**18**	**20**	**23**	**19**	**22**	**26**	**20**	**12**	**160**	**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	AEC	U AEC	AEC 101	Art of Listening, Speaking and Reading Skills	1	0	1	2
2	VAC	U VAC	VAC 101	Environmental Science	2	0	0	2
3	SEC	S SEC	SEC 101	Analytical Reasoning and Aptitude Skills	1	1	1	3
4	FIC	S FIC	FIC 111	Chemical Basis of Life	3	0	0	3
5	FIC	S FIC	FIC 112	Mathematics for the Physical World	3	0	0	3
6	FIC	S FIC	FIC 113	Fundamentals of Computing	2	0	1	3
7	FIC	S FIC	FIC 101	Emerging Technologies	2	0	0	2
				Semester Total	**14**	**1**	**3**	**18**

SEMESTER - II								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	AEC	U AEC	AEC 107	Effective Writing and Presentation Skills	1	0	1	2
2	VAC	U VAC	VAC 102	Universal Human Values and Ethics	2	0	0	2
3	SEC	S SEC	SEC 103	Entrepreneurial Mindset	0	0	2	2
4	FIC	S FIC	FIC 107	Principles of Management	3	0	0	3
5	FIC	S FIC	FIC 124	Psychology for Everyday Living	3	0	0	3
6	CC	Core	MAT 150	Real analysis - I	4	0	0	4
7	CC	Core	MAT 152	Linear Algebra	4	0	0	4
				Semester Total	**15**	**2**	**3**	**20**

SEMESTER - III								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	AEC	S AEC	AEC 108	Problem Solving Skills	1	0	1	2
2	VAC	U VAC	VAC 103	Co-Curricular Activities	0	0	2	2*
3	VAC	U VAC	VAC 104	Community Service and Social Responsibility	2	0	0	2*
4	SEC	D SEC	SEC 102	Digital literacy	2	0	0	2
5	Core	CC	MAT 153	Algebra - I	4	0	0	4
6	Core	CC	MAT 160	Discrete Mathematics and Combinatorics	4	0	0	4
7	Core	CC	MAT 202	Real Analysis – II	4	0	0	4
8	Core	CC	MAT 203	Ordinary Differential Equations - I	4	0	0	4
9	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**22**	**0**	**1**	**23**

SEMESTER - IV								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	AEC	S AEC	AEC 104	Creativity and Critical Thinking Skills	1	0	1	2
2	VAC	U VAC	VAC 103	Co-curricular Activities	0	0	2	2*
3	VAC	U VAC	VAC 104	Community Service and Social Responsibility	2	0	0	2*
4	SEC	D SEC	SEC 107	Mathematical Modelling for Physical Data	2	0	0	2
5	Core	CC	MAT 201	Complex Analysis	3	1	0	4
6	Core	CC	MAT 204	Probability and Statistics	3	1	0	4
7	Core	CC	MAT 207	General Topology	3	1	0	4
8	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**17**	**3**	**3**	**19**

SEMESTER - V								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 103	Co-Curricular Activities	0	0	2	2*
2	VAC	U VAC	VAC 104	Community Service and Social Responsibility	2	0	0	2*
3	SEC	E SEC	SEC 111	Linear Programming Problem	3	0	0	3
4	Core	CC	MAT 301	Real Analysis - III	3	1	0	4
5	Core	CC	MAT 302	Partial Differential Equations - I	3	1	0	4
6	Core	CC	MAT 303	Numerical Analysis	3	1	0	4
7	Core	CC	MAT 304	Number Theory and Introduction to Cryptography	3	1	0	4
8	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**20**	**4**	**2**	**22**

SEMESTER - VI								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 103	Co-Curricular Activities	0	0	2	2
2	VAC	U VAC	VAC 104	Community Service and Social Responsibility	2	0	0	2
3	SEC	E SEC	SEC 134	MATLAB, Sage and Mathematica	2	0	1	3
4	Elective	SE		Specialization Elective	3	1	0	4
5	Elective	SE		Specialization Elective	3	1	0	4
6	Elective	SE		Specialization Elective	3	1	0	4
7	Elective	SE		Specialization Elective	3	1	0	4
8	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**19**	**4**	**3**	**26**

SEMESTER - VII								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	SE		Specialization Elective – V	3	1	0	4
2	Elective	SE		Specialization Elective – VI	3	1	0	4
3	Elective	SE		Specialization Elective - VII	3	1	0	4
4	RDIP	RDIP	MAT 401	Internship	0	0	5	5
5	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**12**	**3**	**5**	**20**

SEMESTER - VIII								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	RDIP	RDIP	MAT 402	Research Project	0	0	12	12
				Semester Total	**0**	**0**	**12**	**12**

Specialization : Pure Mathematics								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE	MAT 403	Measure Theory	3	1	0	4
2	Elective	CE	MAT 412	Advanced Linear Algebra	3	1	0	4
3	Elective	CE	MAT 421	Algebra - II	3	1	0	4
4	Elective	CE	MAT 422	Functional Analysis	3	1	0	4
5	Elective	CE	MAT 423	Algebraic Topology	3	1	0	4
6	Elective	CE	MAT 424	Algebra - III	3	1	0	4
7	Elective	CE	MAT 425	Operator Theory	3	1	0	4

Specialization: Applied Mathematics								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	SE	MAT 411	Optimization techniques	3	1	0	4
2	Elective	SE	MAT 426	Mechanics and Tensor Calculus	3	1	0	4
3	Elective	SE	MAT 428	Ordinary Differential Equations – II	3	1	0	4
4	Elective	SE	MAT 429	Partial Differential Equation - II	3	1	0	4
5	Elective	SE	MAT 430	Dynamical Systems	3	1	0	4
6	Elective	CE	MAT 403	Measure Theory	3	1	0	4
7	Elective	CE	MAT 422	Functional Analysis	3	1	0	4

Specialization: Data Science and Industrial Mathematics								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	SE	MAT 413	Data Structures and Algorithms	3	1	0	4
2	Elective	SE	MAT 431	Applied Statistics	3	1	0	4
3	Elective	SE	MAT 432	Applied Linear Algebra	3	1	0	4
4	Elective	SE	MAT 433	Financial Mathematics	3	1	0	4
5	Elective	SE	MAT 434	Regression analysis	3	1	0	4
6	Elective	SE	MAT 435	Stochastic process and Stochastic Differential Equations	3	1	0	4
7	Elective	SE	MAT 436	Mathematics for Machine learning	3	1	0	4

Minor : Mathematics								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	OE	OE	MAT 243	Cryptography	3	0	0	3
2	OE	OE	MAT 263	Numerical analysis	3	0	0	3
3	OE	OE	MAT 264	Advanced Linear Algebra	3	0	0	3
4	OE	OE	MAT 266	Elementary Number Theory	3	0	0	3
5	OE	OE	MAT 265	Introduction to Partial Differential Equations: Theory and Computation	3	0	0	3

Minor : Statistics								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	OE	OE	MAT 267	Descriptive Statistics	3	0	0	3
2	OE	OE	MAT 268	Statistical inference	3	0	0	3
3	OE	OE	MAT 269	Limit theorems and introduction to Stochastic process	3	0	0	3
4	OE	OE	MAT 270	Applied Regression Analysis	3	0	0	3
5	OE	OE	MAT 271	Generating functions and multivariate functions	3	0	0	3

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The Art of Listening, Speaking and Reading Skills

Course Code	AEC 101	Course Category		L	T	P	C
				1	0	1	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Literature and Languages	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

- To develop and enhance students' proficiency in listening, speaking, and reading skills,
- To help the participants understand the purpose and differentiate various types of audience.
- To prepare the students to produce Language in various contexts be it Oral or Written form.

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 advanced listening skills, to comprehend and respond to a wide range of spoken language varieties, accents, and contexts with increased accuracy and fluency.	2	90%	90%
Outcome 2	Articulate ideas and thoughts clearly and effectively in both informal and formal settings, utilizing appropriate vocabulary, grammar, and speech delivery techniques.	3	90%	90%
Outcome 3	Enhance their reading comprehension and critical analysis abilities, enabling them to understand complex texts, extract key information, and critically evaluate the content within various genres and subjects.	3	70%	70%
Outcome 4	Engage in effective and meaningful conversations, demonstrating improved listening skills, oral communication abilities, and comprehension of written texts, thereby enhancing their overall language proficiency and communication competence	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					1	1		3	2	3		3			
Outcome 2					1	1			1	3		3			
Outcome 3					1	1			1	3		2			
Average					**1**	**1**			**1**	**3**	**3**	**3**			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Augmenting Listening skills**	**9**		
	Course introduction and objectives: Importance of LSRW	1	1	1 a
	Listening - Barriers to active listening and steps to Overcome	2	1	1 b
	Listening Comprehension How to take/ make notes (different ways)	2	1	1b, 2a, 2c
	Listening practice: Identifying main ideas, supporting details, and inferences and summarizing key points	2	1	1b, 2a, 2c
	Practice sessions: memory games, Chinese whisper	2	1	NA
Unit 2	**Developing Speaking Skills**	**9**		
	Strategies for good speech, Basics of grammatically correct speech	1	2	1a, 2 a, b, c
	Basics of phonetics and intonation	2	2	1a
	Oral presentations: do's and don'ts	1	2	1a
	Speaking Practice: Just a minute/ Impromptu, Story-telling/ Story starters Group discussions,	5	2	NA
Unit 3	**Communication and Persuasion**	**9**		
	Verbal Communication and Nonverbal Communication	2	2, 3	1a
	The art of persuasive communication (Ethos, pathos, Logos)	2	2, 3	1a
	Practice sessions (Convince the other Role plays, Self-introduction, Pitching, extempore, public speaking)	5	2, 3	NA
Unit 4	**Reading**	**9**		
	Reading strategies (Skimming and scanning, extensive and intensive)	2	2	1c
	Reading and analyzing various texts, including articles, essays, and academic papers	3	2	1c
	Reading Comprehension Practice	4	2	1c, 2a
Unit 5	**Integrated Skills and Real-World Application**	**9**		
	Engaging in discussions and debates on current issues	2	3	NA
	Real-world application of language skills (e.g., job interviews, social interactions)	2	3	NA
	Pitching Presentation	5	3	NA
	Total contact hours	45		
	Notional hours	15		
	Total Leaning Hours	**60**		

Learning Assessment

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

Recommended Resources

1a. Shoba, L. (2017). Communicative English: A Workbook. U.K: CambridgeUniversity Press.
1b. Leonardo, N. (2020) Active Listening Techniques: 30 Practical Tools to Hone Your Communication Skills. Rockridge Press
1c. Williams, A.J. (2014) Reading Comprehension: How To Drastically Improve Your Reading Comprehension and Speed Reading Fast! (Reading Skills, Speed Reading)

2a. https://learnenglishteens.britishcouncil.org/
2b. https://www.bbc.co.uk/learningenglish/
2c. https://www.ted.com/?geo=hi

Other Resources

1. -

Course Designers

1. -

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

Environmental Science

Course Code	VAC 101	**Course Category**	Value Added Course	**L**	**T**	**P**	**C**
				2	0	0	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Environmental Science and Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To describe the environmental concepts from ecology and earth science to address real-world problems.
- To interpret the complex interactions within and between environmental systems and to evaluate evolving environmental 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	Comprehend the environmental challenges that need attention.	1	80%	70%
Outcome 2	Summarize the types of environmental pollutions and possible effects to society	2	80%	70%
Outcome 3	Classify the natural environmental resources, present state, rate of depletion and future perspectives	2	80%	70%
Outcome 4	Articulate a project-based learning on existing local to global environmental issues	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 Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	-	1	1	-	1	1	1	2	1	-	1	-	-	-
Outcome 2	1	-	1	1	-	1	2	1	2	1	-	1	-	-	-
Outcome 3	1	-	1	2	1	1	3	2	2	1	-	1	-	-	-
Outcome 4	1	-	1	2	2	1	3	3	2	2	1	1	-	-	-
Average	**1**	**-**	**1**	**1.5**	**1.5**	**1**	**2.25**	**1.75**	**2**	**1.25**	**1**	**1**	**-**	**-**	**-**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Human, Environmental Issues, and Climate Change**	**6**	1	1,2,3
	The man-environment interaction	1	1	1,2,3
	Environmental issues and scales	1	1	1,2,3
	Land use and Land cover change	2	1	1,2,3
	Ozone layer depletion	1	1	1,2,3
	Understanding climate change and adaptation	1	1	1,2,3
Unit 2	**Environmental Pollution and Health**	**7**	2	1,2,3
	Understanding pollution; Definitions, sources, impacts on human health and ecosystem	2	2	1,2,3
	Air pollution	1	2	1,2,3
	Water pollution	1.5	2	1,2,3
	Soil pollution	1	2	1,2,3
	Solid waste	1.5	2	1,2,3
Unit 3	**Ecosystems, Biodiversity Conservation, and Sustainable Development**	**9**	3	1,2,3
	Ecosystems and ecosystem services	1	3	1,2,3
	Biodiversity and its distribution	1	3	1,2,3
	Threats to biodiversity and ecosystems	1	3	1,2,3
	Overview of natural resources	1	3	1,2,3
	Biotic resources	1	3	1,2,3
	Water resources; Soil and Energy resources	2	3	1,2,3
	Introduction to Sustainable Development Goals (SDGs)-targets and indicators	2	3	1,2,3
Unit 4	**Environmental Management, Treaties and Legislation**	**8**	4	1,2,3
	Introduction to environmental laws and regulation	2	4	1,2,3
	Environmental management system	2	4	1,2,3
	Pollution control and management	2	4	1,2,3
	Major International Environmental Agreements; Major Indian Environmental Legislations	2	4	1,2,3
Total Contact Hours		30		

Learning Assessment

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

Recommended Resources

1. Rajagopalan, R. (2016) Environmental Studies (3rd edition), Oxford University Press.
2. Sharma, P. D. (2018) Ecology and environment. Rastogi Publications.
3. Anil K. Dey. (2016). Environmental Chemistry. New Age Publisher International Pvt Ltd. ISBN: 9789385923890, 9385923897

Other Resources

1. -

Course Designers

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Analytical Reasoning and Aptitude Skills

Course Code	SEC 101	Course Category	SEC		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 categorize, apply and use thought process to distinguish between concepts of quantitative methods.
2. To prepare and explain the fundamentals related to various possibilities.
3. To critically evaluate numerous possibilities related to puzzles.
4. Explore and apply key concepts in logical thinking to business 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	Use logical thinking and analytical abilities to solve quantitative aptitude questions from company specific and other competitive tests.	1	70%	60%
Outcome 2	Solve questions related to Time and Distance and Time and work from company specific and other competitive tests.	3	65%	70%
Outcome 3	Understand and solve puzzle questions from specific and other competitive tests	1	60%	60%
Outcome 4	Make sound arguments based on mathematical reasoning and careful analysis of data.	1	65%	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 Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1		3	2	2					2						
Outcome 2		3	2	2					1						
Outcome 3		3	2	1					2						
Outcome 4		3	1	2					2						
Average		3	2	2					2						

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Quantitative Aptitude**	**14**		
	Time, speed and distance	5	1,4	1,4
	Time and work, Pipes and cisterns	9	1,4	1,4
Unit II	Numbers, LCM and HCF.	2	1,4	1,4
	P and C	4	1,4	1,4
	Probability, progressions	4	1,4	1,4
Unit III	Geometry, Mensuration	5	1,2	2,3
	Clocks and calendars	4	1,3	1,4
Unit IV	Linear equation and special equations	5	1,2	1,2
	Quadratic equations	2	1,2	1,2
	Inequalities	2	2,3	2,3
	Sets and Venn diagrams	3	1,2	2,4
Total Contact Hours		**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%		Mid -2 15%			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%		50%		40%		50%		50%	
	Understand										
Level 2	Apply	60%		50%		60%		50%		50%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Arun Sharma – How to prepare for Quantitative Aptitude, Tata Mcgraw Hill.
2. R.S. Agarwal – Reasoning. Reasoning for competitive exams – Agarwal.
3. Objective Quantitative Aptitude – Oswaal books.
4. Test of reasoning and numerical ability, quantitative aptitude book – Sahitya bhavan.
5. Radian's Quantitative Aptitude.
6. Quantitative Aptitude and Reasoning – Shyam Saraf / Abhilasha Swarup.
7. Fast track objective Arithmetic – Rajesh Verma.

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

Chemical Basis of Life

Course Code	FIC 111	**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	Biological Sciences/ Chemistry	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To learn the origin and composition of complex biomolecules and primitive cells, focusing on the chemical reactions that drive the force of life
- To gain foundational knowledge in chemical thermodynamics, covering the basic principles of energy, work, and heat, and understanding the first and second laws of thermodynamics, entropy, spontaneity, reversibility, disorder, and the calculation of Gibbs free energy.

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	List and describe biomolecules and cellular structures	2	70%	65%
Outcome 2	Compare different chemical bonding concepts	2	70%	65%
Outcome 3	Analyze and explain cellular processes and structures	4	50%	50%
Outcome 4	Apply thermodynamic principles to chemical systems	3	70%	65%
Outcome 5	Interpret and evaluate energy harvesting reactions in life	6	50%	50%

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	3	1	1				3		3	3	1	2
Outcome 2	3	3	3	3	1	1			1			3	3	3	2
Outcome 3	3	3	3	2	1	1			1			2	3	2	3
Outcome 4	3	2	3	3	1	1			1			3	3	3	3
Outcome 5	3	3	3	3	1	1			2	3		3	3	2	3
Average	**3**	**2.6**	**3**	**2.8**	**1**	**1**			**1.3**	**3**		**2.8**	**3**	**2.2**	**2.6**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Life: Origin, composition, and chemistry**	**9**		
	Origin of complex biomolecules and primitive cells	1.5	1	1, 2
	Chemical basis of life- Importance of carbon & water	1.5	1	1, 2
	Synthesis by polymerization; importance of self-assembly; Selectively permeable membranes	1.5	1	1, 2
	Concepts of acids, bases, and buffers	1.5	1	3
	Concepts and numerical problems on pH, K_a, K_b, K_w	1.5		2, 3
	Henderson-Hasselbalch equation	1.5	1	1, 2, 3
Unit 2	**Chemical bonding**	**9**		
	Definition and importance; Valence electrons and their role in bond formation	1.5	2	3
	Introduction of Lewis dot structure; Covalent bonds- single, double, and triple bonds	1.5		
	Electronegativity and polarity in covalent bonds; Ionic bonds- transfer of electrons, cations and anions	1.5	2	3
	An elementary idea of lattice structure	1.5		3
	Weak intermolecular associations. Coordinate bonds.	1.5	2	3
	Comparison of bond strengths of different bonds with special relation to biological systems.	1.5	2	3
Unit 3	**Life forms and processes**	**9**		
	Prokaryotes and eukaryotes (cell structures and organelles); Virus- lysogenic and lytic cycles	1.5	3	1, 2
	Bacteria- typical bacterial cells, bacterial gene transfer- conjugation, transformation, and transduction	1.5	3	1, 2
	Antibiotic resistance- an emerging threat; Microbiome; Cell cycle- mitosis and meiosis	1.5	3	1, 2
	Structure of DNA and organization of chromosomes	1.5	3	1, 2
	Central dogma- replication in prokaryotes	1.5	3	1, 2
	Central dogma- transcription, and translation in prokaryotes	1.5	3	1, 2
Unit 4	**Chemical thermodynamics**	**9**		
	Introduction to energy, work and heat in chemical systems; Differentiating between open, closed, and isolated systems	1.5	4	3
	First law of thermodynamics: conservation of energy, calculation of internal energy changes, concept of enthalpy	1.5	4	3
	Second law of thermodynamics: definition, concept of entropy, calculation and interpretation of entropy changes	1.5	4	3
	Spontaneity, reversibility, and disorder	1.5	4	3
	Gibbs free energy: calculation, predicting feasibility of reaction	1.5	4	2, 3
	Concept of chemical equilibrium	1.5	4	1, 2, 3
Unit 5	**Energy harvesting reactions by life forms**	**9**		
	Biological reactions: Enzymes	1.5	5	1, 2
	Equilibrium constants (K_{eq}) of enzymes	1.5	5	1, 2
	Metabolism: Glycolysis	1.5	5	1, 2
	Anaerobic respiration	1.5	5	1, 2
	Aerobic cellular respiration	1.5	5	1, 2
	Fate of food in cellular energy cycle.	1.5	5	1, 2
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (30%)	
		CLA-1 (20%)		Mid-1		CLA-2 (25%)		CLA-3 (25%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%				40%		40%		30%	
	Understand										
Level 2	Apply	60%				40%		40%		45%	
	Analyse										
Level 3	Evaluate					20%		20%		25%	
	Create										
Total		**100%**				**100%**		**100%**		**100%**	

Recommended Resources

1. Becker's World of the Cell, Global Edition, 9th Edition (2017). Jeff Hardin, Gregory Paul Lewis J. Kleinsmith.Pearson. ISBN-13: 978-1292177694.
2. Life: The Science of Biology, 11th Edition (2017). David Sadava, David M. Hillis, H. Craig Heller, Sally D. Hacker. Sinauer Associates Inc. ISBN-13: 978-1319121078.
3. Chemistry, 12 the Edition (2015). Raymond Chang, Kenneth A. Goldsby. McGraw-Hill Education. ISBN-13: 978-0078021510.

Other Resources

1. -

Course Designers

1. Dr. Writoban Basu Ball, Dept. Of Biological Sciences. SRM University – AP

SRM University *AP*, Andhra Pradesh

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

Mathematics for Physical World

Course Code	FIC 112	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)

- To enable students from the very beginning of their undergraduate course to know what Mathematics is about.
- To consolidate and improve students' understanding of mathematics by studying core mathematical topics in more depth.
- To understand the usefulness, power, and beauty of mathematics

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	Interpret mathematical concepts of set theory to solve appropriate problems in both familiar and unfamiliar situations including those in real-life contexts.	2	80%	70%
Outcome 2	Demonstrate basic matrix operations and apply the concepts to real-world applications.	3	80%	70%
Outcome 3	Express derivative as a limit and apply these techniques to graph sketching and optimization problems.	3	70%	65%
Outcome 4	Illustrate the process of integration as anti-differentiation and utilize it to solve several real-world problems.	3	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	3	3	3					1			2			
Outcome 2	3	3	3	2	1				2			2			
Outcome 3	3	3	3	3	1				2			2			
Outcome 4	3	3	3	3	3				3			2			
Average	3	3	3	3	2				2			2			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	Reference Used
Unit No. 1	**High School Mathematics and its Applications**	**6**		
	Set Theory	1	1	1
	Tutorial-I	1	1	1
	Permutation	1	1	1
	Tutorial -II	1	1	1
	Combination	1	1	1
	Tutorial-III	1	1	1
Unit No. 2	**Matrices and System of Linear Equations**	**10**		
	Introduction to Matrices	1	2	3
	Matrix Operations and Algebraic Properties of Matrices	2	2	3
	Tutorial-I	1	2	3
	Determinant and inverse of matrices	2	2	3
	Tutorial-II	1	2	3
	System of Linear Equations and their solutions	2	2	3
	Tutorial-III	1	2	3
Unit No. 3	**Differential Calculus**	**9**	3	
	Functions and their graph	2	3	1,2
	Tutorial-I	1	3	1,2
	Limit and Continuity of a function	2	3	1,2
	Derivative of a function and various rules	2	3	1,2
	Increasing and Decreasing functions	1	3	1,2
	Tutorial-II	1	3	1,2
Unit No. 4	**Integral Calculus**	**8**		
	Indefinite Integrals	2	4	1,2
	Tutorial-I	1	4	1,2
	Definite Integrals	2	4	1,2
	Tutorial-II	1	4	1,2
	Fundamental Theorem of Calculus	1	4	1,2
	Tutorial-III	1	4	1,2
Unit No. 5	**Applications**	**12**		
	Applications of Permutations and Combinations: Formation of molecules	1	1	1,2
	Generation of ON/OFF signals in computing	1	1	
	Tutorial-I	1	1	1,2
	Applications of Matrices: Cryptography by Matrices	1	2	1,2
	Electrical circuit problem	1	2	1,2
	Tutorial-II	1	2	
	Applications of Differential Calculus: Work done and Electric field	1	3	1,2
	Energy behaviour of physical system and computation of Area and volume	1	3	1,2
	Tutorial-III	1	3	1,2
	Applications of Integral Calculus: Kinematics of one-dimensional system	1	4	1,2
	Concept of Slope and analysis of its real-life applications	1	4	1,2
	Blood flow and Cardiac Output	1	4	1,2
	Total Contact Hours	**45**		

Learning Assessment

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

Recommended Resources

1. Kenneth H. Rosen, Discrete Mathematics and Applications, Seventh Edition, Tata McGraw-Hill, 2012.
2. Thomas' Calculus, 14th Edition, Joel R. Hass, Christopher E. Heil, and Maurice D. Weir, 2018.
3. David Hill and Bernard Kolman, Elementary Linear Algebra with Applications, 9th Edition, by Pearson 2019.

