Department of Mathematics

B.Sc. (Hons.) Mathematics
Curriculum and Syllabus

(Applicable to the students admitted during AY: 2022-23)

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)		2	60
University AEC	0		
School AEC	2		
Value Added Courses (VAC)		4	120
University VAC	4		
School VAC	0		
Skill Enhancement Courses (SEC)		14	420
School SEC	4		
Department SEC	4		
SEC Elective	6		
Foundation / Interdisciplinary courses (FIC)		28	840
School FIC	28		
Department FIC	0		
Core + Core Elective including Specialization (CC)		80	2400
Core	56		
Core Elective (Inc Specialization)	24		
Minor (MC) + Open Elective (OE)	15	15	450
Research / Design / Internship/ Project (RDIP)		16	480
Internship / Design Project / Startup / NGO	4		
Internship / Research / Thesis	12		
Total		**159**	**4770**

Semester wise Course Credit Distribution Under Various Categories										
Category	**Semester**									
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**	**%**
Ability Enhancement Courses - AEC	0	0	2	0	0	0	0	0	2	1
Value Added Courses - VAC	0	0	0	0	0	4	0	0	4	3
Skill Enhancement Courses - SEC	1	3	2	2	3	3	0	0	14	9
Foundation / Interdisciplinary Courses - FIC	20	8	0	0	0	0	0	0	28	18
CC / SE / CE / TE / DE / HSS	0	16	12	12	16	12	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	4	12	16	10
Grand Total	**21**	**27**	**19**	**17**	**22**	**22**	**19**	**12**	**159**	**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	SEC	S SEC	ISES 101	Industry Specific Employability Skills – I	0	0	1	1
2	FIC	S FIC	MAT 104	Introduction to Mathematics	4	0	0	4
3	FIC	S FIC	BIO 114	A Primer to Biology	3	0	0	3
4	FIC	S FIC	BIO 114L	Practical Biology	0	0	1	1
5	FIC	S FIC	PHY 103	Introduction to Physics	3	0	0	3
6	FIC	S FIC	PHY 103L	Introduction to Physics Laboratory	0	0	1	1
7	FIC	S FIC	CHE 115	Introduction to Chemistry	3	1	0	4
8	FIC	S FIC	CSC 108	Introduction to Computer Science and programming using C	3	0	0	3
9	FIC	S FIC	CSC 108L	Introduction to Computer Science and programming using C Lab	0	0	1	1
				Semester Total	**16**	**1**	**4**	**21**

SEMESTER - II								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	FIC	S FIC	ENV 100	Introduction to Environmental Science	4	0	0	4
2	FIC	S FIC	EGL 100	Introduction to communicative English	4	0	0	4
3	SEC	S SEC	ISES 102	Industry Specific Employability Skills – II	1	0	0	1
4	SEC	S SEC	RM 100	Introduction to Research	1	0	0	1
5	SEC	S SEC	ENTR 100	Exploratory learning and discovery	1	0	0	1
6	Core	CC	MAT 150	Real analysis - I	4	0	0	4
7	Core	CC	MAT 152	Linear Algebra	4	0	0	4
8	Core	CC	MAT 153	Algebra – I	4	0	0	4
9	Core	CC	MAT 160	Discrete Mathematics and Combinatorics	4	0	0	4
				Semester Total	**27**	**0**	**0**	**27**

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	0	0	2	2*
4	SEC	D SEC	SEC 102	Digital literacy	1	0	1	2
5	Core	CC	MAT 201	Complex Analysis	3	1	0	4
6	Core	CC	MAT 202	Real Analysis - II	3	1	0	4
7	Core	CC	MAT 203	Ordinary Differential Equations - I	3	1	0	4
8	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**14**	**3**	**2**	**19**

SEMESTER - IV								
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	0	0	2	2*
3	SEC	D SEC	SEC 107	Mathematical Modelling for Physical Data	2	0	0	2
4	Core	CC	MAT 204	Probability and Statistics	3	1	0	4
5	Core	CC	MAT 205	Numerical Analysis	3	1	0	4
6	Core	CC	MAT 207	General Topology	3	1	0	4
7	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**14**	**3**	**0**	**17**

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	0	0	2	2*
3	SEC	E SEC		Career Skills - I	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	Measure Theory	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	**18**	**4**	**0**	**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		Career Skills - II	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	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**16**	**3**	**3**	**22**

SEMESTER - VII								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	SE		Specialization Elective	3	1	0	4
2	Elective	SE		Specialization Elective	3	1	0	4
3	Elective	SE		Specialization Elective	3	1	0	4
4	Elective	OE		Open Elective / Minor	3	0	0	3
5	RDIP	RDIP	MAT 401	Internship	0	0	4	4
				Semester Total	**12**	**3**	**4**	**19**

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 412	Advanced Linear Algebra	3	1	0	4
2	Elective	CE	MAT 421	Algebra - II	3	1	0	4
3	Elective	CE	MAT 422	Functional Analysis	3	1	0	4
4	Elective	CE	MAT 423	Algebraic Topology	3	1	0	4
5	Elective	CE	MAT 424	Algebra - III	3	1	0	4
6	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	CE	MAT 411	Optimization techniques	3	1	0	4
2	Elective	CE	MAT 426	Mechanics and Tensor Calculus	3	1	0	4
3	Elective	CE	MAT 428	Ordinary Differential Equations - II	3	1	0	4
4	Elective	CE	MAT 429	Partial Differential Equation - II	3	1	0	4
5	Elective	CE	MAT 430	Dynamical Systems	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	CE	MAT 431	Applied Statistics	3	1	0	4
2	Elective	CE	MAT 432	Applied Linear Algebra	3	1	0	4
3	Elective	CE	MAT 433	Financial Mathematics	3	1	0	4
4	Elective	CE	MAT 434	Regression analysis	3	1	0	4
5	Elective	CE	MAT 435	Stochastic process and Stochastic Differential Equations	3	1	0	4
6	Elective	CE	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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Industry Standard Employability Skills – I

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

Course Objectives / Course Learning Rationales (CLRs)

1. Gain the ability to work in a team and learn leadership skills.
2. Gain the ability to be a leader who can cope up with the challenges, risks, and change management.
3. Gain the ability to understand and be professionals with idealistic practical and moral values.
4. Gain ability to acquire decision making skills in different situations.

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	Recognise the leadership skills for teamwork.	1	70%	60%
Outcome 2	Demonstrate the ability to cope up with changes and challenges.	3	80%	70%
Outcome 3	Manage stress and control emotions.	3	70%	60%
Outcome 4	Apply decision making and problem-solving skills to given scenarios.	3	90%	80%

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

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	COs Addressed	References Used
Unit 1	**Interpersonal skills**	**9**		
	Understanding the relationship between Leadership Networking and Teamwork, Realizing Ones Skills in Leadership	3	1,2	1,2
	Networking & Teamwork and Assessing Interpersonal Skills Situation description of Interpersonal Skill.	3	1,4	1,3
	Teamwork Necessity of Team Work Personally, Socially and Educationally.	3	1,4	1,3
Unit 2	**Leadership**	**9**		
	Skills for a good Leader, Assessment of Leadership Skills	3	1,2	1,2
	Change Management, Exploring Challenges	3	1,3	1,2
	Risking Comfort Zone, Managing Change	3	1,3	1,3
Unit 3	**Stress management**	**9**		
	Causes of Stress and its impact, how to manage & distress, Understanding the circle of control, Stress Busters.	3	2,3	3,4
	Emotional Intelligence What is Emotional Intelligence, emotional quotient	3	2,3	3,4
	why Emotional Intelligence matters, Emotion Scales. Managing Emotions.	3	2,3	3,4
Unit 4	**Conflict resolution**	**9**		
	Conflicts in Human Relations	3	1,4	2,3
	Reasons Case Studies	3	4	2,3
	Approaches to conflict resolution	3	1,4	2,3
Unit 5	**Decision making**	**9**		
	Importance and necessity of Decision Making	3	1,4	1,4
	process of Decision Making	3	1,4	1,4
	Practical way of Decision Making, Weighing Positives & Negatives.	3	2,4	1,4
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments Unit 50 %								End Semester Exam Unit 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. Covey Sean, Seven Habit of Highly Effective Teens, New York, Fireside Publishers, 1998.
2. Carnegie Dale, How to Win Friends and Influence People, New York: Simon& Schuster, 1998.
3. Thomas A Harris, I am ok, you are ok, New York-Harper and Row, 1972
4. Daniel Coleman, Emotional Intelligence, Bantam Book, 2006.

