Department of Mechanical Engineering

B.Tech. Mechanical Engineering
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 become distinct and renowned globally by graduating high-quality professionals through rigorous coursework and cutting-edge research.

Department Mission

1. Emerge as a world-class mechanical engineering department in exploring and providing knowledge through high-quality academic programs and experiential learning.
2. Create an ambience for impactful research aligning with the national mission and addressing societal needs.
3. Create entrepreneurs and leaders of the future imparted with knowledge, global awareness, and strategic thinking.
4. Promote high standards of integrity, and ethical behaviour among faculty members, staff, and students.

Program Educational Objectives (PEO)

1. Develop essential professional engineering skills that make them confident to solve real-life engineering problems/issues in various application domains under various realistic constraints.
2. Engage and succeed in their professional careers through teamwork, ethical behaviour, proactive involvement, effective communication, and leadership skills.
3. Ability to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment, and analysis of results.

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

	PEO 1	PEO 2	PEO 3
Mission Statement 1	3	1	2
Mission Statement 2	3	3	2
Mission Statement 3	2	1	3
Mission Statement 4	3	2	3

Program Specific Outcomes (PSO)

1. Apply knowledge of maths, science, and engineering to identify, formulate and solve mechanical engineering problems.
2. Design and conduct experiments and analyse and interpret the data.
3. Design components, systems, and processes to meet desired goals within realistic economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints.

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

Program Learning Outcomes (PLO)															
PEOs	POs												PSOs		
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT 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 Lifelong Learning	PSO 1	PSO 2	PSO 3
PEO 1	3	3	1	1	1	3	2	1	1	1	3	1	3	2	3
PEO 2	1	2	1	1	2	3	3	3	3	3	2	1	2	2	3
PEO 3	3	3	3	3	3	1	1	1	1	1	2	1	3	3	2

Category Wise Credit Distribution			
Course Sub-Category	**Sub-Category Credits**	**Category Credits**	**Learning Hours**
Ability Enhancement Courses (AEC)		5	150
University AEC	1		
School AEC	4		
Value Added Courses (VAC)		4	120
University VAC	4		
School VAC	0		
Skill Enhancement Courses (SEC)		16	480
School SEC	6		
Department SEC	4		
SEC Elective	6		
Foundation / Interdisciplinary courses (FIC)		30	900
School FIC	30		
Department FIC	0		
Core + Core Elective including Specialization (CC)		78	2340
Core	63		
Core Elective (Inc Specialization)	15		
Minor (MC) + Open Elective (OE)	15	15	450
Research / Design / Internship/ Project (RDIP)		17	510
Internship / Design Project / Startup / NGO	5		
Internship / Research / Thesis	12		
Total		**165**	**4950**

Semester wise Course Credit Distribution Under Various Categories										
Category	**Semester**									
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**	**%**
Ability Enhancement Courses - AEC	3	0	2	0	0	0	0	0	5	3
Value Added Courses - VAC	0	0	0	0	0	4	0	0	4	2
Skill Enhancement Courses - SEC	3	3	2	2	3	3	0	0	16	10
Foundation / Interdisciplinary Courses - FIC	12	16	2	0	0	0	0	0	30	18
CC / SE / CE / TE / DE / HSS	1	7	12	17	16	16	9	0	78	47
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	2	0	3	12	17	10
Grand Total	**19**	**26**	**21**	**24**	**24**	**26**	**15**	**12**	**165**	**100**

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

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

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

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

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

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

SEMESTER - I								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	AEC	U AEC	EGL 101	Communicative English	3	0	0	3
2	SEC	S SEC	ENTR 100	Exploratory Learning and Discovery	0	0	1	1
3	SEC	S SEC	IRH 101	Orientation on Internationalization	1	0	0	1
4	SEC	S SEC	ISES 101	Industry Specific Employability Skills -I	0	0	1	1
5	FIC	S FIC	CHE 103	Chemistry for Engineers	2	0	0	2
6	FIC	S FIC	CHE 103L	Chemistry for Engineers Lab	0	0	1	1
7	FIC	S FIC	CSE 108	Introduction To Computer Science and Programming Using C	3	0	0	3
8	FIC	S FIC	CSE 108L	Introduction to Computer Science and Programming Using C Lab	0	0	1	1
9	FIC	S FIC	ENV 111	Environmental Science	2	0	0	2
10	FIC	S FIC	MAT 113	Calculus	3	0	0	3
11	Core	CC	ME 103	Mechanical Engineering Tools	0	0	1	1
				Semester Total	**14**	**0**	**5**	**19**

SEMESTER - II								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	SEC	S SEC	CSE 131	Industry Standard Coding Practice-I	0	0	2	2
2	SEC	S SEC	ISES 102	Industry Specific Employability Skills-II	0	0	1	1
3	FIC	S FIC	BIO 103	Introductory Biology for Engineers	2	0	0	2
4	FIC	S FIC	CSE 107	Data Structures	3	0	0	3
5	FIC	S FIC	CSE 107L	Data Structures Lab	0	0	1	1
6	FIC	S FIC	EEE 103	Basic Electrical and Electronics Engineering	3	0	0	3
7	FIC	S FIC	EEE 103L	Basic Electrical and Electronics Engineering Lab	0	0	1	1
8	FIC	S FIC	MAT 211	Linear Algebra	3	0	0	3
9	FIC	S FIC	PHY 101	Engineering Physics	2	0	0	2
10	FIC	S FIC	PHY 101L	Engineering Physics Lab	0	0	1	1
11	Core	CC	ENG 105	Engineering Graphics	3	0	0	3
12	Core	CC	ENG 105L	Engineering Graphics Lab	0	0	1	1
13	Core	CC	ENG 115	Engineering Mechanics	3	0	0	3
				Semester Total	**19**	**0**	**7**	**26**

SEMESTER - III								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	AEC	S AEC	AEC 105	Analytical Skills for Engineers	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	MCE 201	Design Thinking and Product Design	0	1	1	2
5	FIC	S FIC	FIC 106	Differential equations	3	0	0	3
6	Core	CC	MCE 202	Mechanics of Materials	2	1	1	4
7	Core	CC	MCE 203	Thermodynamics	2	1	1	4
8	Core	CC	MCE 204	Material Science	3	0	1	4
9	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**14**	**3**	**9**	**22**

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	MCE 210	Digital Manufacturing and Industry 4.0	0	1	1	2
4	Core	CC	MCE 205	Design of Machine Elements	2	1	1	4
5	Core	CC	MCE 206	Fluid Mechanics	3	0	1	4
6	Core	CC	MCE 207	Kinematics of Machines	3	0	1	4
7	Core	CC	MCE 208	Digital product development-3D Printing	1	0	1	2
8	Core	CC	MCE 209	Industrial Engineering and Operation Research	2	1	0	3
9	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**14**	**3**	**9**	**22**

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	MCE 301	Fluid Machinery	2	0	1	3
5	Core	CC	MCE 302	IOT and Digital Twins for Mechanical Engineering	2	0	0	2
6	Core	CC	MCE 303	Computational Methods	2	1	1	4
7	Core	CC	MCE 304	Manufacturing Technology	3	0	1	4
8	Elective	CE		Core/Specialization Elective	2	1	0	3
9	Elective	OE		Open Elective / Minor	3	0	0	3
10	RDIP	RDIP	MCE 309	Mini Project	0	0	2	2
				Semester Total	**17**	**2**	**9**	**24**

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	0	0	2	2
3	SEC	E SEC		Career Skills – II	3	0	0	3
4	Elective	CE		Core/Specialization Elective	2	1	0	3
5	Core	CC	MCE 305	Heat and Mass Transfer	3	0	1	4
6	Core	CC	MCE 306	Measurements and Instrumentation	2	0	1	3
7	Core	CC	MCE 307	AI and ML for Mechanical Engineers	2	0	0	2
8	Core	CC	MCE 308	Dynamics and Control	3	0	1	4
9	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**18**	**1**	**7**	**26**

SEMESTER - VII								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE		Core/Specialization Elective	2	1	0	3
2	Elective	CE		Core/Specialization Elective	2	1	0	3
3	Elective	CE		Core/Specialization Elective	2	1	0	3
4	Elective	OE		Open Elective / Minor	3	0	0	3
5	RDIP	RDIP	MCE 402	Technical Seminar	0	0	1	1
6	RDIP	RDIP	MCE 401	Internship	0	0	2	2
				Semester Total	**9**	**3**	**3**	**15**

SEMESTER - VIII								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	RDIP	RDIP	MCE 403	Major Project	0	0	12	12
				Semester Total	**0**	**0**	**12**	**12**

Specialization: Robotics and Automation								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE/SE	MCE 454	Introduction to Robotics	2	1	0	3
2	Elective	CE/SE	MCE 455	Mechatronics	2	1	0	3
3	Elective	CE/SE	MCE 456	Flexible manufacturing systems and Automation	2	1	0	3
4	Elective	CE/SE	MCE 457	AI for Robotics	2	1	0	3
5	Elective	CE/SE	MCE 458	Machine learning in Robotics	2	1	0	3
6	Elective	CE/SE	MCE 459	Advanced Robotics	2	1	0	3
7	Elective	CE/SE	MCE 460	Automation in Manufacturing	2	1	0	3

Specialization: Additive Manufacturing								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE/SE	MCE 461	CAD CAM	2	1	0	3
2	Elective	CE/SE	MCE 462	Laser based AM	2	1	0	3
3	Elective	CE/SE	MCE 463	Design and modeling aspect of additive manufacturing	2	1	0	3
4	Elective	CE/SE	MCE 464	Digital manufacturing	2	1	0	3
5	Elective	CE/SE	MCE 465	Materials for additive manufacturing	2	1	0	3
6	Elective	CE/SE	MCE 466	Bioprinting	2	1	0	3

Specialization: Automotive Engineering								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE/SE	MCE 467	Fundamentals of Combustion Technology	2	1	0	3
2	Elective	CE/SE	MCE 468	Introduction to Automobile Engineering	2	1	0	3
3	Elective	CE/SE	MCE 469	Electric vehicle technology	2	1	0	3
4	Elective	CE/SE	MCE 470	Heavy Vehicle Technology	2	1	0	3
5	Elective	CE/SE	MCE 471	Noise and Vibration	2	1	0	3
6	Elective	CE/SE	MCE 472	Vehicle Dynamics	3	0	0	3

Core Elective: Automotive Engineering								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE	MCE 430	Thermal power engineering	2	1	0	3
2	Elective	CE	MCE 423	Refrigeration and air conditioning	2	1	0	3
3	Elective	CE	MCE 445	Thermal design of electronic equipment	2	1	0	3
4	Elective	CE	MCE 448	Computational fluid dynamics	1	1	1	3

Core Elective: Robotics and Automation								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE	MCE 421	Artificial Intelligence for Mechanical Engineers	2	0	1	3
2	Elective	CE	MCE 422	Machine Learning for Mechanical Engineers	2	1	0	3
3	Elective	CE	MCE 428	Multibody dynamics	2	1	0	3

Core Elective - Additive Manufacturing								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE	MCE 434	Industrial engineering	2	1	0	3
2	Elective	CE	MCE 424	New Product Development	2	1	0	3
3	Elective	CE	MCE 425	Sustainable Product Development	2	1	0	3
4	Elective	CE	MCE 436	Surface engineering	2	0	1	3
5	Elective	CE	MCE 438	Operation research	2	1	0	3
6	Elective	CE	MCE 439	Nanotechnology	2	1	0	3
7	Elective	CE	MCE 446	Advanced material	2	0	1	3
8	Elective	CE	MCE 447	Mechanics of composite material	2	1	0	3
9	Elective	CE	MCE 449	Non-conventional manufacturing	2	1	0	3
10	Elective	CE	MCE 450	Multi-Physics Modeling and Analysis	2	0	1	3
11	Elective	CE	MCE 451	Introduction to Additive manufacturing	2	1	0	3