Other Resources

Course Designers

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

Fundamentals of Computing

Course Code	FIC 113	Course Category	Core Course	L	T	P	C
				2	0	1	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	CSE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

- Gain basic knowledge in Computer Science and problem solving.
- Gain basic knowledge in C programming language.
- Acquire knowledge on Decision making and functions in C.
- Learn arrays, strings and pointers concept in C.

Course Outcomes / Course Learning Outcomes (CLOs)

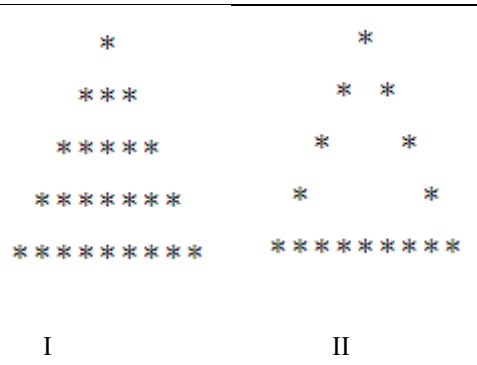
	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe basics of Computing and problem solving	2	75 %	70%
Outcome 2	Describe C structures, enumerators, keywords, header files and operators	3	70 %	65%
Outcome 3	Illustrate Decision-Making statements and Functions.	3	70 %	65%
Outcome 4	Interpret arrays, strings, and pointers programming in C	3	70 %	65%
Outcome 5	Apply Structures, unions, File handling operations on different scenarios	4	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 Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	1									2	2	3
Outcome 2	3	3	2	1									3	2	3
Outcome 3	3	3	2	2									3	2	3
Outcome 4	3	3	2	2									3	2	3
Outcome 5	3	3	2	2								2	3	2	2
Average	3	3	2	2								2	3	2	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**INTRODUCTION TO COMPUTING**	**10**	1	1
	Fundamentals of Computing, Historical perspective, Early computers	2	1	1,2
	Computing machine. Basic organization of a computer.	2	1	1,2
	ALU, input-output units, and addresses - instructions	2	1	1,2
	Computer Memory	2	1	1,2
	Program counter - variables	1	1	1,2
	Store, arithmetic, input and output	1	1	1,2
Unit No. 2	**INTRODUCTION TO PROBLEM SOLVING**	**10**		
	Problem solving: Algorithm / Pseudo code, flowchart, program development steps	2	1	1,2
	Computer languages: Machine, symbolic and high-level langua Level languages	2	1	1,2
	Creating and Running Programs: Writing, editing (any editor),	1	1	1,2
	linking, and executing in Linux environment	1	1	1,2
	Lab Experiment 1: GCC Compiler using Linux, various Linux commands used to edit, compile and executing	2	1	1,2
	Lab Experiment 2: a) Calculation of the area of the triangle. b) Swap two numbers without using a temporary variable. c) Find the roots of a quadratic equation	2	1	1,2
Unit No. 3	**C PROGRAMMING BASICS**	**15**		
	Structure of a C program, identifiers Basic data types and sizes. Constants, Variables	1	1	1,2
	Arithmetic, relational and logical operators, increment and decrement operator's	1	1	1,2
	Conditional operator, assignment operator, expressions Type conversi Type Conversions,	1	1	1,2
	Conditional Expressions Precedence and order of evaluation, Sample Programs.	1	1	1,2
	SELECTION & DECISION MAKING: if-else, null else, nested if, examples, multi-way selection: switch, else-if, examples.	2	1	1,2
	ITERATION: Loops - while, do-while and for, break, continue,	1	1	1,2
	initialization and updating, event and counter controlled loops and examples.	2	1,2	1,2
	Lab Experiment 3: a) Find the sum of individual digits of a positive integer and find the reverse of the given number. b) Generate the first n terms of Fibonacci sequence. c) Generate all the prime numbers between 1 and n, where n is a value supplied by the user.	2	1, 2	1,2
	Lab Experiment 4: a) Print the multiplication table of a given number n up to a given value, where n is entered by the user. b) Decimal number to binary conversion. c) Check whether a given number is the Armstrong number or not.	2	1, 2	1,2
	Lab Experiment 5: Triangle star patterns	2	1, 2	1,2

	 I II			
Unit No. 4	**FUNCTIONS AND ARRAYS**	**19**		
	User defined functions, standard library functions	1	2,3	1,2
	Passing 1-D arrays, 2-D arrays to functions.	1	2,3	1,2
	Recursive functions - Recursive solutions for Fibonacci series, towers of Hanoi.	2	2,3	1,2
	C Pre-processor and header files	1	2,3	1,2
	Concepts, declaration, definition, storing and accessing elements	1	2,3	1,2
	one dimensional, two dimensional and multidimensional arrays	2	2,3	1,2
	array operations and examples, Character arrays and string manipulations	2	2,3	1,2
	Lab Experiment 6: **a)** (nCr) and (nPr) of the given numbers b) $1+x+x^2\backslash 2+x^3\backslash 3!+x^4\backslash 4!+\ldots\ldots\ldots X^n\backslash n!$	2	2,3	1,2
	Lab Experiment 7: a) Interchange the largest and smallest numbers in the array. b) Searching an element in an array c) Sorting array elements.	2	2,3	1,2
	Lab Experiment 8: a. Transpose of a matrix. b. Addition and multiplication of 2 matrices.	2	2,3	1,2
	Lab Experiment 9: a. Function to find both the largest and smallest number of an array of integers. b. Liner search. **c.** Replace a character of string either from beginning or ending or at a specified location.	2	2,3	1,2
	Lab Experiment 10: Pre-processor directives a. If Def b. Undef c. Pragma	1	2,3	1,2
Unit No. 5	**POINTERS**	**14**		
	Concepts, initialization of pointer variables	1	3,4	1,2
	pointers as function arguments, passing by address, dangling memory, address arithmetic	2	3,4	1,2
	character pointers and functions, pointers to pointers	2	3,4	1,2
	pointers and multi-dimensional arrays, dynamic memory management functions	2	3,4	1,2
	command line arguments	1	3,4	1,2

	Lab Experiment 10: a. Illustrate call by value and call by reference. b. Reverse a string using pointers c. Compare two arrays using pointers	2	3, 4	1,2,3
	Lab Experiment 11: a. Array of Int and Char Pointers. b. Array with Malloc(), calloc() and realloc().	2	3, 4	1,2,3
	Lab Experiment 12: a. To find the factorial of a given integer. b. To find the GCD (greatest common divisor) of two given integers. **c.** Towers of Hanoi	2	3, 4	1,2,3
	Lab Experiment 14: a.File copy b. Word, line and character count in a file.	2	5	2, 3, 4
Total Hours		**68**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50 %)**								**End Semester Exam (50 %)**	
		CLA-1 (10 %)		**CLA-2 (10 %)**		**CLA-3 (10 %)**		**Mid Term(20 %)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	70%		30%		30%		60%	50%	50%	50%
	Understand										
Level 2	Apply	30%		70%		70%		40%	50%	50%	50%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. The C programming Language by Brian Kernighan and Dennis Richie.
2. Programming in C, Pradip Dey and Manas Ghosh, Second Edition, OXFORD Higher Education, 2011.
3. Problem Solving and Program Design in C, Hanly, Koffman, 7th edition, PEARSON 2013.
4. Programming with C by R S Bichkar, Universities Press, 2012.

Other Resources

1. "Programming with C", Byron Gottfried, Mcgraw hill Education, Fourteenth reprint,2016.

Course Designers

1. -

Emerging Technologies

Course Code	FIC 101	Course Category	FIC	L	T	P	C
				2	0	0	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	ECE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Foster a comprehensive grasp of diverse emerging technologies and their transformative impacts on society and industries.
2. Cultivate critical thinking skills to analyze challenges, opportunities, and applications within each technological domain.
3. Develop practical skills through hands-on experiences and assignments, translating theoretical concepts into real-world applications.
4. Raise awareness of ethical considerations, particularly in the context of Artificial Intelligence, and Machine Learning, IoT, Electric Vehicles, and Semiconductor Technology.

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	Exhibit a thorough understanding of quantum computing principles, including superposition, entanglement, and interference.	1	80%	90%
Outcome 2	Illustrate understanding by explaining the history, synthesis, and applications of nanomaterial and green hydrogen.	1	80%	90%
Outcome 3	Understand and classify 3D printing technologies.	2	75%	85%
Outcome 4	Demonstrate understanding of the evolution, classification, and applications of UAVs.	2	75%	85%
Outcome 5	Apply knowledge of Artificial Intelligence and Machine Learning, IoT, Electric Vehicles, and Semiconductor Technology.	2	75%	85%

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	1	2	2	3	2	2	2	1	2	2	1	1	1	1
Outcome 2	2	1	1	2	3	1	2	2	2	2	2	1	1	1	1
Outcome 3	2	2	2	3	3	3	1	1	3	2	2	1	1	2	2
Outcome 4	2	2	2	2	3	3	2	2	3	2	2	1	2	2	1
Outcome 5	3	2	3	2	2	3	3	2	3	2	2	1	2	2	1
Average	2	2	2	2	3	2	2	2	2	2	2	1	2	2	1

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Quantum Computer and early ideas, classical and quantum computing approaches, superposition, entanglement, and interference in quantum computing.	1	1	1
	QUBITS and their types; representation of data in quantum mechanics.	1	1	1
	Shor's Algorithm, Grover's search algorithm.	1	1	1
	Quantum programming languages; Obstacles in building quantum computers.	1	1	1
	Applications of quantum computers; Opportunities in the field of quantum computing.	1	1	1
	Introduction of quantum communication pillers, quantum network, Heisenberg's uncertainty principle and QKD.	1	1	1
	Challenges in QKD, National Quantum Mission, Future perspectives.	1	1	1
Unit No. 2	Introduction to the nanometer scale. history of nanomaterials	1	2	2
	Synthesis of nanomaterials: Bottom-up and Top-down approach	1	2	2
	Tools & techniques to characterize nanomaterials. Applications of nanomaterials.	1	2	2
	Green Technology: Definition, types of Green Technologies, Green Hydrogen production.	1	2	2
	Challenges involved in the storage of Green Hydrogen produced from PEM based electrolysis.	1	2	2
	Applications of Green Hydrogen.	1	2	2
Unit No. 3	Introduction to 3D printing and additive manufacturing	1	3	3
	Capabilities of 3D printing	1	3	3
	Applications of 3D printing	1	3	3
	Classification based on ASTM	1	3	3
	Working principles of 3D printing technologies	1	3	3
Unit No. 4	Introduction to the evolution of drones	1	4	4
	Classification of drones	1	4	4
	Basic components of drones	1	4	4
	Principles of flight	1	4	4
	Applications of drones	1	4	4
	Drones rules in India, Challenges and future scope.	1	4	4
Unit No. 5	Introduction to Artificial Intelligence, Machine Learning, and Deep learning; applications	1	5	5
	Introduction to the Internet of Things (IoT)	1	5	6
	Applications of IoT	1	5	6
	Basic architecture of the Electric Vehicles (EVs)	1	5	7
	Trends and challenges in EVs	1	5	7
	Introduction to semiconductor mission and chip fabrication	1	5	8

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (100%)				
		CLA-1 20%	CLA-2 20%	CLA-3 20%	CLA-4 20%	CLA-5 20%
Level 1	Remember	90 %	90 %	80 %	75 %	85 %
	Understand					
Level 2	Apply	10 %	10 %	20 %	25 %	15 %
	Analyse					
Level 3	Evaluate	0%	0%	0%	0%	0%
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Quantum Computation and Quantum Information by Michael A. Nielsen, Isaac L. Chuang, 2010.
2. Nanotechnologies: Principles, Applications, Implications and Hands-on Activities – A compendium for educators by Luisa Filipponi and Duncan Sutherland, European Commission Research and Innovation, 2013.
3. Additive manufacturing: Principles, Technologies and applications by C.P. Paul and A.N. Jinoop, 2021.
4. Make: Getting Started with Drones - Build And Customize Your Own Quadcopter by Terry Kilby and Belinda Kilby, 2016.
5. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig, 2010.
6. Fundamentals of Internet of Things: For Students and Professionals by F. John Dian, 2022.
7. Electric Vehicle Engineering by Per Enge, Nick Enge, and Stephen Zoepf, 2021.
8. Fundamentals of Semiconductor Manufacturing and Process Control by Gary S. May and Costas J. Spanos, 2006.

Course Designers

1. Dr. Sunil Chinnadurai, Associate Professor, ECE Department.
2. Dr. Pardha Saradhi Maram, Associate Professor, Chemistry Department.
3. Dr. Sangjukta Devi, Assistant Professor, Mechanical Engineering Department.
4. Dr. Harish Puppala, Assistant Professor, Civil Engineering Department.
5. Dr. Pranav RT Peddinti, Assistant Professor, Civil Engineering Department.
6. Dr. Ravi Kumar, Assistant Professor, Physics Department.
7. Dr. Sujith Kalluri, Associate Professor, ECE Department.

SRM University *AP*, Andhra Pradesh

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

Effective Writing and Presentation Skills

Course Code	AEC 107	Course Category		L	T	P	C
				1	0	1	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Literature and Languages	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

- Demonstrate proficiency in written communication, including the ability to compose clear, grammatically structured and organized written documents, as well as deliver well-structured and engaging presentations
- Critically analyse and synthesize information from various sources, conduct research, and effectively use evidence to support their arguments in both written assignments and oral presentations, that will enhance their critical thinking and research skills
- Through a combination of theoretical knowledge and practical exercises, the course aims to enhance students' ability to express ideas clearly, engage an audience, and deliver persuasive and impactful messages in both written and spoken formats.

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 coherent and well-structured written communication by generating clear and concise written content with logical organization, appropriate grammar	2	90%	90%
Outcome 2	Recognize and analyse the expectations of specific target audiences by adjusting tone, language and style to suit the intended purpose of the audience of written communication and tailoring written content to various formats such as reports, essays, emails, and professional correspondence.	3	90%	90%
Outcome 3	Demonstrate confident Public Speaking with the ability to deliver structured, well-organized, and persuasive presentations by employing visual and interactive aids, storytelling techniques.	3	70%	70%
Outcome 4	Develop strong critical thinking and research skills, enabling them to evaluate information critically, synthesize sources effectively, and provide well-reasoned arguments in their written work and presentations.	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					1	1		3	2	3		3			
Outcome 2					1	1			1	3		3			
Outcome 3					1	1			1	3		2			
Outcome 4					1	1			1	3	3	3			
Average					**1**	**1**		**3**	**1**	**3**	**3**	**3**			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Basics of Grammatically correct writing**	**9**	1	
	SVO	1	1	1a, 2a,b
	Punctuation	3	1	1a, 2a,b
	Articles and Preposition	2	1	1a, 2a, b
	Tense and Apostrophe	1	1	1a, 2a, b
	Subject-Verb-Agreement	2	1	1a, 2a, b
Unit 2	**Categories of Writing**	**9**		
	Emails – different types (Official mails : Requesting Leave/ Enquiring vacancy/ Resigning from job/ requesting internship etc.)	3	1, 2	1b, c
	Notice and Agenda,	2	1, 2	1b, c
	Minutes of Meeting	2	1, 2	1b, c
	Paragraph writing	2	1, 2	1b, c
Unit 3	**Advanced Writing**	**9**		
	Writing Cover Letters	3	1, 2	1e
	Resume writing	2	1, 2	1d
	SOP, Abstract	2	1, 2	1g
	Project Report Writing	2	1, 2	2, d
Unit 4	**Effective Presentation Techniques**	**9**		
	Understanding the elements of successful presentations – Non-verbal communication in presentaions	3	2,3, 4	1f, 2c
	Creating engaging PPTs	2	2,3, 4	1f, 2c
	Structuring presentations for clarity and impact - Logical flow of topics and connected writing in line with storyboard	2	2, 3, 4	1f, 2c
	Handling Questions and Answers	2	2, 3, 4	1f, 2c
Unit 5	**Project Based Learning**	**15**		
	Community Based Project	15	1, 2, 3, 4	NA
	Total Learning Hours	**60**		

Learning Assessment

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

Recommended Resources

1a) Swan, M. (2005). Practical English usage (Vol. 688). Oxford: Oxford university press.
1b) Fenning, C. (2023). Effective Emails: The secret to straightforward communication at work: 1 (Business CommunicationSkills): Sanage Publishing University Press.
1c) Talbot, F. (2009). How to Write Effective Business English: The Essential Toolkit for Composing Powerful Letters, Emails and More, for Today's Business Needs. Kogan Page Publishers
1d) Yate, M. (2016). Knock'em Dead Resumes: A Killer Resume Gets More Job Interviews! Simon and Schuster.
1e) Yate, M. J. (2018). Ultimate Cover Letters: Master the Art of Writing the Perfect Cover Letter to Boost Your Employability (Vol. 5). Kogan Page Publishers.
1f) Carnegie, D. (2013). The Art of Public Speaking. Wyatt North Publishing, LLC.
2a. https://learnenglishteens.britishcouncil.org/
2b. https://www.bbc.co.uk/learningenglish/
2c. https://www.ted.com/?geo=hi
2d .https://www.tifr.res.in/~cccf/data/InternDocs/How_to_write_a_structured_Project_Report.pdf

Other Resources

Course Designers

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

Universal Human Values and Ethics

Course Code	VAC 102	Course Category	VAC			L	T	P	C
						2	0	0	2
Pre-Requisite Course(s)	NA	Co-Requisite Course(s)	NA	Progressive Course(s)	NA				
Course Offering Department	Psychology Department	Professional / Licensing Standards	NA						

Course Objectives / Course Learning Rationales (CLRs)

- To cultivate deep understanding of human values by teaching students the core principles of universal human values and their significance.
- To promote ethical decision-making skills by equipping the students with the ability to make ethical choices in life, work, and society.
- To foster a diverse and inclusive ethical perspective by sensitizing the students to diversity, equity, inclusion, gender, and cultural differences.
- To highlight the relevance of ethics in society and professions by showcasing the practical importance of ethics in personal, societal, and professional contexts.
- To address common challenges by preparing the students to overcome obstacles to ethical behaviour, fostering a commitment to universal values.

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	Evaluate the significance of value inputs in formal education and start applying them in their life and profession	1	70%	80%
Outcome 2	Students will foster diverse and inclusive perspectives, contributing to more equitable and harmonious communities and workplaces	2	70%	70%
Outcome 3	Students will be able to apply ethical principles effectively in their personal and professional lives, leading to improved relationships and ethical practices in society	3	60%	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 Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1			3		2		2	3	3	1	1	3			
Outcome 2			3		2		1	3	3	1	1	3			
Outcome 3			3		2		2	3	3	1	1	3			
Average			3		2		1.6	3	3	1	1	3			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Fundamentals of Human Values and Ethics**	**7**	1	1, 2, 3, 4, 5
	Introduction to human values and ethics.	1		
	Theory of wellbeing	2		
	Purpose and relevance of human values	4		
Unit 2	**Culture and Ethical Principles**	**5**	2	1, 2, 3, 4, 5
	Culture and ethics.	2		
	Ethics in the community and society	3		
Unit 3	**Ethics and Inclusivity**	**6**	2	1, 2, 3, 4, 5
	Ethics and diversity & inclusion	3		
	Equity, equality, and addressing violence	3		
Unit 4	**Ethics in various life spheres**	**6**	3	1, 2, 3, 4, 5
	Ethics in family, society, and workplace	4		
	Ethics in IPR and plagiarism	2		
Unit 5	**Overcoming ethical challenges**	**6**	3	1, 2, 3, 4, 5
	Identifying common challenges	3		
	Strategies to overcome challenges	3		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**		
		CLA-1 (10%)	**CLA 2 (20%)**	**CLA-3 (20%)**
		Theory	**Theory**	**Theory**
Level 1	Remember	50%	50%	50%
	Understand			
Level 2	Apply	50%	50%	50%
	Analyse			
Level 3	Evaluate			
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Landau, RS. (2019). Living Ethics. New York: Oxford University Press.
2. Nagarazan, R.S. (2022). A Text book on Professional Ethics and Human Values. New Delhi: New Age International Publisher.
3. Rachels, J., & Rachels, S. (2012). The elements of moral philosophy 7e. McGraw Hill.
4. Singer, P. (1986). Applied Ethics. Oxford: Oxford University Press.
5. Gensler, H., Spurgin, E., & Swindal, J. (2004). Ethics: contemporary readings. Routledge.

Course Designers

1. Department of Psychology, SLASS, SRM University-AP

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

Entrepreneurial Mindset

Course Code	SEC 103	**Course Category**		**L**	**T**	**P**	**C**
				0	0	2	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Paari School of Business	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To develop the Entrepreneurial Mindset of Students
- To provide tools and techniques for navigating the uncertain path 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	Recall the key entrepreneurship and innovation concepts	1	80	80
Outcome 2	Identify Entrepreneurial Opportunity and ideate solutions	2	80	70
Outcome 3	Develop innovative business plans with sound entrepreneurial concepts.	3	70	70
Outcome 4	Recall concepts of Startup Funding and Pitching	4	80	80

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

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1															
Outcome 2															
Outcome 3															
Average															

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1				
Unit 2				
Unit 3				
Unit 4				
Unit 5				

Learning Assessment

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

Recommended Resources

1. -

Other Resources

1. -

Course Designers

1. -

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

Principles of Management

Course Code	FIC 107	**Course Category**		**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)

- Understand the basic principles and theories of management.
- Analyse the roles and functions of managers within organizations.
- Apply management principles to real-world scenarios.
- Develop critical thinking and problem-solving skills in management 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 comprehension of key management theories and concepts.	2	80%	75%
Outcome 2	Evaluate the effectiveness of management practices in different organizational settings.	5	80%	75%
Outcome 3	Apply management principles to solve complex problems and make informed decisions.	4	75%	75%
Outcome 4	Communicate effectively and collaborate with others in managerial roles.	5	75%	70%

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	2	3	3	3	1	3	2	3	2	3	3	2	3
Outcome 2	3	3	3	3	2	1	3	2	2	3	3	3	3	3
Outcome 3	3	3	3	3	3	1	3	3	3	3	3	3	2	3
Outcome 4	3	3	3	3	3	1	3	3	3	3	3	3	2	2
Average	**3**	**3**	**3**	**3**	**3**	1	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
	Introduction to Management			
Unit No. 1	Definition and nature of management: Understanding what management entails and its significance in achieving organizational goals. Evolution of management theories: Exploring the historical development of management theories from classical to modern approaches. Functions of management: Introduction to the four primary functions of management – planning, organizing, leading, and controlling. Roles and responsibilities of managers: Analysing the various roles managers undertake, including interpersonal, informational, and decisional roles.	12	1	1,3,5,11
Unit No. 2	Planning and Decision-Making Importance of planning in management: Understanding the role of planning in setting organizational objectives and guiding future actions. Types of plans: Strategic, tactical, and operational plans and their relevance at different organizational levels. Decision-making process and techniques: Exploring the steps involved in decision making and different decision-making techniques such as rational, intuitive, and bounded rationality. Setting goals and objectives: Learning how to establish SMART (Specific, Measurable, Achievable, Relevant, Time-bound) goals and objectives to facilitate effective planning.	12	1, 2	1,2,3,5,12
Unit No. 3	Organizational Structure and Design Organizational structure and its types: Understanding the different types of organizational structures, including functional, divisional, matrix, and network structures. Departmentalization and span of control: Examining how organizations group activities into departments and the implications of span of control on managerial effectiveness. Authority, responsibility, and delegation: Understanding the concepts of authority, responsibility, and delegation in organizational settings and their impact on managerial decision making. Factors influencing organizational design: Analysing internal and external factors that influence organizational design, such as strategy, environment, technology, and size.	12	3	4,5,8,9,11

Unit No. 4	Theories of leadership: Exploring various leadership theories, including trait theory, behavioural theory, contingency theory, and transformational leadership. Leadership styles and their effectiveness: Understanding different leadership styles such as autocratic, democratic, laissez-faire, and their impact on employee motivation and performance. Motivation theories: Examining motivational theories such as Maslows hierarchy of needs, Herzberg two-factor theory, and expectancy theory, and their implications for managerial practice. Techniques for motivating employees: Exploring practical techniques and strategies for motivating employees, including recognition, rewards, job enrichment, and empowerment.	12	1, 3	2,3,8,11,13
Unit No. 5	Process of control: Understanding the control process, including establishing standards, measuring performance, comparing results, and taking corrective action. Types of control: Exploring different types of control mechanisms, including feedforward, concurrent, and feedback control, and their applications in organizational settings. Performance appraisal methods: Analysing various performance appraisal methods such as graphic rating scales, behaviourally anchored rating scales (BARS), and 360-degree feedback. Continuous improvement and quality management: Understanding the concepts of continuous improvement and quality management, including Total Quality Management (TQM).	12	4	1,7,12
Total Contact Hours		**60**		

Learning Assessment

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

Recommended Resources

1. Prasad, L.M. (2021), Principles and Practices of Management, Sultan Chand Publisher, New Delhi.

Other Resources

1. Vasishthm, N. & Vasishth, V. (2022), Taxmann's Principles of Management, Taxmann publications.
2. Tripathi, P.C. & Reddy, P.N. (2021), Principles of Management, McGraw Hill
3. Jayashankar, J. (2009) Principles of Management, Margham Publications
4. Mintzberg, H. (2009). Managing. San Francisco, Berrett-Koehler Publishers. P. 26-28.
5. Hannaway, J. (1989). Managers Managing: The Workings of an Administrative System. New York: Oxford University Press, P. 391.
6. Eccles, R. G. & Nohria, N. (1992). Beyond the Hype: Rediscovering the Essence of Management. Boston: The Harvard Business School Press, p. 471.
7. Kotter, J. P. (1982). The General Managers. New York: The Free Press
8. Mintzberg, H. (1973). The Nature of Managerial Work. New York: Harper; Row. P. 371.
9. Kotter, J. P. (1999). “What Effective General Managers Really Do,” Harvard Business Review, March–April 1999, pp. 145–1591.
10. Sproull, L. S. (1984).“The Nature of Managerial Attention,” in L. S. Sproull (ed.)
11. Advances in Information Processing in Organizations. Greenwich, CT: JAI Press1.
12. Stewart, R. (1967). Managers and Their Jobs. London: Macmillan.
13. Pondy, L. R. (1978). “Leadership Is a Language Game,” in M. W. McCall, Jr. and M.
14. M. Lombardo (eds.), Leadership: Where Else Can We Go? Durham, NC: Duke University Press.
15. Mintzberg, H. (2009). Managing. San Francisco, Berrett-Koehler Publishers. P. 26-281.
16. McGregor, J. (2008). “Bezos: How Frugality Drives Innovation,” BusinessWeek, April 28, 2008, pp. 64–661.Katz, Robert L., (1974). “Skills of an Effective Administrator.” Harvard Business Review, September-October 1974.