Other Resources

Course Designers

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

Introduction to Mathematics

Course Code	MAT 104	**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)

1. To firm up the language of mathematics, primarily the notion of sets, functions, sequences.
2. To understand polynomials, solving simultaneous linear equations, exponential and logarithmic functions.
3. To learn to count the outcomes of permutations and combinations, appreciate the importance of mathematical modelling and data analysis.
4. To understand spatial representation, the connection between geometry and algebra, notions such as symmetry.
5. To learn the basics of calculus.

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	Write mathematical arguments logically and use the symbol system that is in use universally	3	90%	75%
Outcome 2	Solve problems involving a system of simultaneous linear equations, quadratic polynomials, and other simple algebraic equations algebraically and graphically	3	75%	65%
Outcome 3	Compute the permutations and combinations, sort and arrange data and do elementary data analysis	3	75%	65%
Outcome 4	Differentiate and integrate simple functions and apply their knowledge	3	75%	65%

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

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Numbers Sets and Number Systems**	**14**		
	A brief history of numbers and numeration systems, number base, place value notation, zero as a number	2	1	1,2
	Base 10 and algorithmizablility of the four basic operations, counting and counting numbers, measurement, ratio-proportions and fractions, commensurability, and irrationality	2	1	1,2
	The language of sets- notation, subsets, union, intersection, complementation, powerset of a set, finite and infinite sets	2	1	1,2
	Functions- one-one, onto, one-to-one correspondence, inverse of a function, operations on functions	2	1	1,2
	Natural numbers, integers, rational, real, and complex number systems, representation on the number line, complex plane	2	1	1,2
	Number patterns, Arithmetic, and geometric progressions	2	1	1,2
	Sequences including Fibonacci and series, summability	2	1	1,2
Unit 2	**Algebraic Thinking**	**12**		
	Representing unknowns and variables, arithmetic on symbols, turning sentences into algebraic expressions	2	2	1,2
	Polynomial expressions, degree of a polynomial, polynomial equations, factorizing polynomials,	2	2	1,2,
	Algebraic equations, identities, inequalities, graphical representation of polynomials, roots of a polynomial, solving quadratic equations in one variable	3	2	1,2
	solving linear equations in 2 or 3 variables,	2	2	1,2,
	Factor and remainder theorem, Some fascinating examples from history. Polynomial, exponential, logarithmic, and rational functions.	3	2	1,2
Unit3	**Spatial Understanding**	**12**		
	A brief look at Euclidean and other geometries, Descartes and the Cartesian coordinate system,	2	2	1,2
	coordinate geometry and algebraic representation of some familiar geometrical objects;	2	2	1,2
	solving polynomial equations- a geometric perspective,	3	2	1,2
	Trigonometry, and trigonometric functions	3	2	1,2
	Symmetries of polygons	2	2	1,2
Unit4	**Mathematical Modelling and Data Analysis**	**14**		
	Permutations and Combinations	4	3	1,2
	Elementary graph theory and some famous problems,	2	3	1,2
	Data, Sorting and representing data as tables and pictograms,	2	3	1,2
	Measures of central tendency: Mean, median, mode, Variations and standard deviation,	4	3	1,2
	Mathematical Models and Constructing mathematical models	2	3	1,2
Unit5	**Calculus: An Introduction**	**8**		
	Derivative of polynomial, exponential and trigonometric functions	2	4	1,2
	Applications of derivative, ,	2	4	1,2
	Integration of a function	2	4	1,2
	Applications of integration	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 20%	Mid-1 15%	CLA-2 10%	CLA-3 15%	
Level 1	Remember	70%	50%	70%	70%	30%
	Understand					
Level 2	Apply	30%	50%	30%	30%	70%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. An Introduction to Mathematics by A. N. Whitehead, Williams and Norgate Henry Holt and Co., New York.
2. Introduction to The Foundations of Mathematics, By Raymond L. Wilder, Dover Publications, Inc. Mineola, New York.

Other Resources

Course Designers

1. Sazzad Ali Biswasand Jayasree Subramanian

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

A Primer to Biology

Course Code	BIO 114	**Course Category**	CC		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Biological Science	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Understanding the importance of studying biology and the evolution of complex biomolecules and life on Earth provides a foundation for engineers to appreciate the biological principles and systems that underpin many engineering applications.
2. Understanding the structure, function, and significance of biomolecules allows engineers to understand how these fundamental building blocks of life contribute to biological processes.
3. Explaining the structure and function of prokaryotic and eukaryotic cells and understanding the diversity of life.
4. Understanding membrane transport processes, cellular respiration, energy generation, photosynthesis, enzymes, vitamins, and hormones equips engineers with the knowledge of how energy and molecules are processed and utilized within cells, which is essential for designing and optimizing engineered systems.
5. Understanding the structure and organization of DNA and chromosomes and comprehending the central dogma of DNA replication, transcription, and translation provides engineers with a fundamental understanding of genetic information, enabling them to work on genetic engineering, synthetic biology, and other biotechnology applications.
6. Understanding the processes of cell division, understanding mutations, cancer, and genetic diseases gives engineers insights into the genetic basis of diseases and the potential for developing therapeutic interventions or engineering solutions in the field of healthcare and biomedicine.
7. Comprehending the principles and applications of genomics, transcriptomics, proteomics, and metabolomics allows engineers to leverage large-scale biological data to inform design and optimization of engineered biological systems or develop innovative bioinformatics tools and technologies.
8. Applying the knowledge of biological sequences and databases for analyzing biological data empowers engineers to navigate and extract meaningful insights from vast amounts of biological information, enabling them to contribute to areas such as precision medicine, drug discovery, and biotechnology research and development.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain the importance of studying biology and the evolution of complex biomolecules and life on Earth.	2	80%	75%
Outcome 2	Describe the structure, function, and significance of biomolecules, including carbohydrates, lipids, nucleic acids, and proteins.	2	80%	70%
Outcome 3	Explain the structure and functions of prokaryotic and eukaryotic cells, including organelles, and recognize the diversity of life.	2	80%	70%
Outcome 4	Describe membrane transport processes, cellular respiration, energy generation, photosynthesis, enzymes, vitamins, and hormones.	2	75%	70%
Outcome 5	Describe the structure and organization of DNA and chromosomes, and comprehend the central dogma of DNA replication, transcription, and translation.	2	75%	70%
Outcome 6	Explain the processes of cell division (mitosis and meiosis) and understand the concepts of mutations, cancer, and genetic diseases.	2	75%	70%
Outcome 7	Explain the principles and applications of genomics, transcriptomics, proteomics, and metabolomics.	2	80%	75%
Outcome 8	Explain the concept of biological sequences and databases, including the use of tools such as BLAST and protein/Gene ID conversion, for analysing biological data.	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	1	-	5	-	-	-	2	-	-	3	2	6	3	1	2
Outcome 2	2	3	-	-	-	-	2	3	-	3	2	-	3	2	2
Outcome 3	2	3	-	-	-	-		3	3	-	2	-	3	2	2
Outcome 4	2	3	-	4	-	-	3	2	-	3	2	2	3	2	2
Outcome 5	2	3	-	-	-	-	-	3	3	-	2	3	3	2	2
Outcome 6	2	3	5	-	-	-	4	3	4	2	2	-	3	1	2
Outcome 7	2	3	-	-	5	-	3	3	3	3	2	3	3	2	2
Outcome 8	2	3	-	-	-	3	-	-	3	3	2	2	3	2	2
Average	**2**	**3**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Life: Origin, composition and chemistry**	**5**		
	Origin of complex Biomolecules and primitive cells	1	1, 2	1, 2, 3
	Chemical basis of life	1	1, 2	1, 2, 3
	Importance of carbon - synthesis by polymerization; importance of self assembly;	1	1, 2	1, 2, 3
	Importance of Water- synthesis by polymerization; importance of self assembly;	1	1, 2, 5	1, 2, 3
	Selectively permeable membranes	1	1, 2	1, 2, 3
Unit 2	**Cell Biology**	**12**		
	Prokaryotes and eukaryotes (cell structures and organelles);	2	1, 2, 3	1, 2, 3
	Virus- lysogenic and lytic cycles;	3	1, 2, 3	1, 2, 3
	Bacteria- typical bacterial cells, bacterial gene transfer- conjugation, transformation, and transduction	3	1, 2, 3	1, 2, 3
	Antibiotic resistance- an emerging threat; Microbiome	3	1, 2, 3	1, 2, 3
	Cell cycle- mitosis and meiosis.	1	1,2	1, 2, 3
Unit 3	**Energy harvesting reactions by life forms**	**10**		
	The importance of energy in biological systems; Gibbs free energy (Δ G);	2	1,3	1, 2, 3
	Biological reactions: Enzymes and their equilibrium constants (Keq);	2	1, 2	1, 2, 3
	Energy harvesting: Chemotrophic, Phototrophic;	2	1,2	1, 2, 3
	Metabolism: Glycolysis, anaerobic and aerobic cellular respiration.	2	1,2	1, 2, 3
	Fate of food in cellular energy cycle.	2	1,2	1, 2, 3
Unit 4	**Molecular Biology**	**9**		
	Structure of DNA and organization of chromosomes;	2	1-5	1, 2, 3
	Central dogma- replication, transcription, and translation in prokaryotes.	3	1-5	1, 2, 3
	Mutations, cancer and hereditary diseases.	2	1-5	1, 2, 3
	Introduction to genetic manipulation- concepts of restriction digestion, cloning	2	1-5	1, 2, 3
Unit 5	**Bioinformatics**	**9**		
	Biological sequences and evolution of sequencing technologies.	3	1,5	4
	Utilization of sequence information in personalized medicine and disease detection.	3	1,5	4
	Structural Biology: Biomolecular structures and their databases.	3	1,5	4
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments 50%				End Semester Exam 50%
		CLA-1 10%	Mid-1 15%	CLA-2 10%	CLA-3 15%	
Level 1	Remember	80%	90%	90%	50%	80%
	Understand					
Level 2	Apply	20%	10%	10%	50%	20%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	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
2. Life: The Science of Biology, 11th Edition (2017). David Sadava, David M. Hillis, H. Craig Heller, Sally D. Hacker. SINAUER ASSOCIATES MACMILLAN.