Minor: Robotics								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	OE	MCE 241	Introduction to Robotics	3	0	0	3
2	Elective	OE	MCE 242	Mechatronics	3	0	0	3
3	Elective	OE	MCE 243	AI for Robotics	3	0	0	3
4	Elective	OE	MCE 244	Dynamics and control	3	0	0	3
5	Elective	OE	MCE 245	Advanced Robotics	3	0	0	3
6	Elective	OE	MCE 246	Flexible manufacturing system	3	0	0	3

Open Electives								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	OE	MCE 247	Introduction to industrial engineering	3	0	0	3
2	Elective	OE	MCE 248	Introduction to Additive manufacturing	3	0	0	3
3	Elective	OE	MCE 249	Introduction to aircraft systems	3	0	0	3
4	Elective	OE	MCE 250	Introduction to Robotics	3	0	0	3
5	Elective	OE	MCE 251	Surface engineering	3	0	0	3
6	Elective	OE	MCE 252	Smart materials and systems	3	0	0	3
7	Elective	OE	MCE 253	Mechanical Behavior of Materials	3	0	0	3
8	Elective	OE	MCE 254	Numerical methods	3	0	0	3

Carrer Skill Courses								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	SEC	E SEC	SEC 140	Finite Element Analysis	3	0	0	3

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

Communicative English

Course Code	EGL 101	Course Category	AEC	L	T	P	C
				3	0	0	3
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. Introduce the Principles and Practices of Effective Communication Skills in various contexts.
2. To understand the purpose and differentiate various types of audience.
3. To encourage self-evaluation while collaborating with peers during learning.
4. To prepare the students to produce Language in various contexts be it Oral or Written form

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Employ all four skills (listening/speaking/ reading/writing) to express themselves using production skills (Speak and Write)	3	90%	90%
Outcome 2	Illustrate views using Power Point and Word.	3	70%	80%
Outcome 3	Express with proper grammar.	2	60%	50%
Outcome 4	Apply listening skills to practice.	3	80%	80%
Outcome 5	Employ reading skills to read the given text.	4	60%	50%
Outcome 6	Demonstrate the forms of writings	3	70%	70%

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

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT 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 Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1			2	2	3			3	3	3		3			
Outcome 2					3	3		3	3	3		3			
Outcome 3								3	2	3		3			
Outcome 4										3		3			
Outcome 5								2	3	3		3			
Outcome 6								3	3	3		3			
Average			2	2	3	3		3	3	3		3			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1		**7**		
	Course Introduction and Overview	1	**1,2,3**	
	Parts of Speech	1		**1,2**
	Tenses	1		**1,2**
	Vocabulary (Etymology, Prefixes, Suffix)	2		**1,2**
	Capitalization & Punctuations	1		**1,2**
	Principles of Sentence Structure & Paragraph Writing (*S+V+O*)	1		**1,2,3**
Unit 2		**6**		
	The Fundamentals of Speech (*Ethos, Pathos & Logos*)	1	**1,2**	**1,2**
	How to give a good Speech? (*Rhetoric & Speech Delivery*)	1		**1,2**
	Verbal Communication (Turn taking strategies, Questioning, Types of Qs)	2		**1,2**
	Nonverbal Communication (Cultural Contexts, Importance and Types)	1		**1,2**
	Fundamentals of Personal, Informative, and Scientific Speech	1		**1,2**
Unit 3		**10**		
	Listening Skills: Definition, Barriers, Steps to Overcome	2	**4**	**2**
	Listening Comprehension	3		**2**
	Listening to Influence, Negotiate	2		**2**
	Listening to Specific Information	1		**2**
	Note taking & Making while Listening	2		**2**
Unit 4		**10**		
	Read to Skim, and Scan	2	**5**	**1,2**
	Read to Comprehend (Predict, Answer Questions & Summarize)	2		**1,2**
	Read to Appreciate, Compose and Present	3		**1,2**
	Read to Understand Referencing Skills for Academic Report Writing and Plagiarism (APA 6th Ed)	3		**1,2**
Unit 5		**12**		
	Write to Interpret Data (Flow charts, Bar Diagrams)	2	**6**	**4**
	Write to Inform (News, Emails, Notice, Agenda & Minutes)	2		**4**
	Write to Define (Definitions & Essays)	2		**4**
	Resume and Cover Letter	2		**4**
	Write an Effective Abstract and a Comprehensive Summary	2		**4**
	Write Project Proposal	2		**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%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%		50%		30%		40%		50%	
	Understand										
Level 2	Apply	60%		50%		70%		60%		50%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. Shoba, Lourdes. (2017). Communicative English: A Workbook. U.K: Cambridge University Press.
2. Steven, Susan, Diana. (2015). Communication: Principles for a Lifetime. U.S.A: Pearson 6th Ed.
3. Publication Manual of the American Psychological Association, (2010). 6th Ed.
4. Kosslyn, S.M. "Understanding Charts and Graphs", Applied Cognitive Psychology, vol. 3, pp. 185-226, 1989.

Other Resources

Course Designers

1. Dr. Priyank Verma, Assistant Professor. Department of English, SRM University- AP
2. Dr. Ugen Bhutia, Assistant Professor. Department of Journalism, SRM Unviersity-AP

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

Exploratory Learning and Discovery

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

Course Objectives / Course Learning Rationales (CLRs)

- Enter Data

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1				
Outcome 2				
Outcome 3				
Outcome 4				

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

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

Course Unitization Plan

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

Learning Assessment

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

Recommended Resources

1. Enter Data

Other Resources

1. Enter Data

Course Designers

1. Enter Data

SRM University *AP*, Andhra Pradesh

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

Orientation on Internationalization

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

Course Objectives / Course Learning Rationales (CLRs)

1. To Understand the need and Importance of Internationalization as per the New Education Policy and to make student aware about the different pathways of Internationalization, which will help them to achieve their International Goals

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the Need and importance of internationalization in Indian Higher Education system and Comparison with the global standards			
Outcome 2	Know the guidelines issued by the University grant commission for the internationalization of institutions and the importance in New Education Policy			
Outcome 3	Know the Different Pathways of Internationalization, Efforts of SRM University AP for various Pathways, available opportunities and application process.			

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

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**INTERNATIONALISATION OF HIGHER EDUCATION**	**3**		
	Internationalization, Global Trends and Indian Initiatives	1		
	Internationalization and Indian higher education	1		
	Internationalization as the pathway to the Future universities	1		
Unit 2	**GUIDELINES FOR INTERNATIONALIZATION OF HIGHER EDUCATION**	**3**		
	NEP and Internationalization	1		
	Strategic Programs and Initiatives - I	1		
	Strategic Programs and Initiatives – II and Role of Institutions	1		
Unit 3	**INTENATIONALIZATION PATHWAYS**	**10**		
	International Partnerships, Need and Importance, Key for Internationalization goals, Type, Process and Current status	1		
	Pathway -1: International Internships, its role in internationalization, Need, Scope and Benefits, Comparison with global institutions1	1		
	Opportunities, Process and Policy guidelines	1		
	Languages, Centre of Excellences for Languages, Purpose and Scope	1		
	Pathway -2: Immersion Programs (Inbound and Outbound), its role in internationalization, Need, Scope and Benefits, Comparison with global institutions, how it is different from Internships	1		
	Opportunities, Process and Policy guidelines	1		
	Pathway -3: Semester Abroad and Exchange Program, Its role in Internationalization, Scope and Benefits, Process and Guidelines	1		
	Pathway -4: International Transfer Program Program, Its role in Internationalization, Scope and Benefits, Process and Guidelines, Credit Transfer	1		
	Pathway -5: Higher Studies (India or Abroad), Importance, Need and Scope, Process and Component of Higher Studies abroad, Benefits, Training and Support	1		
	Other Pathways of Internationalizations, SRM University AP Goals and Vision for Internationalizations, Intranet Portal a tool.	1		
	Total contact hours	**16**		

Learning Assessment

Course Nature				**Theory**
Assessment Method – Theory Component (Weightage 100%)				
In-semester	**Assessment tool**	Mid Term I	Mid Term II	**Total**
	Weightage	**15%**	**15%**	**30%**
End semester examination Weightage: 70%				**70%**

Recommended Resources

Other Resources

1. https://drive.google.com/drive/u/1/folders/1uUiQV30enEAuU3Ov6Gx0R0EGSaha4rzl
2. https://drive.google.com/file/d/1yTO36ezB8x2kDIh-RtEfg6J-W3SxEai_/view?usp=sharing
3. https://drive.google.com/file/d/1AYeCeGaGb4pQ4a7VvEAbmooywRJHDZVY/view?usp=sharing

Course Designers

1. Directorate of International Relations and Higher Studies

SRM University *AP*, Andhra Pradesh

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

Industry Specific Employability Skills - I

Course Code	ISES 101	Course Category	SEC	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. Develop interpersonal skills to become a good team player.
2. Develop socialization skills, positive attitude, and behavioural skills.
3. Eliminate their barriers of communication and take conscious efforts to improve their skill sets.
4. Recognise practice and acquire the skills necessary to deliver effective presentation with clarity and impact.

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 factors which motivate him in learning.	1	70%	60%
Outcome 2	Apply the knowledge of creativity and originality.	3	80%	70%
Outcome 3	Employ lateral thinking in solving problems.	1	70%	60%
Outcome 4	Identify themselves as team player.	1	90%	80%

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

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Quants**			
	Speed calculations, Time, and Distance	1	2,3	2,4
	Problems on Trains, Boats and Streams, Races and Games, Escalator problems	1	2,3	2,4
	Time and work, Chain rule, Pipes and Cistern	1	2,3	2,4
	Simplification, surds and indices,	1	2,3	2,4
	square roots and cube roots, Functions	1	2,3	2,4
Unit 2	**Reasoning**			
	Number Series, Alphabet series, Odd Man Out, Missing number, Wrong number	1	2,3	1,4
	Analogies, Mathematical Operations, Calendars, Clocks	1	2,3	1,4
	Cryptarithmetics, Identification of cross variable relations	1	2,3	1,4
	SUDOKU	1	2,3	1,4
Unit 3	**Verbal**			
	Basic sentence structure: Nouns, Pronouns, Adjectives, Parts of speech, Degree of comparison	1	1,2	3,7
	Articles, conditionals, and sentences (kinds), Verb Tense, Sentence formation.	1	1,2	3,7
	Paragraph formation, change of voice, Change of speech, Synonyms, Antonyms.	1	1,2	3,7
Unit 4	**Communication Skills**			
	Self-introduction	1	1,4	5,6
	Presentations	1	1,4	5,6
	E-Mail Etiquettes	1	1,4	5,6
Total Contact Hours		**15**		

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

Recommended Resources

1. 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. Asghar Ahamad, Soft skills trainer, Department of CDC, SRM University AP.