Course Designers

1. Dr Vimal Babu, Associate Professor, SRM University-AP

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

Psychology for Everyday Living

Course Code	FIC 124	**Course Category**	Generic Elective	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Psychology	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To understand the fundamental psychological processes in everyday living.
- To apply knowledge of psychology in improving self and others.
- To apply knowledge of psychology in enhancing quality of life.

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 fundamental psychological processes in everyday living	2	80%	70%
Outcome 2	Describe important theories in psychology in the areas of sensation, perception, personality and learning	2	75%	70%
Outcome 3	Illustrate personal, professional and social applications of psychology	4	75%	60%
Outcome 4	Interpret results from certain personality tests	5	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			
Outcome 2	1			1					2	1					
Outcome 3	1	1	1				1	1	2	2		2			
Outcome 4	2		2		1			2	1	1		1			
Average	2	1	2	1	1		1	1	2	1		1			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References
Unit No. 1	**Myths and Misconceptions in Psychology**	**12**	1	1
	Definition, nature and goals of psychology	4		
	Common myths and misconceptions about psychology	4		
	Schools of psychology; Basic and applied areas of psychology	4		
Unit No. 2	**The Role of Perception and Attitude towards Understanding the World**	**12**	2, 3	2
	Perception: Understanding perception, Gestalt laws of organization, common illusions	3		
	Perceptual constancy - depth perception, size perception, perception of movement	3		
	Attitude formation	3		
	Attitude change	3		
Unit No. 3	**Intelligence and Learning**	**12**	2, 3	2
	Definitions and nature of intelligence	3		
	Emotional and social intelligence; Measuring IQ, EQ and SQ	3		
	Fundamentals of learning and its applications	3		
	Memory techniques	3		
Unit No. 4	**Understanding the Self**	**12**	2, 4	1
	Definition; Approaches to personality – trait and type	4		
	Psychoanalytical and humanistic theory, Tests of personality – MBTI and NEO-PI	4		
	Identity; Self-concept, self-esteem and self-efficacy	4		
Unit No. 5	**Stress, Coping and Quality of Life**	**12**	2, 3	1
	Nature, sources of stress and its reactions	3		
	Factors influencing stress	3		
	Coping with and managing stress - cognitive and behavioural techniques	3		
	Improving quality of life	3		

Learning Assessment

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

Recommended Resources

1. Baron, R. A. (2001). Psychology. New Delhi: Pearson Education India.
2. Nolen-Hoeksema, S., Fredrickson, B.L. & Loftus, G.R. (2014). Atkinson & Hilgard's Introduction to Psychology. 16th Ed. United Kingdom: Cengage Learning.

Other Resources

1. Morgan, C. T., King, R. A., & Schopler, J. (2004). Introduction to Psychology. New Delhi: Tata McGraw Hill.

Course Designers

1. Internal (Institutional) Subject Matter Experts: Dr. Salome Divya Joseph (Assistant Professor & Faculty Co-ordinator) and Ms. Ayesha Parveen Haroon (Lecturer), Department of Psychology.
2. Expert Reviewers from Institutes of National Importance / Institutes of International Repute: Prof. Akbar Hussain (Prof. and Head, Department of Psychology, Aligarh Muslim University) and Prof. H.S. Ashok (Prof. and Head, Department of Psychology, Bangalore University)

SRM University *AP*, Andhra Pradesh

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

Real Analysis - 1

Course Code	MAT 150	Course Category	CC	L	T	P	C
				4	0	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)

- Verify the existence of the limit of a function. Verify the continuity of a function at a point and on a set of points.
- Verify the differentiability from an analytical point of view instead of the computational method used previously.
- Studying the notion of continuous functions and their properties.

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 natural numbers, integers, rational numbers, and the completeness property.	2	80%	80%
Outcome 2	Apply the concepts of limits of sequences and limits of functions.	3	65%	60%
Outcome 3	Demonstrate the concepts of monotone functions, Power series and Theory of derivatives.	3	70%	70%
Outcome 4	Illustrate the uniform convergence of derivatives and spaces of functions as metric spaces.	3	65%	60%
Outcome 5	Apply change of variables and properties of integration	3	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	2	3	2	2	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	3								3	3	3
Average	**3**	**3**	**3**	**3**	**3**								**2**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs addressed	References Used
Unit 1	**Sets and real numbers**	**6**		
	Sets, ordered sets, countable sets, fields (R), ordered fields, least upper bounds, the real numbers, the Archimedean principle	1	1	1
	Decimal expansion	1	1	1
	Intersections of closed intervals	1	1	1
	Metric spaces, ball neighbourhoods.	1	2	1
	Open subsets	1	2	1
	Limit points, closed subsets, dense subsets	1	2	1
Unit 2	**Sequences and limits**	**16**		
	Compact subsets of metric spaces, Limit points and compactness	2	2	1
	compactness of closed bounded subsets in Euclidean space, convergent sequences in metric spaces	3	2,3	1
	Cauchy sequences, completeness	3	2,3	1
	Cauchy's theorem	2	3	1
	Sub sequential limits, lim sup and lim inf	3	3	1
	Absolute convergence, product of series	3	3	1
Unit 3	**Continuity, derivatives**	**15**		
	Power series, convergence radius	2	3	1
	The exponential function, sine and cosine function, Continuous maps between metric spaces	2	3	1
	Images of compact subsets	2	3	1
	Continuity of inverse maps, Continuity of the exponential, the logarithm	2	3	1
	Intermediate Value Theorem	2	3	1
	uniform continuity, Derivatives, the chain rule	2	3	1
	Rolle's theorem, Mean Value Theorem Derivative of inverse functions; higher derivatives, Taylor's theorem	3	3	1
Unit 4	**Function spaces**	**13**		
	Pointwise convergence, uniform convergence	2	3,4	1
	Weierstrass criterion	2	3,4	1
	Continuity of uniform limits	3	3,4	1
	Application to power series, Uniform convergence of derivatives, Spaces of functions as metric spaces	3	3,4	1
	Beginning of the proof of the Stone-Weierstrass Theorem, End of Stone-Weierstrass	3	3,4	1
Unit 5	**Integration**	**10**		
	Beginning of the theory of integration (continuous functions as uniform limits of piecewise linear functions), Riemann-Stjeltjes integral	2	5	1,2
	Definition, basic properties, Riemann integrability of products	2	5	1,2
	Change of variables, Fundamental theorem of calculus	2	5	1,2
	Back to power series: continuity, differentiability, Review of exponential, log, sine, cosine, Review of series	2	5	1,2
	Fourier series	2	5	1,2
Total Contact Hours		**60**		

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 15%	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Stephen Abbott. Understanding Analysis (Undergraduate Texts in Mathematics) 1st ed. 2001. Corr. 2nd printing 2002 Edition.
2. A. N. Kolmogorov, S. V. Fomin. Introductory Real Analysis (Dover Books on Mathematics) 1st Edition

Other Resources

1. -

Course Designers

1. -

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

Linear Algebra

Course Code	MAT 152	**Course Category**	CC	**L**	**T**	**P**	**C**
				4	0	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)

- Understand the representation and solution of linear systems through matrices, exploring operations, LU-Factorization, and applications of determinants.
- Develop proficiency in vectors, subspaces, linear independence, basis, and dimension, applying these concepts to solve homogeneous systems and determine matrix rank.
- Study inner product spaces, length, direction, and orthogonalization processes like Gram-Schmidt, applying these to solve problems involving least squares.
- Define and analyze linear transformations, matrices, eigenvalues, and eigenvectors, exploring concepts of similarity, diagonalization, and their applications in spectral and singular value decomposition.

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 mathematical techniques and algorithms to solve linear systems, manipulate matrices, and use determinants in various contexts.	3	75%	70%
Outcome 2	Illustrate the concepts of vector spaces, subspaces, bases, dimension and their properties.	2	80%	75%
Outcome 3	Apply properties of inner product spaces to determine orthogonality in inner product spaces.	3	75%	72%
Outcome 4	Relate matrices and linear transformations, compute eigenvalues and eigenvectors of linear transformations and matrices.	3	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	2	2	1	-	-	-	-	-	-	-	3	2	2
Outcome 2	2	3	3	3	1	-	-	-	-	-	-	-	2	3	3
Outcome 3	2	2	2	2	1	-	-	-	-	-	-	-	2	3	3
Outcome 4	2	3	3	3	1	-	-	-	-	-	-	-	3	3	3
Average	**2**	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Linear Equations, Matrices and determinants:**	**14 Hours**		
	Introduction to Systems of Linear Equations, Gaussian Elimination, and Types of Solutions.	2	1	1
	Matrix Operations: Addition, Subtraction, Scalar Multiplication, and Multiplication.	2	1	1
	Echelon Form of a Matrix, Row Operations, and Reduced Row Echelon Form.	2	1	1
	Solving Linear Systems: Matrix Representation, Row Reduction, and Applications.	2	1	1
	Elementary Matrices, Finding A-1, and Properties of Inverse Matrices.	2	1	1
	Equivalent Matrices, Row, and Column Equivalence in Solving Systems.	2	1	1
	LU-Factorization, Solving Systems, and Applications in Numerical Methods.	2	1	1
Unit 2	**Vector Spaces:**	**12 Hours**		
	Vectors in 2D and 3D, operations on vectors, and the definition and properties of vector spaces.	2	2	1
	Subspaces, the concept of span, and criteria for linear independence in vector spaces.	2	2	1
	Bases for vector spaces, the concept of dimension, and the dimension theorem.	2	2	1
	Homogeneous systems of linear equations and delve into vector coordinates and changes of basis.	2	2	1
	Isomorphisms between vector spaces, their properties, and the concept of matrix rank.	2	2	1
	Vector space concepts to real-world scenarios	2	2	1
Unit 3	**Inner Product Spaces:**	**10 Hours**		
	Vector basics, covering length, direction, and real-world applications through examples.	2	3	1
	Inner product spaces, properties, and R^2 and R^3 examples with applications.	2	3	1
	Gram-Schmidt for orthogonalization, apply to vectors, and applications with examples and computations.	2	3	1
	Orthogonal complements, applications in linear systems, and examples.	2	3	1
	Least squares, discuss applications, cover computational techniques	2	3	1
Unit 4	**Linear Transformations and Matrices:**	**12 Hours**		
	Linear transformations and examples. Kernel and range concepts.	2	4	1, 2
	Matrix of a Linear Transformation	2	4	1, 2
	Vector Space of Matrices and Vector Space of Linear Transformations.	2	4	1, 2
	Concept of similarity between matrices.	2	4	1, 2
	Introduction to Homogeneous Coordinates	2	4	1
	Applications of Linear Transformations	2	4	1
Unit 5	**Eigenvalues and Eigenvectors:**	**12 Hours**		
	Introduction to Eigenvalues and Eigenvectors	2	4	1, 2
	Diagonalization and Similar Matrices	2	4	1, 2
	Diagonalization of Symmetric Matrices	2	4	1, 2
	Spectral Decomposition	2	4	1, 2
	Singular Value Decomposition (SVD)	2	4	1, 2
	Review and Applications	2	4	1, 2
Total Contact Hours		**60**		

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%)	Mid-2 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. David Hill and Bernard Kolman, Elementary Linear Algebra with Applications, 9th Edition | By Pearson 2019.
2. K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall of India, 1996.

Other Resources

1. -

Course Designers

1. -

SRM University *AP*, Andhra Pradesh

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Problem Solving Skills

Course Code	AEC 108	**Course Category**		**L**	**T**	**P**	**C**
				1	0	1	2
Pre-Requisite Course(s)	SEC 101	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To categorize, apply and use thought process to distinguish between concepts of quantitative methods.
2. To prepare and explain the fundamentals related to various possibilities.
3. To critically evaluate numerous possibilities related to puzzles.
4. Explore and apply key concepts in logical thinking to business 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	Use logical thinking and analytical abilities to solve quantitative aptitude questions from company specific and other competitive tests.	1	70%	60%
Outcome 2	Solve questions related to Time and Distance and Time and work from company specific and other competitive tests.	3	65%	70%
Outcome 3	Understand and solve puzzle questions from specific and other competitive tests	1	60%	60%
Outcome 4	Make sound arguments based on mathematical reasoning and careful analysis of data.	1	65%	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 Reasoningand Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multiculturaland 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	2	1				1						
Outcome 2		2	1	2	1										
Outcome 3		3	2	2					1						
Outcome 4		3	1	2											
Average		**3**	**2**	**2**	**1**				**1**						

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Clocks, Calendars	**2**	1,4	2,3
	Logical Reasoning Basics, Linear Arrangements, Circular Arrangements	**3**	**1,4**	**2,3**
	Logical Reasoning – Selections, Distributions, Selection decision table, Circular / Tabular arrangements	**6**	**1,4**	**2,4**
	Direction Sence, Blood Relations, Directions, Blood Relations, Problems based on dice and cubes	**5**	**1,4**	**2,3**
Unit No. 2	Data interpretation – Introduction, Line Graph	**3**	1,4	1,3
	Data interpretation – Bar Graph, Pie-Charts	3	1,4	1,3
	Data Interpretation – Tables, Case lets	3	1,4	1,3
Unit No. 3	Statistics: Basics, Concept Review Questions	**2**	**1,2**	**4**
	Mean, Median, Mode, QD, MD, SD, Advanced Problems.	**3**	**1,2**	**4**
	Functions Basics, Graphs Basics, Functions and Graphs-Advanced.	**3**	**1,2**	**5**
Unit No. 4	**Geometry and Mensuration**	**3**	1,2	**1**
	Venn diagram with two variables and three variables ,logical deductions	**3**	1,2	**2,3**
Unit No. 5	**Coding Maths – problems based on Number System Coding Maths - Pigeon Hole Principle**	**3**	2,3	1,5
	Coding Maths - Discrete Math Graph Theory	**3**	1,2	5

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (_50%)	
		CLA-1 (10%)		CLA-2 (15%)		CLA-3 (10%)		Mid Term (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	20%		25%		20%		25%		25%	
	Understand	20%		25%		20%		25%		25%	
Level 2	Apply	30%		25%		30%		25%		25%	
	Analyse	30%		25%		30%		25%		25%	
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Arun Sharma – How to prepare for Quantitative Aptitude, Tata McGraw Hill.
2. R.S. Agarwal – Reasoning. Reasoning for competitive exams – Agarwal.
3. Logical Reasoning and Data Interpretation for CAT, By Nishit K. Sinha
4. Basic Statistics - B.L. Agarwal.
5. Graph Theory and Its Applications – Jonathan L. Gross

Other Resources

1. Geeks for Geeks
2. Indiabix.
3. M4maths.com

Course Designers

1. Mr. Naresh Adapa – Quantitative Aptitude Trainer, Department of CR&CS SRM University AP.
2. Mr. Shaik Mohammed Musa Kaleemullah, Verbal Ability Trainer, Department of CR&CS, SRM University AP.
3. Dr. Fouzul Atik – Assistant Professor, Department of Mathematics, SRM University AP.

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Digital Literacy

Course Code	SEC 102	Course Category	SEC	L	T	P	C
				2	0	0	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	ITKM	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

- Introduce basic digital skills that are needed in today's 21st century work environment.
- develop the skills that they need to effectively integrate technology into their respective professional practices.
- Learn practical-oriented and will have a lot of hands-on exercises.
- Understand basic and practical digital skills.
- learn and use software and hardware systems, including the basic troubleshooting.
- Learn issues pertaining to emerging technologies and creating digital identity in various platforms.

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	Discuss the importance of Digital Literacy	2	75%	80%
Outcome 2	Compare and Contrast collaborative features in digital platforms	3	70%	70%
Outcome 3	Create digital identity profile on LinkedIn	3	75%	75%
Outcome 4	Demonstrate best practices of digitally managed workspace on MS office 365 and G Suite	3	70%	75%
Outcome 5	Identify relevant information from authentic data sources	3	70%	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		1	2	3		3			
Outcome 2					3	3		1	2	3		3			
Outcome 3					3	3		1	2	3		3			
Outcome 4					3	3		1	2	3		3			
Average					3	3		1	2	3		3			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	COs Addressed	References Used
Unit 1	**Introduction - Digital Literacy**	**2**	**1**	1,2,3
	About Digital Literacy	0.5	1	1,2,3
	Importance of digital literacy	0.5	1	1,2,3
	Overview of Computing Systems and Platforms	0.5	1	1,2,3
	Digital Proficiency for Career prospects and Everyday living	0.5	1	1,2,3
Unit 2	**Know your computer**	**3**	**1**	1,2,3
	Types of computing	0.5	1	1,2,3
	Accessories & peripherals	0.5	1	1,2,3
	System upkeep & maintenance	0.5	1	1,2,3
	Basic Troubleshooting	0.5	1	1,2,3
	Operating Systems	1	1	1,2,3
Unit 3	**Microsoft Office Automation software**	**5**	4	1,2,3
	Word Processing	1	4	1,2,3
	Excel - Data Analysis	1	4	1,2,3
	PowerPoint Presentations	1	4	1,2,3
	Digital software tools	1	4	1,2,3
	Best practices	1	4	1,2,3
Unit 4	**Google Automation Software**	**3.5**	4	1,2,3
	Word Processing	1	4	1,2,3
	Spreadsheet	1	4	1,2,3
	Presentations	1	4	1,2,3
	Best practices	0.5	4	1,2,3
Unit 5	**Digital Communication tools**	**4**	2	1,2,3
	Emails Systems - Gmail, MS Outlook, Zimbra, etc	0.5	2	1,2,3
	Calendar Functionality	0.5	2	1,2,3
	Drive - Access Permissions - Best practices	1	2	1,2,3
	Chat functionality and Use	1	2	1,2,3
	Zoom, MS Teams, Google meet, Jiomeet,	1	2	1,2,3
Unit 6	**Network and Internet**	**3**	1	1,2,3
	Basics of Network	1	1	1,2,3
	Types of browsers, Safety measures, bookmarks	1	1	1,2,3
	Search engines	1	1	1,2,3
Unit 7	**Digital Identity for Professional Connect activities**	**5**	3	1,2,3
	Social media	1	3	1,2,3
	Dos and Don’ts handling Social Media Accounts	2	3	1,2,3
	Digital Profile	3	3	1,2,3
Unit 8	**Cybersecurity**	**1.5**	1	1,2,3
	Introduction to Cybersecurity	0.5	1	1,2,3
	Strategies to project the personal and professional data	0.5	1	1,2,3
	Awareness on various Cyber Attacks	0.5	1	1,2,3
	Security measures for Email, Personal computing systems		1	1,2,3
Unit 9	**Information and Data Literacy**	**4**	5	1,2,3
	Information & Data Mining Strategies	1	5	1,2,3
	Online resources	2	5	1,2,3
	Understanding on Plagiarism	1	5	1,2,3
Total Contact Hours		**30**		

Learning Assessment

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

Recommended Resources

1. Digital Literacy (20210401) Kindle Edition by Mandy Reininger (Author), Darrel Karbginsky (Author) Format: Kindle Edition
2. Digital Literacies: Concepts, Policies and Practices (New Literacies and Digital Epistemologies) New Edition by Colin Lankshear (Editor), Michele Knobel (Editor
3. Read the World: Rethinking Literacy for Empathy and Action in a Digital Age Illustrated Edition by Kristin Ziemke (Author), Katie Muhtaris (Author)

Other Resources

1.

Course Designers

1. Dr. Arundhati G, Associate Director, ITKM, SRM University AP.
2. Dr. Suhasini B, Assistant Director, ITKM, SRM University AP.
3. Dr. Mohan K, Director, ITKM, 5SRM University AP

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Algebra - 1

Course Code	MAT 153	**Course Category**	CC	**L**	**T**	**P**	**C**
				4	0	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)

- To understand the algebraic structures of groups, subgroups, cyclic subgroups and permutation groups.
- To learn group action and Sylow's theorem.
- To understand group homomorphisms,
- To study external and internal direct products of groups.

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 groups and its various structures.	2	90%	80%
Outcome 2	Describe properties of various groups and subgroups	2	80%	70%
Outcome 3	Apply Lagrange's theorem	3	70%	70%
Outcome 4	Apply group homeomorphism and the isomorphism theorems.	3	70%	60%
Outcome 5	Apply Sylow's theorem	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 Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	2	2	1								2	2	1
Outcome 2	2	3	2	2	1								3	3	1
Outcome 3	3	3	3	3	2								3	2	3
Outcome 4	3	2	2	3	2								3	2	3
Outcome 5	3	2	2	2	3								3	3	2
Average	**3**	**3**	**2**	**2**	**2**								**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Groups and Subgroups**	**10**		
	Symmetries of square, Dihedral groups	1	1	1
	Definition of group and examples	3	1	1
	Elementary properties of groups	2	2	1
	Subgroups and examples	2	1	1
	Centralizer, Normalizer and centre of a group	2	1	1
Unit 2	**Cyclic Groups, Permutation Groups and Lagrange's Theorem**	**15**		
	Cyclic groups and subgroups of cyclic groups	3	1,2	1
	Permutation groups	2	1	1
	Cosets and Lagrange's theorem	3	1,2	1
	Application of Lagrange's theorem	3	3	1
	Normal subgroups, Quotient groups	3	1,2	1
	Cauchy's theorem for finite abelian groups	1	1,2	1
Unit 3	**Group Homomorphisms**	**8**		
	Definition and properties	2	4	1
	Isomorphism and properties	2	4	1
	Cayley's theorem	1	4	1
	Three isomorphism theorems for groups	3	4	1
Unit 4	**Group Action and Sylow's Theorem**	**18**		
	Group action and permutation representation	3	1,2	1
	Stabilizer and Kernel of group action	2	1,2	1
	Group action by left multiplication and conjugation	3	1,2	1
	Class equation, p-groups, Sylow's theorem	4	1,2	1
	Application of Sylow's theorem	3	5	1
	Simple groups and simplicity of Alternating groups	3	1,2	1
Unit 5	**External and Internal Products of Groups**	**9**		
	External direct product of groups and properties	3	1,2	1,2
	Internal direct product of groups and properties	2	1,2	1,2
	Classification of p-groups	2	1,2	1,2
	Fundamental theorem of finite abelian groups	2	1,2	1,2
Total Contact Hours		**60**		

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%)	Mid-2 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Dummit, David S., and Foote, Richard M. (2016). Abstract Algebra (3rd ed.). Wiley India.
2. I.N. Herstein, Topics in Algebra (2nd ed.), Wiley India, 2006.