Other Resources

1. The Physiological Society (https://www.youtube.com/user/PhysocTV)

Course Designers

1. All Faculty Members, Department of Biological Sciences, SRM University – AP.

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

Practical Biology Lab

Course Code	BIO 114 L	**Course Category**	CC	**L**	**T**	**P**	**C**
				0	0	2	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Biological Sciences	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand and implement lab safety rules and proficiently handle micropipettes and pH meters for secure laboratory practices.
2. Develop skills in buffer preparation and gain familiarity with basic laboratory instruments, including microscopes, autoclaves, spectrophotometers, centrifuges, incubators, and laminar air-flow cabinets.
3. Master cell counting using a hemacytometer, enabling precise quantification of cell populations for diverse biological applications.
4. Acquire proficiency in growth media and plate preparation through demonstration and develop skills in culturing microorganisms from various sources, showcasing competence in microbiological techniques.

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 lab safety protocols and proficiently handle essential laboratory equipment, ensuring a secure working environment.	4	80%	75%
Outcome 2	Develop precision in using micropipettes and pH meters, successfully prepare buffers and growth media, and acquire skills in observing mitosis stages in onion root tips and thin plant specimens under a microscope.	3	70%	65%
Outcome 3	Gain competence in the operation and safety procedures of fundamental laboratory instruments, including microscopes, autoclaves, spectrophotometers, centrifuges, incubators, and laminar air-flow cabinets.	3	70%	65%
Outcome 4	Acquire practical expertise in culturing microorganisms from various sources (air, soil, coins, and skin), observe the preparation of growth media and plates through a demonstration, and master cell counting using a hemocytometer.	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	3	3	3	2	1	3	3	3	-	-	3	1	2
Outcome 2	3	2	3	3	3	2	1	3	3		-	-	3	2	2
Outcome 3	3	3	3	3	3	2	1	3	3	3	-	-	3	3	2
Outcome 4	3	2	3	3	3	2	1	3	3	3	-	-	3	3	2
Average	**3**	**2**	**3**	**3**	**3**	**2**	**1**	**3**	**3**	**3**	-	-	**3**	**2**	**2**

Course Unitization Plan

Exp No.	Description of Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Lab safety introduction Handling micropipettes and pH meter	5	1	1
2	Preparation of buffers; Introduction to basic instrumentation: microscope, autoclave, spectrophotometer, centrifuge, incubators, and laminar air-flow cabinets	5	2	1
3	Observing stages of mitosis in onion root tip. Observing thin specimens of plant samples under the microscope	5	3,4	1
4	Preparation of growth media and plates (demonstration)	5		
5	Culturing microorganisms from air, soil, coins, and skin	5	3,4	1
6	Cell counting using hemocytometer	5	3,4	1
Total Contact Hours		**30**		

Learning Assessment

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

Recommended Resources

1. Practical Biochemistry, Leininger

Other Resources

1. https://amrita.edu/course/biochemistry-practical/

Course Designers

1. Dr. Writoban Basu Ball, Associate Professor, Department of Biological Sciences, SRM University – AP.

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

Introduction to Physics

Course Code	PHY 103	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Physics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Knowledge on great scientific discoveries in modern physics.
2. To understand fundamental concepts of classical mechanics with practical pplications.
3. To understand fundamental concepts of electricity and magnetism with practical applications.
4. To understand fundamental concepts crystal physics with X-ray/electron diffraction methods.
5. To understand types of solids based on energy band diagram

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	Great discoveries in Physics 19 Century	2	70%	65%
Outcome 2	Explain and apply conservation of linear momentum and conservation of mechanical energy	2	70%	65%
Outcome 3	Understand and explain concepts magnetic ekectric field and electromagnetic field	3	70%	65%
Outcome 4	Explain concept of wave particle duality, Quantum Mechanics	3	70%	65%
Outcome 5	Explain basic concept of lattice and X-ray diffraction of crystalline materials	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	2	3	3	2	1	2	-	-	-	-	-	-	2	2	2
Outcome 2	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Outcome 3	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Outcome 4	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Outcome 5	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Average	**3**	**3**	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Great Discoveries in Physics**	**9**		
	Bremsstrahlung: Braking radiation	1	1	1,2
	Radioactivity	1	1	1,2
	Various models of atoms	1	1	1,2
	Light: Particle or Wave?	1	1	
	Radio waves and long-distance communication	1	1	1,2
	Raman effect and applications	1	1	1,2
	Concept of Ether: Michelson-Morley experiment	1	1	1,2
	Gravitational Waves	1	1	1,2
	Zero resistance and superconductivity	1	1	1,2
Unit 2	**Mechanics**	**9**		
	Scalars and vectors, their various products	1	1,2	1,2
	Newton's Laws of motion and kinematics	1	1,2	1,2
	Free body force diagrams and applications on Inclined plane motion	1	1,2	1,2
	Simple Pulley	1	1,2	1,2
	Problem solving, quiz and Group activities on kinematics	1	1,2	1,2
	Impulse and Average force	1	1,2	1,2
	Conservation of linear momentum	1	1,2	1,2
	Work Energy conservation, and application in bullet's motion	1	1,2	1,2
	Conservation of mechanical energy: Pendulum systems	1	1,2	1,2
Unit 3	**Electricity and magnetism**	**9**		
	Atoms, types of charge carriers and quantization	1	1,2,3	1,2
	Force between charges, electric field and electric lines of force	1	1,2,3	1,2
	Concept of electric potential and potential difference	1	1,2,3	1,2
	Current through a conductor and Ohm's law	1	1,2,3	1,2
	Force between two current carrying conductors	1	1,2,3	1,2
	Magnetic field and magnetic lines of forces and types of magnets	1	1,2,3	1,2
	Force on a charge due to electric and magnetic field	1	1,2,3	1,2
	Cyclotron motion	1	1,2,3	1,2
	Accelerated charged particles and electromagnetic wave (concept)	1	1,2,3	1,2
Unit 4	**Modern Physics**	**9**		
	Longitudinal and transverse waves, travelling wave	1	4	1, 2
	Electromagnetic waves and EM spectrum	1	4	1, 2
	Blackbody radiation, classical interpretation and Planck's hypothesis	1	4	1, 2
	Photoelectric effect and particle nature of wave	1	4	1, 2
	Wave properties of particles and de-Broglie hypothesis	1	4	1, 2
	Concept of Wave function	1	2,4	1, 2
	Probability, physical significance of wavefunction	1	1,2,4	1, 2
	Wavefunction, probability and energy of particle in a box with infinite potential (concept only)	1	1,2,4	1, 2
	Heisenberg's uncertainty principle	1	1,2,4	1, 2
Unit 5	**Crystal Physics**	**9**		
	Crystalline, amorphous and glassy phases	1	3,5	2, 3
	Concept of lattice and basis	1	3,5	2, 3
	Primitive unit cell, Bravais lattice, Symmetry elements and operations: rotation, reflection, inversion	1	3,5	2, 3
	in simple, face centered and body centered cubic lattices	1	3,5	2, 3
	Lattice planes and Miller indices	1	3,5	2, 3
	Bragg's law of X-Ray diffraction in crystal	1	3,5	2, 3
	Group activities on X-Ray diffraction methods	1	3,5	2, 3
	Energy band diagrams in metals, insulators and semiconductors	1	3,5	2, 3
	X-ray and Electron diffraction, their applications in solid state physics.	1	3,5	2, 3
Total Contact hours		**45**		