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

Chemistry for Engineers

Course Code	CHE 103	**Course Category**	FIC	**L**	**T**	**P**	**C**
				2	0	0	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Department of Chemistry	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To distinguish the types of bonding and can predict the structure, electronic and magnetic properties of small molecules and to learn the type of chemical reactions based on the reaction energetics and kinetics.
2. To gain in-depth knowledge about crystalline materials and to understand the types of polymers and familiar with industrial applications.
3. To learn the formation of proper electrochemical cell and their real-world applications.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the theories of chemical bonding to predict molecular shapes and properties	2	80	70
Outcome 2	Apply phase diagrams and thermochemical data for physical and chemical processes	3	75	65
Outcome 3	Understand the crystallographic concepts to evaluate material properties	2	80	70
Outcome 4	Apply the concepts of polymer science and electrochemistry	3	80	75

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	1	1	2	2	1	1	-	-	1	1	-	1	2	1	1
Outcome 2	1	2	2	2	1	1	-	-	1	1	-	1	2	2	1
Outcome 3	1	1	1	2	1	1	-	-	1	1	-	1	1	1	2
Outcome 4	1	1	3	2	1	1	-	-	1	1	-	1	1	1	1
Average	1	1	2	2	1	1	-	-	1	1	-	1	1	1	1

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Ionic, covalent, and metallic bonds, Theories of bonding: Valence bond theory, nature of covalent bond, sigma (σ) bond, Pi (π) bond.	2	1	1,2
	Hydrogen bonding, Hybridization: Types of hybridization, sp, sp2, sp3, sp3d, d2sp3.	1	1	1,2
	Shapes of molecules (VSEPR Theory): BeCl2, CO2, BF3, H2O, NH3, CH4, PCl5, XeF2, SF6, XeF4.	2	1	1,2
	Molecular orbital theory: Linear combination of atomic orbitals (LCAO Method)	1	1	1,2
Unit No. 2	Phase rule, Definition of the terms used in phase rule with examples	2	2	1,2
	Application of phase rule to water system water system	1	2	1,2
	Basics of thermochemistry: Standard terms in thermochemistry and their significance.	2	2	1,2
	Kinetics: Order and molecularity of reactions, Zero order and first order reactions	1	2	1,2
Unit No. 3	Crystal structure: crystal systems, Properties of cubic crystals, Bragg's Law, Bravais lattices	1	3	1,2
	Miller indices	1	3	1,2
	Point defects	1	3	1,2
	Band theory: metals, insulators, and semiconductors.	3	3	1,2
Unit No. 4	Classification of polymers	2	4	1,2,3
	Properties of polymers: Tg, Tacticity, Molecular weight, weight average.	1	4	1,2,3
	Degradation of polymer, Common Polymers: Elastomer, Conducting polymer, biodegradable polymer.	2	4	1,2,3
	Demineralization of water and Zeolite process	1	4	1,2,3
Unit No. 5	Electrochemical cells	1	4	1,2
	Primary and secondary cells	2	4	1,2
	Lead-acid battery	1	4	1,2
	Li+ batteries and Fuel cells	2	4	1,2

Learning Assessment

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

Recommended Resources

1. A. Bahl, B.S. Bahl, G.D. Tuli, Essentials of Physical Chemistry, (2016), S Chand Publishing Company
2. T. Jain, Y. Jain, Engineering Chemistry, 16th Edition (2017), Dhanpat Rai Publication Company
3. V. R. Gowariker, N. V. Viswanathan, J. Sreedhar, Polymer Science, New Age International, 1986. ISBN: 0-85226-307-4

Other Resources

1. B. R. Puri, L. R. Sharma & M. S. Pathania, Principles of Physical Chemistry, 46th Edition (2013), Vishal Publication Company
2. F.W. Billmeyer, Text Book of Polymer Science, 3rd Ed., John Wiley & Sons, New York, 2003.
3. A.J.Bard and L.R. Faulkner, Electrochemical methods –Fundamentals and Applications,,2nd Ed., John Wiley and Sons, 2001.
4. D.M. Adams, Inorganic Solids, An introduction to concepts in solid state structural chemistry. J. Willey & Sons, 1974.

Course Designers

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

Chemistry for Engineers Lab

Course Code	CHE 103L	**Course Category**	FIC	**L**	**T**	**P**	**C**
				0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Department 0of Chemistry	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To choose the appropriate indicator and other methods for a given acid base titration and may also predict the pH and pOH of the given solutions.
2. To Explain the principles and working of electrochemistry.
3. To learn the principles of complex formation in solution.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the conductometric and pH meter techniques for titration analysis	2	80	70
Outcome 2	Analyse and standardize solutions using redox and complexometric titrations	4	75	65
Outcome 3	Analyse and quantify metal ions using potentiometry	4	80	70

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

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	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	1	1	2	2	1	1	-	-	1	1	-	1	2	1	1
Outcome 2	1	2	2	2	1	1	-	-	1	1	-	1	2	2	1
Outcome 3	1	1	1	2	1	1	-	-	1	1	-	1	1	1	2
Outcome 4	1	1	2	2	1	1	-	-	1	1	-	1	1	1	1
Average	1	1	2	2	1	1	-	-	1	1	-	1	2	1	1

Course Unitization Plan

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	Volumetric titration of HCl vs NaOH	4	1	1,2
2.	Standardization of potassium permanganate by Oxalic acid	4	2	1,2
3.	Conductometric titration of HCl vs NaOH	4	1	1,2
4.	Determination of strength of given hydrochloric acid using pH meter	4	1	1,2
5.	Determination of hardness of water by EDTA method	4	2	1,2
6.	Estimation of iron content of the given solution using potentiometer	4	3	1,2
7.	Iodometric Determination of Ascorbic Acid (Vitamin C)	6	2	1,2

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)			End Semester Exam (50%)
		Experiments (20%)	Record / Observation Note (10%)	Viva and Model (20%)	
Level 1	Remember	40%	40%	40%	50%
	Understand				
Level 2	Apply	40%	40%	40%	40%
	Analyse				
Level 3	Evaluate	20%	20%	20%	10%
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. G.H Jeffery, J Bassett, J Mendham, R.C Denny, Vogel's Textbook of Quantitative Chemical Analysis, Longmann Scientific and Technical, John Wiley, New York.
2. J.B Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.

Other Resources

1. A.I Vogel, A.R Tatchell, B.S Furnis, A.J Hannaford, P.W.G Smith, Vogel's Textbook of Practical Organic Chemistry, Longman and Scientific Technical, New York, 1989.
2. J.V. McCullagh, K.A. Daggett, J. Chem. Ed. 2007, 84, 1799.

Course Designers

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

Introduction to Computer Science and Programming Using C

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

Course Objectives / Course Learning Rationales (CLRs)

1. Gain basic knowledge in C programminglanguage.
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 %	65%
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)														
	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	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 I	**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 II	**C PROGRAMMING BASICS**	9		
	Structure of a C program, identifiers Basic data types and sizes. Constants, Variables	1	1	1,2
	Arithmetic, relational and logical operators, increment and decrement operator's	1	1	1,2
	Conditional operator, assignment operator, expressions Type conversion	1	1	1,2
	Conditional Expressions Precedence and order of evaluation, Sam Programs.	1	1	1,2
	SELECTION & DECISION MAKING: if-else, null else, nested i ıy 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 III	**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 IV	**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 V	**ENUMERATED, STRUCTURE AND UNION TYPES**	9		
	Structures - Declaration, definition, and initialization of structures, accessing structures	2	5	2, 3, 4
	nested structures, arrays of structures, structures and functions, pointers to structures,	2	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 Hours	**47**		

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**	FIC	**L**	**T**	**P**	**C**
				0	0	1	1
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. 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 %	65%
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)													
	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	3	3	2				2				3	2	2
Outcome 2	2	2	3	3	2				2				2	2	2
Outcome 3	2	3	3	2	2				2				2	2	2
Outcome 4	3	3	3	3	2				3				2	3	3
Outcome 5	2	3	3	3	3				3				2	2	2
Average	2	3	3	3	2				2				2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	INTRODUCTION TO COMPUTER SCIENCE	4		
1	Lab Experiment 1: GCC Compiler using Lir various Linux commands used to edit, comp and executing	2	1	1,2
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 II	C PROGRAMMING BASICS	6		
3	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
4	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
5	Lab Experiment 5: Triangle star patterns * *** ***** ******* ********* I * * * * * * * ********* II	2	1,2	1,2
UNIT III	FUNCTIONS AND ARRAYS	9		
6	Lab Experiment 6: a) (nCr) and (nPr) of the given numbers $1+x+x^2\2+x^3\3!+x^4\4!+\ldots\ldots\ldots..X^n\n!$	2	2,3	1,2
7	Lab Experiment 7: a) Interchange the largest and smallest numbers in the array. Searching an element in an array Sorting array elements.	2	2,3	1,2
8	Lab Experiment 8: Transpose of a matrix. b.Addition and multiplication of 2 matrices.	2	2,3	1,2
9	Lab Experiment 9: Function to find both the largest and smallest number of an array of integers. Liner search. c. Replace a character of string either from beginning or ending or at a specified location.	2	2,3	1,2
10	Lab Experiment 10: Pre-processor directives a. If Def b. Undef c. Pragma	1	2,3	1,2
UNIT IV	POINTERS	6		
11	Lab Experiment 10: a. Illustrate call by value and call by reference.	2	3, 4	1,2,3

	b. Reverse a string using pointers Compare two arrays using pointers			
12	Lab Experiment 11: a. Array of Int and Char Pointers. Array with Malloc(), calloc() and realloc().	2	3, 4	1,2,3
13	Lab Experiment 12: a. To find the factorial of a given integer. b. To find the GCD (greatest common divisor) of two given integers. c. Towers of Hanoi	2	3, 4	1,2,3
UNIT V	ENUMERATED, STRUCTURE AND UNION TYPES	4		
14	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
15	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%)**	**Project (20%)**	**Project Presentation (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

Course Designers

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

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

Environmental Science

Course Code	ENV 111	Course Category	FIC	L	T	P	C
				2	0	0	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Environmental Science and Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Aims to provide a comprehensive introduction to wide-ranging environmental issues and their drivers.
2. To understand numerous approaches to reduce a variety of contemporary environmental problems for a sustainable future.