Other Resources

1. -

Course Designers

1. -

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

Discrete Mathematics and Combinatorics

Course Code	MAT 160	**Course Category**	CC	**L**	**T**	**P**	**C**
				4	0	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)

- To understand the basics of propositional calculus on which is based the fundamental principles of computing.
- To understand basic set theory and elementary properties of whole numbers as essential mathematical skills.
- To understand basic principles of counting and recurrence relations.
- To get an elementary introduction to the theory of graphs as it is essential for various applications of computer science.

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 properties of propositional logic	2	75%	70%
Outcome 2	Apply basic set theory and elementary properties of whole numbers	3	80%	75%
Outcome 3	Apply basic principles of counting and recurrence relations.	3	80%	75%
Outcome 4	Apply concepts in the theory of graphs.	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	3	3	3	2	1								2	3	2
Outcome 2	3	3	3	2	2								3	3	3
Outcome 3	3	3	3	2	2								2	2	3
Outcome 4	2	3	3	2	2								3	3	3
Average	**3**	**3**	**3**	**2**	**2**								**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Foundations: Logic and proofs**	**13**		
	Propositional Logic, Propositional Equivalences	2	1	1
	Predicates and Quantifiers, Nested Quantifiers	3	1	1
	Rules of Inference, Introduction to Proofs, Proof Methods and Strategy,	3	1	1
	Mathematical Induction, Strong Induction and Well-Ordering	3	1	1
	Recursive Definitions and Structural Induction.	2	1	1
Unit 2	**Counting Principles**	**11**		
	The Basics of Counting, The Pigeonhole Principle,	3	2	1
	Permutations and Combinations	2	3	1
	Binomial Coefficients and Identities	3	3	1
	Generalized Permutations and Combinations.	3	3	1
Unit 3	**Advanced Counting Techniques**	**12**		
	Recurrence Relations, Solving Linear Recurrence Relations,	4	3	1
	Generating Functions, Inclusion– Exclusion,	4	3	1
	Special Counting Numbers (Partition number, Bell Numbers, Catalan numbers, Stirling numbers, Ramsey Numbers).	4	3	1
Unit 4	**Introduction to Graph Theory**	**12**		
	Graphs and Graph Models,	2	4	1
	Graph Terminology and Special Types of Graphs,	3	4	1
	Representing Graphs and Graph Isomorphism,	3	4	1
	Connectivity	2	4	1
	Euler and Hamilton Paths, Shortest-Path Problems	2	4	1
Unit 5	**Graphs Theory**	**12**		
	Graph Terminology, Complete Graphs, Cycles, Wheels, Higher Dimensional Cubes	3	4	1
	Bipartite Graphs, Complete Bipartite Graphs, Matrix Representation of Graphs, Graph Isomorphism	4	4	1
	Connectedness in Directed and Undirected Graphs	2	4	1
	Counting Paths between Vertices, Euler and Hamilton Paths.	3	4	1
	TOTAL	**60**		

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%)	Mid-2 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Kenneth H. Rosen, Discrete Mathematics and Applications, McGraw-Hill International Editions: Mathematics Series.

Other Resources

1. -

Course Designers

1. -

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

Real Analysis - 2

Course Code	MAT 202	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	Real Analysis -1	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To understand the integration of bounded functions on a closed and bounded interval and its extension to the cases where either the interval of integration is infinite, or the integrand has infinite limits at a finite number of points on the interval of integration.
- To find the limit of a sequence of real valued functions, verify uniform convergence of sequence of functions and understand its effect on the limit function.
- To understand the behaviour of continuous functions on metric spaces as a generalisation of that on the set of real numbers, appreciate the topological aspect of Metric spaces.

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	Verify Riemann integrability of a function by definition or properties, apply Fundamental theorem of integral calculus and examine convergence of improper integrals	1, 2	75%	80%
Outcome 2	Find pointwise limit of sequence of functions, verify uniform convergence by definition or observe the analytic properties of limit function.	2, 3	80%	80%
Outcome 3	Observe different Metric spaces, review the basics of Real Analysis and understand complete Metric spaces	1, 2	75%	80%
Outcome 4	Develop the concepts of compactness, connectedness in a Metric space and the behaviour of continuous functions on Metric spaces	2, 3	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	2	3	2	2	1								2	2	2
Outcome 2	2	3	2	2	1								3	3	2
Outcome 3	2	3	3	3	2								3	2	3
Outcome 4	3	2	3	3	2								3	2	3
Outcome 5	2	2	2	2	3								3	3	2
Average	**2**	**3**	**3**	**2**	**2**								**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Riemann Integral**	**20 Hours**		
	Review of Real Analysis 1	2	1	1
	Upper and lower Riemann sums	4	1	1
	Necessary and sufficient condition for Riemann integrability	2	1	1
	Algebra of Riemann integrable functions	2	1	1
	First mean value theorem, Fundamental Theorem of Calculus	3	1	1
	Substitution, integration by parts	2	1	1
	Improper integral	3	1	1
	Beta and gamma functions	2	1	1
Unit 2	**Sequence of functions**	**12 Hours**		
	Review of Real Analysis 1	2	2	1
	Pointwise and uniform convergence	3	2	1
	Cauchy criterion for uniform convergence	3	2	1
	Uniform convergence and continuity	1	2	1
	Uniform convergence and Riemann integration	1	2	1
	Uniform convergence and differntiability	2	2	1
Unit 3	**An introduction to Metric spaces**	**14 Hours**		
	Definition and examples of Metric spaces	4	3	1
	Subspace and product metric	2	3	1
	Open sets, closed sets	2	3	1
	Hausdorff property	1	3	1
	Sequences in Metric spaces	3	3	1
	Completion	2	3	1
Unit 4	**Some topological aspects of Metric space**	**14 Hours**		
	Continuity	4	4	1,2
	Urysohn's lemma, homeomorphism	2	4	1,2
	Compact sets	4	4	1,2
	Connectedness	4	4	1,2
Total		**60**		

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%)	Mid-2 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Introduction to Topology and modern Analysis, G. F. Simmons, Tata Mcgraw-Hill, 2013
2. Introduction to Real Analysis, S. K. Mapa, Sarat Book House, 2014.

Other Resources

1. -

Course Designers

1. -

SRM University *AP*, Andhra Pradesh

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

Ordinary Differential Equations - 1

Course Code	MAT 203	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)

- Develop a comprehensive set of skills and knowledge to solve complex differential equations and utilizing derivative of functions by introducing integration, vector spaces, and their applications in real-world scenarios.
- To gain proficiency in understanding and manipulating linear differential operators, function spaces, and non-linear differential equations, enabling them to analyse and interpret diverse mathematical models.
- To analyze techniques for solving first and higher-order differential equations, employing methods like reduction of order and variation of parameters to tackle real-world problems involving dynamic systems.

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	Formation of differential equations, Order and degree of differential equations, Classification of ordinary and partial differential equations, Discuss of linear and non-linear differential equations, Solution of differential equations, Initial value problems	2	75%	80%
Outcome 2	Illustrate the geometrical meaning of first-order differential equations. Applications of differential equations of first order and first degree. Solve first-order differential equations by a few analytical methods.	3	70%	65%
Outcome 3	Establish the existence, uniqueness, and classification of solutions. Solve various types of first-order differential equations.	3	75%	70%
Outcome 4	Explore homogeneous equations with constant coefficients and Euler-Cauchy equations with solution methods like undetermined coefficients and variation of parameters. Find general solutions of non-homogeneous equations with initial data.	3	70%	65%
Outcome 5	Transform higher-order equations into systems of differential equations. Compute the solution of a system of differential equations. Emphasizing critical points and stability. Solve nonhomogeneous linear systems using methods like undetermined coefficients and variation of parameters.	4	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	2		2								3	1	1
Outcome 2	3	3	3		3								3	2	3
Outcome 3	3	3	3		3								3	2	3
Outcome 4	3	3	2		2								2	3	3
Outcome 5	2	2	1		2								3	2	1
Average	**3**	**3**	**2**		**2**								**3**	**2**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Formation and classification of differential equations**	**12 Hours**		
	Differential equations, their formation and solutions Introduction to differential equation.	2	1	1,3
	Ordinary and partial differential equations.	1	1	1,3
	Order and degree of linear and nonlinear differential equations.	1	1	1,3
	Solution of a differential equation, general, particular and singular solution of a differential equation.	1	1	1,3
	Existence and uniqueness theorem.	2	1	1,3
	Initial value Problems.	1	1	1,3
	Applications of differential equations.	2	1	1,3
	Analytical methods for solving differential equations.	1	1	1,3
	Quiz	1	1	1,3
Unit 2	**Geometrical meaning of differential equations with classification of solutions**	**12 Hours**		
	Equations of first order and first-degree Introduction, Geometrical meaning of y'=f(x, y).	1	2	1,3
	Separation of variables, Homogeneous, Equations reducible to homogeneous form.	2	2	1,3
	Exact, Necessary and sufficient conditions for exactness, Integrating Factor, Linear differential equation	2	2	1,3
	Equations reducible to linear form, Bernoulli's form.	1	2	1,3
	Trajectory, Orthogonal trajectory in cartesian and polar coordinates, Self orthogonal, Oblique trajectory.	3	2	1,3
	Applications of equations of first order and first degree.	2	2	1,3
	Class Assessment	1	2	1,3
Unit 3	**First order differential equations**	**12 Hours**		
	Equations of the first order but not of the first degree.	1	3	2,3
	Existence and uniqueness of solution.	1	3	2
	Different methods of finding the general solutions (Equations solvable for p, x, y and Clairaut's form)	3	3	2,4,3
	Singular solutions.	2	3	2
	Extraneous Loci (Tac, Node and Cusp)	3	3	2
	Bernoulli differential equations, Initial value problems.	2	3	2,3
Unit 4	**Second or higher order linear differential equations**	**12 Hours**		
	Second or Higher order differential equations	1	4	2
	Linear and non-linear differential equations	1	4	2
	General solution of differential equations.	2	4	2,4
	Homogeneous and non-homogeneous equations	1	4	2
	Homogeneous Euler-Cauchy differential equations	1	4	2
	Method of undetermined coefficients	2	4	2
	Method of variation of parameters.	2	4	2
	Operator methods for finding particular solution.	2	4	2,4
Unit 5	**System of first order differential equations**	**12 Hours**		
	Solution of homogeneous constant coefficient system of differential equations	2	5	2,3
	Converting higher order differential equations into system of equations	1	5	2,3
	Tutorial	1	5	2,4
	Critical points and stability	1	5	2,3
	Nonhomogeneous Linear Systems of ODEs.	1	5	2,3
	Method of undetermined coefficients	1	5	2,4
	Tutorial	1	5	2.3
	Method of variation of parameters	2	5	2,3
	Linearization of Nonlinear Systems.	1	5	2,4
	Quiz	1	5	2,4
Total		**60**		

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%)	Mid-2 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. William Boyce and Richard DiPrima, Elementary Differential Equations and Boundary Value Problems, 11th Edition, Wiley-I
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India.
3. G. F. Simmons, Differential Equations with Applications and Historical Notes, Tata McGraw-Hill Edition, Delhi (2003).
4. S. L. Rossc, Differential Equations 3rd Edition, Wiley, (2016).

Other Resources

1. -

Course Designers

1. -

SRM University *AP*, Andhra Pradesh

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

Creativity and Critical Thinking Skills

Course Code	AEC 104	**Course Category**	Ability Enhancement Course (AEC)	**L**	**T**	**P**	**C**
				1	0	1	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Literature and Language	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- Identify key concepts associated with creative problem-solving and critical analysis.
- Interpret and summarize various models and frameworks used in fostering creative and critical thinking skills.
- Apply divergent thinking methods to generate innovative solutions to multifaceted problems.
- Assess and compare the strengths and weaknesses of various critical thinking approaches in decision-making.

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 and describe fundamental concepts and theories related to creativity and critical thinking.	1	80%	80%
Outcome 2	Explain the significance of creativity and critical thinking in problem-solving and decision-making processes.	2	80%	60%
Outcome 3	Implement critical thinking strategies to analyse and evaluate information and arguments effectively.	3	80%	70%
Outcome 4	Analyse and assess the effectiveness of specific creative thinking methods in addressing real-world problems.	4	80%	70%

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

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modem Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1			1	3	3			3		3		3			
Outcome 2		3		3	3			3		3		3			
Outcome 3		3	3		3			3		3		3			
Outcome 4		3	3	3	3			3		3		3			
Average		**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 Creativity and Critical Thinking**	**6**		
	Introduction to key concepts	2	1,3	1
	Importance in personal and professional contexts	2	1,3	1,2
	Understanding the differences	1	2,3	1,4
	Real-world applications	1	1,3	1,3
Unit 2	**Overcoming Mental Blocks**	**6**		
	Identifying and addressing barriers	3	1	14
	Exercises for mental flexibility	3	4	1,2
Unit 3	**Critical Thinking Skills**	**6**		
	Recognizing common pitfalls	1	1,3	1,2
	Examples and group discussion	1	2,3	1,2
	Techniques for assessing information credibility	2	1,3	1
	Case studies and research exercises	2	1,3	3
Unit 4	**Application of Creative Solutions**	**6**		
	Practical problem-solving exercises	1	1,3	1,4
	Group projects and case studies	2	2,3	2,3
	Integrating ethics into creative and critical thinking	1	1,3	1
	Discussions on ethical dilemmas and decision-making	2	1,3	3
Unit 5	**Application of Creative Solutions**	**6**		
	Quizzes on concepts and techniques	1	1,3	1,2
	Individual and group assignments	1	2,3	1,2
	Applying creativity and critical thinking to a real-world scenario	2	1,3	1
	Presentation and peer evaluation	2	1,3	3
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (75%)			
		CLA-1 (20%)	CLA-2 (20%)	CLA-3 (20%)	Project Work (45%)
Level 1	Remember	30%		10%	
	Understand				
Level 2	Apply	70%	100%	90%	100%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Creative Confidence: Unleashing the Creative Potential Within Us All by Tom Kelley and David Kelley
2. Critical Thinking: An Introduction by Alec Fisher
3. Think Like a Freak: The Authors of Freakonomics Offer to Retrain Your Brain by Steven D. Levitt and Stephen J. Dubner
4. Creative Intelligence: Harnessing the Power to Create, Connect, and Inspire by Bruce Nussbaum

Other Resources

1. -

Course Designers

1. -

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

Mathematical Modelling of Physical Data

Course Code	SEC 107	**Course Category**	SEC	**L**	**T**	**P**	**C**
				2	0	0	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Physics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To gain a foundational understanding of statistics and probability, and error analysis.
- To know different types of mathematical models used to understand a data set.
- To construct appropriate mathematical through formulation of real-life problems, solve those problems and validate the results.
- To develop job-relevant skills with hands-on projects.

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	Idea of basics of statistics and probability, and different data fitting methods	2	70%	65%
Outcome 2	Knowledge of error analysis using a given data set	3	70%	65%
Outcome 3	Understand different types of mathematical models for fitting the data and solve those numerically	3	70%	65%
Outcome 4	Learn to write a report using Latex	4	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 Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	1	2							2	2	2	2
Outcome 2	3	3	3	3	3				2			2	2	2	3
Outcome 3	3	3	3	3	3				2			2	3	2	3
Outcome 4	3	3	3	3	3				2			2	3	2	3
Average	**3**	**3**	**3**	**3**	**3**				**2**			**2**	**3**	**2**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Probability distributions	1	1	1
	Mean, Variance, and Standard deviations	1	1	1
	Central limit theorem	1	1	1
	Gradient decent Method	1	1	1
	Regression	1	1	1
Unit 2	Precision and accuracy	1	1,2	1
	Significant digits and round-off	1	1,2	1
	Error propagation	1	1,2	1
	Weighted average	1	1,2	1
	Least-square fitting and chi-squared test	1	1,2	1
Unit 3	Different types of Mathematical models	2	3	2,3
	Linear Modeling	2	3	2,3
	Exponential Modeling	2	3	2,3
	Modeling with Differential Equations	2	3	2,3
	Implementation of some of these models using Python	3	3	4
Unit 4	Basics of Latex	3	4	5
	Preparing a report using Latex	3	4	5
Total Contact Hours		30		

Learning Assessment

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

Recommended Resources

1. An introduction to Numerical methods and analysis, 2nd Edition, James F Epperson, Wiley Publication
2. Mathematical Modeling, Mark M. Meerschaert (https://www.stt.msu.edu/~mcubed/modeling.html)
3. Precalculus: Mathematical Modeling" by Joseph W. Cutrone (https://www.coursera.org/learn/precalculus-mathematical-modelling#modules)
4. Modelling with Differential Equations" by Marleen Keijzer et al (https://online-learning.tudelft.nl/courses/modelling-with-differential-equations/)
5. Latex for Beginners (https://www.colorado.edu/aps/sites/default/files/attached-files/latex_primer.pdf)

Other Resources

1. -

Course Designers

1. -

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

Complex Analysis

Course Code	MAT 201	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)

- Understand the inadequacy of real numbers both algebraically and geometrically, and how complex numbers are adequate for these purposes.
- Comprehend how the theory of complex functions is enriched by the notion of line integral.
- Introduce theories for functions of single complex variable, via exploration of the algebraic, geometric, and topological structures of the complex number field.
- Discuss classification of isolated singularities, and applications of the calculus of residues in the evaluation of integrals.

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 the geometric, algebraic, and topological properties of complex numbers.	3	80%	70%
Outcome 2	Evaluate limits, continuity, and differentiation of functions of complex variables.	3	80%	70%
Outcome 3	Compute complex integrations using direct method and by applying "Fundamental" and "Cauchy" theorems.	3	60%	60%
Outcome 4	Represent functions as power and Taylor series and describe conformal mappings between plane regions.	3	60%	70%
Outcome 5	Classify singularities & poles and evaluate complex integrals using the residue theorem.	3	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	2	3	2	2	1								3	2	2
Outcome 2	2	3	3	2	3								2	3	3
Outcome 3	2	3	3	3	3								2	3	3
Outcome 4	1	2	3	3	2								2	3	3
Outcome 5	1	3	3	3	3								2	3	3
Average	**2**	**3**	**3**	**3**	**2**								**2**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact hours	CLOs Addressed	References Used
Unit 1	**The Algebra, Geometry and Topology of the Complex Plane**	**12**		
	Complex numbers, conjugation, modulus, argument, and inequalities. Powers and roots of complex numbers,	2	1	1, 2
	geometry in the complex plane, the extended complex plane	2	1	1, 2
	Topology of the complex plane, open sets	2	1	1, 2
	Open s closed sets, limit points, isolated points	2	1	1, 2
	interior points, boundary points, exterior points, compact sets	2	1	1, 2
	connected sets, sequences and series of complex numbers and convergence	2	1	1, 2
Unit 2	**Complex Functions: Limits, Continuity and Differentiation**	**8**		
	Limits and continuity	3	2	1, 2
	Differentiation and the Cauchy-Riemann equations	3	2	1, 2
	analytic functions, harmonic functions	2	2	1, 2
Unit 3	**Complex Integration Theory**	**16**		
	Introducing curves, paths and contours, contour integrals and their properties,	3	3	1, 2
	Fundamental theorem of calculus	3	3	1, 2
	Cauchy's theorem as a version of Green's theorem	2	3	1, 2
	Cauchy-Goursat theorem for a rectangle	2	3	1, 2
	The antiderivative theorem	2	3	1, 2
	Cauchy-Goursat theorem for a disc	2	3	1, 2
	The deformation theorem	2	3	1, 2
Unit 4	**Further Properties of Analytic Functions**	**12**		
	Power series, their analyticity, Taylor's theorem	3	4	1, 2
	Zeroes of analytic functions, Rouche's theorem	3	4	1, 2
	Zeroes of analytic functions, Rouche's theorem (Applications)	2	4	1, 2
	Open mapping theorem	2	4	1, 2
	Maximum modulus theorem	2	4	1, 2
Unit 5	**Isolated Singularities and Residue Theorem**	**12**		
	Isolated singularities, removable singularities, Poles	3	5	1, 2
	Classification of isolated singularities	2	5	1, 2
	Casoratti-Weierstrass theorem, Laurent's theorem	3	5	1, 2
	Residue theorem	2	5	1, 2
	The argument principle	2	5	1, 2
Total Contact Hours		**60**		

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%)	Mid-2 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Saff Edward B., Snider Arthur David. Fundamentals of complex analysis: engineering, science, and mathematics. Harlow, England
2. H.A. Priestley, Introduction to Complex Analysis, 2nd edition (Indian), Oxford, 2006

Other Resources

1. -

Course Designers

1. -

SRM University *AP*, Andhra Pradesh

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

Probability and Statistics

Course Code	MAT 204	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)

- Understand concepts of discrete probability, conditional probability, independence, and be able to apply these concepts.
- Understand mathematical descriptions of random variables including probability mass functions (PMFs), cumulative distribution functions (CDFs), probability distribution functions (PDFs), conditional mass, conditional distribution and conditional density functions.
- Understand correlation, covariance, correlation coefficient and how these quantities relate to the independence of random variables
- Understand basic principles of statistical inference.

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 basic counting techniques (multiplication rule, combinations, permutations) to compute probability and	3	75%	70%
Outcome 2	Work with continuous random variables. Know what expectation and variance mean and be able to compute them understand the law of large numbers and the central limit theorem;	3	75%	70%
Outcome 3	Compute the covariance and correlation between jointly distributed variables	2	80%	70%
Outcome 4	Create and interpret scatter plots and histograms;	2	80%	80%
Outcome 5	calculate various moments of common random variables including at least means, variances and standard deviations.	3	70%	65%
Outcome 6	calculate the distribution of a function of a random variable.	3	70%	60%
Outcome 7	Compute the sample mean and sample standard deviation of a series of independent observations of a random variable.	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	3	3	2	1								3	2	1
Outcome 2	2	3	3	2	1								3	3	2
Outcome 3	2	2	2	2	1								3	3	2
Outcome 4	1	1	2	2	1								2	2	1
Outcome 5	2	2	2	3	2								3	3	2
Outcome 6	2	3	3	2	2								3	3	2
Outcome 7	2	3	3	2	2								3	3	2
Average	**2**	**3**	**3**	**2**	**1**								**3**	**3**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Probability Model**	**7**		
	What is Probability (a Measure of Uncertainty), and Why Do We Need probability Theory?	1	1	1,2
	Probability Models: Venn Diagrams and Subsets	1	1	2,3
	Properties of Probability Models	2	1,3	1,2
	Uniform Probability on Finite Spaces: – Combinatorial Principles	1	3	1,2,3
	Conditional Probability and Independence: –Conditional Probability, and Independence of Events	2	1,3	1,2,3
Unit 2	**Random Variables and Distributions**	**14**		
	Random Variables and Distributions of Random Variables	2	1,6	1,2
	Discrete Distributions: –Important Discrete Distributions	1	1,2	1,2
	Continuous Distributions:–Important Absolutely Continuous Distributions	1	6	
	Cumulative Distribution Functions: –Properties of Distribution Functions, Cdfs of Discrete Distributions, Cdfs of Absolutely Continuous Distributions, Mixture Distributions, Distributions Neither Discrete Nor Continuous	4	1,2,3,4	1,2,3
	One Dimensional Change of Variable: – Discrete and Continuous Cases	2	1,2	1,2
	Joint Distributions: –Joint Cumulative Distribution Functions: Marginal Distribution	2	1,2,3	1,2,3
	Conditioning and Independence: – Conditioning on Discrete Random Variables, Conditioning on Continuous Random Variables, Independence of Random Variables.	2	4,5	1,2,3
Unit-3	**Expectation**	9		
	The Discrete Case	1	1	1,2,3
	The Absolutely Continuous Case	1	1,2	1,2,3
	Variance, Covariance, and Correlation	2	1,4,5	1,2,3
	Generating Functions: – Characteristic Functions	1	1	1,2
	Conditional Expectation: –Discrete Case, Absolutely Continuous Case, Double Expectations, Conditional Variance	3	3,4,5	1,2,3
	General Expectations	1	1	2
Unit-4	**Sampling Distributions and Limits**	15		
	Sampling Distributions	2	1,2,7	1,2
	Convergence in Probability: – The Weak Law of Large Numbers	2	1,3	1,2,3
	Convergence with Probability: – The Strong Law of Large Numbers	2	1,3	1,2,3
	Convergence in Distribution: –The Central Limit Theorem, The Central Limit Theorem and Assessing Error	4	3,4,5	1,2,3
	Monte Carlo Approximations	2	3,4	1,2
	Normal Distribution Theory: –The Chi-Squared Distribution, The t-Distribution, and The F- Distribution	3	1,3,4	1,2,3
Unit-5	**Statistical Inference**	15		
	Why Do We Need Statistics?	1	1,2	1,2
	Inference Using a Probability Model	2	1,2	1,2,3
	Statistical Models	2	1,3	1,2
	Data Collection: –Finite Populations, Simple Random Sampling, Histograms, Survey Sampling	4	1,2,3,4,5,7	1,2,3
	Some Basic Inferences: – Descriptive Statistics, Plotting Data, Types of Inferences	3	1,2,3,4	1,2,3
	Bayesian Inference	3	1,3	1,2,3
Total Contact Hours		**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	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Michael J. Evans and Jeffrey S. Rosenthal, Probability and Statistics: The Science of Uncertainty.
2. Marek Fisz, Probability theory and mathematical statistics-Wiley (1963).
3. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Academic Press, (2009).