Learning Assessment

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

Recommended Resources

1. Physics for Scientist and Engineers - Raymond A. Serway, John W. Jewett, XIX Edition (2017), Publisher - Cengage India Private Limited
2. Concept of Modern Physics - Arthur Beiser, Shobhit Mahajan, S Rai, 2017 Edition, Publisher - Tata McGraw Hill

Other Resources

1. Introduction to Solid State Physics, 8th Edition Charles Kittel 8th edition Wiley India Pvt Ltd
2. K.G. Mazumdar and B. Ghosh, "Advanced Practical Physics" Sreedhar Publishers, Revised edition Jan 2004
3. R.K. Shukla and Anchal Srivastava, "Practical Physics" New Age international (P) limited Publishers, 2006 [ISBN(13) – 978-81-224-2482-9]

Course Designers

1. Dr Sabyasachi Mukhopadhyay, Assistant Professor, Dept. of Physics, SRM University - AP
2. Dr. Pranab Mandal, Assistant Professor, Dept. of Physics, SRM University - AP
3. Prof. Ranjit Thapa, Professor. Dept. of Physics. SRM University - AP
4. Prof. M. S. Ramachandra Rao, Professor, Department of Physics, Indian Institute of Technology, Madras
5. Prof. D. Narayana Rao, Raja Ramanna Fellow, University of Hyderabad

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Introduction to Physics Lab

Course Code	PHY 103L	**Course Category**	CC	**L**	**T**	**P**	**C**
				0	0	2	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	PHY 103	**Progressive Course(s)**			
Course Offering Department	Physics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Operate physics equipment and measurement tools.
2. Determine physical constants and fundamental materials properties in mechanics, electromagnetism, and optics.
3. To collect experimental data, analyse and graph plot.

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 basic equipment operation and analysis	2	70%	65%
Outcome 2	Compute time period, acceleration due to gravity, viscosity and spring constant	2	70%	65%
Outcome 3	Explain working principle of compound pendulum, spring and thermodynamic laws	3	70%	65%
Outcome 4	Verify basic laws of electromagnetism and optics using experimental results	3	70%	65%
Outcome 5	Plot graphs and analyse the experimental results	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	2	3	3	2	1	2	-	-	-	-	-	-	2	2	2
Outcome 2	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Outcome 3	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Outcome 4	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Outcome 5	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Average	**3**	**3**	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Exp. No.	Description of Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Compound Pendulum: Acceleration due to gravity and radius of gyration of the given pendulum	4	2	4, 5
2	Hooke's law and determination of spring constant for a given spring	2	2	4, 5
3	Biot-savart law: Dependence of magnetic field on the current and magnetic field variation along the axis of a current carrying circular loop	4	2	4, 5
4	Faraday law & Induced E.M.F: Measurement of the induced voltage and calculation of the magnetic flux induced by a falling magnet	2		
5	Verification of Stefan's Law of blackbody radiation	2	3	4, 5
6	Measurement of dielectric constant of air and a given object using parallel plate capacitor	4	3	4, 5
7	Photoelectric effect and Planck's Constant determination	4	4	4, 5
8	Spectral lines from Hydrogen discharge lamp: Balmer Series and Rydberg constant	4	4	4, 5
9	Powder X-Ray diffraction patterns of NaCl and KCl	4	5	4, 5
	Total contact hours	**30 Hours**		

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%		CLA-3 15%			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember		40%		40%		60%				50%
	Understand										
Level 2	Apply		60%		60%		40%				50%
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%				100%	

Recommended Resources

1. Laboratory manuals, SRM University – AP
2. R.K. Shukla and Anchal Srivastava, "Practical Physics" New Age international (P) limited Publishers, 2006 [ISBN(13) – 978-81-224-2482-9]

Other Resources

1. Physics for Scientist and Engineers - Raymond A. Serway, John W. Jewett, XIX Edition (2017), Publisher - Cengage India Private Limited
2. Concept of Modern Physics - Arthur Beiser, Shobhit Mahajan, S Rai, 2017 Edition, Publisher - Tata McGraw Hill

Course Designers

1. Dr Sabyasachi Mukhopadhyay, Assistant Professor, Dept. of Physics, SRM University - AP
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3. Prof. Ranjit Thapa, Professor. Dept. of Physics. SRM University - AP
4. Prof. M. S. Ramachandra Rao, Professor, Department of Physics, Indian Institute of Technology, Madras
5. Prof. D. Narayana Rao, Raja Ramanna Fellow, University of Hyderabad

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Introduction to Chemistry

Course Code	CHE 115	**Course Category**	FIC	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Chemistry	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To distinguish the types of bonding and predict the shape of the molecules using the valence shell electron pair (VSEPR) model and molecular orbital (MO) theory.
2. To classify the states of matter and discuss their behavior and properties.
3. To explain the redox reactions and demonstrate their applications in the electrochemical cells
4. To explain the classification, nomenclature, and electronic properties of organic compounds.
5. To describe the different types of organic reactions and their purification techniques.
6. To discuss the structures and the properties of carbohydrates, amino acids, proteins and vitamins, and nucleic acids and list the toxicity of the metals