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 sustainable solutions for various environmental issues.	2	80%	70%
Outcome 2	Infer the functioning of ecosystems, matter cycling, and diversity of species around us.	2	80%	70%
Outcome 3	Determine the impact of overexploitation of natural resources on our environment.	3	80%	70%
Outcome 4	Explore the extent of environmental pollution and diverse regulations, policies and efforts to reduce the environmental burden.	3	80%	70%

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

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	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	1	-	-	-	-	-	3	1	-	-	-	1	-	-	-
Outcome 2	1	1	-	-	-	-	3	-	-	-	-	1	-	-	-
Outcome 3	1	-	-	-	-	-	3	-	-	-	-	1	-	-	-
Outcome 4	1	1	-	-	-	-	3	-	-	-	-	1	-	-	-
Average	1	1	-	-	-	-	3	1	-	-	-	1	-	-	-

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**ENVIRONMENTAL CRISIS AND SUSTAINABLE DEVELOPMENT**	**3**	**1**	**1, 2**
	Need for environmental science studies, Fundamentals of ENV – Atmosphere, lithosphere, hydrosphere, biosphere. Global environmental crisis and its causes, Man-Environment relationship & interaction	**2**	**1**	**1, 2**
	Ecological footprint, Sustainable development	**1**	**1**	**1, 2**
Unit No. 2	**ECOSYSTEMS**	**5**	**2, 3**	**1, 3**
	Ecosystem - Structure and functions of an ecosystem	**1**	**2, 3**	**1, 3**
	Energy flow in an ecosystem, biomass flow in an ecosystem, food chain and web, Ecological Succession	**1**	**2, 3**	**1, 3**
	Ecological pyramid, Water cycle, Carbon cycle, Sulphur cycle, Nitrogen cycle	**1**	**2, 3**	**1, 3**
	Forest ecosystems: tropical rain forest, coniferous forests, tundra forests, temperate forests, Grasslands and desert ecosystems	**2**	**2, 3**	**1, 3**
	Aquatic ecosystems: Freshwater zones, streams, rivers, state of rivers in India, wetlands, Zones in ocean, ocean activities, coastal zones, Estuaries, Mangroves	**1**	**2, 3**	**1, 3**
Unit No. 3	**RENEWABLE AND NON-RENEWABLE RESOURCES**	**5**	**3, 4**	**1, 2**
	Energy resources: Global energy crisis, energy sources, energy needs, global energy consumption, Renewable and Non-renewable energy sources: Hydropower, Solar, tidal, wind, energy, Bioenergy, coal, natural gas	**2**	**3, 4**	**1, 2**
	Energy resources: fossil fuel vs renewable fuels, peak oil Conventional and unconventional oil, oil price determination	**1**	**3, 4**	**1, 2**
	Environmental implications of Energy use: India and world, Energy use pattern – national and global	**1**	**3, 4**	**1, 2**
	Water availability, Water for irrigation, water situation in India	**1**	**3, 4**	**1, 2**
Unit No. 4	**BIODIVERSITY**	**6**	**2, 3**	**1, 2, 3**
	Significance of biodiversity, Current state of biodiversity: National and global, Causes of biodiversity loss	**2**	**2, 3**	**1, 2, 3**
	Biological hotspots, aquatic biodiversity	**1**	**2, 3**	**1, 2, 3**
	Endangered species and endemic species of India	**1**	**2, 3**	**1, 2, 3**
	Biodiversity conservation: Seed banks, botanical gardens, marine biodiversity protection, national and international efforts	**2**	**2, 3**	**1, 2, 3**
Unit No. 5	**Environmental Pollution and Control**	**11**	**1, 4**	**1, 2, 4**
	Types of Environmental Pollution Air pollution: Sources, effects, and control Air standards, Air pollution in India and the world Sources of air pollution, Outdoor & Indoor air pollution Point source, mobile, area source, Effects of air pollution: Smog, urban heat island, ozone layer depletion, acid rain, Controlling air pollution: Emission regulation, e-cars	**2**	**1, 4**	**1, 2, 4**

	Water pollution: Sources & effects, Water Quality standards, Water pollutants, eutrophication, thermal pollution, bio-magnification, Wastewater treatment, Methods of water purification	**2**	**1, 4**	**1, 2, 4**
	Soil pollution: Sources, causes and effects Control of soil pollution: Air purging, phytoremediation, and bio-remediation	**2**	**1, 4**	**1, 2, 4**
	Solid waste management, Types and sources of solid wastes, Hazardous waste, and electronic wastes, Recycling, and management of solid wastes (4Rs), Sanitary landfills and leachate management	**2**	**1, 4**	**1, 2, 4**
	Noise pollution: Sources, effects, and control Air quality standards with respect to noise	**1**	**1, 4**	**1, 2, 4**
	Introduction to Climate change: Impact of climate change, IPCC assessment, Carbon footprint, carbon sequestration, carbon trade, carbon credits, Kyoto protocol, Montreal protocol, Paris agreement	**2**	**1, 4**	**1, 2, 4**

Learning Assessment

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

Recommended Resources

1. R. Rajagopalan (2016). Environmental Studies (3rd edition), Oxford University Press. ISBN: 9780199459759
2. Deeksha Dave, S.S. Katewa (2012). Textbook of Environmental Studies (2nd edition), Cengage. ISBN: 9788131517604
3. W. Cunningham, M. Cunningham (2016). Principles of Environmental Science (8th Edition), McGraw-Hill. ISBN: 0078036070
4. APHA and AWWA (1999): Standard Methods for the Examination of Water and Wastewater. American Public Health Association (APHA), 20th Ed, Washington, D.C., USA. ISBN: 9780875532356
5. KL Rao (1979). India's water wealth. Orient Black Swan. ISBN: 8125007040
6. Saadat, S., Rawtani, D., & Hussain, C. M. (2020). Environmental perspective of COVID-19. Science of The Total Environment, 138870. https://doi.org/10.1016/j.scitotenv.2020.138870

Other Resources

Course Designers

1.

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

Calculus

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

Course Objectives / Course Learning Rationales (CLRs)

1. Develop a comprehensive understanding of the fundamental concepts of calculus, including limits, derivatives, and integrals. Apply calculus techniques to solve a wide range of mathematical problems.
2. Utilize calculus to find extreme values of functions and understand the Mean Value Theorem. Apply calculus to analyze monotonic functions, identify inflection points, and sketch curves.
3. Apply Lagrange multipliers to solve optimization problems with single constraints. Calculate double and iterated integrals over various regions and in polar form. Utilize triple integrals in rectangular coordinates and apply them to real-world scenarios to find volumes, masses, and more.

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 functions and their graphs to identify key characteristics such as domain, range, and behaviour.	2	75%	80%
Outcome 2	Compute derivatives of single-variable functions at specific points and apply various differentiation rules.	3	70%	75%
Outcome 3	Determine definite and indefinite integrals of functions and their applications.	3	75%	80%
Outcome 4	Apply calculus techniques to solve practical problems, including finding extreme values of functions. Utilize the Mean Value Theorem to understand rate of change in real-world applications.	4	72%	75%
Outcome 5	Analyse double and triple integrals over various regions and apply calculus to real-world problems such as finding volumes, masses, and areas.	4	70%	75%

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

Course Unitization Plan

Session	Description of Topic	Contact Hours Required	CLOs Addressed	References Used
1	**Unit I: Limit, Continuity, Derivative, and Integrals of Single Variable**	**10 Hours**		
2	Functions and Their Graphs,	1	**CO 1**	1
3	Limit of a function at a point and limit laws,	2	**CO 1**	1
4	Continuity of a function,	1	**CO 1**	1
5	Derivative of a function at a point,	2	**CO 2**	1
6	Various rules of Derivative,	1	**CO 2**	1
7	Definite and indefinite integral,	2	**CO 3**	1
8	Fundamental Theorem of Calculus.	1	**CO 3**	1
9	**Unit II: Applications of Calculus (Single Variable)**	**9 Hours**		
10	Extreme Values of Functions	2	**CO 4**	1
11	The Mean Value Theorem, Monotonic Functions	2	**CO 4**	1
12	Concavity and curve sketching	2	**CO 4**	1
1	Newton's Method to find roots	1	**CO 4**	1
14	Area between curves	1	**CO 4**	1
15	Arc length.	1	**CO 4**	1
16	**Unit III: Limit, Continuity, Partial Derivatives of Multi-Variables Function**	**10 Hours**		
17	Three-dimensional rectangular coordinate systems	1	**CO 1**	1
18	Functions of several variables	2	**CO 1**	1
19	Limits and continuity	2	**CO 2**	1
20	Partial Derivatives	1	**CO 3**	1
21	The Chain Rule, Directional Derivatives,	2	**CO 3**	1
22	Gradient.	2	**CO 3**	1
23	**Unit IV: Extrema of Multi-Variables Function**	**6 Hours**		
24	Extreme values	1	**CO 4**	1
25	Saddle points	1	**CO 4**	1
26	Absolute Maxima and Minima on Closed Bounded Regions,	2	**CO 4**	1
27	Lagrange multipliers (Single Constraints).	2	**CO 4**	1
28	**Unit V: Multiple Integrals**	**10 Hours**		
29	Double and Iterated Integrals over Rectangles	2	**CO 5**	1
30	Double Integrals over General Regions.	2	**CO 5**	1
31	Area by Double Integration,	1	**CO 5**	1
32	Double Integrals in Polar Form	1	**CO 5**	1
33	Triple Integrals in Rectangular Coordinates	2	**CO 5**	1
34	Applications.	2	**CO 5**	1
Total		**45**		

Learning Assessment

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

Recommended Resources

1. Thomas' Calculus, 14th Edition, Joel R. Hass, Christopher E. Heil, Maurice D. Weir, 2018.

Other Resources

Course Designers

1. Prof. V. Kannan, Professor, Mathematics Department, SRM University AP.
2. Dr. Fouzul Atik, Assistant Professor, Mathematics Department, SRM University AP.
3. Dr. Sazzad Ali Biswas, Assistant Professor, Mathematics Department, SRM University AP.
4. Dr. Anirban Bose, Assistant Professor, Mathematics Department, SRM University AP.

SRM University *AP*, Andhra Pradesh

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

Mechanical Engineering Tools

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

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the use of fitting tools to perform fitting operations.
2. To learn different machine tools, accessories, and attachments
3. To gain knowledge of fitting and machining operations to enrich their practical skills.
4. To inculcate team qualities and expose students to shop floor activities.

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	Read working drawings based on operational symbols and execute machining operations	2	70%	75%
Outcome 2	Illustrate integral parts of lathe, shaping & milling machines, and their accessories & attachments	3	70%	75%
Outcome 3	Select cutting parameters such as cutting speed, feed, depth of cut, and tooling for machining operations	3	70%	75%
Outcome 4	Perform cylindrical turning operations such as plain turning, taper turning, step turning, thread cutting, facing, knurling, internal thread cutting, eccentric turning and estimate cutting time	3	70%	75%

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Preparation of at least two fitting joint models by proficient handling and application of hand tools- Vblock, marking gauge, files, hack saw drills etc.	6	**1,2,3,4**	**1**
Unit 2	Preparation of three models on lathe involving - Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning. Exercises should include selection of cutting parameters and cutting time estimation	8	**1,2,3,4**	**1**
Unit 3	Cutting of V Groove/ dovetail / Rectangular groove using a shaper. Cutting of Gear Teeth using a Milling Machine. Exercises should include selection of cutting parameters and cutting time estimation.	8	**1,2,3,4**	**1**
Unit 4	Study & Demonstration of power tools like power drill, power hacksaw, portable hand grinding, cordless screwdrivers, production air tools, wood cutter, etc., used in Mechanical Engineering	8	**1,2,3,4**	**1**
	Total Contact Hours	**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**			**End Semester Exam (50%)**
		Experiments (30%)	**Record / Observation Note (10%)**	**Viva + Model (10%)**	
Level 1	Remember	40%	30%	40%	40%
	Understand				
Level 2	Apply	60%	70%	60%	60%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Workshop manual, SRM University AP