Other Resources

1. -

Course Designers

1. -

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

General Topology

Course Code	MAT 207	**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)

- To introduce the student to elementary properties of topological spaces and structures defined on them.
- To introduce the student to maps between topological spaces.
- 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 and illustrate the concept of topological spaces and continuous functions, and prove and apply a selection of related theorems.	1, 2, 3	80	70
Outcome 2	Define and illustrate the concept of product topology and subspace topology, and prove and apply a selection of related theorems.	2, 3	60	80
Outcome 3	Define connectedness and compactness, and prove and apply a selection of related theorems.	1, 2, 3	60	70
Outcome 4	Define and illustrate the concepts of the separation axioms, and prove and apply a selection of related theorems.	2, 3	60	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**	12	1,2	1,2
	Continuity of a function	4	1,2	1,2
	Homeomorphism, Constructing continuous functions	4	1,2	1,2
	Metric topology	4	1,2	1,2
Unit 3	**Connectedness**	12	1,3	1,2
	Connected Space	5	1,3	1,2
	Connected subspace of the real line	3	1,3	1,2
	Components and Local Connectedness	4	1,3	1,2
Unit 4	**Compactness**	14	1,3	1,2
	Compact topological space	4	1,3	1,2
	Limit Point Compactness	5	1,3	1,2
	Local Compactness	5	1,3	1,2
Unit 5	**Separation Axioms**	12	1,4	1,2
	Regular space, Normal space	3	1,4	1,2
	The Urysohn Lemma	3	1,4	1,2
	The Urysohn Metrization Theorem	3	1,4	1,2
	The Tietze Extension Theorem	3	1,4	1,2
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	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

1. -

Course Designers

1. -

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

Linear Programming Problem

Course Code	SEC 117	**Course Category**	SEC	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	MAT 211	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	MATHEMATICS	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Equip the students with the mathematical definitions, proofs and applicable methods.
2. Introduction of Simplex method and its variants.

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	Illustrate fundamentals of optimization theory	3	80%	70%
Outcome 2	Use simplex method and do sensitivity analysis	3	60%	60%
Outcome 3	Demonstrate Duality theory and use Dual simplex procedure.	3	60%	70%
Outcome 4	Apply integer programming and solve problems.	3	60%	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	3	2	2	1	-	-	-	-	-	-	-	3	2	2
Outcome 2	2	3	3	2	3	-	-	-	-	-	-	-	2	3	3
Outcome 3	2	3	3	3	3	-	-	-	-	-	-	-	2	3	3
Outcome 4	1	3	3	3	2	-	-	-	-	-	-	-	2	3	3
Average	**2**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Interpretation of optimality**	**10**		
	Linear programming (LPP) modelling, Optimal solutions and graphical interpretation of optimality.	1	1	1
	Notion of convex set, convex function, their properties & applications in context of LPP. Preliminary definitions (like convex combination, extreme point etc.).	3	1,3	1
	Optimal hyper-plane and existence of optimal solution of LPP.	1	1	1
	Basic feasible solutions: algebraic interpretation of extreme point.	1	1,2,3	1
	Relationship between extreme points and corresponding BFS. Adjacent extreme points and corresponding BFS along with examples. Fundamental theorem of LPP and its illustration through examples.	4	1,2,3	1
Unit 2	**Simplex method**	**10**		
	LPP in canonical form to get the initial BFS & method of improving current BFS.	4	1,2,3	1
	Case of unbounded LPP, Simplex algorithm and illustration through examples.	3	1,2,3	1
	Artificial variables and its interpretation in context of feasibility.	1	1,2,3,4	1
	Two phase method and illustration.	1	1,2,3	1
	Degeneracy and its consequences including cases of cycling.	1	1,2,3	1
Unit 3	**Duality theory**	**10**		
	Introduction to duality & formulation of dual LPP for different models through examples.	2	1,2,3	1,2
	Duality theorems and their interpretations.	1	1,2,3	1
	Complementary slackness theorem, Farkas Lemma, Examples.	1	1,2,3,4	1
	Economic interpretation & applications of duality.	2	1,2,3	1
	Dual simplex method and its illustration.	1	3	1
	Post optimality analysis: the cases of change in resources, change in cost coefficients.	1	4,5	1
	Sensitivity analysis for addition and deletion of variables and constraints.	2	5	1
Unit 4	**Interior point methods and Integer Programming**	**10**		
	Complexity issues of LPP & introduction to interior point method.	2	3	1
	Narendra Karmarkar's interior point method.	2	4,5	1
	How to model the given LPP in Karmarkar's framework?	1	5	1
	Complexity issue of Karmarkar's method.	1	1,2,3	1
	Integer programming: modelling & a look at its feasible set.	1	1,2,3,4	1
	Gomory cut algorithm and derivation of cut equation.	2	1,2,3	1
	Branch and Bound algorithm.	1	3	1
Unit 5	**Transportation, Assignment and Networks**	**13**		
	Special LPPs: Transportation programming problem (TP), modelling, and unimodular matrix.	2	4,5	1
	Initial BFS and optimal solution of balanced TP problem.	2	5	1
	Other forms of TP and requisite modifications.	1	1,2,3	1
	Assignment problems and permutation matrix.	2	1,2,3	1,2
	Hungarian Method.	1	1,2,3	1
	Weighted network problem and LPP formulation.	1	1,2,3,4	1
	Network simplex algorithm.	1	1,2,3	1
	Matrix game and concept of saddle point.	1	1,2,3	1
	Graphical solution and rule of dominance.	1	3	1
	LPP and matrix game equivalence.	1		
Unit 6	**Non-linear optimization**	**3**		
	Introduction to nonlinear optimization	3	4,5	1

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 15%	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. NPTEL on Linear Programming and extensions. https://nptel.ac.in/courses/111/104/111104027/
2. Engineering optimization: Theory and practice Rao, S. S., Jan 1 2019, wiley. 798 p.

Other Resources

Course Designers

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

Real Analysis - III

Course Code	MAT 301	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)

- To learn the basic topological properties of functions several variables.
- To extreme values of the functions of several variables.
- To evaluate integrals over curves and surfaces.
- To learn and apply Gauss', Green's and Stokes' theorems.

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 the concept of continuity and uniform continuity of functions of several variables	2	70%	70%
Outcome 2	Determine the derivatives, directional derivatives and gradient's	3	60%	60%
Outcome 3	Calculate the extreme values of the functions using the differential calculus	3	65%	60%
Outcome 4	Evaluate integrals and understand its geometrical interpretation	3	60%	55%
Outcome 5	Determine the length of an arc, area of surfaces and volumes by applying the techniques of double and triple integrals	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 Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	3	1			1						3	3	2	1
Outcome 2	2	3	2	2		1						3	3	1	2
Outcome 3	3	3	2	3	2	1						3	2	2	2
Outcome 4	3	3	3	2	3							3	3	1	3
Outcome 5	2	2	3	3	3							2	2	3	3
Average	**2**	**3**	**2**	**2**	**2**	**1**						**3**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Functions, limit and continuity**	**10**		
	Inner product on Euclidean space and its geometry, norm of vectors, matrices, and linear transformations.	1	1	1,3
	Real valued function of several variables (implicit and explicit). Domain and range	1	1	1,3
	Level curves, graphs, and surfaces (parameterized, implicit and explicit).	1	1	1,3
	Limit of a function(existence, nonexistence), Cauchy criterion for the existence of the limit of functions, repeated limits. Algebra of limit of functions.	1	1	1,3
	Definition of a continuous function. Sequential criterion of a continuous function. Continuity in terms of open/closed sets, continuity and oscillation of a function, algebra of continuous functions.	1	1	1,3
	Topological properties preserved by continuous function. Intermediate value property. Topological properties of sets defined in terms of continuous functions.	2	1	2
	Upper semi continuous, lower semi continuous functions and attainment of extremum values by semicontinuous functions.	1	1	2
	Uniform continuous functions. Tutorial I	2	1	2
Unit 2	**Differential calculus**	**10**		
	Definition of partial and directional derivatives.	1	2	2,3
	Mean value theorem for directional derivatives, sufficient condition for continuity in terms of partial derivatives.	2	2	2,3
	Derivatives (total derivative) and its geometrical interpretation.	1	2,3	2,3
	Existence of all partial derivatives and gradient vectors of differentiable functions.	1	2,3	2,3
	Direction of steepest descent, Sufficient condition for the differentiability of a function in terms of partial derivatives. Algebra of Differentiable Functions.	2	2,3	2,3
	Higher order partial derivatives. Equality of second order mixed derivatives. Derivatives of function of functions[Chain rule].	1	2,3	2,3
	Euler's theorem for homogeneous function. Introduction to Big oh, small oh and multi index notation.	1	2,3	2,3
	Taylor's theorem[with different form of remainders]	1		
Unit 3	**Application of differential calculus**	**12**		
	Images and inverses: The inverse function theorem(in one and two variable cases).	2	3	2
	Jacobian and higher dimension case(Without proof).Implicit function theorem for one equation (two variables) , a system of two equations in three variables and implicit differentiation formula. m Equations in n variables (example only).	3	3	2
	Equation of curves and surfaces in three dimensional space. Equation of the normal and tangent line to the surfaces and curves defined by functional equations and system of functional equations respectively.	2	2,3	2
	Hessian its eigenvalues and eigenvectors. Principal curvature and directions for the surfaces u=f(x,y).	2	2,3	2
	Necessary condition of extremum. Extremum values and its relation with eigenvalues of Hessian.	1	3	2
	Lagrange multipliers technique for the constrained(surface or curve) extremum problem. General case without proof.	2	3	2
Unit 4	**Integration of function of several variables**	**13**		
	Double (Triple) Integrals over Rectangles(Rectangular Coordinates) and general regions, Fubini's Theorem for calculating Double Integrals.	3	4	3
	Changing the order of integral. Algebra of double integral.	2	4	3
	Substitution in double and triple integral. Double integral in polar coordinate, Changing Cartesian Integrals into Polar Integrals.	3	4	3
	Triple Integrals in Cylindrical and Spherical Coordinates.	2	4	3
	Convolution of functions, mollifiers, mollification of functions, Marcinkiewicz-Zygmund Theorem(A converse of Taylor's Theorem).	3	4	3
Unit 5	**Integration of vector fields**	**15**		
	Vector fields, continuity and differentiability of the vector fields. Gradient as a vector field, conservative vector fields, divergence of a vector field.	3	5	3
	Smooth and Piecewise Smooth Paths. Arclength of the rectifiable paths, A Non rectifiable parameterized path.	1	4,5	3
	Line integral of scalar functions, Line integral of vector fields (introduction to one form.) Line integration in conservative fields(Fundamental theorem of line integral) and its consequences.	3	4,5	3
	Green Theorem in the plane and Integration by Parts.	3	5	3
	Surface area and surface integral: Surface integral of scalar function and vector fields.	2	5	3
	Stokes theorem. Gauss divergence theorem, Integration by parts, Green's theorem.	3	5	3
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Patric M. Fitzpatrick: Advanced Calculus, Second edition, ISBN: 0821852094, American Mathematical Society 2010.
2. Gerald B. Folland: Advanced Calculus, First edition, ISBN: 8131768570, Pearson Education India 2011.
3. George B. Thomas, Joel Hass, Christopher Heil, and Maurice D. Weir: Thomas' Calculus, 14th edition, ISBN: 978-9353060411, Pearson Education.

Other Resources

1. Mariano Giaquinta and Giuseppe Modica, Mathematical analysis, An introduction to functions of several variables, ISBN: 0817645071, Birkhäuser 2009.
2. Walter Rudin: Principle of Mathematical Analysis, ISBN:9781259064784, third edition, McGraw Hill Education 2017

Course Designers

1. -

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

Partial Differential Equations - I

Course Code	MAT 302	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	Multivariable Calculus, Differential Equations	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To recognize basic natural phenomena around us and express them in the corresponding governing equation.
- To understand the nature of first and second order PDE's and obtain its explicit solutions.
- To understand the qualitative behaviour of solutions by writing the solutions explicitly in terms of Green functions.

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 the natural phenomenon around us and describe the corresponding model equations.	1	80%	70%
Outcome 2	Identify and classify all the PDE up to second order equations among itself.	2	60%	70%
Outcome 3	Solve first order equations and associated initial value problems.	2	60%	60%
Outcome 4	Solve the Laplace, Heat and Wave equations and associated boundary value problems in the plane.	2	60%	70%
Outcome 5	Identify and transform the Linear second order PDE into its canonical form and obtain the solution.	2	60%	70%
Outcome 6	Construct green functions and Heat Kernel in two-dimension case by eigenfunction method and write the explicit solutions of corresponding BVP/IBVP in terms of these green functions.	3	60%	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	1								3	2	2
Outcome 2	2	3	3	2	3								2	3	3
Outcome 3	2	3	3	3	3								2	3	3
Outcome 4	1	3	3	3	2								2	3	3
Outcome 5	1	3	3	3	3								2	3	3
Outcome 6	1	3	3	3	3								2	3	3
Average	**2**	**3**	**3**	**3**	**2**								**2**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**General Information and first-order PDE**	**11**		
	Dependent variable, independent variables, curves and surfaces, tangent and normal. Definition of differential equations. Some Physical principles and PDEs, Formation of partial differential equations by eliminating arbitrary constants and functions.	4	1	1,2,4
	Classification and well posedness of the problems.	2	2	1,2,4
	Methods of characteristics to solve the Cauchy problem for first order equations.	5	2	1,2,4
Unit 2	**Second order equation in two independent variables**	**12**		
	Constant Coefficient: Method of finding complementary functions to linear homogeneous and non-homogeneous(reducible, non reducible) partial differential equations. with zero right hand side term.	3	2	2,4
	Constant Coefficient Continued: Method of finding a particular solution (integral) of the above class of equations.	2	2	2,4
	Variable coefficient: Classification of linear second order PDEs (elliptic, parabolic, hyperbolic equations).	2	2	2,4
	Method of finding solutions to elliptic, parabolic, hyperbolic equations by method of characteristics.	5	2	1,2,4
Unit 3	**Introduction to Fourier Series and Fourier Transform**	**12**		
	Introduction to Fourier Series	4	2	2,4
	Bessel's inequality. Parseval's relation.	2	2	2,4
	Introduction to Fourier transform and Laplace transform	6		2,4
Unit 4	**Separation of variable techniques for three fundamental PDEs**	**16**		
	Different types of initial/boundary conditions and its physical significance.	3	2	1,2
	Separation of variable technique to find the solutions to BVP associated to Laplace equation in rectangle, interior and exterior to the disc in plane.	4	2	1,2
	Eigenvalues and eigenfunction expansion for Laplace equation in rectangle.	2	3	1,2
	Initial boundary value problems associated to Heat and wave equations.	3	3	1,2
	Heat kernel/Green function for initial boundary value problem for heat equation. Method of eigenfunctions to obtain the Green's function in a rectangle	4	3	1,2
Unit 5	**Revisit of Three fundamental PDE's**	10		
	Introductions to Characteristic and non-characteristic curves/surfaces for second order PDE's. Power series and Cauchy-Kovalevskaya theorem for Cauchy problem (through examples with-out proof).	3	2,4, 5	1,3
	Application of Laplace and Fourier transform to solve BVP/IBVP associated to Laplace, Heat and Wave equation	5	3, 4, 6	2,4
	Maximum Principle for Laplace and Heat Equation	2	2, 4, 6	1,2
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Fritz John: Partial differential equations, 2nd edition, ISBN: 8184892136, Springer (India) Pvt. Ltd 2009.
2. Walter A. Strauss, Partial Differential Equations: An Introduction, 2nd edition, ISBN: 0470054565, Wiley 2008.
3. Robert C. McOwen, Partial differential equations method and application, 2nd edition ISBN- 0130093351, Pearson 2002.
4. K. Sankara Rao: Introduction to partial differential equation 3rd edition, ISBN 8120342224, PHI Learning Private Limited New Delhi-10001

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh

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

Numerical Analysis

Course Code	MAT 303	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. Develop an idea of the elements of error analysis for numerical methods and to analyse techniques of various numerical root finding methods.
2. Analysing techniques for solving numerical solutions of a system of linear equations.
3. To gain proficiency in understanding interpolation.
4. Find the solution of ordinary differential equation of first order by numerical methods.

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	Analysis the error for numerical methods	3	70%	70%
Outcome 2	Apply the numerical methods to find the root	2	60%	70%
Outcome 3	To find the solution of a system of linear equation using numerical technics	3	60%	60%
Outcome 4	Apply to find the unknown values that lie in between the known data points	2	60%	70%
Outcome 5	Calculate the solution of integration and differentiation using numerical methods	3	60%	70%
Outcome 6	Solve the first order ordinary differential equations using numerical methods	3	60%	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	1	-	-	-	-	-	-	-	3	2	2
Outcome 2	2	3	3	2	3	-	-	-	-	-	-	-	2	3	3
Outcome 3	2	3	3	3	3	-	-	-	-	-	-	-	2	3	3
Outcome 4	1	3	3	3	2	-	-	-	-	-	-	-	2	3	3
Outcome 5	1	3	3	3	3	-	-	-	-	-	-	-	2	3	3
Outcome 6	1	3	3	3	3	-	-	-	-	-	-	-	2	3	3
Average	**2**	**3**	**3**	**3**	**2**	-	-	-	-	-	-	-	**2**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Accuracy and Numerical Solution of Nonlinear Equations**	**14**		
	Approximate numbers, Significant figures, Rounding off numbers absolute	2	1	1
	Relative and Percentage errors General formula for errors and its applications	3	1	1
	Propagation of round off errors in arithmetic operations	2	1	1
	Tabulation method Bisection method regular-Falsi Method	3	2	1
	Fixed point iteration method Newton-Raphson method	2	2	1
	Geometrical significance and convergence of these methods	2	2	1
Unit 2	**Numerical Solution of a System of Linear Equations**	**10**		
	Directs methods: Gaussian elimination	2	3	1
	Gauss-Jordan elimination Operation counts	2	3	1
	Matrix inversion.	3	3	1
	Iterative methods: Jacobi Gauss-Seidel Their convergence	3	3	1
Unit 3	**Interpolation**	**16**		
	Weierstrass' approximation theorem (statement only)	2	4	1,2
	Polynomial interpolation Existence and uniqueness of interpolating polynomial	2	4	1,2
	Finite differences: Forward and Backward Difference operators (Forward and Backward)	2	4	1,2
	Shifting operator, Properties and Relations between these operators, Difference table	2	4	1,2
	Error in the entry values, noise level	2	1,4	1
	Differences of a polynomial, Derivation of the error in interpolation	2	1,4	1
	Newton's forward and backward interpolation formulae	2	4	1
	Lagrange's interpolation formula Inverse interpolation	2	4	1
Unit 4	**Numerical Differentiation and Numerical Integration**	**10**		
	Differentiation formulae based on Newton's forward and backward interpolation formulae	3	5	1,2
	Error in differentiation. Newton-Cotes quadrature formula (without error)	3	1,5	1,2
	Degree of precision Trapezoidal rule Simpson's one-third rule and one-sixth rule	2	5	1,2
	Weddle's rule Composite rules Derivation of the error for Trapezoidal and Simpson's 1/3rd and 1/6th rules	2	5	1,2
Unit 5	**Initial Value Problems**	**10**		
	Solution of first order ordinary differential equations	2	6	1,2
	Picard's method, Taylor's method Euler's method and its modified form (concept of Predictor-Corrector method)	3	6	1,2
	Error estimate and its convergence	2	1, 6	1,2
	Runge-Kutta method of second and fourth orders and their significance	3	6	1,2
Total Contact Hours		**60**		

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 15%	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. M.K. Jain, S.R. K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, Wiley Eastern Limited, (1991).
2. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India (2006).

Other Resources

Course Designers

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

Number Theory and Introduction to Cryptography

Course Code	MAT 304	**Course Category**	Core	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	Basic Set Theory, classical algebra	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To understand the structure of finite abelian group and its application in cryptography.
- An introduction to elementary number theory
- To develop and explain the notion of provable security and its usage for the design of secure protocols.
- To understand how to secure a message over insecure channel by various means.

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 the primality and factoring of a given natural number.	3	75%	70%
Outcome 2	Study the Discrete Logarithm problem and its application in cryptography.	3	75%	75%
Outcome 3	Have in-depth understanding of security of the data over the network	3	70%	70%
Outcome 4	Conduct research in the emerging areas of cryptography	5	90%	90%

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	3	1								3	3	2
Outcome 2	2	3	3	3	2								3	3	2
Outcome 3	3	3	3	3	2								3	3	2
Outcome 4	3	2	2	3	3								3	2	2
Average	**3**	**3**	**3**	**3**	**2**								**3**	**3**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Finite Group Theory**	**10**		
	Group-theoretic background: Cyclic group and finding a generator of a cyclic group	2	1,3	1
	Structure of finite abelian group	2	1,2,3	1
	Discrete Logarithm Problem for finite abelian group	2	1,3,4	2,3,5
	Group structure of elliptic curves.	4	1,2,3	2,3,5
Unit 2	**Some Topics in Elementary Number Theory**	**20**		
	Integer arithmetic: Basic operations, The Euclidean algorithm	2	1	6
	Modular arithmetic: Basic operations, computing modular inverses	3	1,2,3	6
	Properties of various arithmetic functions	4	1,2,3	6
	Chinese Remainder Theorem	2	1,2	6
	Primality testing	3	1,2,3	5,6
	Factoring algorithms	3	1,2,3	5,6
	Elliptic curves primality test	3	1,2,3	2,5,6
Unit-3	**Introduction and classical Ciphers**	**8**		
	Definition of Cryptography: Classical and Modern Cryptography	2	1,3	4,5
	The setting of Private-key Encryption	2	1,2,3	4,5
	Historical ciphers and their crypto analysis	2	1,3	2,4,5
	Basic Principles of Modern Cryptography: Formation of exact definitions, and various examples	2	1,2,3	2,4,5
Unit-4	**Private-key (Symmetric) Cryptography**	**10**		
	Private-key encryption and Pseudo randomness	2	1,3	2,4,5
	Message Authentication Codes and Collision-Resistant Hash Functions	3	1,2,3	2,4,5
	Pseudorandom Objects in Practice: Block Ciphers	2	3	2,4,5
	Private-Key Cryptography Necessary and Sufficient Assumptions	3	3	2,4,5
Unit-5	**Public-key (Asymmetric) Cryptography**	**12**		
	One-Way Functions and Permutations	3	3,4	2,4,5
	Constructing Collision-Resistant Hash Functions	3	3,4	2,45
	Private-Key Management and the Public-Key Revolution	2	2,3	2,4,5
	Public-Key Encryption	4	2,3,4	2,4,5
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Abstract Algebra by Dummit and Foote.
2. Lecture Notes on Cryptography by Shafi Goldwasser and Mihir Bellare.
3. A Course in Cryptography by Rafael Pass and Abhi Shelat.
4. A Course in Number Theory and Cryptography by Neal Koblitz.
5. Cryptography: Theory and Practice, by Douglas R. Stinson and Maura B. Paterson.
6. Elementary Number Theory by G. A . Jones and J. M. Jones.