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	Distinguish the types of bonding and predict the shape of the molecules using the valence shell electron pair (VSEPR) model and molecular orbital (MO) theory.	2	80%	85%
Outcome 2	Classify the states of matter and their behavior and properties	2	80%	80%
Outcome 3	Explain the redox reactions and demonstrate their application in the electrochemical cells.	3	80%	75%
Outcome 4	Classify electronic properties of organic compounds and reactions.	2	80%	70%
Outcome 5	Discuss the structures and the properties of carbohydrates, amino acids, proteins and vitamins, nucleic acids and can list the toxicity of the metals.	2	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	2	3	2	2	-	2	2	1	3	2	2	2	2	2	2
Outcome 2	2	2	2	1	-	2	2	1	1	3	2	2	2	2	2
Outcome 3	2	2	1	1	-	2	3	3	3	3	2	1	2	2	1
Outcome 4	2	3	2	2	-	2	2	1	3	2	2	1	2	2	3
Outcome 5	2	2	1	1	-	2	3	3	2	2	2	1	2	2	2
Average	**2**	**2**	**2**	**1**	-	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Chemical Bonding and Molecular Structure**	**8**		
	Importance and scope of chemistry (Central Science)	1	1	2
	Valence electrons, ionic bond, covalent bond, Hydrogen bond	1	1	2
	Valence bond theory	1	1	2
	The geometry of covalent molecules	1	1	
	VSEPR theory	1	1	2
	The concept of hybridization involving *s, p,* and *d* orbitals	1	1	2
	Shapes of some simple molecules	1	1	2
	Molecular orbital theory of homonuclear diatomic molecules (qualitative idea only)	1	1	2
	Tutorial 1	3	1	2
Unit 2	**States of Matter**	**12**		
	Three states of matter, intermolecular interactions Gases: The behavior of gases, changes in the volume of a gas with pressure; Boyle's law	1	2	1
	Change in volume of a gas with temperature; Charles's law	1	2	1
	Gay Lussac's law, Avogadro's law, Ideal gas law	1	2	1
	Empirical derivation of gas equation, Kinetic molecular theory	1	2	1
	Deviation from ideal gas law.	1	2	1
	Liquids – Liquid State – Vapour pressure, viscosity, and surface tension	1	2	1
	Introduction to solutions, different types of solutions	1	2	1
	Raoult's Law (change of state),	1	2	1
	Constant boiling mixtures (azeotropic mixtures (distillation)	1	2	1
	Nature and different types of solids including covalent, non-covalent ionic, and metallic solids	1	2	1
	Solids and their bonding, Band theory	1	2	1
	Application of crystalline materials in electronic devices.	1	2	1
	Tutorial 2	3	1	1
Unit 3	**Redox Reactions**	**8**		
	Concept of oxidation and reduction, redox reactions	1	3	2
	redox reactions	1	3	2
	Oxidation number, balancing redox reactions in terms of loss and gain of electron and change in oxidation numbers	1	3	2
	Applications of redox reactions	1	3	2
	Nomenclature applicable to electrochemical cells, viz., electromotive force, electrochemical series.	2	3	2
	Evolution of electrochemical cells: from voltaic cells to Li-ion battery	2	3	2
	Tutorial 3	3	3	2
Unit 4	**Basic Principles of Organic Chemistry**	**12**		
	General introduction, classification	1	4	3,4
	IUPAC nomenclature of organic compounds.	2	4	3,4
	Electronic displacements in a covalent bond	1	4	3,4
	Inductive effect, electrometric effect, resonance, and hyperconjugation	2	4	3,4
	Homolytic and heterolytic fission of a covalent bond	1	4	3,4
	Free radicals, carbocations, carbanions	1	4	3,4
	Electrophiles and nucleophiles	1	4	3,4
	Types of organic reactions	1	4	3,4
	Purification methods: Qualitative and quantitative analysis	2	4	3,4
	Tutorial 4	3	4	3,4
Unit 5	**Chemistry of Life**	**5**		
	Carbohydrates, Amino acids, peptide bonds	1	5	3,4
	Secondary and tertiary structures of proteins, enzymes, vitamins, Nucleic acids, bioinorganic chemistry	2	5	3,4
	Toxicity of heavy metals (Cu, Fe, As, Pb, Hg, Co, Cr, Cd, etc.),	2	5	3,4
	Tutorial 5	3	5	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 15%	CLA-3 10%	
Level 1	Remember	40%	60%	40%	60%	30%
	Understand					
Level 2	Apply	60%	40%	60%	40%	70%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Peter Atkins, & Paula, J. de. Elements of Physical Chemistry 7th Ed., Oxford University Press (2014).
2. Concise Inorganic Chemistry: J.D. Lee (1999) 5th edition, Blackwell Science.
3. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.

Other Resources

Course Designers

1. Dr. Mahesh Kumar Ravva, Asst. Professor, Dept. of Chemistry, SRM University – AP.
2. Dr. Pardha Saradhi Maram, Assoc. Professor, Dept. of Chemistry, SRM University – AP.

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

Introduction to Computer Science and Programming Using C

Course Code	CSC 108	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	0	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)

1. Gain basic knowledge in C programming language.
2. Acquire knowledge on Decision making and functions in C.
3. Learn arrays, strings and pointers concept in C.
4. Understand the basics concepts of Structures, Union and File handling techniques using C Programming.

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 C structures, enumerators, keywords, header files and operators	2	75%	70%
Outcome 2	Illustrate Decision-Making statements and Functions.	3	70%	65%
Outcome 3	Interpret arrays, strings, and pointers programming in C	3	70%	65%
Outcome 4	Apply Structures, unions, File handling operations on different scenarios	3	70%	65%
Outcome 5	Solve given projects based on C concepts	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	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.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**INTRODUCTION TO COMPUTER SCIENCE**	**9**	1	1
	Fundamentals of Computing, Historical perspective, Early computers	2	1	1,2
	Computing machine. Basic organization of a computer: ALU, input-output units, memory, program counter - variables and addresses - instructions: store, arithmetic, input and output	2	1	1,2
	Problem solving: Algorithm / Pseudo code, flowchart, program development steps	2	1	1,2
	Computer languages: Machine, symbolic and high-level langua Level languages	1	1	1,2
	Creating and Running Programs: Writing, editing (any editor), compiling (gcc)	1	1	1,2
	linking, and executing in Linux environment	1	1	1,2
Unit 2	**C PROGRAMMING BASICS**	**9**		
	Structure of a C program, identifiers Basic data types and sizes. Constan 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 conversion	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, examp 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
Unit 3	**FUNCTIONS AND ARRAYS**	**10**		
	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
Unit 4	**POINTERS**	**10**		
	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
Unit 5	**ENUMERATED, STRUCTURE AND UNION TYPES**	**7**		
	Structures - Declaration, definition, and initialization of structures, accessing structures	1	5	2, 3, 4
	nested structures, arrays of structures, structures and functions, pointers to structures,	1	5	2, 3, 4
	self-referential structures. Unions, typedef, bit-fields, program applications	2	5	2, 3, 4
	Bit-wise operators: logical, shift, rotation, masks.	1	5	2, 3, 4
	FILE HANDLING: Concept of a file, text files and binary files, formatted I/O, file I/O operations and example programs.	2	5	2, 3, 4
	Total Contact Hours	**45**		

Learning Assessment

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

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

Introduction to Computer Science and Programming using C Lab

Course Code	CSE 108L	**Course Category**	CC	**L**	**T**	**P**	**C**
				0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	CSC 108	**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Learn and understand C programming basics and paradigm.
2. Acquire knowledge on decision making and functions in C.
3. Acquire knowledge on decision making, loop concept, control statements, arrays, string and functions using C.
4. Learn basics of Structures, Union, and File handling concepts in C.

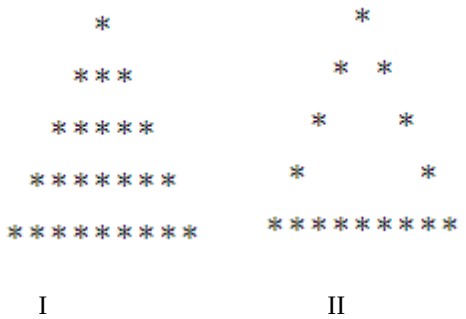
Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe fundamentals in C, enumerators, datatypes, vakeywords, header files and operators	2	75%	70%
Outcome 2	Illustrate Decision-Making statements and Functions.	3	70%	65%
Outcome 3	Interpret arrays, strings, and pointers programming in C	3	70%	65%
Outcome 4	Apply Structures, unions, File handling operations on different scenarios	3	70%	65%
Outcome 5	Solve given projects based on C concepts	4	70%	65%

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

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**INTRODUCTION TO COMPUTER SCIENCE**	**4**		
	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 2	**C PROGRAMMING BASICS**	**6**		
	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  I II	2	1,2	1,2
Unit 3	**FUNCTIONS AND ARRAYS**	**9**		
	Lab Experiment 6: **a)** (nCr) and (nPr) of the given numbers $1+x+x^2\backslash 2+x^3\backslash 3!+x^4\backslash 4!+\ldots\ldots\ldots X^n\backslash n!$	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 b. 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 4	**POINTERS**	**6**		
	Lab Experiment 10: a. Illustrate call by value and call by reference. b. Reverse a string using pointers Compare two arrays using pointers	2	3, 4	1,2,3
	Lab Experiment 11: a. Array of Int and Char Pointers. 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.	2	3, 4	1,2,3

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
	c. Towers of Hanoi			
Unit 5	**ENUMERATED, STRUCTURE AND UNION TYPES**	**4**		
	Lab Experiment 13: a. Reading a complex number b. Writing a complex number. c. Addition of two complex numbers Multiplication of two complex numbers	2	5	2, 3, 4
	Lab Experiment 14: a. File copy b. Word, line and character count in a file.	2	5	2, 3, 4
Total Hours		**29**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments 50%		End Semester Exam 50%	
		Lab Record 20%	Projects Presentations 30%	Lab Record 20%	Projects Presentations 30%
Level 1	Remember	70%	60%	30%	40%
	Understand				
Level 2	Apply	30%	40%	70%	60%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**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