Course Designers

SRM University *AP*, Andhra Pradesh

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

Industry Standard Coding Practice-I

Course Code	CSE 131	Course Category	SEC		L	T	P	C
					0	0	2	2
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. Develop foundational programming skills.
2. Enhance problem-solving abilities with a focus on efficiency.
3. Master advanced programming concepts related to memory.
4. Explore advanced problem-solving techniques and programming constructs.
5. Introduce Python programming for problem-solving.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Students will have a strong foundation in basic coding practices and be able to apply them to solve programming problems.	3	75%	70%
Outcome 2	Students will develop efficient problem-solving skills, especially in dealing with linear list data, arrays, and matrix-related challenges.	4	70%	60%
Outcome 3	Proficiency in advanced programming concepts like pointers, memory handling, and string manipulation will be achieved.	4	75%	70%
Outcome 4	Students will gain expertise in advanced problem-solving techniques, including parameter passing, recursion, and working with structures and unions.	5	70%	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	1	3							1	3	2	
Outcome 2	2	3	1	1	3							1	3	2	
Outcome 3	2	3	1	1	3							1	3	2	
Outcome 4	2	3	1	1	3							1	3	2	
Average	2	3	1	1	3							1	3	2	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Problem Solving with - Basic coding practices	10		
	Expression Evaluation	2	1	1,2
	Operators Usage	2	1	1,2
	Expressions	2	1	1,2
	Control Structures	2	1	1,2
	Loop & Iterations for all test case scenarios	2	1	1,2
Unit 2	Problem Solving using time efficient logics	12		
	Linear list data	4	2	1,2
	Array problems	4	2	1,2
	2D Arrays and Matrix Data for all test case scenarios	4	2	1,2
Unit 3	Problem Solving	8		
	Pointers & Memory referencing,	4	3	1,2
	String Handling functions for all test case scenarios	4	3	1,2
Unit 4	Problem Solving	8		
	Parameter passing	2	4	1,2
	Recursion	2	4	1,2
	Recursion Analysis	2	4	1,2
	Structures and unions	2	4	1,2
	Enumerations & Memory allocation for all test case scenarios	1	4	1,2
Unit 5	Problem Solving using Python	12		
	String manipulations	2	3	3
	Lists	2	2	3
	Display patterns	1	2	3
	Matrix	2	2	3
	Tuples	1	2	3
	Dictionaries	1	2	3
	Modules	1	4	3
	Packages	1	4	3
	Exception handling	1	4	3
Total Contact Hours		**50**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (30%)				Practical (20%)		
		CLA-1 (5%)	Mid-1 (10%)	CLA-2 (5%)	Mid-2 (10%)		Theory (30%)	Practical (20%)
Level 1	Remember							
	Understand							
Level 2	Apply	80%	70%	80%	70%	40%	70%	
	Analyse							
Level 3	Evaluate	20%	30%	20%	30%	40%	30%	100%
	Create							
Total		100%	100%	100%	100%	100%	100%	100%

Recommended Resources

1. Problem solving with C++ -9e- Walter Savitch – Pearson.
2. The complete Reference C, Fourth REdition – Herbert Schildt – MC Graw Hill.
3. Programming in Python 3, A complete introduction to Python language - 2e - Mark Summerfield – Addison-Wiley.

Course Designers

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**
				0	0	1	1
Pre-Requisite Course(s)	ISES 101	**Co-Requisite Course(s)**		**Progressive Course(s)**			
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)														
	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			
Outcome 2		2		1											
Outcome 3			2	3	1							2			
Outcome 4								2	3	2		2			
Outcome 5										3					
Average		**2**	**2**	**2**				**2**	**3**	**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

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

Introductory Biology for Engineers

Course Code	BIO 103	**Course Category**	FIC	**L**	**T**	**P**	**C**
				2	0	0	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Department of Biological Sciences	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the importance of Biological Sciences
2. To understand the biomolecules and their importance in biological systems.
3. To understand the structure and function of prokaryotic and eukaryotic cells, as whole entities and in terms of their subcellular processes including the molecular biology of cells.
4. To understand the importance of bioinformatics in biological sciences research

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain the importance of biology in everyday life.	2	80%	75%
Outcome 2	Describe the evolution of life forms and the importance of biomolecules in living systems	2	80%	65%
Outcome 3	Explain the structure of different types of cells and cellular respiration, photosynthesis.	2	70%	65%
Outcome 4	Describe the molecular biology of cells and the process of cell division	2	70%	65%
Outcome 5	Discuss the use of bioinformatics tools for analysis of DNA and proteins.	2	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	3	2	3	3	1	1	3	3	3	3		2			
Outcome 2	3	2	3	3	2	1	3		1			2			
Outcome 3	3	2	3	3	3	1	3		1			2			
Outcome 4	3	2	3	3	3	1	3		1			2			
Outcome 5	3	2	3	3	3	3	2		2			3			
Average	**3**	**2**	**3**	**3**	**2**	**1**	**3**	**3**	**2**	**3**		**2**			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**Biomolecules**	**6**		
	Why study Biology?	1	1	1, 2, 3
	Evolution of complex biomolecules	1	1, 2	1, 2, 3
	Life on earth	1	1, 2	1, 2, 3
	Biomolecules - carbohydrates	1	1, 2	1, 2, 3
	Biomolecules – lipids and fats	1	1, 2	1, 2, 3
	Biomolecules – nucleic acids and proteins	1	1, 2	1, 2, 3
Unit 2	**Cell Biology**	**6**		
	Prokaryotic cell structure	2	1, 2, 3	1, 2, 3
	Eukaryotic cell (Animal and Plant) - structure and functions of organelles	2	1, 2, 3	1, 2, 3
	Diversity of life: virus, bacteria, archaea and eukarya	2	1,2,3	1, 2, 3
Unit 3	**Cell Physiology**	**6**		
	Membrane transport	1	2,3,4	1, 2, 3
	Cellular respiration and energy generation	2	2,3,4	1, 2, 3
	Brief account of Photosynthesis	1	2,3,4	1, 2, 3
	Enzymes and their kinetics	1	2,3,4	1, 2, 3
	Vitamins, Hormones	1	2,3,4	1, 2, 3
Unit 4	**Molecular Biology**	**6**		
	DNA and Chromosomes: structure and organization	1	2,3	1, 2, 3
	Central Dogma- DNA replication, transcription and translation	2	2,3	1, 2, 3
	Cell division – mitosis and meiosis	1	2,3	1, 2, 3
	Mutations, Cancer, and genetic diseases.	2	2,3	1, 2, 3
Unit 5	**Biological Sequences and Databases**	**6**		
	Concept of genomics, transcriptomics, proteomics, and metabolomics	1	2,3,5	4, 5
	FASTA file format	1	2,3,5	4, 5
	Biological databases – NCBI	1	2,3,5	4, 5
	Applications of BLAST and protein/Gene ID conversion	1	2,3,5	4, 5
	Hands on experience in analyzing biological data using above mentioned tools	2	2,3,5	4, 5
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (15%)	CLA-2 (10%)	CLA-3 (15%)	
		Th	Th	Th	Th	Th
Level 1	Remember	90%	90%	90%	80%	80%
	Understand					
Level 2	Apply	10%	10%	10%	20%	20%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Thrives in Biochemistry and Molecular Biology, Edition 1, 2014, Cox, Harris, Pears, Oxford University Press.
2. Thrives in Cell Biology, Ed. 1, 2013, Qiuyu Wang, Chris Smith and Davis, Oxford University Press.
3. Genetics: A Molecular Approach by Peter J Russell, 3rd edition, Pearson International Edition.
4. Bioinformatics Introduction – Mark Gerstein

Other Resources

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

Course Designers

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

Data Structures

Course Code	CSE 107	**Course Category**	FIC	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the basic concepts such as abstract data types, linear and non-linear data structures.
2. To understand the behaviour of data structures such as arrays, linked lists, stacks, queues, trees, hash tables, search trees, graphs, and their representations.
3. To provide an independent view of data structures, including its representation and operations performed on them, which are then linked to sorting, searching and indexing methods to increase the knowledge of usage of data structures in an algorithmic perspective.
4. To choose an appropriate data structure for a specified application.

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	Compare and contrast the algorithms for linked list, stack and queue operations.	4	77%	70%
Outcome 2	Illustrate algorithms for Binary Search Trees and AVL Trees.	4	75%	70%
Outcome 3	Analyze Graph traversal and minimum cost spanning tree algorithms.	4	72%	70%
Outcome 4	Distinguish searching and sorting techniques.	3	78%	80%

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

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	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	
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 Data Structures	9		
	Abstract Data Type (ADT), Time and space requirements of algorithms	2	1	1
	Array ADT, Representing polynomials	1	1	1,2
	Sparse matrix using arrays and its operations	1	1	1
	Stacks: representation and application, implementation of stack operations using C.	1	1	1
	Example applications on Stacks	1	1	
	Queues: representation and application, implementation of queue operations using C.	1	1	1,2
	Example applications on Queues	2	1	1,2
Unit 2	Linked lists	8		
	Linked lists: Single linked lists representation	1	1	1,2
	Implementation of linked list various operation using C	3	1	1
	Doubly linked list representation and Implementation of doubly linked list various operation using C	2	1	5
	Implementation of Circular linked list various operation using C	2	1	4,5
Unit 3	Trees	10		
	Tree terminology	1	2	1
	Binary tree, Representation of Binary Trees using Arrays and Linked lists	1	2	1
	Binary search tree	1	2	1
	Binary Search Trees- Basic Concepts, BST Operations: Insertion, Deletion	2	2	1
	Tree Traversals, Construction of tree using traversals	2	2	
	Applications, Expression tree	1	2	1
	General tree	1	2	1
	Heap Sort, Balanced Binary Trees, AVL Trees, Insertion, Deletion and Rotations.	1	2	1
Unit 4	Graphs	9		
	Graph terminology, Representation of graphs, path matrix	1	3	3
	BFS (breadth first search)	1	3	3
	DFS (depth first search)	2	3	3
	Topological sorting	1	3	3
	Priority Queues: Heap structures	1	3	5
	Binomial heaps, leftist heaps	1	3	2
	Shortest path algorithms.	1	3	2
	Implementation of shortest path algorithm using C	1	3	2
Unit 5	Sorting and Searching techniques	9		
	Bubble sort,selection sort and their algorithm analysis	1	4	2
	Insertion sort and its algorithm analysis	1	4	2
	Quick sort and its algorithm analysis	1	4	2,3
	Merge sort and its algorithm analysis	1	4	3
	Heap sort and its algorithm analysis	1	4	3
	Radix sort and its algorithm analysis	1	4	5
	Linear and binary search methods and its algorithm analysis.	2	4	5
	Hashing techniques and hash functions	1	4	5

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (5%)	Mid-1 (25%)	CLA-2 (10%)	CLA-3 (10%)	Th
Level 1	Remember	40%	40%	40%	40%	40%
	Understand					
Level 2	Apply	40%	40%	40%	40%	40%
	Analyse					
Level 3	Evaluate	20%	20%	20%	20%	20%
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Aaron M. Tenenbaum, Y Langsam and Mosche J. Augenstein "Data structure using C", Pearson publication.
2. Mark Allen Weiss, "Data structures and Algorithm Analysis in C", Pearson publications, Second Edition.
3. Horowitz, Sahani & Anderson Freed "Fundamentals of data structure in C", Computer Science Press.
4. Schaums Series, "Fundamental of Data Structures", Tata-McGraw-Hill
5. "Data Structures and Algorithms: Concepts, Techniques & Algorithm" G.A.V.Pai: Tata McGraw Hill.
6. Robert Kruse, C L Tondo, Bruce Leung and Shashi Mogalla. For pseudocode "Data Structures and Program Design in C"

Other Resources

1. Byron Gottfried, Mcgraw hill Education "Programming with C", Fourteenth reprint,2016
2. P. Dey and M Ghosh, Second Edition "Programming in C"., Oxford University Press

Course Designers

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

Data Structures Lab

Course Code	CSE 107L	**Course Category**	FIC		**L**	**T**	**P**	**C**
					0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	CSC 107	**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the basic concepts such as abstract data types, linear and non-linear data structures.
2. To understand the behaviour of data structures such as arrays, linked lists, stacks, queues, trees, hash tables, search trees, graphs, and their representations.
3. To provide an independent view of data structures, including its representation and operations performed on them, which are then linked to sorting, searching and indexing methods to increase the knowledge of usage of data structures in an algorithmic perspective.
4. To choose an appropriate data structure for a specified application.