Other Resources

1. -

Course Designers

1. -

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

CO-CURRICULAR ACTIVITIES

Course Code	VAC 103	**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	SA	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Develop essential skills, including leadership, communication, and teamwork, among students.
2. Offer opportunities for students to apply academic concepts in practical, real-world scenarios.
3. Promote self-exploration, confidence-building, and social responsibility.

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 confidence in leading group activities, communicate clearly, and collaborate effectively with diverse teams.	2	80%	75%
Outcome 2	Apply theories to practical tasks by solving problems and adapting concepts to real-life situations through cocurricular activities	2	80%	70%
Outcome 3	Develop new experiences with an open approach through guided reflection to assess personal growth, skills, and learning for holistic development.	3	80%	70%

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments 100%			
		CLA-1 25%	CLA-2 25%	CLA-3 25%	CLA-4 25%
Level 1	Remember				
	Understand				
Level 2	Apply	15%	15%	15%	15%
	Analyse				
Level 3	Evaluate	10%	10%	10%	10%
	Create				
Total		**25%**	**25%**	**25%**	**25%**

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

COMMUNITY SERVICE AND SOCIAL RESPONSIBILITY

Course Code	VAC 104	**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.

MATLAB, Sage, and Mathematica

Course Code	SEC 134	**Course Category**	SEC	**L**	**T**	**P**	**C**
				2	0	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)

- Equip students with fundamental and advanced skills in MATLAB, Sage, and Mathematica.
- Mastering programming, data visualisation, symbolic computations, and linear algebra.
- Develop critical thinking, problem-solving abilities, and effective communication in diverse mathematical contexts through practical applications and comparative analysis.

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 programming and computational techniques using powerful mathematical software tools.	2	70%	70%
Outcome 2	Write and execute code for diverse mathematical and scientific applications, leveraging the capabilities of MATLAB, Sage, and Mathematica	3	72%	74%
Outcome 3	Use mathematical software for symbolic and numerical computations, data analysis, visualisation, and problem-solving in various mathematical and scientific domains.	3	72%	75%
Outcome 4	Solve ordinary differential equation (ODE) and partial differential equation (PDE) in MATLAB, Sage, and Mathematica.	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 Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2	2	3	-	-	-	-	-	-	3	2	2
Outcome 2	2	3	3	3	2	3	-	-	-	-	-	-	2	3	3
Outcome 3	2	3	2	2	2	3	-	-	-	-	-	-	2	3	3
Outcome 4	2	3	2	2	2	3	-	-	-	-	-	-	2	3	3
Average	**2**	**3**	**2**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to MATLAB**	**5 Hours**		
	Overview of MATLAB environment	1	1,2	1
	Basic syntax, variables, and data types	1	1	1
	Mathematical operations and functions	1	1,2	1
	Scripting and programming fundamentals	1	1	1
	Data visualisation and plotting in MATLAB	1	3	1
Unit 2	**Numerical Analysis with MATLAB**	**5 Hours**		
	Solving linear and nonlinear equations	1	1, 3	1
	Interpolation and curve fitting	1	3	1
	Numerical integration and differentiation	1	3	1
	Ordinary differential equations (ODEs) and partial differential equations (PDEs) in MATLAB	2	2,4	1
Unit 3	**Introduction to Sage**	**5 Hours**		
	Overview of SageMath environment	1	1, 2	2, 3
	Basic syntax and symbolic computation	1	2	2, 3
	Algebraic manipulations and simplifications	1	2	2, 3
	Solving equations symbolically	1	2	2, 3
	Plotting and visualizing mathematical expressions in Sage	1	4	2, 3
Unit 4	**Advanced Topics in Sage**	**5 Hours**		
	Multivariable calculus and vector calculus in Sage	1	2	2, 3
	Linear algebra and matrix computations	2	2, 3	2, 3
	Discrete mathematics and combinatorics with Sage	2	2	2, 3
Unit 5	**Mathematica**	**10 Hours**		
	Mathematica environment and interface	1	1	4, 5
	Symbolic manipulation and simplification	1	3	4, 5
	Solving algebraic and transcendental equations	1	2, 3	4, 5
	Symbolic calculus, including differentiation and integration	2	2, 3	4, 5
	Linear algebra and matrix manipulations in Mathematica	1	3,4	4, 5
	Differential equations and boundary value problems	2	3,4	4, 5
	3D plotting and visualization in Mathematica	2	4	4, 5
Total Contact Hours		**30**		

Course Unitization Plan Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Practical for Introduction to MATLAB	5	1, 3	1
2	Practical for Numerical Analysis with MATLAB	5	2, 3	1
3	Practical for Introduction to Sage	5	2, 3	2, 3
4	Practical for Advanced Topics in Sage	5	2, 3	2, 3
5	Practical for Mathematica	5	2, 3	4, 5
6	Practical for Advanced Topics in Mathematica	5	2, 3	4, 5
Total Contact Hours		**30**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. "MATLAB for Engineers" by Holly Moore
2. "Sage Tutorial" by William Stein,
3. SageMath Documentation (online)
4. "Mathematica Cookbook" by Sal Mangano,
5. Mathematica: A System for Doing Mathematics by Wolfram Research

Other Resources

1. -

Course Designers

1. -

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

Internship

Course Code	MAT 401	**Course Category**	RDIP	**L**	**T**	**P**	**C**
				0	0	5	5
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- Gain a comprehensive understanding of research processes.
- 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.	4	70%	65%
Outcome 2	Conduct a comprehensive literature survey.	3	70%	65%
Outcome 3	Analyse the feasibility of a research project	4	70%	65%
Outcome 4	Prepare a short report.	3	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 Life Long 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
Outcome 5	2	2	1	3	3			3	3	3		3	3	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	**Project Ideation**	**30**		
	Explore personal interests to generate a project idea.	16	1	1
	Conduct a feasibility assessment for the proposed project.	14	1	1
Unit 2	**Conceptualization and Abstract Development**	**80**		
	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	25	3	1
Unit 3	**Report Writing**	**40**		
	Collaboratively write a report based on the results	40	4	1
	Total	**150**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

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

Other Resources

1. -

Course Designers

1. -

SRM University *AP*, Andhra Pradesh

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

Research Project

Course Code	MAT 402	Course Category	RDIP	L	T	P	C
				0	0	12	12
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mathematics	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

- Gain a comprehensive understanding of research processes.
- Foster creativity and effective ideation skills.
- Acquire skills in devising and implementing project plans.
- 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.	4	70%	65%
Outcome 2	Conduct a comprehensive literature survey.	3	70%	65%
Outcome 3	Develop an idea tailored to address the specified problem.	5	70%	65%
Outcome 4	Describe the significance of the idea.	3	70%	65%
Outcome 5	Prepare a report intended for peer review.	5	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**	**55**		
	Explore personal interests to generate a project idea.	31	1,4	1
	Conduct a feasibility assessment for the proposed project.	24	1,4	1
Unit 2	**Conceptualization and Abstract Development**	**65**		
	Conduct a literature survey to gather relevant information. Submit an abstract outlining the conceptualized idea.	45	2	1
	Write an abstract of the proposed idea	20	2	1
Unit 3	**Develop an idea**	**120**		
	Formulate an idea.	75	3	1
	Establish a timeline for executing different project modules.	45	3	1
Unit 4	**Execution Planning**	**60**		
	Create a detailed timeline for the project's module execution. Conduct numerical analysis to validate the model if applicable.	60	4	1
Unit 5	**Results Analysis and Report Writing**	**60**		
	Analyze the results obtained from the project modules.	30	3	1
	Collaboratively write a report based on the results	30	5	1,2
	Total	**360**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

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

Other Resources

1.

Course Designers

1.

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

Measure Theory

Course Code	MAT 403	**Course Category**	SE	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	Real Analysis III	**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To give a comprehensive and sound introduction to modern measure theory and integration.
- Understand Lebesgue measure and integration, absolutely continuous function & function of bounded variation, Lp spaces.
- Compute Lebesgue integrals using the Fundamental Theorem of Calculus, Monotone and Dominated Convergence Theorems, and the Fubini Theorems.

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 outer measures and their relation to measures and computing Lebesgue integrals for simple functions.	1	75%	70%
Outcome 2	Illustrate the proofs of the convergence theorems, such as the Monotone Convergence Theorem, Dominated Convergence Theorem, and Fatou's Lemma.	2	70%	75%
Outcome 3	Demonstrate the use of the theorem for decomposing measures.	3	75%	70%
Outcome 4	Define and work with product measures on product spaces.	3	75%	65%
Outcome 5	Describe Lp spaces and the integration of functions on these spaces.	1	70%	70%
Outcome 6	Define Haar measure and prove its existence	2	70%	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	2	1								3	2	2
Outcome 2	2	3	3	2	3								2	3	3
Outcome 3	2	3	3	3	3								2	3	3
Outcome 4	1	3	3	3	2								2	3	3
Outcome 5	1	3	3	3	3								2	3	3
Outcome 6	1	3	3	3	3								2	3	3
Average	**2**	**3**	**3**	**3**	**2**								**2**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Measure on the real line**	**12 Hours**		
	Sigma algebra, Lebesgue measure and its properties	2	**1**	1
	Outer measure, Measurable sets, Properties of outer measure	2	**1**	1
	Borel sets, Lebesgue measurable sets	2	**3**	1,2
	Caratheodory's theorem, Ulam's theorem, Measure zero sets	3	**3**	1
	Non-measurable sets, Existence of non-Lebesgue measurable sets, Measurable functions,	3	**1**	1,2
	Egoroff's theorem, Lusin's theorem			
Unit 2	**Integration of functions**	**12 Hours**		
	Simple function, Properties of integrable function,	2	**2**	1
	Sequence of integrable simple functions, Properties of non-negative integrable function	2	**2**	1
	Construction of Lebesgue integral on R^n, almost everywhere and its properties,	3	**2**	1
	Lebesgue bounded convergence theorem, Fatau's lemma	3	**2**	1
	Dominated convergence theorem	2	**2**	1
Unit 3	**Signed measure & its derivatives**	**14 Hours**		
	Signed measures & its properties	2	**3**	2
	Hahn and Jordan decomposition	3	**3**	2
	Absolute continuity, Radon-Nikodym theorem	3	**3**	2
	Derivatives of signed measures, Lebesgue differentiation theorem	3	**3**	2
	Product measure, Fubini's theorem	3	**3**	2
Unit 4	**L^p spaces & its inequalities**	**10 Hours**		
	L^p Spaces, Hölder's inequality, Minkowskii's inequality	3	**4**	1,2
	Completeness	2	**4**	1,2
	Uniform integrability	3	**4**	1,2
	Vitali's convergence theorem	2	**4**	1,2
Unit 5	**Haar measure**	**12 Hours**		
	Topological measure space, Regular Borel measure	3	**5**	1
	Topological groups, Locally compact group	3	**5**	1
	Haar measure	3	**6**	1
	Existence and uniqueness of Haar measure	3	**6**	1,2
Total		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. G de Barra, Measure Theory & Integration
2. H. L. Royden, Real Analysis.

Other Resources

1. -

Course Designers

1. -

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

Advanced Linear Algebra

Course Code	MAT 412	**Course Category**	SE	**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)

- Students will be able to find eigenvalues and eigenvectors of square matrices.
- Learn to use eigenvalues in solving differential equations.
- Able to find optimal values and singular value decomposition.
- Learn to solve Linear Programming 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	Compute the eigenvalues and eigenvectors of square matrices.	3	75%	60%
Outcome 2	Solve differential equations using eigenvalues.	3	75%	60%
Outcome 3	Carry out important computations involving matrices such as finding optimal values and singular value decomposition.	3	75%	60%
Outcome 4	Illustrate and solve the linear programming problems	4	75%	60%

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

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	-	-	1	-	-	-	2	-	-	-	2	3	3
Outcome 2	2	3	-	-	1	-	-	-	2	-	-	-	3	2	3
Outcome 3	2	3	-	-	1	-	-	-	2	-	-	-	3	3	3
Outcome 4	2	3	-	-	1	-	-	-	2	-	-	-	3	3	3
Average	**2**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Recalling Vector Spaces**	**9**		
	Vector Spaces, Subspaces, Span	3	1	**1, 2**
	Linear Independence, basis, Dimension	2	1	**1, 2**
	Orthogonality, Orthogonal complement, Orthonormal basis	2	1	**1, 2**
	QR decomposition	2	1	**1, 2**
Unit 2	**Eigenvalues and Eigenvectors**	**12**		
	Definition, finding of eigenvalues and eigenvectors.	2	1	**1, 2**
	Diagonalization of a matrix	2	1	**1, 2**
	Difference Equations and Powers A^K	2	1	**1, 2**
	Differential equations and e^At	2	1	**1, 2**
	Complex Matrices	2	1	**1, 2**
	Similarity Transformations	2	1	**1, 2**
Unit 3	**Positive Definite Matrices**	**14**		
	Minima, Maxima, and Saddle Points	3	2	**1, 2**
	Tests for Positive Definiteness	3	2	**1, 2**
	Singular Value Decomposition	3	2	**1, 2**
	Minimum Principles	3	2	**1, 2**
	The Finite Element Method	2	2	**1, 2**
Unit 4	**Computations with Matrices**	**12**		
	Matrix Norm and Condition Number	4	**3**	**1, 2**
	Computation of Eigenvalues	4	3	**1, 2**
	Iterative Methods for Ax = b	4	3	**1, 2**
Unit 5	**Linear Programming and Game Theory**	**13**		
	Linear Inequalities	3	4	**1, 2**
	The Simplex Method	2	4	**1, 2**
	The Dual Problem	3	4	**1, 2**
	Network Models	3	4	**1, 2**
	Game Theory	2	4	**1, 2**
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Gilbert Strang, Linear Algebra and Its Applications, Nelson Engineering, 4th Edn., 2007
2. S. Axler, Linear Algebra Done Right, 2nd Edn., UTM, Springer, Indian edition, 2010.

Other Resources

1. -

Course Designers

1. -

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

Algebra II

Course Code	MAT 421	**Course Category**	SE	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	Algebra I	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- **Rings and integral domains:** To understand the definition and examples of rings, Properties of rings, integral domains and characteristic of a ring. To learn the notion of an ideal, Quotient rings, operations on ideals, prime ideals, maximal ideals, Properties of ring homomorphisms, isomorphism theorems, their applications and Chinese remainder Theorem.
- **Integral Domains:** Study Irreducible and prime elements, Unique Factorisation Domains, Principal Ideal Domain and Euclidean Domain.
- **Polynomial Rings:** Study definition and basic properties, factorisation of polynomials over fields, Gauss lemma, irreducibility criteria.
- **Fields and field extensions and Modules:** Field extensions, finite and algebraic extensions. Definition and examples of modules, Submodules, Quotient Modules, Module homomorphisms, Direct sums, Free modules.

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 a ring and an ideal, summarize their basic properties and review related notions like characteristic	2	75%	75%
Outcome 2	Employ the homomorphism and isomorphism theorems and the Chinese remainder theorem	3	70%	75%
Outcome 3	Demonstrate the divisibility in integral domains and identify the domains like Unique Factorisation Domain, Principal Ideal Domain and Euclidean Domain.	4	65%	70%
Outcome 4	Describe the factorisation of polynomials over fields and recall irreducibility criteria. Define a field and illustrate finite and algebraic field extensions.	3	70%	75%
Outcome 5	Discuss the concept of modules, submodules, quotient modules, module homomorphisms, direct sums and free modules.	2	60%	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	2	2	2								3	1	1
Outcome 2	3	3	3	2	3								3	2	3
Outcome 3	3	3	3	2	3								3	2	3
Outcome 4	3	3	2	3	2								2	3	3
Outcome 5	3	2	1	2	2								3	2	1
Average	**3**	**3**	**2**	**2**	**2**								**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Unit Name: Introduction to rings and ideals**	**12**	**1**	**1,2,4**
	Concept 1: Introduction to the course, and why we study rings. Definition of a ring	2	1	**1,2,4**
	Concept 2: Examples of rings, Discussion on certain properties of rings	1	1	**1,2,4**
	Concept 3: Integral domains and fields	3	1	**1,2,4**
	Concept 4: Characteristic of a ring, Ideal, Quotient rings, operations on ideals	3	1	**1,2,4**
	Concept 5: Definition, examples and properties of prime and maximal ideals.	3	1	**1,2,4**
Unit 2	**Unit Name: Ring homomorphism**	**9**	**2**	**1,2,4**
	Concept 1 Definition and examples of ring homomorphisms. Properties of ring homomorphisms	3	2	**1,2,4**
	Concept 2: Isomorphism theorems and their applications	3	2	**1,2,4**
	Concept 3: Chinese remainder theorem and its applications	3	2	**1,2,4**
Unit 3	**Unit name: Divisibility in integral domain**	**12**	**3**	**1,2,3,4**
	Concept 1: Definition and examples of irreducible and prime elements and significance of their study	3	3	**1,2,3,4**
	Concept 2: Definition and examples of a unique factorisation domain (UFD). Discussion on certain properties highlighting significance of the study of UFDs.	3	3	**1,2,3,4**
	Concept 3: Definition and examples of a Principal Ideal Domain (PID). Discussion on certain properties highlighting significance of the study of PIDs.	3	3	**1,2,3,4**
	Concept 4: Definition and examples of a Euclidean Domain (ED). Discussion on certain properties highlighting significance of the study of Eds (for instance the ring of Gaussian integers is an ED and shares properties with the ring of integers).	3	3	**1,2,3,4**
Unit 4	**Unit name: Polynomial Rings**	**17**	**4**	**1,2,4**
	Concept 1: Definition, examples and basic properties of polynomial rings	2	4	**1,2,4**
	Concept 2: Factorisation of polynomials over fields	3	4	**1,2,4**
	Concept 3: Gauss lemma	3	4	**1,2,4**
	Concept 4: Irreducibility criteria	3	4	**1,2,4**
	Concept 5: Field extensions	3	4	**1,2,4**
	Concept 6: Finite and algebraic extensions	3	4	**1,2,4**
Unit 5	**Unit name: Introduction to modules**	**10**	5	**1,3**
	Concept 1: Definition and examples of modules	2	5	**1,3**
	Concept 2: Definition and examples of submodules	2	5	**1,3**
	Concept 3: Definition and examples of Quotient Modules, The module homomorphisms	3	5	**1,3**
	Concept 4: Direct sum of modules, The notion of a free module and basis.	3	5	**1,3**
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Dummit, David S., & Foote, Richard M. (2016). Abstract Algebra (3rd ed.). Student Dummit Edition Wiley, India
2. Gallian, Joseph. A. (2013). Contemporary Abstract Algebra (8th edition). Cengage Learning India Private Limited. Delhi. Fourth impression, 2015.
3. Michael Artin, Algebra by Michael Artin (2nd edition), Prentice Hall India, 2011.
4. John B. Fraleigh, A First Course in Algebra (7th edition), Pearson,2003

Other Resources

1. -

Course Designers

1. -

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

Functional Analysis

Course Code	MAT 422	**Course Category**	SE	**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)

- Able to learn vector spaces and their applications in solving linear algebraic problems, comprehending normed linear spaces with proficiency in using norms.
- 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.
- To proficiently apply a diverse set of established techniques and develop a reasonable skill level in calculations and material manipulation. Emphasising 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.	2	75%	80%
Outcome 2	Delve into the theory of Hilbert spaces, grasping the properties and applications of inner product spaces with a focus on completeness.	2	75%	75%
Outcome 3	Grasp the significance and applications of Zorn's lemma in establishing existence and maximality in partially ordered sets.	3	75%	80%
Outcome 4	Illustrate a comprehensive and advanced skill set, enabling them to navigate intricate problems in functional analysis and linear algebra with confidence.	3	75%	75%
Outcome 5	Illustrate fixed-point theorems and extend them to broader mappings and spaces.	3	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	3	2	2	1	-	-	-	-	-	-	-	3	2	2
Outcome 2	2	3	3	2	3	-	-	-	-	-	-	-	2	3	3
Outcome 3	2	3	3	3	3	-	-	-	-	-	-	-	2	3	3
Outcome 4	1	3	3	3	2	-	-	-	-	-	-	-	2	3	3
Outcome 5	1	3	3	3	3								2	3	3
Average	**2**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1		**10**		
	Vector space, normed linear space, bounded space	3	1	1
	Holder, Minkowski's inequality,	2	1	1
	Compactness and finite dimension,	3	1	1
	Continuous linear operator, linear functional, dual space, Completeness.	2	1	1
Unit 2		**14**		
	Hilbert space, Cauchy-Schwarz inequality, Bessel's inequality.	4	2	1
	Parallelogram identity, Apollonius identity, Polarization identity,	4	2	1
	Parseval identity, Riesz representation	2	2	1
	Hilbert adjoint operator, projections	2	2	1
	Bounded linear functional on Hilbert space	2	2	1
Unit 3		**14**		
	Zorn's lemma, Hamel basis,	3	3,4	1,2
	Hahn-Banach theorem and its consequences, geometric form, applications,	3	3,4	1,2
	Baire Category theorem, Uniform Boundedness theorem,	3	3,4	1,2
	Strong and weak convergence,	3	3,4	1,2
	Open mapping theorem, Closed graph theorem.	2	3,4	
Unit 4		**12**		
	Reflexive space, separability of dual space, best approximations, strict and uniform convexity..	3	5	1,3
	Frechet Differentiability, Gateaux Differentiability, smoothness, extreme point.	3	5	1,3
	Haar uniqueness theorem, Chebysev polynomial, compact convex sets, seminorm and local convexity,	2	5	1,3
	Banach Alaoglu theorem, Banach -Steinhaus theorem,	2	5	1,3
	Banach Mazur theorem, Generalized Stone-Weierstrass theorem.	2	5	1,3
Unit 5		**10**		
	Banach fixed point theorem, Contraction theorem,	3		1,2,3
	Brouwer fixed point theorem,	3	6	1,2,3
	Kakutani's fixed point theorem,	2	6	1,2,3
	Schauder fixed point theorem. Picard's theorem	2	6	1,2,3
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	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

1. -

Course Designers

1. -

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

Algebraic Topology

Course Code	MAT 423	Course Category	SE	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)

- Gain basic understanding of paths, covering spaces, universal cover and lifting theorems along with applications in different settings.
- 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.
- Obtain proficiency in simplicial homology theory, including simplicial, chain and CW complexes along with computation of simplicial homology groups and their applications. Gain basic understanding of singular homology theory, including the interplay between singular, cellular and simplicial homologies, Mayer-Vietoris sequence and chain homotopy.
- 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	Apply and analyze basic aspects of Algebraic Topology such as paths, covers and fundamental groups.	3	70%	80%
Outcome 2	Demonstrate important results related to fundamental groups and apply them in different settings.	3	70%	75%
Outcome 3	Demonstrate the concepts and applications of simplicial and singular homology theory.	3	70%	70%
Outcome 4	Apply the basics of cohomology theory along with certain advanced topics such as Poincaré duality and relative cohomology.	4	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	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
Outcome 2	3	3	3	2	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	**Basic Topological Notions**	**10**		
	Homotopy of maps.	2	1	1,2,4
	paths and path connectedness, quotient topology revisited, examples and applications.	4	1	1,2,4
	covering spaces, lifting theorems.	4	1	1,2,4
Unit 2	**Fundamental Groups**	**14**		
	Multiplication of paths, the fundamental group.	4	2	1,2,3
	Induced homomorphisms, fundamental group of the circle.	5	2	1,2,3
	Seifert-van Kampen theorem, applications, universal cover.	5	2	1,2,3
Unit 3	**Simplicial Homology**	**13**		
	Simplicial complexes, chain complexes.	3	3	1,2
	Definition and computation of simplicial homology groups.	4	3	1,2
	Properties of homology groups and their applications.	4	3	1,2
	CW complex	2	3	1,2
Unit 4	**Singular Homology**	**12**		
	Singular homology, comparison with simplical and cellular homology (statements).	3	3	1,2
	Excision, Mayer-Vietoris sequence.	4	3	1,2
	Chain homotopy.	2	3	1,2
	Homology with coefficients, Universal coefficient theorem (statement).	3	3	1,2
Unit 5	**Cohomology**	**11**		
	Cohomology groups, relative cohomology.	4	4	1,2,3
	Cup and Cap products, Examples.	4	4	1,2,3
	Orientation on manifolds	2	4	1,2,3
	Poincaré duality	1	4	1,2,3
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	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

1. -

Course Designers

1. -

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

Algebra III

Course Code	MAT 424	**Course Category**	SE	**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)

- To make students understand a systematic method for determining whether a polynomial equation is solvable by radicals. Galois theory helps identify which polynomial equations can be solved using square roots, cube roots etc..
- This course deepens the understanding of field extensions, which are crucial in various areas of Mathematics, including algebraic number theory and algebraic geometry.