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

Environmental Science

Course Code	ENV 100	**Course Category**	FIC	**L**	**T**	**P**	**C**
				4	0	0	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Environmental Science	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To study the scope of Environmental Science and the idea of sustainability.
2. To acquire basic knowledge of environmental ethics, critical environmental laws, and policies.
3. To explore various sources and challenges in the renewable energy sector in replacing conventional 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	Recognise the scope and purview of Environmental Science, the Idea of sustainability, environmental ethics, and global efforts to overcome the hindrance for sustainability.	2	80%	70%
Outcome 2	Interpret the environmental laws and policies.	3	80%	70%
Outcome 3	Investigate climate change, the way it affects life at different scales (global, regional, and local scales), and various mitigation strategies.	2	70%	60%
Outcome 4	Analyse the extent of environmental pollution and pollution reduction strategies through and resource optimization, renewable energy, and waste management.	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	-	-	-	1	-	3	1	1	-	1	1	-	-	-
Outcome 2	1	-	1	-	1	-	3	-	1	-	1	1	-	-	-
Outcome 3	1	-	-	-	1	-	3	-	1	-	1	1	-	-	-
Outcome 4	1	-	-	-	1	-	3	-	1	-	1	1	-	-	-
Average	**1**	**-**	**1**	**-**	**1**	**-**	**3**	**1**	**1**	**-**	**1**	**1**	**-**	**-**	**-**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Fundamental Concepts in Environmental Science**	**12**	1	1, 2, 3, 4, 5, 6, 7, 8, 10
	Human population and environment	1		
	Environmental education and awareness Environmental ethics Evolution of Environmental ethics – Leopold's land ethics, Silent Spring	2		
	Population growth, Ecological overshoot, and Ecological Footprint	2		
	Defining global sustainability, Garret Hardin's "Tragedy of the Commons', Brundtland commission report, Principles of sustainable development, Sustainable Development Goals (SDGs), Triple bottom line of sustainable development	2		
	Technology and Society: Information Technology - Human health & Environmental health, Environmental misconception	2		
	Sustainable ethics: Overcoming the obstacles of sustainability Individualizing Responsibility for a sustainable future - Consumption and its impact on sustainable development	3		
Unit 2	**Social issues and Environment**	**10**	4	1, 3, 9
	Fronterism, Biological Imperialism, and Natural rights, Significance of Human rights; Human rights and environment	3		
	Wastewater reclamation, Water conservation, Rainwater harvesting, Watershed management, Urban problems related to energy, Nuclear accidents	3		
	Global Environmental Policy, Environmental acts and laws, Water Act 1974, Environmental Protection Act 1986	4		
Unit 3	**Global Climate Change**	**14**	3	10, 3
	Differentiating Climate and Weather, Interconnection of Earth systems (Hydrosphere, Geosphere, Cryosphere, Atmosphere, and Biosphere)	2		
	Climate change through data (global temperature, and CO_2 – Mauna Lao Earth observatory)	3		
	Climate change: Impacts - Extreme weather events, Sea-level rise, Food and water security, and Human health & well-being, Biodiversity loss	4		
	Climate change: Adaptation – local to global scales, Synthesis	2		
	Disaster management – landslides, Tsunamis floods, earthquakes, anthropogenic disasters, Bhopal tragedy	2		
	Communicating climate change	1		
Unit 4	**Energy and Environment**	**8**	4	3, 4
	Renewable Energy: Global Status and trends	2		
	Global Renewable Energy Applications	2		
	Technical Issues, Challenges & Opportunities Solar, tidal, hydropower, Bioenergy, nuclear	2		
	Renewable Energy Markets	2		
Unit 5	**Environmental Pollution and Management**	**16**	2, 4	3, 11
	Pollution: Air pollution, Noise pollution, Water pollution, Soil pollution	4		
	Solid waste management: Collection, Handling, and solid waste management rules	4		
	E-waste and hazardous waste management, biomedical waste management	4		
	Wastewater treatment systems: Industrial and sewage treatment	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%	Mid-2 15%	
Level 1	Remember	70%	70%	30%	30%	70%
	Understand					
Level 2	Apply	30%	30%	70%	70%	30%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Daniel D. Chiras (2012), Environmental Science 9th Edition. Jones & Barlet Publishers
2. Carson, R. (2002). Silent spring. Houghton Mifflin Harcourt.
3. Rajagopalan, R (2015). Environmental Science – from crisis to cure, 3rd Edition. Oxford Higher Education.
4. Walter K Dodds (2018). Humanity's Footprint: Momentum, Impact, and Our Global Environment. Columbia University Press
5. Hayley Stevenson (2018). Global Environmental Politics Problems, Policy and Practice. Cambridge University Press
6. Garette Hardin (1968). The Tragedy of the Commons. Science 162 (3859), 1243-1248. DOI: 10.1126/science.162.3859.1243
7. Brutland Commission Report, 1987. Oxford University Press
8. TRANSFORMING OUR WORLD: The 2030 Agenda for Sustainable Development
9. Shastri, S.C. (2015) Environmental Law by 5th edition, EBC Publications.
10. Intergovernmental Panel on Climate Change (IPCC) Synthesis Report, 2014.
11. C.S. Rao (2018) Environmental Pollution Control Engineering, New Age International Publishers.

Other Resources

1. W. Cunningham, M. Cunningham (2016). Principles of Environmental Science (8th Edition), McGraw-Hill
2. Divan Shyam (2002). Environmental Law and Policy in India, OUP India
3. Jonathan Cowie, (2002). Climate change: Biological and Human Aspects, 2nd Edition. Cambridge University Press
4. Hanjalic, Kemo, Roel Van de Krol, and Alija Lekic, eds. (2017). Sustainable energy technologies: options and prospects. Springer Science & Business Media

Course Designers

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

Introduction to Communicative English

Course Code	EGL 100	**Course Category**	FIC	**L**	**T**	**P**	**C**
				4	0	0	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	English	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To know the fundamentals of producing a spoken and written language.
2. To understand language Production skills while learning its importance in communication using written and spoken form.
3. To gain knowledge of the Persuasive Communication Principles in both academic and non-academic contexts focusing/preparing for the audience at hand.
4. To use Persuasive skills while presenting Scientific Data in written form with attention to various modes of presentation.

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 fundamental knowledge critically while writing to persuade	3	75%	75%
Outcome 2	Demonstrate communication skills using Writing as a skill for communication.	3	75%	75%
Outcome 3	Analyse the role and use of writing in context suitable for academic and informative use.	2	75%	75%
Outcome 4	Utilize persuasion skills to study the art of comparing and contrasting.	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	-	3	3	3	2	3	-	3	3	3	1	3	-	-	-
Outcome 2	-	3	3	3	2	3	-	3	3	3	1	3	-	-	-
Outcome 3	-	3	3	3	2	3	-	3	3	3	1	3	-	-	-
Outcome 4	-	3	3	3	2	3	-	3	3	3	1	3	-	-	-
Average	-	**3**	**3**	**3**	**2**	**3**	-	**3**	**3**	**3**	**1**	**3**	-	-	-

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**HORIZONTAL AND VERTICAL WRITING**	**6**		
	Fundamentals of Vertical and Horizontal Writing	2	1,4	1
	Reading and Illustrating best writing	2	1,4	1,2
	Expressing Ideas using Critical thought	2	1,4	1
Unit 2	**BASIC ENGLISH CONCEPTS AND INTRODUCTION TO LINGUISTICS**	**8**		
	Reading Skills – Introduction, Skill & Process	2	2	1
	Writing Skills – Introduction, Skill & Production	2	2	1,2
	Production Concepts- Reading, Writing Process & production of Language	4	2	1
Unit 3	**CREATIVE WRITING**	**12**		
	Introduction to Persuasive clarity	3	3	1
	Examine Reading: Comprehension and Creative Clarity	3	3	1
	Examine Writing: Expressive clarity using Rhetoric	3	3	1,2,3
	Production of Creative and Expressive clarity	3	3,4	1,2,3
Unit 4	**RESEARCH WRITING**	**12**		
	Fundamentals of Research Paper Writing	4	3,4	2, 3
	Understanding the role of Bibliography and Referencing	4	3,4	3
	Constructing a Write up using Fundamentals of Writing	4	3,4	2, 3
Unit 5	**Persuasion, ideology and media bias**	**7**		
	Identifying: combining and synthesizing information	2	4	3
	Processing: Clarity to Inform and persuade in written form	2	4	2,3
	Applying the skill within small and large group	3	4	1,3
Total Contact Hours		**45**		

Learning Assessment

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

Recommended Resources

1. Beebe, Beebe and Ivy (2016). Communication: Principles for a Lifetime. (6th Edition). Pearson Publishing.
2. Taylor and Lindof (2011). Qualitative Communication Research Methods. (3rd Edition). Sage Publication.
3. Myers and Anderson (2008). The Fundamentals of Small Group Communication. Sage Publication

Other Resources

Course Designers

1. Dr. G. Priyank Varma, Asst. Prof Dept. of English, SRM University – AP.
2. Prof. Rajesh Kumar, Professor, IIT Madras.
3. Dr. Md. Mojibur Rahman, Associate Professor, IIT Dhanbad

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

INDUSTRY SPECIFIC EMPLOYABILITY SKILLS - II

Course Code	ISES 102	**Course Category**	SEC	**L**	**T**	**P**	**C**
				1	0	0	1
Pre-Requisite Course(s)	ISES 101	**Co-Requisite Course(s)**		**Progressive Course(s)**	**ISES 201**		
Course Offering Department	CDC	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To develop aptitude skills.
2. Develop the ability to solve logical problems.
3. To develop self-awareness and understand his emotions.
4. Build vocabulary through methodical approaches and nurture passion for learning new words.
5. Develop an ability to function on multidisciplinary teams.