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	Compare and contrast the algorithms for linked list, stack and queue operations.	4	77%	70%
Outcome 2	Illustrate algorithms for Binary Search Trees and AVL Trees.	4	75%	70%
Outcome 3	Analyze Graph traversal and minimum cost spanning tree algorithms.	4	72%	70%
Outcome 4	Distinguish searching and sorting techniques.	3	78%	80%

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

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Week 1 and 2	Simulate the following operations: a. Conversion of infix expression to postfix expression a. Evaluation of expressions a. Assignment-1: Tower of Hanoi is a mathematical puzzle where we have three rods and n disks. The objective of the puzzle is to move the entire stack to another rod, obeying the following simple rules: Only one disk can be moved at a time. Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack i.e. a disk can only be moved if it is the uppermost disk on a stack. i.No disk may be placed on top of a smaller disk You can choose to use the function *move (4, 1, 3, 2), w*here 4 represents the number of disks. 1 represents disks on source shaft, 3 represents the destination shaft which holds the disks after the move and finally 2 represents the intermediate support shaft – temporary storage. Write a C program to simulate the given problem and: Perform the algorithmic complexity analysis for the solution you propose. Resources: https://www.youtube.com/watch?v=YstLjLCGmgg	4	1	1,6
Week 3 & 4:	Simulate the following tasks: a. Implementation the following operations: enqueue, dequeue and finding an element: Linear Queue using arrays Circular queue arrays Priority queue singly linked list. b. Assignment-2: The "*4-Queens Problem*" consists of placing four queens on a 4 x 4 chessboard so that no two queens can capture each other. That is, no two queens are allowed to be placed on the same row, the same column or the same diagonal (both primary and secondary diagonals). Write a C program to simulate the given problem and perform the algorithmic complexity analysis for the solution you propose.	4	1	1,6
Week 5 &6:	Demonstrate the following though simulation: a. Create a singly linked list and perform the following operations: i.Add an element at the end of the list Delete an element from the beginning of the list Find the middle element of the list Search the given key form the list Polynomial addition using linked list Sparse matrix operations using linked list b. Assignment-3: Let us consider a small but busy airport with only one run-way (shown in figure). In each time unit, one plane can land or one plane can take off, but not both. Planes arrive ready to land or to take off at random times, so at any given unit of time, the runway may be idle or a plan may be landing or taking off, and there may be several planes waiting either to land or take off. We therefore need two queues, called *landing* and *takeoff*, to hold these planes. It is better to keep a plane waiting on the ground than in the air, so a small airport allows a plane to take off only if there are no planes waiting to land. Hence, after receiving requests from new planes to land or take off, our simulation will first service the head of the queue of planes waiting to land, and only if the landing queue is empty will it allow a plane to take off. We shall wish to run the simulation through many units of time, and therefore, we embed the main action of the program in a loop that runs for cur-time (denoting current time) from 1 to a variable end-time. the given scenario using and write the output for different inputs.	4	1	1,6
Week 7 & 8:	Write code to perform the following operations: a. Develop a code to test whether the given tree is binary tree or not. a. Implementation of Binary tree traversals techniques – pre-order, in-order, and post-order. a. Implementation of AVL tree and its operations	4	2	5

	a. Assignment-4: Given a mathematical expression, evaluate it using appropriate tree structure.			
Week 9:	Write a C program for implementation of Graph traversals techniques (BFS and DFS).	2	3	1,6
Week 10:	The Dijkstra's algorithm is an algorithm that gives the shortest path between two given vertices of a graph. In this problem we are given a directed graph with each edge having a non-negative weight. Thus, a solution requires a path of many other that costs least. We can think of the problem as like this: think graph G as a map of the airline routes, each node of the graph as the cities and the weights on each edge as the cost of flying from one city to another city. The solution we have to find a routing from a city v to city w such that the total cost is minimum. Write a C program to simulate the given problem. That is find the shortest path between node A and node F in the given graph.	1	3	1,6
Week 11:	Write a C program for Linear search and Binary search algorithms. What is the best case and worst-case time complexity of those searching algorithms?	2	4	2
Week 12:	Write a C program for bubble sort algorithm. What is the best case and worst-case time complexity of Bubble sort algorithm? Write a C program for Selection sort algorithm. What is the worst case or average case time complexity of selection sort algorithm?	2	4	2
Week 13:	Write a C program for Insertion sort algorithm. What is the worst case or average case time complexity of Insertion sort algorithm?	1	4	2
Week 14:	Write a C program for Quick sort algorithm. What is the worst case or average case time complexity of Quick sort algorithm?	1	4	3
Week 15:	Write a C program for Merge sort algorithm. What is the worst case or average case time complexity of Merge sort algorithm?	1	4	3

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)		End Semester Exam (50%)
		Weekly Evaluation (30%)	Project (20%)	Final Exam (50%)
Level 1	Remember	40%	40%	40%
	Understand			
Level 2	Apply	40%	40%	40%
	Analyse			
Level 3	Evaluate	20%	20%	20%
	Create			
Total		100%	100%	100%

Recommended Resources

1. Aaron M. Tenenbaum, Y Langsam and Mosche J. Augenstein "Data structure using C", Pearson publication.
2. Mark Allen Weiss, "Data structures and Algorithm Analysis in C", Pearson publications, Second Edition.
3. Horowitz, Sahani & Anderson Freed "Fundamentals of data structure in C", Computer Science Press.
4. Schaums Series, "Fundamental of Data Structures", Tata-McGraw-Hill
5. "Data Structures and Algorithms: Concepts, Techniques & Algorithm" G.A.V.Pai: Tata McGraw Hill.
6. Robert Kruse, C L Tondo, Bruce Leung and Shashi Mogalla. For pseudocode "Data Structures and Program Design in C"

Other Resources

1. "Programming with C", Byron Gottfried, Mcgraw hill Education, Fourteenth reprint,2016
2. "Programming in C". P. Dey and M Ghosh, Second Edition, Oxford University Press.
3. Data Structures and Program Design in C by Robert Kruse, C L Tondo, Bruce Leung and Shashi Mogalla. For pseudocode, refer the following pages 201 to 209.
4. Online resources: Use the following link to get a better understanding https://www.youtube.com/watch?v=TrR-suFO4to&list=PLWZxDaGQjf0sgrCJXH- OjMQQUcQlFcUsP&index=

Course Designers

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

Basic Electrical and Electronics

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

Course Objectives / Course Learning Rationales (CLRs)

1. To provide the basic idea on electrical and electronic circuits.
2. Describe the laws and concepts on electrical circuits.
3. Discuss the network theorems under DC Excitation
4. Conduct Steady State Analysis on Pure R, L, C Circuits, RL, RC and RLC circuits under single-phase AC Excitation.
5. Illustrate the basic semiconductor devices, analog circuits and 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	Describe the application on electrical engineering in daily life	2	70%	70%
Outcome 2	Discuss the laws and concepts for electrical circuits.	2	70%	70%
Outcome 3	Apply the network theorems under DC Excitation	3	70%	70%
Outcome 4	Conduct Steady State Analysis on Pure R, L, C Circuits, RL, RC and RLC circuits under single-phase AC Excitation.	2	70%	70%
Outcome 5	Describe the basic semiconductor devices and applications.	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	3		1		2				1	1		2	2	1	
Outcome 2	3	3	1		2				1	1		2	2	1	
Outcome 3	3	3	1		2				1	1		2	2	1	
Outcome 4	3	3	1		2				1	1		2	1	1	
Outcome 5	3	3	1		2				1	1		2	2	1	
Average	3	2	1		2				1	1		2	2	1	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Basic Circuit Analysis**	**8**		
	Ohm's law, Kirchhoff's laws, Concept of Node, Path, Loop, Branch, Mesh	2	1, 2	1, 2
	Voltage and Current Division, Ideal and Practical Voltage and Current Source, Source transformations	2	1, 2	1, 2
	Nodal Analysis and Supernode - Presence of independent voltage and current sources.	2	1, 2	1, 2
	Mesh Analysis and Super mesh - Presence of independent voltage and current sources. Illustrative examples.	2	1, 2	1, 3
Unit 2	**Network Theorems with DC Source**	**6**		
	Introduction to Network Theorems and Techniques, Superposition Theorem	1	1, 3	2, 3
	Thevenin's Theorem	2	1, 3	1, 2
	Norton's Theorem	1	1, 3	1, 2
	Maximum Power Transfer Theorem, Illustrative examples.	2	1, 3	1, 2
Unit 3	**Single-Phase AC Circuits**	**11**		
	Basic Concepts Related to Generation of Sinusoidal AC Voltage. Definition and Numerical values of Average Value, Root Mean Square Value, Form Factor and Peak Factor for sinusoidal varying quantities	2	1, 4	1, 2
	Steady State Analysis of Pure R, L, C Circuits.	2	1, 4	1, 2
	Steady State Analysis of RL, RC and RLC Series Circuits with Phasor Diagrams	5	1, 4	1, 2
	Definitions of Real Power, Reactive Power, Apparent Power, and Power Factor. Concepts of Resonance Illustrative examples.	2	1, 4	1, 2
Unit 4	**Semiconductor Devices and Circuits**	**12**		
	PN junction diode structure	1	1, 5	1, 2
	Forward and reverse bias operation and characteristics of PN junction diode	1	1, 5	1, 2
	Half-wave, full wave, bridge rectifiers, clipping circuits using PN junction diode	2	1, 5	2, 3
	Bipolar junction transistors (BJTs) structure and operation	2	1, 5	1, 2
	common-base, common-collector, and common-emitter configurations using BJTs	6	1, 5	1,2
Unit 5	**Basic Analog Circuits and Applications**	**8**		
18.	Characteristics of an operational amplifier and Definitions of characteristics	3	1, 5	1, 2
19.	Inverting and non-inverting op-amps, summing amplifier, Difference amplifier, Integrator and differentiator design using op-amp	3	1, 5	4,5
20.	Op Amp Applications as Voltage to Current Converter and Current to Voltage converters, filters	2	1, 5	1, 2
Total Contact Hours		**45**		

Learning Assessment

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

Recommended Resources

1. William H Hayt, J E Kemmerly and Steven M Durbin, "Engineering Circuit Analysis", McGraw Hill, 8th Edition, 2011.
2. Abhijit Chakrabarti, "Circuit Theory Analysis and Synthesis", Dhanpat Rai & Co. 7th Edition, 2017.
3. Online Sources

Other Resources

1. Electrical Engineering Fundamentals, Vincent Del Toro, Second Edition, PHI
2. Fundamentals of Electrical Engineering, Second edition, Leonard S. Bobrow, Oxford University press, 2011

Course Designers

1. Dr. Tarkeshwar, Asst Professor, Department of EEE, SRM University - AP
2. Dr. Somesh Vinayak Tewari, Asst Professor, Department of EEE, SRM University - AP

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

Basic Electrical and Electronics Lab

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

Course Objectives / Course Learning Rationales (CLRs)