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	Grasp the meaning of key concepts like algebraic closure, solvability by radicals.	2	80%	70%
Outcome 2	Discuss the relation between field extensions and polynomials.	2	80%	70%
Outcome 3	Apply Galois theory to solve specific polynomial equations.	3	80%	70%
Outcome 4	Apply the principles of the filed extensions in practical problems.	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	3	2	3	1	2								3	2	1
Outcome 2	2	2	2	2	3								3	2	1
Outcome 3	2	2	2	2	3								3	3	1
Outcome 4	2	2	2	2	3								2	3	2
Average	**2**	**2**	**2**	**2**	**3**								**3**	**3**	**1**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Field extensions**	**12**		
	Algebraic extension of fields	4	1,2	1
	Splitting fields and Kronecker's theorem	5	1,2	1
	Algebraically closed fields	3	1,2	1
Unit 2	**Galois theory**	**12**		
	Automorphisms	4	2,3	1
	Separability, Normal extensions and Galois extensions	4	2,3	1
	The fundamental theorem of Galois theory	2	2,3	1
	Examples	2	2,3,4	1
Unit 3	**Galois theory in characteristic zero**	**13**		
	Cyclotomic extensions	5	2,3,4	1,2
	Abelian extensions	4	2,3,4	1,2
	Cyclic extensions	2	2,3,4	1,2
	Kummer extensions	2	2,3,4	1,2
Unit 4	**Galois theory in positive characteristic**	**11**		
	Finite fields, Subfields of finite fields	4	2,3	3
	Galois groups of finite fields and Frobenius mappings	4	2,3	3
	The trace, and norm mappings.	3	2,3	3
Unit 5	**Applications of Galois theory**	**12**		
	Discriminants, Polynomials of degrees three and four	3		1,2,3
	The transcendence of π and e	3	2,3	1,2,3
	Ruler and compass constructions	2	2,3	1,2,3
	Solvability by radicals, Insolvability of a quintic	2	2,3	1,2,3
	The fundamental theorem of Algebra	2	2,3	1,2,3
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. David S. Dummit, Richard M. Foote, Abstract algebra.
2. Michael Artin, Algebra.
3. John B. Fraleigh – Galois Theory, U Glasgow course.

Other Resources

1. -

Course Designers

1. -

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

Operator Theory

Course Code	MAT 425	**Course Category**	SE	**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)

- To demonstrate the properties of various types of operators.
- To employ the knowledge of bounded linear operators and the properties of their respective spectrums.
- To comprehend the generalized concepts of Banach Algebra and C^* Algebra.
- To exhibit specialized knowledge like that of weak convergence, strong convergence of compact linear operators on Hilbert space. Furthermore, to become familiar with numerical range, numerical radius, convexity of numerical 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	Describe bounded linear operators and their properties such as compact operator, Toeplitz operator.	2	70%	70%
Outcome 2	Demonstrate the concept of bounded linear operators in their associated spectrums.	2	70%	70%
Outcome 3	Illustrate Mazur's theorem, Gel'fand spectrum, Gel'fand transform, Symmetric involutions, Bochner Raikov theorem for given bounded linear operators on Banach Algebra and C^* Algebra.	3	70%	60%
Outcome 4	Apply the concepts of weak and strong convergence, numerical range, numerical radius, convexity of numerical range of bounded linear operators.	3	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	2	3	2	3	-	-	-	-	-	-	-	2	2	2
Outcome 2	3	2	3	3	3	-	-	-	-	-	-	-	3	2	3
Outcome 3	3	2	2	3	3	-	-	-	-	-	-	-	3	3	3
Outcome 4	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
Average	**3**	**2**	**3**	**3**	**3**	-	-	-	-	-	-	-	**3**	**2**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1		**8**		**1, 3, 4**
	Topologies and the related concepts.	2	1	1
	Special classes of operators self-adjoint, normal, unitary operators.	2	1	1, 3
	Isometries, projection and its properties.	2	2	1, 3
	Square root of a positive operator.	1	1	1, 3
	Polar decomposition, Singular value decomposition.	1	1	4
Unit 2		**8**		**1, 3, 4**
	Regular value, spectrum and spectral radius of a bounded linear operator, resolvent set, properties of spectrum of bounded linear operator and compact operator.	4	1,2	1, 3
	Spectral mapping theorem (self-adjoint, normal, unitary operators), Spectrum on a complex Banach space.	4	2	1, 3, 4
Unit 3		**18**		**2, 5. 6**
	Banach algebra, symbolic calculus, invertible element of a Banach algebra.	4	3	2, 6
	Lomonosov's invariant subspace theorem, convergence of an infinite series on a Banach algebra, Mazur's theorem on a Banach field.	4	3	2, 5, 6
	The Gel'fand spectrum and Gel'fand transform, homomorphism on a Banach algebra and its properties.	6	3	2, 5, 6
	Symmetric involutions, Bochner Raikov theorem, introduction to C^* algebra.	4	3	2, 5, 6
Unit 4		**16**		**2, 5, 6**
	Compact linear operator, sequence of compact operators.	2	3,4	2, 6
	Weak convergence, range of compact operators.	2	4	2, 6
	Adjoint of a compact operator, eigenvalues of a compact operator.	4	4	2, 5, 6
	Sum, product and compositions of compact operators.	2	4	2, 5, 6
	Operator equation involving compact operators, unbounded linear operators in Hilbert space.	2	4	2, 5, 6
	Spectral properties of compact operators, Hellinger-Toeplitz theorem.	2	4	2, 5, 6
	Wecken's lemma, Bishop-Phelps theorem.	2		5, 6
Unit 5		**10**		**4, 6, 7, 8**
	Numerical range, numerical radius, convexity of numerical range.	3	4	4, 6
	Toeplitz- theorem, numerical radius for 2 by 2 matrix, numerical radius norm.	2	4	4, 6
	Numerical radius orthogonality, numerical radius for operator matrix.	2	4	4, 6, 7, 8
	Joint numerical range, C-numerical range, K-numerical range.	3	4	7, 8
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	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

1.

SRM University *AP*, Andhra Pradesh

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

Optimization Techniques

Course Code	MAT 411	**Course Category**	CEC	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	Analysis and Linear Algebra	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- 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.
- 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.
- The objective is to analyze and create numerical algorithms that can solve both linear and nonlinear optimization problems.
- 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	Design problems as mathematical programming problems. Classification of optimization problems, Optimization techniques – classical and advanced techniques.	Study& Analyze	75%	80%
Outcome 2	Formulation of 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.	Analyze & Implement	70%	65%
Outcome 3	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.	Study & Apply	75%	70%
Outcome 4	Convex Optimization: Convex function, Constrained-Unconstrained Problems, Lagrange Multipliers, Karush-Kuhn-Tucker Conditions, Gradient-descent method.	Study & Develop	70%	65%

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

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1															
Outcome 2															
Outcome 3															
Outcome 4															
Average															

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.**	**15 Hours**		
	History of optimization problems	2	**CO 1**	1,2
	Study of optimization problems	2	**CO 1**	1,2
	Formulation of design problems as mathematical programming problems.	2	**CO 1**	1,2
	Classsification of optimization problems	2	**CO 1**	1,2
	Explore classical and advanced techniques for solving optimization problems	2	**CO 1**	1,2
	Writing code for efficient algorithms for programing problems.	2	**CO 1**	1,2
	Implement of efficient algorithms for real world model problem.	2	**CO 1**	1,2
	Quizes and presentations	1	**CO 1**	1,2
Unit 2	**Linear Programming Problems.**	**18 Hours**		
	Formulation of Linear Programming problems	3	**CO 1, CO2**	1,2
	Classification of solution for Linear Programming problems.	3	**CO 1, CO2**	1,2
	Maximal & minimal solution for Linear Programming problems.	3	**CO 1, CO2**	1,2
	Simplex Algorithm	3	**CO 1, CO2**	1,2
	Big-M method, Two-phase method	2	**CO 1, CO2**	1,2
	Duality in linear programming	2	**CO1, CO2**	1,2
	Integer linear programming	2	**CO 1, CO2**	1,2
Unit 3	**Transportation (TP) and Assignment (TP) Problems**	**12 Hours**		
	Balanced TP, Unbalanced TP	3	**CO 3**	1,2
	North-West Corner Rule	2	**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.	3	**CO 3**	1,2
Unit 4	**Nonlinear optimization problem**	**15 Hours**		
	Formulation of nonlinear programming problems	2	**CO1, CO 4**	1,2
	Classification of nonlinear optimization problems	2	**CO1, CO 4**	1,2
	Constrained-Unconstrained Problems	2	**CO 4**	1,2
	Lagrange Multipliers,	2	**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		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	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

1. -

Course Designers

1. -

SRM University *AP*, Andhra Pradesh

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

Mechanics and Tensor calculus

Course Code	MAT 426	Course Category	SE	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)

- Develop a solid foundation in tensor algebra, including index notation, summation convention, transformations, and product operations.
- Gain proficiency in applying vector and tensor calculus to scalar and vector fields, including operations like gradient, divergence, and curl, as well as line, surface, and volume integrals.
- Analyze and describe the motion, deformation, and flows of materials using kinematic concepts such as displacement and velocity fields, deformation gradient tensors, strain tensors, and motion descriptions (Eulerian and Lagrangian).
- Describe internal and external forces acting on materials, stress analysis using Cauchy stress and stress transformations, and comprehend conservation laws such as mass, linear and angular momentum, and energy conservation in continua.

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 algebra concepts to solve engineering problems involving transformations, products, and decomposition of tensors.	2	75	70
Outcome 2	Analyze and interpret scalar and vector fields using vector and tensor calculus operations, and apply theorems like Gauss, Stokes, and Green's theorems in problem-solving.	2	75	70
Outcome 3	Analyze and describe the deformation and motion of materials using kinematic concepts and differentiate between Eulerian and Lagrangian descriptions in various scenarios.	3	75	70
Outcome 4	Apply conservation laws, including mass, linear and angular momentum, and energy conservation, to analyse and solve problems related to continuum mechanics.	4	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	-	-	-	-	-	-	2	3	2	2
Outcome 2	2	2	2	3	3	-	-	-	-	-	-	2	2	2	3
Outcome 3	2	2	2	2	3	-	-	-	-	-	-	2	2	2	3
Outcome 4	3	3	3	3	2	-	-	-	-	-	-	2	3	3	3
Average	**2**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Tensors**	**15**		
	Introduction to tensors, index notation, and summation convention.	3	1	1,3
	Tensor algebra, linear vector transformations, dyadic representation.Transformation of components, a product of tensors, transpose.	3	1	1,3
	Decomposition into symmetric and antisymmetric parts, invariants.Decomposition into isotropic and deviatoric parts, inner product, norm.	3	1	1,3
	Inverse, orthogonal tensors, eigenvalues, eigenvectors. Square-root, positive definite symmetric tensor, polar decomposition.	4	1	1,3
	Tensors of higher order.	2	1	1,3
Unit 2	**Vector and Tensor Calculus**	**15**		
	Scalar fields, gradient, directional derivative, potential.	3	2	2,4
	Vector fields, divergence, curl, solenoidal, and irrotational vector fields.	2	2	2,4
	Line integral, path independence.	2	2	2,4
	Surface, volume integrals, Gauss, Stokes, Green's theorems.	3	2	2,4
	Tensor calculus, a tensor derivative of the scalar field, the gradient of a vector field.	3	2	2,4
	Divergence of tensor field.	2	2	2,4
Unit 3	**Kinematics**	**15**		
	The continuum, inertial reference frames.	2	3	1,4
	Reference configuration, current configuration of deformed solid.	2	3	1,4
	Displacement, velocity field, examples of deformations, motions.	2	3	1
	Eulerian, Lagrangian descriptions of motion.	2	3	1
	Deformation gradient tensor, deformation of line, volume, and area elements.	2	3	1
	Strain tensors, Lagrange strain, Eulerian strain, Cauchy Green strain.	1	3	1
	Infinitesimal strains, compatibility, Polar decomposition of deformation gradient.	2	3	1
	Rotation tensor, left right stretch tensors, Principal stretches, strains.	2	3	1,4
Unit 4	**Field Equations and Conservation Laws**	**15**		
	Time derivatives of motion, velocity gradient, stretch rate, spin, vorticity.	2	4	1,4
	Spatial description of acceleration, Reynolds transport relation. Circulation-vorticity relations.	2	4	1,4
	External loading, surface tractions, body forces. Internal forces, Cauchy Stress, Principal stresses, stress invariants.	2	4	1,4
	Stresses near a surface, Piola-Kirchhoff stresses (Nominal, material stress). Mass Conservation, Linear, angular momentum, static equilibrium.	3	4	1,4
	First and second laws of thermodynamics for continua. Conservation laws for a control volume.	3	4	1,4
	Transformation of field quantities under changes of reference frame.	3	4	1,4

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Introduction to Tensor Calculus and Continuum Mechanics by J. H. Heinbockel, 2001
2. The Mechanics and Thermodynamics of Continua, by Eliot Fried, Lallit Anand, and Morton Gurtin
3. Advanced Engineering Mathematics by E. Kreyszig, John Wiley and Sons, International 8th Revised Edition, 1999
4. Continuum Mechanics Volume II of Lecture Notes on the Mechanics of Solids Rohan Abeyaratne, MIT web.2012

Other Resources

1. -

Course Designers

1. -

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

ODE II

Course Code	MAT 428	**Course Category**	SE	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	ODE I	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To develop a comprehensive set of skills and knowledge to solve complex differential equations and utilize derivatives of functions by introducing integration, vector spaces, and their applications in real-world scenarios.
- To gain proficiency in understanding and manipulating differential operator, function spaces, and non-linear differential-equation, enabling them to analyse and interpret diverse mathematical models. To apply the power series method for solving differential equations. Finding radius of convergence and interval of convergence. Application of Sturm-Liouville Boundary-Value Problems. Calculating Ordinary and singular points.
- To analyse techniques for solving first and higher-order differential equations, employing methods like reduction of order and variation of parameters to tackle real-world problems involving dynamic systems.
- Introduction of Fourier series, Application of Fourier series, Legendre and Bessel function and their application. Introduction of Laplace transform. Solution of differential equation by Laplace Transform.

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 analyse the concept of existence and uniqueness Theorems, Lipschitz condition, Piccard's method of successive approximation, classification of ODEs. Applications of ODEs.	2	75%	80%
Outcome 2	Apply Series Solution Technique of ODEs. Analyse power series, Radius and interval of convergence, Ordinary and singular points, Power series solution in powers of (x-x_0), Frobenius method.	3	70%	65%
Outcome 3	Understand Legendre and Bessel equations and its solutions; Legendre polynomial, Bessel's functions and their generating functions; Trigonometric expansion involving Bessel's function, Orthogonality.	3	75%	70%
Outcome 4	Describe Sturm-Liouville Boundary-Value Problems and its solution, Characteristic values, and Characteristic functions.	4	70%	65%
Outcome 5	Apply Laplace Transform method to solve linear differential equations and linear systems.	4	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	2		2								3	1	1
Outcome 2	3	3	3		3								3	2	3
Outcome 3	3	3	3		3								3	2	3
Outcome 4	3	3	2		2								2	3	3
Outcome 5	3	2	1		2								3	2	1
Average	**3**	**3**	**3**		**2**								**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Formation and classification of differential equations**	**13**		
	Existence and Uniqueness Theory .	2	**CO 1**	1,3
	Lipschitz condition, Piccard's method of successive approximation.	2	**CO 1**	1,3
	Fundamental existence and uniqueness theorem .	1	**CO 1**	1,3
	Dependence of solutions on initial conditions and on the functions f (dy/dx=f(x,y)).	1	**CO 1**	1,3
	Existence and uniqueness theorem for systems and higher order differential equations	2	**CO 1**	1,3
	Initial value Problems.	1	**CO 1**	1,3
	Applications of differential equations.	2	**CO 1**	1,3
	Analytical methods for solving differential equations.	1	**CO 1**	1,3
	Quiz	1	**CO 1**	1,3
Unit 2	**Geometrical meaning of differential equations with classification of solutions**	**10**		
	Series Solution Technique of ODEs, Introduction to power series .	2	**CO 2**	1,3
	Radius and interval of convergence.	2	**CO 2**	1,3
	Ordinary and singular points, Power series solution in powers of (x-x_0).	2	**CO 2**	1,3
	Frobenius method.	1	**CO 2**	1,3
	Applications of equations of first order and first degree.	2	**CO 2**	1,3
	Class Assessment	1	**CO 2**	1,3
Unit 3	**First order differential equations**	**15**		
	Legendre and Bessel equations Legendre's equation and its solutions, Legendre polynomial, Generating function for the Legendre polynomials.	3	**CO 3**	2,3
	Existence and uniqueness of solution. Orthogonal properties, Recurrence relations, Rodrigue's formula, Legendre series for f(x) (for polynomial case of f(x)).	3	**CO 3**	2
	Expansion of function in a series of Legendre polynomials Bessel's equations and its solution.	2	**CO 3**	2,4,3
	Bessel's function of the first kind of order n (integer), Relation between J_n(x) and J_-n(x) .	2	**CO 3**	2
	Recurrence relations for J_n(x), Generating function for Bessel's functions .	3	**CO 3**	2
	Trigonometric expansion involving Bessel's function, Orthogonality.	2	**CO 3**	2,3
Unit 4	**Second or higher order linear differential equations**	**12**		
	Sturm-Liouville Boundary-Value Problems.	1	**CO 4**	2
	Fourier Series, Self-adjoint equations of the second order ODEs .	2	**CO 4**	2
	Sturm-Liouville boundary value problems.	2	**CO 4**	2,4
	Characteristic values and Characteristic functions.	1	**CO 4**	2
	Orthogonality of characteristic functions.	1	**CO 4**	2
	Fourier Series .	2	**CO 4**	2
	Application of Fourier Series .	2	**CO 4**	2
	Class Assessment	1	**CO 4**	2,4
Unit 5	**System of first order differential equations**	**10**		
	Laplace Transform Definition.	2	**CO 5**	2,3
	Existence, and basic properties of Laplace transform.	1	**CO 5**	2,3
	The inverse transform and convolution .	1	**CO 5**	2,4
	Solutions of linear differential equations with constant coefficients	1	**CO 5**	2,3
	Nonhomogeneous Linear Systems of ODEs.	1	**CO 5**	2,3
	Tutorial	1	**CO 5**	2.3
	Solutions of linear differential equations with constant coefficients and linear systems using Laplace transform.	2	**CO 5**	2,4
	Quiz	1	**CO 5**	2,4
Total		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. S.L. Ross, Differential Equations 3rd Edition, Wiley (2016).
2. G. F. Simmons, Differential Equations with Applications and Historical notes, Tata McGraw Hill Edition, Delhi (2003).

Other Resources

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley- India.
2. William Boyce and Richard DiPrima, Elementary Differential Equations and Boundary Value Problems, 11th Edition, Wiley-India.

Course Designers

1. -

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

PDE II

Course Code	MAT 429	**Course Category**	SE	**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)

- To master the concept of generalized functions, their derivatives, and their role in solving differential equations.
- To gain proficiency in applying transform methods like Laplace and Fourier transformations to solve partial differential equations.
- To develop a deep understanding of specific equations like Laplace, heat, and wave equations.
- To comprehend the classification of second-order linear partial differential equations into elliptic, parabolic, and hyperbolic categories.

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 the ability to comprehend and analyse various types of partial differential equations (elliptic, parabolic, hyperbolic) and apply appropriate techniques (such as transform methods, Green functions, and generalized functions) to solve them	2	80%	70%
Outcome 2	Exhibit a deep understanding of fundamental concepts such as generalized functions, distributions, weak derivatives, Sobolev spaces, and their applications in PDEs.	2	70%	70%
Outcome 3	Apply mathematical techniques, including shock analysis, Rankine-Hugoniot conditions, d'Alembert solutions for wave equations, and the maximum principle for various types of equations (elliptic, parabolic).	3	70%	60%
Outcome 4	Implement critical thinking skills by formulating weak formulations for Poisson equations, understanding existence theorems for weak solutions, and utilizing Lagrange multiplier theorems for eigenvalues of Laplace equations.	2	60%	60%

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

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long 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**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to generalized functions and its derivative**	**8**		
	Continuous functions, Support of a function, Smooth functions with compact support (Test functions).	2	1	1
	Mollifiers, convolution of functions.	2	1	1
	Mollifications.	1	2	1
	Distribution, a convergence of distribution, derivative of distributions.	**1**	**1**	**1**
	Weak Derivative and Sobolev Spaces (Definition)	2	1	**1**
Unit 2	**Revisit of first-order equations**	**5**		
	Scalar conservation laws.	2	1,2	1
	Shocks, Distribution solutions, Rankine-Hugoniot conditions.	3	2	1
Unit 3	**Transform methods for PDEs**	**20**		
	Piecewise continuous function, Function of exponential order, Laplace transformation, Properties of Laplace transformation.	5	3	2
	Inverse Laplace transform and its properties Rapidly decreasing functions (Schwartz class of functions).	5	2	2
	Fourier inversion formula, Parseval Formula, Plancherel Theorem, Fourier transform of square-integrable functions.	5	3	2
	Application of Laplace and Fourier transformation to Solve Initial and boundary value problems	5	3	2
Unit 4	**Revisit of Laplace, Heat and Wave equation.**	**17**		
	Green Identities and uniqueness, Fundamental solutions, Revisit the Green functions for the Laplace equations and its properties.	4	3,4	2
	Green functions in a ball and half space.	2	4	2
	Mean values theorem and its consequences (maximum principle for the Laplace equation, Harnack inequality, Differential Harnack inequality, Liouville type Theorem).	3	4	2
	Poisson integral formula and Poisson kernel and its properties Fundamental solution of Heat equation and its properties.	2	4	2
	Solution of the initial value problem for the Heat equation.	2	4,3	2
	Mean Value formula and maximum principle for heat equations.	2	4	2
	D'Alembert solutions for wave equation, Domain of dependence and region of the influence.	2		2
Unit 5	**Some Generalizations**	**10**		
	General second-order linear partial differential equations and its classification as uniformly elliptic, parabolic, and hyperbolic equations.	3	4,3	2
	Maximum principle for elliptic and parabolic equations.	2	3	2
	Weak formulation of Poisson equation and existence of weak solutions.	2	4	2
	Lagrange multiplier theorem and existence of their eigenvalues of the Laplace equations.	3	4	2
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Q. Han, A. Basic course in partial differential equation, (GSM) AMS.
2. Murray H. Preterm. Weinberger, Maximum principle in differential equations, ISBN: 0387960686, Springer-1 May 1999.

Other Resources

1. -

Course Designers

1. -

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

Dynamical Systems

Course Code	MAT 430	Course Category	SE	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)

- Understand key dynamical systems concepts, including topology, continuity, and root finding
- Master fixed-point theorems, attraction-repulsion dynamics, and key bifurcations like saddle-node and period doubling
- Explore quadratic family dynamics, Cantor set, and period doubling, focusing on chaos transition through orbit diagrams
- 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%	60%
Outcome 2	Exhibit proficiency in applying fixed-point theorems, understanding attraction-repulsion dynamics, and analyzing saddle-node and period-doubling bifurcations.	3	70%	60%
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%	50%
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.	4	60%	50%

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							3	3	2	2
Outcome 2	3	3	3	2	3							2	3	2	2
Outcome 3	3	3	3	2	3							1	2	3	2
Outcome 4	2	3	3	3	3							2	1	3	3
Average	**3**	**3**	**3**	**2**	**3**							**2**	**3**	**3**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Dynamical Systems**	**15**		**1**
	A brief history of dynamical systems.	3	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	4	1	
	Graphical Analysis: Phase portrait, Orbit analysis	4	1	
Unit 2	**Fixed Points and Bifurcation**	**12**		1
	A fixed-point theorem,	2	1	
	Attraction & Repulsion	1	2	
	Calculus of fixed points,, periodic points	2	**2**	
	Introduction to bifurcation;	3	1	
	dynamics of quadratic map Saddle node bifurcation,	2	2	
	Period doubling bifurcation	2	2	
Unit 3	**Quadratic family & Transition to Chaos**	**10**		1,2
	Introduction to quadratic family,	2	1,2	
	Cantor middle-thirds set	2	2	
	Orbit diagram,	3	**2**	
	period doubling	3	2,3	
Unit 4	**Symbolic Dynamics & Chaos**	**14**		1,3
	Itineraries,	2	3	
	the sequence space,	1	3	
	the shift map,	2	2,3	
	conjugacy	1	3	
	Three properties of chaotic map,	3	3,4	
	Manifestation of chaos,	3	4	
	Other chaotic systems	2	4	
Unit 5	**Sharkovsky's theorem**	**9**		2,3
	Period 3 implies chaos,	3	4	
	Sharkovsky's theorem,	2	4	
	Critical points	1	2,3,4	
	Basin of Attraction	3	3,4	
	Total contact hours	**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	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

1. -

SRM University *AP*, Andhra Pradesh

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

Data Structures and Algorithms

Course Code	MAT 413	Course Category	SE	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)

- Students will study data structures, Arrays, linked lists, Stacks and Queues and study algorithms and be able to use algorithms in computing.
- Define asymptotic notation, standard notations and common functions and recurrence and study searching and sorting algorithms.
- Study the Trees- Binary tree, Binary search tree, Hash tables and Heaps.
- To gain knowledge on Graphs- Representations of graphs, Breadth-first search, Depth-first search, Minimum spanning trees, shortest paths, and Topological sort.