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	Solve the basic mathematical problems.	3	90%	80%
Outcome 2	Demonstrate the ability in solving the logical reasoning problems.	3	70%	80%
Outcome 3	Use the images in solving the problems related to reasoning.	3	80%	70%
Outcome 4	Use emotional intelligence in developing interpersonal relations.	3	70%	60%
Outcome 5	Memorise grammatic rules for making flawless use of language.	1	80%	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	-	-	-
Outcome 2	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-
Outcome 3	-	-	2	3	1	-	-	-	-	-	-	2	-	-	-
Outcome 4	-	-	-	-	-	-	-	2	3	2	-	2	-	-	-
Outcome 5	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
Course Average	**-**	**3**	**1**	**3**	**-**	**-**	**-**	**1**	**2**	**3**	**-**	**2**	**-**	**-**	**-**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Quants**			
	Concept 1: Averages, Aligation or Mixture, Percentage	1	1	2,4
	Concept 2: Profit and loss, True discount	1	1	2,4
	Concept 3: Partnership, Height, and Distance	1	1	2,4
Unit 2	**Reasoning**			
	Concept 1: Logical deductions, Syllogism	1	2,3	1,3,4
	Concept 2: Image based problems, Coding and Decoding	1	2,3	1,3,4
	Concept 3: Cubes and Cuboids, Inequalities, Input output tracing	1	2,3	1,3,4
Unit 3	**Verbal**			
	Concept 1: Ordering of sentences, Comprehension, Verbal Analogies.	1	5	7
	Concept 2: Essential parts of a sentence, One-word substitutes.	1	5	7
	Concept 3: Cause and effect, Syllogism	1	5	7
Unit 4	**Communication skills**			
	Concept 1: Sentence formation (Practical)	1	6	5,6
	Concept 2: Word group categorization, Casual conversation (Practical)	1	6	5,6
	Concept 3: Formal conversation (interpersonal)	1	6	5,6

Learning Assessment

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

Recommended Resources

1. R.S. Agarwal, A Modern Approach to Verbal & Non-Verbal Reasoning, S. Chand Publication
2. How to prepare for Quantitative Aptitude for CAT – Arun Sharma
3. Meenakshi Upadhyay, Arun Sharma -Verbal Ability and Reading Comprehension
4. How to prepare for Logical reasoning and data interpretation for CAT – Arun Sharma.
5. Mastering Soft skills – Julian Vyner.
6. Soft skills – Key to success in workplace and life – Meenakshi Raman, Shalini Upadhyay.
7. English grammar and composition – S. C. Gupta.

Other Resources

Course Designers

1. Mr. Naresh Adapa, Quantitative Aptitude trainer, Department of CDC, SRM University AP.
2. Ghanshyam Pandey, Assistant Professor, Department of Economics, SRM University AP

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

Introduction to Research

Course Code	RM 100	**Course Category**	FIC	**L**	**T**	**P**	**C**
				1	0	0	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Chemistry	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To facilitate the students in understanding the basics of research
2. To educate the young researchers on methods of research
3. To prepare the students to apply research in scientific 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	Illustrate the importance of research	2	85%	80%
Outcome 2	Demonstrate research acumen in the research process	3	80%	75%
Outcome 3	Apply the research method in given scenarios	5	80%	75%

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

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Scientific Research**	**7**	**1**	**1,2**
	Importance of Research	2		
	Objectives of Research	2		
	Types of Research	3		
Unit 2	**Introduction to Research Articles**	**8**	**2**	**1,3**
	Literature survey	2		
	Tools to collect research articles	2		
	Identifying research problem	1		
	Understanding research articles	1		
	Different components in a research article	1		
	Review articles and book chapters, report writing	1		
Unit 3	**Scientific Conduct**	**8**	3	**1,2,3**
	Ethics with respect to science and research	2		
	Intellectual honesty and research integrity	2		
	Scientific misconducts: falsification, fabrication, and plagiarism	2		
	Redundant publications: duplicate and overlapping publications	2		
Unit 4	**Research Management and Collaboration**	**7**	3	**1**
	Google scholar, ResearchGate	3		
	Citations, h-index, i10 index	2		
	Bibliography, reference manager (Mendeley)	2		
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. Bordens K.S. and Abbott, B.b.: Research Design and Methods, Mc Graw Hill, 2008
2. Kothari C.K., Research Methodology- Methods and Techniques (New Age International, New Delhi), 2004
3. Catherine Dawson, Introduction to Research Methods, 2005

Other Resources

Course Designers

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

Real Analysis - I

Course Code	MAT 150	**Course Category**	CC	**L**	**T**	**P**	**C**
				4	0	0	4
Pre-Requisite Course(s)	MAT 104	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Verify the existence of the limit of a function. Verify the continuity of a function at a point and on a set of points.
2. Verify the differentiability from an analytical point of view instead of the computational method used previously.
3. 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.	Description of Topic	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

Course Designers

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)

1. Understand the representation and solution of linear systems through matrices, exploring operations, LU-Factorization, and applications of determinants.
2. Develop proficiency in vectors, subspaces, linear independence, basis, and dimension, applying these concepts to solve homogeneous systems and determine matrix rank.
3. Study inner product spaces, length, direction, and orthogonalization processes like Gram-Schmidt, applying these to solve problems involving least squares.
4. 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

Course Designers

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

Algebra - I

Course Code	MAT 153	**Course Category**	CC	**L**	**T**	**P**	**C**
				4	0	0	4
Pre-Requisite Course(s)	Foundation of Mathematics	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the algebraic structures of groups, subgroups, cyclic subgroups and permutation groups.
2. To learn group action and Sylow's theorem.
3. To understand group homomorphisms,
4. 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

Course Designers

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)	Plus 2 level mathematics	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the basics of propositional calculus on which is based the fundamental principles of computing.
2. To understand basic set theory and elementary properties of whole numbers as essential mathematical skills.
3. To understand basic principles of counting and recurrence relations.
4. 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	**Introduction to Graph theory Graphs**	**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

Course Designers

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

Digital Literacy

Course Code	SEC 102	**Course Category**	SEC	**L**	**T**	**P**	**C**
				1	0	1	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)

1. Introduce basic digital skills that are needed in today's 21st century work environment.
2. develop the skills that they need to effectively integrate technology into their respective professional practices.
3. Learn practical-oriented and will have a lot of hands-on exercises.
4. Understand basic and practical digital skills.
5. learn and use software and hardware systems, including the basic troubleshooting.
6. 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

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

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)

1. Understand the inadequacy of real numbers both algebraically and geometrically, and how complex numbers are adequate for these purposes.
2. Comprehend how the theory of complex functions is enriched by the notion of line integral.
3. Introduce theories for functions of single complex variable, via exploration of the algebraic, geometric, and topological structures of the complex number field.
4. 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	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

Course Designers

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

Real Analysis - II

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)

1. 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.
2. 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.
3. 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	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

Course Designers

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

Ordinary Differential Equations - I

Course Code	MAT 203	**Course Category**	CC	**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)

1. 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.
2. 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.
3. 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	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

Course Designers

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	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To gain a foundational understanding of statistics and probability, and error analysis.
2. To know different types of mathematical models used to understand a data set.
3. To construct appropriate mathematical through formulation of real-life problems, solve those problems and validate the results.
4. 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 Lifelong 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

Course Designers

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)	Basic Set Theory and Calculus.	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand concepts of discrete probability, conditional probability, independence, and be able to apply these concepts.
2. 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.
3. Understand correlation, covariance, correlation coefficient and how these quantities relate to the independence of random variables
4. Understand the law of large numbers and the central limit theorem and how these concepts are used to model various random phenomena.
5. 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

Course Designers

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

Numerical Analysis

Course Code	MAT 205	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	Calculus, Theory of Equations and Differential Equations	**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.
2. To analyse techniques of various numerical root finding methods.
3. Analysing techniques for solving numerical solutions of a system of linear equations.
4. To gain proficiency in understanding interpolation.
5. 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.