1. To provide the basic idea for electrical and electronic circuits.
2. Describe the laws and concepts on electrical circuits.
3. Discuss the network theorems under DC Excitation
4. Conduct Steady State Analysis on Pure R, L, C Circuits, RL, RC and RLC circuits under single-phase AC Excitation.
5. Summarize the basic semiconductor devices, analog circuits and 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	Describe the electrical engineering application in daily life	2	70%	70%
Outcome 2	Discuss the electrical circuits laws and concepts	2	70%	70%
Outcome 3	Apply the network theorems under DC Excitation	3	70%	70%
Outcome 4	Conduct Steady State Analysis on Pure R, L, C Circuits, RL, RC and RLC circuits under single-phase AC Excitation.	2	70%	70%
Outcome 5	Describe the basic semiconductor devices and applications.	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	3		1		2				1	1		2	2	1	3
Outcome 2	3	3	1		2				1	1		2	2	1	3
Outcome 3	3	3	1		2				1	1		2	2	1	3
Outcome 4	3	3	1		2				1	1		2	1	1	3
Outcome 5	3	3	1		2				1	1		2	2	1	3
Average	**3**	**2**	**1**		**2**				**1**	**1**		**2**	**2**	**1**	**3**

Course Unitization Plan

Exp. No.	Name of Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Verification of Ohm's Law	3	1,2	1, 2
2	Verification of Kirchoff's Law	3	1,2	1, 2
3	Verification of Superposition theorem	3	1,3	1, 2
4	Verification of Thevenin's and Norton's theorem	3	1,3	1, 3
5	Verification of Maximum Power transfer theorem.	3	3,4	1, 2
6	P-N junction diode I-V characteristics	3	1,5	4, 5
7	Application of P-N junction diode	3	1,5	1, 3
8	BJT I-V characteristics (I/P and O/P)	3	4,5	1, 2
9	Op-Amp Inverting and Non-inverting mode - Gain verification	3	1,5	2, 4
10	Verification of truth tables of basic logic gates	3	3,5	1, 2
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)			End Semester Exam (50%)
		Lab Performance (20%)	Observation Notes (10%)	Viva Voce + Model examination (20%)	
Level 1	Remember	30%	60%	30%	30%
	Understand				
Level 2	Apply	70%	40%	70%	70%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. William H Hayt, J E Kemmerly and Steven M Durbin, "Engineering Circuit Analysis", McGraw Hill, 8th Edition, 2011.
2. Abhijit Chakrabarti, "Circuit Theory Analysis and Synthesis", Dhanpat Rai & Co. 7th Edition, 2017.
3. Online Sources

Other Resources

1. Electrical Engineering Fundamentals, Vincent Del Toro, Second Edition, PHI
2. Fundamentals of Electrical Engineering, Second edition, Leonard S. Bobrow, Oxford University press, 2011

Course Designers

1. Dr. Tarkeshwar, Asst Professor, Department of EEE, SRM University - AP
2. Dr. Somesh Vinayak Tewari, Asst Professor, Department of EEE, SRM University - AP

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

Linear Algebra

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

Course Objectives / Course Learning Rationales (CLRs)

1. To make students understand the central ideas of linear algebra like solving linear equations performing matrix algebra, calculating determinants, finding eigenvalues and eigenvectors.
2. Equip the student with various solution techniques and modelling of linear and non-linear first and second-order differential equations, including systems of equations.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Use the systems of linear equations for solving given problems in science and engineering.	2	80%	70%
Outcome 2	Demonstrate the procedures of solving linear equations.	3	80%	70%
Outcome 3	Performing matrix algebra, calculating determinants, finding eigenvalues and eigenvectors.	3	80%	70%
Outcome 4	Demonstrate the qualitative nature of system of differential equations using matrix algebra.	3	70%	70%

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

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	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											
Outcome 2	2	3	2	2											
Outcome 3	2	3	2	2											
Outcome 4	3	3	3	3											
Average	2	3	2	2											

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	**Matrices and Gaussian elimination**	**10**		
	Introduction, Geometry of Linear Equations	1	1	1
	Gaussian Elimination	2	1,2	1
	Matrix Notation and Matrix Multiplication	2	2	1
	Triangular Factors and Row Exchanges	3	1,2	1
	Inverses and Transposes	2	3, 4	1
Unit II	**Vector spaces**	**9**		
	Vector spaces and Subspaces	1	1,2	1
	Solving Ax = 0 and Ax = b	2	1,2	1
	Linear Independence, Basis and Dimension	2	1,2	1
	The Four Fundamental Subspaces	2	1,2	1
	Graphs and Networks, Linear Transformations	2	2	1,2
Unit III	**Orthogonality**	**8**		
	Orthogonal Vectors and Subspaces	1	1,2	1
	Cosines and Projections onto Lines	2	,2,3	1
	Projections and Least Squares	3	2	1,2
	Orthogonal Bases and Gram-Schmidt	2	1,3	1,2
Unit IV	**Determinants**	**8**		
	ntroduction	1	3	1
	Properties of the Determinant	2	1,3	1
	Formulas for the Determinant	2	1,3	1
	Applications of Determinants	3	1,3	1,2
Unit V	**Eigenvalues and eigenvectors**	**10**		
	Introduction, Diagonalization of a Matrix	3	3	1,2
	Difference Equations and Powers Ak	2	3	1,2
	Differential Equations and etA and phase portrait	3	3,4	1,2
	Complex Matrices, Similarity Transformations	2	3	1,2
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (ds60%)				End Semester Assessments (40%)
		CLA-1 (15%)	Mid-1 (25%)	CLA-2 (10%)	CLA-3 (10%)	
Level 1	Remember	30%	20%	25%	25%	20%
	Understand	20%	30%	30%	25%	30%
Level 2	Apply	25%	30%	25%	25%	25%
	Analyse	25%	20%	20%	25%	25%
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. 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

Course Designers

SRM University *AP*, Andhra Pradesh

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

Engineering Physics

Course Code	PHY 101	**Course Category**	FIC		**L**	**T**	**P**	**C**
					2	0	0	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	PHY101L	**Progressive Course(s)**				
Course Offering Department	Physics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To understand fundamental concepts of classical mechanics and elastic properties of solids.
2. To understand laws of Geometrical and Wave Optics and waves properties of light.
3. To learn fundamentals of Electromagnetism and Maxwell's equation as the foundation of Maxwell's Equation.
4. To familiarize about particle properties of waves and related fundamentals.

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 concepts of classical mechanics	2	70%	65%
Outcome 2	Explain Electromagnetic Equations and its applications	2	70%	65%
Outcome 3	Illustrate Laws of Optics and waves properties of light	3	70%	65%
Outcome 4	Demonstrate particle properties of waves and related fundamentals	3	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					1				2			2			
Outcome 2					2				2			2			
Outcome 3		2			2				2			2			
Outcome 4		2			2				3			2			
Average		2			3				2			2			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Address ed	Referenc es Used
Unit 1	**CLASSICAL PHYSICS**	**8**		
	Introduction	1	1	1, 2
	Newton's laws of mechanics, Free body force diagram	1	1	1, 2
	Momentum and Impulse,Conservation of linear momentum	1	1	1, 2
	Work-Kinetic Energy Theorem and related problems	1	1	1,2
	Conservation of mechanical energy: Worked out problems	1	1	1, 2
	Elastic properties of solids, Stress-strain relationship, elastic constants, and their significance	1	1	1, 2
	Lab experiment: Hooke's law and determine spring constant for a given spring	2	1	4
Unit 2	**OPTICS**	**12**		
	Concept of Electromagnetic waves & EMW Spectra	1	3	1,2
	Geometrical & Wave Optics: Laws of reflection and refraction	1	3	1,2
	Concept of Interference	1	3	1,2
	Phase Difference and Path Difference	1	3	1,2
	Double-Slit Interference	1	3	1,2
	Diffraction: types and single slit	1	3	1,2
Unit 3	**MODERN PHYSICS**	**8**		
	Black Body Radiation; Wien's displacement law	1	4	1,2,3
	Discussion on failure of classical laws to explain Black Body Radiation, and concept of Planck's Hypothesis	1	4	1,2,3
	What is Light? Photon and Overview on Planck Constant	1	4	1,2,3
	Photoelectric effect – Concept and Experimental Setup	1	4	1,2,3
	Photoelectric effect – Intensity vs Current, Frequency vs Kinetic Energy, the drawback of Wave theory to explain Photoelectric effect	1	4	1,2,3
	Wave properties of particle: De Broglie wave	1	4	1,2,3
Unit 4	**ELECTRO-MAGNETISM – I**	**8**		
	Focus on Maxwell's Equation I: Discuss lines of force and Electrostatic flux, Introduce Gauss's law (differential and integral form)	1	2	1, 2, 5
	Application of Gauss Law: ES field due to infinite wire and sheet.	1	2	1, 2, 5
	Electrostatic field due to conducting and insulating sphere.	1	2	1, 2, 5
	Concept of Electrostatic Potential and Potential Energy Inter-relation with electrostatic field.	1	2	1, 2, 5

	Capacitor and Capacitance:	1	2	1, 2, 5
	Capacitance of a parallel plate capacitor.	1	2	1, 2, 5
Unit 5	**ELECTRO-MAGNETISM - II**	**10**		
	Introduce Biot-Savart Law as an alternative approach to calculate magnetic field.	1	2	1, 2, 5
	Calculate Magnetic field due to finite current element using Biot Savart Law.	1	2	1, 2, 5
	Focus on Maxwell's Equation IV: Discuss Ampere's circuital law.	1	2	1, 2, 5
	Calculate Magnetic field due to Infinite wire and Solenoid using Ampere's Law.	1	2	1, 2, 5
	Focus on Maxwell's Equation III: Lenz's Law and Faraday's law: Induced EMF and Current	1	2	1, 2, 5
	Describe Maxwell Equations as the foundation of electro-magnetism. Derive differential forms starting from Integral forms. Discuss Physical Significance.	1	2	1, 2, 5

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**					**End Semester Exam (50%)**	
		Theory (30%)				**Practical (20%)**		
		CLA-1 (5%)	**Mid-1 (10%)**	**CLA-2 (5%)**	**Mid-2 (10%)**	**Internal**	**Th**	**Prac**
Level 1	Remember	70%	60%	50%	40%	50%	30%	30%
	Understand							
Level 2	Apply	30%	40%	50%	60%	50%	70%	70%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**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. University Physics with Modern Physics with Mastering Physics - D Young, Roger A Freedman And Lewis Ford, XII Edition (2018), Publisher – PEARSON
3. Concept of Modern Physics - Arthur Beiser, Shobhit Mahajan, S Rai, 2017 Edition, Publisher - Tata McGraw Hill
4. Laboratory manuals, SRM University-AP

Other Resources

1. Introduction to Electrodynamics – David J. Griffiths. 4th Edition (2012), Publisher - PHI Eastern Economy Editions
2. Electricity and Magnetism - A S Mahajan and A A Rangwala, Revised of 1 Edition (2001), Publisher - McGraw-Hill.