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 data structures, Arrays, linked lists, Stacks and Queues.	2	70	65
Outcome 2	Think about what is meant by algorithm and explore knowledge on the role of algorithms in computing.	2	70	65
Outcome 3	Illustrate the asymptotic notation, Standard notations and Common functions and recurrences.	2	70	60
Outcome 4	Apply the algorithms like Linear search, Binary search, Hashing and Sorting algorithms like Bubble sort, Merge sort, Heapsort, Quicksort, Lower Bounds for sorting, Counting sort, Radix sort, Bucket sort.	3	70	65
Outcome 5	Describe the concept of Trees- Binary tree, Binary search tree, Hash tables, Heaps.	3	70	65
Outcome 6	Knowledge on Graphs- Representations of graphs, Breadth-first search, Depth-first search, Minimum spanning trees, shortest paths, Topological sort.	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 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	-	-	-	-	-	-	3	3	3	3
Outcome 4	3	3	3	3	2	-	-	-	-	-	-	2	3	3	3
Outcome 5	3	3	3	3	2	-	-	-	-	-	-	3	3	3	3
Outcome 6	3	3	3	3	2	-	-	-	-	-	-	3	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		**12**		**1,2**
	Data Structures	4	1	1,2
	Arrays, linked lists	4	1	1,2
	Stacks and Queues	4	1	1,2
Unit 2		**12**		
	Introduction to algorithms	4	2,3	1,2
	The role of algorithms in computing	4	2,3	1,2
	Asymptotic notation, Standard notations and Common functions, Recurrences	4	2,3	1,2
Unit 3		**12**		
	Searching Algorithms: Linear search, Binary search and Hashing	3	4	1,2
	Sorting algorithms like Bubble Sort,	3	4	1,2
	Merge sort, Heapsort, Quicksort,	3	4	1,2
	Lower Bounds for sorting, Counting sort, Radix sort,	3	4	1,2
Unit 4		**12**		
	Trees- Binary tree	6	5	1,2
	Hash tables, Heaps	6	5	1,2
Unit 5		**12**		
	Representations of graphs	3	6	1,2
	Breadth-first search, Depth-first search	3	6	1,2
	Minimum spanning trees	2	6	1,2
	Shortest paths	2	6	1,2
	Topological sort	2	6	1,2
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	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. E. Horowitz and S. Sahni, "Fundamentals of Data Structures", Publisher Computer Science Press, Second Edition, 2008

Other Resources

1. -

Course Designers

1. -

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

Applied Statistics

Course Code	MAT 431	**Course Category**	SE	**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)

- To understand the notion of statistical analysis like quality control time series, statistical design etc.
- 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	Apply statistical quality control	3	75%	70%
Outcome 2	Analyze time series	3	75%	70%
Outcome 3	Construct, classify and analyze index numbers	3	75%	70%
Outcome 4	Design experiments and ANOVA	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	1	-	-	-	-	-	-	-	3	2	2
Outcome 2	2	2	2	3	2	-	-	-	-	-	-	-	2	3	3
Outcome 3	2	2	2	2	2	-	-	-	-	-	-	-	2	3	3
Outcome 4	3	3	3	3	2	-	-	-	-	-	-	-	3	3	3
Average	**2**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Statistical quality control**	**14**		
	Introduction, basics and benefits of SQC	2	1	1,2
	Process control, product control	2	1	1,2
	Control charts, tools for SQC	3	1	1,2
	Control charts for attributes and variables	2	1	1,2
	Natural tolerance limits and specification limits	3	1	1,2
	Sampling inspection plan for attributes	2	1	1,2
Unit 2	**Time series**	**12**		
	Introduction and components of time series	2	2	1
	Analysis of time series, measures of trends	3	2	1
	Measurement of seasonal variation and cyclic variation	3	2	1
	Auto regression series	2	2	1
	Auto correlation and Correlogram and Random component in a time series	2	2	1
Unit 3	**Index Numbers**	**13**		
	Basics of index numbers	2	3	1
	Construction of index numbers , Criteria of a good index number	2	3	1
	Classification of index numbers	2	3	1
	Base shifting splicing and deflation of index numbers	3	3	1
	Index of industrial production	2	3	1
	use and limitation of index numbers	2	3	1
Unit 4	**Design of experiments**	**16**		
	Introduction to design of experiments	2	4	1
	Completely randomised design, Random block design	3	4	1
	Latin square design, Analysis of Covariance	3	4	1
	Missing plot techniques	2	4	1
	Factorial experiments, Confounding in factorial designs	2	4	1
	A 2^n-Factorial experiment in 2^k-block - blocks per replicate	2	4	1
	Split-plot design and Balanced block designs	2	4	1
Unit 5	**ANOVA**	**5**		
	Introduction	2	4	1
	One way and two way classifications	3	4	1
	Total Contact Hours	**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	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

Other Resources

1. -

Course Designers

1. -

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

Applied Linear Algebra

Course Code	MAT 432	**Course Category**	SE	**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)

- Introducing the theory and methods of applied linear algebra.
- To bring out the fundamental concepts and techniques that underlie the many ways in which linear algebra is used in 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	Know the fundamental subspaces of a vectors space and change of basis	2	80%	70%
Outcome 2	Analyse the applications of matrix factorization and structure of eigenspace of a matrix	2	80%	60%
Outcome 3	Apply the linear algebra to solve calculus problems	3	80%	70%
Outcome 4	Solve regression analysis and boundary value problems	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	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	**Fundamental Subspaces**	**8**		
	Review of basics of vector spaces and linear transformation	2	1	1
	Change of bases	2	1	1
	Rank-Nullity Theorem	2	1	1
	Rank Theorem for Column-Row spaces	2	1	1, 2
Unit 2	**Matrix Factorization and Spectral Theory**	**17**		
	Gaussian elimination, Gram-Schmidt orthogonalization,	3	2	1
	PLU decomposition Methods for eigenvalue computation	2	2	1
	Polar decomposition, Cholesky factorization	4	2	1
	Diagonalization, Spectral theorem	5	2	1
	Singular value decomposition	3	1, 2	1
Unit 3	**Special Topics**	**13**		
	Orthogonal projections	2	2	1,2
	Householder transformation, Bezier curves	4	3	1,2
	Fast Fourier Transform, Polynomial fit for bilinear interpolation	4	3	1,2
	Conjugate gradient method for minimization	3	3	1,2
Unit 4	**Matrix Inverse and Least Square**	**22**		
	Generalized inverses	4	4	1,2
	Linear support vector machines, Discrete Lyapunov equation	4	4	1,2
	Sylvester's equation, Algebraic Riccati equation for linear quadratic control	4	4	1,2
	Least-squares regression, Solving nonlinear system	5	4	1,2
	Solving discrete boundary value problems using implicit schemes.	5	4	1,2
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Stephen Boyd and Lieven Vandenberghe, Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares, Cambridge University Press, 2018.
2. Peter D Lax, Linear Algebra and Its Applications, Wiley-Interscience, 2nd Edition, 2007.

Other Resources

1. -

Course Designers

1. -

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

Financial Mathematics

Course Code	MAT 433	**Course Category**	SE	**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)

- To understand the notion of financial mathematics and its concepts
- 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	Apply the concept of interest types and rates	3	75%	70%
Outcome 2	Employ the basics of no arbitrage principle	2	75%	70%
Outcome 3	Demonstrate Black Schole model and option pricing	2	75%	70%
Outcome 4	Practice stochastic analysis of stock price prediction	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	3	3	3										2	1	2
Outcome 2	2	3	2										2	2	2
Outcome 3	2	2	2										3	2	3
Outcome 4	3	2	3										3	2	3
Average	**2**	**2**	**2**										**3**	**2**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1		**15**		
	Introduction and basics of interest rates and types of rates	5	1	1
	Measuring interest rates,bon pricing, forward rate duration	5	1	1
	Convexity exchange, derivations	5	1	1
Unit 2		**16**		
	Mechanics and properties of option no arbitrage principle	4	2	1
	Forward price for an investment, types of options	4	2	1
	Option positions and underlying assets	4	2	1
	Put Call parity and effect of dividends	4	2	1
Unit 3		**17**		
	Stochastic analysis of stock price prediction, black scholes model	5	3	1
	Lognormal properties of stock prices	4	3	1
	Distribution of rate of return and related topics	4	3	1
	Extension of risk neutral valuation to assets following GBM, Black−Scholes formula for European options.	4	3	1
Unit 4		**12**		
	Hedging Parameters, Trading Strategies and Swaps Hedging parameters (the Greeks: Delta, Gamma, Theta, Rho and Vega),	4	4	1,2
	Trading strategies involving options, Swaps, Mechanics of interest rate swaps, Comparative advantage argument	4	4	1,2
	Valuation of interest rate swaps, Currency swaps, Valuation of currency swaps.	4	4	1,2
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Hull, J. C., and Basu, S. (2010). Options, Futures and Other Derivatives (7th ed.). Pearson Education. New Delhi.
2. Luenberger, David G. (1998). Investment Science, Oxford University Press. Delhi.

Other Resources

1. -

Course Designers

1. -

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

Regression Analysis

Course Code	MAT 434	**Course Category**	SE	**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)

- Outline the fundamentals of linear, including ordinary least square methods and model validation using t, F, and p tests.
- Comprehend variance stabilising transformations and utilise Box-Cox methods and other transformation techniques to linearise models.
- Explain the components of Generalized Linear Models (GLM) and perform parameter estimation, inference, and prediction with GLMs.
- Implement variable selection and model-building techniques. Modelling of nonlinear models and understanding nonlinear least squares and parameter estimation in nonlinear systems.

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 the Ordinary Least Squares (OLS) method to construct and interpret simple linear regression models and validate and interpret regression models using t-tests, F-tests, and p-tests.	2	80%	70%
Outcome 2	Describe multiple regression models and assess model fit, address overfitting issues, and compare different regression models effectively.	2	75%	70%
Outcome 3	Identify and handle outliers, assess the lack of fit in regression models, address issues of autocorrelation and heteroscedasticity, and implement transformations on predictor variables.	3	70%	65%
Outcome 4	Employ the concepts of generalized linear models, including link functions, parameter estimation, and inference.	3	60%	60%
Outcome 5	Apply nonlinear regression methodologies, such as nonlinear least squares and parameter estimation, in nonlinear systems and conduct statistical inference.	3	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	3	2	2	2	2							2	3	1	1
Outcome 2	3	3	3	2	3							2	3	2	3
Outcome 3	3	3	3	2	3							3	3	2	3
Outcome 4	3	3	2	3	2							2	2	3	3
Outcome 5	3	2	1	2	2							2	3	2	1
Average	**3**	**3**	**2**	**2**	**2**							**2**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1: Simple Regression Analysis		**8**		
	Introduction to a linear and nonlinear model. Ordinary Least Square methods.	2	1	1,3
	Fitting a linear trend to time series data	2	1	1,3
	Validating simple regression model using t, F, and p test.	2	1	1,3
	Developing confidence interval. Precautions in interpreting regression results.	1	1	1,3
	Discussion and Tutorial-I	1	1	1,3
Unit 2: Multiple Regression Analysis		**11**		
	Concept of Multiple regression model to describe a linear relationship.	2	1,2	1,3
	Assessing the fit of the regression line, inferences from multiple regression analysis.	2	1,2	1,3
	The problem of overfitting and underfitting of a model,	2	2	1,3
	Comparing two regression models, prediction with multiple regression equation.	2	2	1,3
	Application of multiple regression in different sectors such as finance and biology.	2	2	1,3
	Discussion and problem-solving.	1	2	1,3
Unit 3: Fitting Curves and Model Adequacy Checking		**11**		
	Introduction, fitting curvilinear relationship, residual analysis.	2	2	1,4
	PRESS statistics, detection, and treatment of outliers.	2	2	1,4
	Lack of fit of the regression model, test of lack of fit.	2	2	1,4
	Problem of autocorrelation and heteroscedasticity.	2	2,3	1,4
	Estimation of pure errors from near neighbours.	2	2,3	1,4
	Discussion and Tutorial	1	2.3	1,4
Unit 4: Transformation techniques		**9**		
	Introduction of variance stabilising transformations.	2	3	1,4
	Transformations to linearise the model.	2	3	1,4
	Box-Cox methods, transformations on the repressor's variables.	2	3	1,4
	Generalised and weighted least squares and some practical applications.	2	3	1,4
	Tutorial	1	3	1,4
Unit 5: Generalized Linear Models		**10**		
	Link functions and linear predictors.	2	4	1,2
	Parameter estimation and inference in the GLM.	2	4	1,2
	Prediction and estimation with the GLM.	2	4	1,2
	Residual Analysis and concept of overdispersion.	2	4	1,2
	Applications and problem discussion.	2	4	1,2
Unit 6: Model Building and Nonlinear Regression		**11**		
	Variable selection, model building, model misspecification.	2	5	1,2
	Model validation techniques: Analysis of model coefficients and predicted values, data splitting method.	2	5	1,2
	Nonlinear regression model and nonlinear least squares,	2	5	1,4
	Transformation to the linear model and parameter estimation in a nonlinear system.	2	5	1,4
	Statistical inference in nonlinear regression.	2	5	1,4
	Discussion and Tutorial	1	5	1,2,4
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining, Introduction to Linear Regression Analysis, Third Ed., Wiley India Pvt. Ltd., 2016.
2. Norman R. Draper, Harry Smith; Applied Regression Analysis, WILEY India Pvt. Ltd. New Delhi; Third Edition, 2015.
3. Johnson, R A., Wichern, D. W., Applied Multivariate Statistical Analysis, Sixth Ed., PHI Learning Pvt., Ltd., 2013.
4. Iain Pardoe, Applied Regression Modelling, John Wiley and Sons, Inc 2012

Other Resources

1. -

Course Designers

1. -

SRM University *AP*, Andhra Pradesh

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

Stochastic Process and Stochastic Differential Equations

Course Code	MAT 435	Course Category	SE	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)

- Define and classify stochastic processes based on state and parameter spaces. Differentiate between various types of stochastic processes. Analyse Markov chains using transition probability matrices and Chapman-Kolmogorov equations.
- Study renewal processes, renewal theorems, and their applications. Analyse branching processes and determine probabilities of extinction. Understand weakly and strongly stationary processes, moving averages, and autoregressive processes.
- Understand Riemann-Stieltjes and Lebesgue integrals. Study Ito integrals for simple and general processes, along with their properties. Understand Brownian motion as a limit of random walk.
- Understand properties, convergence, and applications of martingales, particularly in finance. Solve problems related to stochastic and stochastic integral equations. Explore applications of stochastic differential equations in finance.

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 probability spaces, understanding their axiomatic foundations. Discuss the various modes of convergence in sequences of random variables and law of large number.	2	70%	65%
Outcome 2	Solve problems using transition probability matrices and Chapman-Kolmogorov equations. Identify and classify states within Markov chains, ergodicity and stationary distributions.	2	70%	65%
Outcome 3	Describe renewal theorems and fundamental renewal theorems in various scenarios. Evaluate cost/rewards associated with renewals and branching processes. Differentiate between weakly and strongly stationary processes.	2	70%	65%
Outcome 4	Illustrate Riemann-Stieltjes and Lebesgue integrals and their properties. Application of Stochastic Calculus through Brownian motion. Interpret multivariate stochastic calculus and its applications.	3	70%	65%
Outcome 5	Solve problems related to stochastic and stochastic integral equations. Apply the concept of stochastic differential equations and martingales to solve the problems related to finance.	3	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	2	2	2							3	3	1	1
Outcome 2	3	3	3	2	3							2	3	2	3
Outcome 3	3	3	3	2	3							3	3	2	3
Outcome 4	3	3	2	3	2							2	2	3	3
Outcome 5	3	2	1	2	2							2	3	2	1
Average	**3**	**3**	**2**	**2**	**2**							**2**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact hours	CLOs Addressed	Reference Used
Unit 1	**Probability Theory Revision and Introduction to Stochastic Processes (SPs)**	**10**		
	Axiomatic construction of probability spaces, random variables, vectors, and distributions.	2	1	1,2
	Functions of random variables, expectations, transforms and generating functions.	2	1	1,2
	Modes of convergence of sequences of random variables, laws of large numbers and central limit theorem.	2	1	1,2
	Definition and examples of SPs, classification of random processes according to state space and parameter space, types of SPs.	2	1	1,2
	Discussion and Tutorial-I	2	1	1,2
Unit 2	**Discrete-time and Continuous-time Markov Chains (MCs)**	**11**		
	Definition and examples of MCs, transition probability matrix,	2	2	1,2
	Chapman-Kolmogorov equations; calculation of n-step transition probabilities, limiting probabilities,	2	2	1,2
	Classification of states, ergodicity, stationary distribution, transient MC;	2	2	1,2
	Random walk and gambler's ruin problem	2	2	1,2
	Kolmogorov-Feller differential equations, and Poisson process, birth-death process	2	2	1,2
	Applications to queueing theory and communication networks, inventory analysis, and application in finance and biology.	1	2	1,2
Unit 3	**Renewal Processes, Branching Processes and Stationary Processes**	**11**		
	Renewal function and its properties, elementary and fundamental renewal theorems.	2	3	3,4
	Markov renewal and regenerative processes, renewal theorems, cost/rewards associated with renewals, and applications of Markov regenerative processes.	2	3	3,4
	Definition and examples of branching processes, probability generating function, mean and variance,	2	3	3,4
	Galton-Watson branching process, probability of extinction.	1	3	3,4
	Weakly stationary and strongly stationary processes, moving average and autoregressive processes.	3	3	3,4
	Discussion and Tutorial	1	3	3,4
Unit 4	**Stochastic Calculus**	**10**		
	The notion of Riemann-Stieltjes and Lebesgue integral, Ito Integral for simple processes and their properties	2	4	4,5
	Integration of Non-random process concerning Brownian motion,	2	4	4,5
	Ito Integral for general processes, Properties of Ito Integral,	1	4	4,5
	Ito's formula for Brownian motion, Ito diffusion, Ito's formula for Ito Diffusion,	2	4	4,5
	Multivariate Stochastic Calculus	2	4	4,5
	Tutorial	1	4	4,5
Unit 5	**Stochastic Calculus**	**12**		
	Wiener process as a limit of random walk stochastic,	2	5	3,5
	Process derived from Brownian motion, first passage time and other problems,	2	5	3,5
	Stochastic Differential equation,	2	5	3,5
	Stochastic integral equation	2	5	5
	Some important SDEs and their solutions,	2	5	5
	Applications to finance.	2	5	5,6
Unit 6	**Martingales**	**6**		
	Conditional expectations, definition, and examples of martingales.	2	5	2,5
	Inequality, convergence, and smoothing properties	2	5	2,5
	Discussion and applications	1	5	2,5,6
	Tutorial and Q&A	1	5	1,2,5
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. J. Medhi, Stochastic Processes, 3rd Edition, New Age International, 2009.
2. S.M. Ross, Stochastic Processes, 2nd Edition, Wiley, 1996.
3. S Karlin and H M Taylor, A First Course in Stochastic Processes, 2nd edition, Academic Press, 1975.
4. G. R. Grimmett and D. R. Stirzaker, Probability and Random Processes, 3rd Edition, Oxford University Press, 2001.
5. H.M. Taylor and S. Karlin, An Introduction to Stochastic Modeling, 3rd Edition, Academic Press, New York, 1998.
6. P. E. Kloeden, and E. Platen, Numerical Solution of Stochastic Differential Equations, Springer, 1992.

Other Resources

1. -

Course Designers

1. -

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

Mathematics for Machine Learning

Course Code	MAT 436	**Course Category**	SE	**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)

- Understand essential mathematical concepts like linear algebra, calculus, and probability theory to analyze and implement machine learning algorithms effectively.
- Learn statistical tools and techniques for analyzing data, evaluating model performance, and making informed decisions in machine learning tasks.
- Master optimization techniques essential for training and fine-tuning machine learning models to achieve optimal performance.
- 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.	1,5	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.	3	90%	90%
Outcome 3	Utilize optimization techniques to train machine learning algorithms effectively, including gradient-based optimization methods and advanced optimization algorithms.	3	70%	70%
Outcome 4	Implement and evaluate artificial neural networks (ANNs) and deep learning architectures for various machine learning tasks, including image classification, sequence prediction, and generative modeling.	4	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	**Mathematical Foundations for Machine Learning**	**15**		**1**
	Introduction to mathematical notation and its importance in machine learning.	2	1	
	Algebraic concepts in machine learning: variables, equations, and functions.	2	1	
	Basics of calculus: derivatives and their role in optimization.	2	1	
	Further calculus concepts: integration and its application in probability.	2	1	
	Introduction to linear algebra: vectors and matrices.	2	1	
	Matrix operations and their applications in machine learning.	1	1	
	Eigenvalues and eigenvectors in machine learning.	1	1	
	Introduction to linear regression and its mathematical foundation.	1	1	
	Principal Component Analysis (PCA) for dimensionality reduction.	1	1	
	Review and Q&A session.	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	
	Statistical inference techniques: hypothesis testing and confidence intervals.	3	2	
	Bayesian statistics in machine learning: concepts and applications.	3	2	
	Model evaluation metrics in machine learning.	2	2	
	Feature selection techniques based on statistical analysis.	2	2	
	Uncertainty estimation using Bayesian inference.	2	2	
	Applications of probability and statistics in machine learning: case studies.	2	2	
	Review and Q&A session.	1		
Unit 3	**Optimization Methods for Machine Learning**	**13**		3
	Introduction to optimization: objectives, constraints, and optimality conditions.	2	3	
	Gradient-based optimization techniques: gradient descent and its variants.	2	3	
	Advanced optimization algorithms: momentum, AdaGrad, Adam.	1	3	
	Challenges in convex and non-convex optimization in machine learning.	2	3	
	Training neural networks using gradient descent.	2	3	
	Hyperparameter tuning techniques: grid search and Bayesian optimization.	1	2,3	

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
	Model selection criteria and techniques.	1	2,3	
	Applications of optimization methods in machine learning: case studies.	1	3,4	
	Review and Q&A session.	1		
Unit 4	**Artificial Neural Networks (ANNs) and Deep Learning**	**14**		**4**
	Introduction to Artificial Neural Networks (ANNs): architecture and components.	1	4	
	Activation functions and their role in ANNs.	1	4	
	Training ANNs: backpropagation algorithm and loss functions.	1	4	
	Optimizing ANNs using various optimization algorithms.	2	4	
	Introduction to Convolutional Neural Networks (CNNs) and their architecture.	2	4	
	Applications of CNNs in image classification tasks.	2	4	
	Introduction to Recurrent Neural Networks (RNNs) and their architecture.	1	4	
	Applications of RNNs in sequence prediction tasks.	1	4	
	Advanced topics in deep learning: attention mechanisms, GANs.	1	4	
	Applications of ANNs and deep learning in machine learning: case studies.	1	**4**	
	Review and Q&A session.	1		
Total Contact Hours		**60**		

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 (15%)	
Level 1	Remember	60%	50%	60%	40%	40%
	Understand					
Level 2	Apply	40%	50%	40%	60%	60%
	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

Course Designers

1.