General Topology

Course Code	MAT 207	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	MAT 104	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

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

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Define 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	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

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)

1. To learn the basic topological properties of functions several variables.
2. To understand geometrical interpretations of derivative of a function.
3. To extreme values of the functions of several variables.
4. To evaluate integrals over curves and surfaces.
5. 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

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)

1. To recognize basic natural phenomena around us and express them in the corresponding governing equation.
2. To understand the nature of first and second order PDE's and obtain its explicit solutions.
3. 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**	**15**		
	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.

Other Resources

1. Robert C. McOwen, Partial differential equations method and application, 2nd edition ISBN- 0130093351, Pearson 2002.
2. K. Sankara Rao: Introduction to partial differential equation 3rd edition, ISBN 8120342224, PHI Learning Private Limited New Delhi-10001

Course Designers

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

Measure Theory

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

Course Objectives / Course Learning Rationales (CLRs)

1. To give a comprehensive and sound introduction to modern measure theory and integration.
2. Understand Lebesgue measure and integration, absolutely continuous function & function of bounded variation, Lp spaces.
3. 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	**CO 1**	1
	Outer measure, Measurable sets, Properties of outer measure	2	**CO 1**	1
	Borel sets, Lebesgue measurable sets	2	**CO 3**	1,2
	Caratheodory's theorem, Ulam's theorem, Measure zero sets	3	**CO 3**	1
	Non-measurable sets, Existence of non-Lebesgue measurable sets, Measurable functions,	3	**CO 1**	1,2
	Egoroff's theorem, Lusin's theorem			
Unit 2	**Integration of functions**	**12 Hours**		
	Simple function, Properties of integrable function,	2	**CO 2**	1
	Sequence of integrable simple functions, Properties of non-negative integrable function	2	**CO 2**	1
	Construction of Lebesgue integral on R^n, almost everywhere and its properties,	3	**CO 2**	1
	Lebesgue bounded convergence theorem, Fatau's lemma	3	**CO 2**	1
	Dominated convergence theorem	2	**CO 2**	1
Unit 3	**Signed measure & its derivatives**	**14 Hours**		
	Signed measures & its properties	2	**CO 3**	2
	Hahn and Jordan decomposition	3	**CO 3**	2
	Absolute continuity, Radon-Nikodym theorem	3	**CO 3**	2
	Derivatives of signed measures, Lebesgue differentiation theorem	3	**CO 3**	2
	Product measure, Fubini's theorem	3	**CO 3**	2
Unit 4	**L^p spaces & its inequalities**	**10 Hours**		
	L^p Spaces, Hölder's inequality, Minkowskii's inequality	3	**CO 4**	1,2
	Completeness	2	**CO 4**	1,2
	Uniform integrability	3	**CO 4**	1,2
	Vitali's convergence theorem	2	**CO 4**	1,2
Unit 5	**Haar measure**	**12 Hours**		
	Topological measure space, Regular Borel measure	3	**CO 5**	1
	Topological groups, Locally compact group	3	**CO 5**	1
	Haar measure	3	**CO 6**	1
	Existence and uniqueness of Haar measure	3	**CO 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.
3. Paul R. Halmos, Measure Theory
4. Inder K. Rana, An introduction to Measure & Integration
5. Walter Rudin, Real & Complex Analysis.

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**	CC	**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)

1. To understand the structure of finite abelian group and its application in cryptography.
2. An introduction to elementary number theory
3. To develop and explain the notion of provable security and its usage for the design of secure protocols.
4. 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	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

Course Designers

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%**

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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.

Internship

Course Code	MAT 401	Course Category	RDIP	L	T	P	C
				0	0	4	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. Gain a comprehensive understanding of research processes.
2. Foster creativity and effective ideation skills.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Outline the phases involved in the ideation process.	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 Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	-	-	-	2	-	1	2	3	2	1	3	2	2	3
Outcome 2	2	3	2	3	3	1	1	3	3	3	2	3	2	2	3
Outcome 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
Outcome 4	-	1	-	-	-	3	3	3	-	-	3	3	2	2	3
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

Course Designers

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.	21	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	10	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.	20	4	1
Unit 5	**Results Analysis and Report Writing**	**60**		
	Analyze the results obtained from the project modules.	20	3	1
	Collaboratively write a report based on the results	20	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

Course Designers

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

Advanced Linear Algebra

Course Code	MAT 412	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	1	0	4
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. Students will be able to find eigenvalues and eigenvectors of square matrices.
2. Learn to use eigenvalues in solving differential equations.
3. Able to find optimal values and singular value decomposition.
4. 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**	CE	**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)

1. **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.
2. **Integral Domains:** Study Irreducible and prime elements, Unique Factorisation Domains, Principal Ideal Domain and Euclidean Domain.
3. **Polynomial Rings:** Study definition and basic properties, factorisation of polynomials over fields, Gauss lemma, irreducibility criteria.
4. **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

Course Designers

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

Functional Analysis

Course Code	MAT 422	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	Metric Space & Real Analysis	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Able to learn vector spaces and their applications in solving linear algebraic problems, comprehending normed linear spaces with proficiency in using norms.
2. The objectives of basic functional analysis include building a strong foundation in vector spaces, norms, and linear operators. Emphasis is placed on developing practical skills to apply mathematical analysis concepts in diverse contexts.
3. To proficiently apply a diverse set of established techniques and develop a reasonable 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

Course Designers

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

Algebraic Topology

Course Code	MAT 423	Course Category	CE	L	T	P	C
				3	1	0	4
Pre-Requisite Course(s)	Topology, Algebra-1, 2, Analysis-1, 2.	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mathematics	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

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

Course Designers

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

Algebra - III

Course Code	MAT 424	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	MAT 153 MAT 204	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	MATHEMATICS	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. 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..
2. 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	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

Course Designers

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

Operator Theory

Course Code	MAT 425	**Course Category**	CE		**L**	**T**	**P**	**C**
					3	1	0	4
Pre-Requisite Course(s)	MAT 150, MAT 201, MAT 306, MAT 152 MAT 253	**Co-Requisite Course(s)**	MAT 357	**Progressive Course(s)**	MAT 205, MAT 358			
Course Offering Department	Mathematics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To demonstrate the properties of various types of operators.
2. To employ the knowledge of bounded linear operators and the properties of their respective spectrums.
3. To comprehend the generalized concepts of Banach Algebra and C^* Algebra.
4. 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

Other Resources

1. Numerical Range- Gustafson and Rao
2. Inequalities for numerical radius of bounded linear operator-Dragomir

Course Designers

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

Optimization Techniques

Course Code	MAT 411	**Course Category**	CE	**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**	CE	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	Multivariable calculus	**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	CE	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**	CE	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	PDE I	**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**	CE	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	MAT 152, MAT 203	**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.

Other Resources

1. Strogatz, Steven H. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Westview Press, 2014.
2. R. K. Nagle, E. B. Saff, and A. D. Snider. Fundamentals of Differential Equations and Boundary Value Problems, 7th edition, ISBN: 9780321977175, Pearson, 2017.

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**	CE	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	MAT 204	**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

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**	CE	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	MAT 152, MAT 306	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Introducing the theory and methods of applied linear algebra.
2. 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

Course Designers

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

Financial Mathematics

Course Code	MAT 433	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	Basic Probability and Statistics	**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

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Course Designers

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

Regression Analysis

Course Code	MAT 434	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	MAT 254	**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.
- Grasp the concept of multiple regression models for describing linear relationships and apply multiple regression equations for prediction problems. Also, able to perform residual analysis and evaluate model adequacy.
- 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

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Course Designers

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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**	CE	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	MAT 308	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- Construct and analyse probability spaces, random variables, and distributions. Apply laws of large numbers and central limit theorems.
- 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

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

Course Objectives / Course Learning Rationales (CLRs)

- 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

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

Course Designers

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