Course Designers

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

Engineering Physics Lab

Course Code	PHY 101L	**Course Category**	FIC		**L**	**T**	**P**	**C**
					0	**0**	1	**1**
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	PHY101	**Progressive Course(s)**				
Course Offering Department	Physics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Operate physics equipment and measurement tools experience.
2. Determine physical parameters of mechanics, thermodynamics, 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	Illustrate equipment operation and analysis	2	70%	65%
Outcome 2	Compute time period, acceleration due to gravity, viscosity and spring constant	3	70%	65%
Outcome 3	Explain working principle of compound pendulum, spring and thermodynamic laws	2	70%	65%
Outcome 4	Verify the laws of electromagnetism and optics using experimental results	5	70%	65%
Outcome 5	Plot graphs and analyse the experimental results	5	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		3	2	3	3				3						
Outcome 2		3	2	3	3				3						
Outcome 3	2	3	3	3	3				2			1			
Outcome 4	2	3	2	3	3				3						
Outcome 5		3	2	3	3				3			2			
Average	**2**	**3**	**2**	**3**	**3**				**3**			**2**			

Course Unitization Plan

Sl	Experiment Description	Required Contact Hours	CLOs Addressed	References Used
1	Moment of inertia of a flywheel	2	1,2,5	1,2
2	Hooke's law and determine spring constant for a given spring	2	1,2,5	1,2
3	Compound Pendulum: Acceleration due to gravity and radius of gyration of the given pendulum	4	1,2,5	1,2
	To determine the rigidity modulus of steel wire by torsional Pendulum **[Optional]**			
	To calculate Young's modulus of a given material by deflection method **[Optional]**			
4	Faraday law & Induced E.M.F: Measurement of the induced voltage and calculation of the magnetic flux induced by a falling magnet	2	1,4,5	1,2
	To study the B-H curve of the given material and the permeability curve of the given material. [**Optional**]			
5	Biot-savart law: To study the dependence of magnetic field on the current and magnetic field along the axis of a current carrying circular loop	4		
	Hall Effect: Determination of type of semiconductor and carrier concentration in a given semiconductor **[optional]**		1,4,5	1,2
	Magnetic field in Helmholtz coil [**Optional**] a. To investigate the spatial distribution of magnetic field between coils and determine the spacing for uniform magnetic field. b. To demonstrate the superposition of the magnetic fields of the two individual coils.		1,4,5	1,2
6	To determine the dielectric constant of air using dielectric constant kit.	4	1,4,5	1,2
	Measurement of Resistivity of a semiconductor using Four probes [**Optional**]		1,4,5	1,2
7	Michelson interferometer kit with diode laser	4	1,4,5	1,2
	Resolving power of A Telescope **[Optional]**			
	Balmer Series and Rydberg constant **[Optional]**			
8	He-Ne laser kit: Optical Interference and Diffraction	2	1,4,5	1,2
	Solar cell characteristics**[Optional]**			
	Frank Hertz Experiment **[Optional]**			
9	Particle size measurement	4	1,4,5	1,2
10	Verification of Stefan's Law	2	1,3,5	1,2
	Measurement of specific heat capacity of any given material **[optional]**		1,3,5	1,2
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 Voce + Model examination (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember				40%		30%		
	Understand								
Level 2	Apply		40%		60%		30%		50%
	Analyse								
Level 3	Evaluate		60%				40%		50%
	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]

Course Designers

SRM University *AP*, Andhra Pradesh

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

Engineering Graphics

Course Code	ENG 105	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	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To acquire knowledge about different types of lines & use of different types of pencils in an engineering drawing and to know how to represent letters & numbers in drawing sheet
2. To acquire abilities to draw projection of points, straight lines, solids and to know about types of angle of projections
3. To make the students understand the concept of development of different types of surfaces and projections of sections.
4. To acquire abilities to draw isometric projection and perspective projections.
5. To understand geometric dimensioning and tolerances and to gain the knowledge to use software tool for creating machine drawing views.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Interpret engineering drawings using drawing instruments based on BIS codes	3	70%	65%
Outcome 2	Apply isometric and orthographic views for given objects	3	70%	65%
Outcome 3	Apply projections of points, lines & solids; and sectioning for given objects	3	70%	65%
Outcome 4	Illustrate the development of surfaces for given objects	3	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	3	2	1	2	2				2			3	3	2	3
Outcome 2	3	3	2	3	2				3			3	3	2	3
Outcome 3	3	3	3	3	2				3			3	3	2	3
Outcome 4	3	3	3	3	3				2			3	3	3	3
Average	3	3	3	3	3				3			3	3	2	3

Course Unitization Plan

Course Unitization Plan-Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	**Introduction**	**19**		
	Importance of graphics in engineering applications, drawing instruments and accessories, BIS code of practice for general engineering drawing, drawing sheet layouts, Folding of drawing sheets, Lettering and dimensioning, Scales.	5	1	1,3
	Orthographic Projection of Points.	2	1	1,3
	Projection of straight lines inclined to one of the reference planes.	2	1,3	1,3
	Projection of straight lines inclined to both the principal planes.	2	1,3	1,3
	True length and inclination of lines with reference planes.	2	1,3	1,3
	Projection of planes inclined to both the principal planes.	3	1,3	1,3
	Projection of simple solids with axis inclined to one of the reference planes.	3	1,3	1,3
UNIT II	**Sections and development**	**6**		
	Sections of simple solids in simple vertical positions with section planes inclined to one of the reference planes- Obtaining true shape of the section.	4	1,2,3	1, 3, 4
	Development of surfaces of simple and sectioned solids.	3	1,2,4	1, 3, 4
UNIT III	**Isometric and perspective projection**	**8**		
	Isometric projection of simple solids and truncated solids	3	1,2,3	1, 2, 3, 4
	Conversion of isometric views to orthographic views and vice versa. Perspective projection of simple solids.	5	1,2,3	1, 2, 3, 4
UNIT IV	**Geometric dimensioning and tolerancing**	**5**		
	GD&T-rules & concepts, Geometric characteristics, Geometric modifiers.	3	1,3,4	1, 3
	Datums and datum reference, Feature control frame	2	1,3,4	1, 3
UNIT V	**Free hand sketching and CAD**	**7**		
	Free hand sketching of real objects, Free hand sketching of multiple views from pictorial Views.	3	1,2,3,4	1, 2, 3
	CAD-SolidWorks- Creation of 2D drawings, Solid modelling, Sectioning of solids, Assembly drawings, Exploded views, Creation of technical drawings	4	1,2,3,4	1, 2, 3
	Total Contact Hours	**45**		

Learning Assessment

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

Recommended Resources

1. Bhatt, N.D, Engineering Drawing, Charotar Publishers, 2014
2. Bhatt, N.D, Machine Drawing, Charotar Publishers, 2014
3. Venugopal, K. and Prabhu Raja, V., Engineering Graphics, Eighth Edition (Revised), New Age International Publishers, Chennai, 2007.
4. Narayanan, K. L. and Kannaiah, P., Engineering Graphics, Scitech Publications, Chennai, 1999.
5. Engineering Graphics manual, SRM University AP.

Course Designers

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

Engineering Graphics Lab

Course Code	ENG 105L	**Course Category**	CC	**L**	**T**	**P**	**C**
				0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To acquire knowledge about different types of lines & use of different types of pencils in an engineering drawing and to know how to represent letters & numbers in drawing sheet
2. To acquire abilities to draw projection of points, straight lines, solids and to know about types of angle of projections
3. To make the students understand the concept of development of different types of surfaces and projections of sections.
4. To acquire abilities to draw isometric projection and perspective projections.
5. To understand geometric dimensioning and tolerances and to gain the knowledge to use software tool for creating machine drawing views.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Interpret engineering drawings using drawing instruments based on BIS codes	3	70%	65%
Outcome 2	Apply isometric and orthographic views for given objects	3	70%	65%
Outcome 3	Apply projections of points, lines & solids; and sectioning for given objects	3	70%	65%
Outcome 4	Illustrate the development of surfaces for given objects	3	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	3	2	1	2	2				2			3	3	2	3
Outcome 2	3	3	2	3	2				3			3	3	2	3
Outcome 3	3	3	3	3	2				3			3	3	2	3
Outcome 4	3	3	3	3	3				2			3	3	3	3
Average	3	3	3	3	3				3			3	3	2	3

Course Unitization Plan-Practical

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	GUI familiarity, features, commands, shortcuts, mouse features, drop down menus etc.	2	1	1,2,3,4,5
2.	Sketch entities Inference line, centerline, line, circle, arc, ellipse.	2	1	1,2,3,4,5
3.	Rectangle, slots, polygon, spline, points, text, snap, grid sketch Tools fillet, chamfer, offset, trim, extend, mirror, copy, rotate, scale, sketch, blocks, create blocks, add/remove, explode.	4	1,2	1,2,3,4,5
4.	Assignment on 2-D sketching with geometrical and dimensional constraints.	4	1,2	1,2,3,4,5
5.	Assignment on parametric solid modeling of a machine component	5	1,2,3	1,2,3,4,5
6.	Assignment on solid modelling of the parts of a machine (min. 5 components).	5	1,2,3	1,2,3,4,5
7.	Assignment on assembly modelling of the parts modelled in assignment 3 using proper mating conditions and generation of exploded view.	4	1,2,3,4	1,2,3,4,5
8.	Generation of production drawings of the parts and assembly with appropriate tolerance	4	1,2,3,4	1,2,3,4,5
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**		**End Semester Exam (50%)**
		Lab (50%)		
		Lab Performance (35%)	**Observation note (15%)**	**Prac**
Level 1	Remember	40%	30%	40%
	Understand			
Level 2	Apply	60%	70%	60%
	Analyse			
Level 3	Evaluate			
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Bhatt, N.D, Engineering Drawing, Charotar Publishers, 2014
2. Bhatt, N.D, Machine Drawing, Charotar Publishers, 2014
3. Venugopal, K. and Prabhu Raja, V., Engineering Graphics, Eighth Edition (Revised), New Age International Publishers, Chennai, 2007.
4. Narayanan, K. L. and Kannaiah, P., Engineering Graphics, Scitech Publications, Chennai, 1999.
5. Engineering Graphics manual, SRM University AP

Course Designers

SRM University *AP*, Andhra Pradesh

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

Engineering Mechanics

Course Code	ENG 115	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	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To give the students an overview of the various branches of mechanics and make them understand the physics behind various practical phenomena in the field of mechanical engineering.
2. To teach students how to analyse planar and spatial systems and determine the forces in members of trusses and frames.
3. To teach the students how to find the motion parameters for a body subjected to a given force system.
4. To make the learn the concepts of centroid and second moment of area of various objects and the fundamentals of dynamics.

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 mechanical and physical principles to design mechanical systems.	3	80%	75%
Outcome 2	Solve problems on finding the forces and moments associated with a static system.	3	70%	65%
Outcome 3	Determine the motion parameters related to physical systems under given forces.	2	70%	65%
Outcome 4	Implement concepts of dynamics in given problems.	5	80%	75%

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

Course Unitization Plan

Session	Description of Topic	Contact hours required	CLOs addressed	References used
	UNIT I: STATICS OF PARTICLES AND RIGID BODIES	**14**		
1.	forces on particles	1	1,2	1-4
2.	resolution of forces	1	1,2	1-4
3.	free body diagrams	1	1,2	1-4
4.	Equilibrium of particles	1	1,2	1-4
5.	Equilibrium of particles (Numerical Problems)	1	1,2	1-4
6.	forces in a plane	1	1,2	1-4
7.	forces in space	1	1,2	1-4
8.	forces in space (Numerical Problems)	1	1,2	1-4
9.	forces in space (Numerical Problems)	1	1,2	1-4
10.	force equivalence	1	1,2	1-4
11.	force equivalence (Numerical Problems)	1	1,2	1-4
12.	Rigid body equilibrium	1	1,2	1-4
13.	Rigid body equilibrium (Numerical Problems)	1	1,2	1-4
14.	Rigid body equilibrium (Numerical Problems)	1	1,2	1-4
	UNIT II: FRICTION	**5**		
15.	Laws of friction, dry friction	1	1,2	1-4
16.	wedge friction, rolling friction	1	1,2	1-4
17.	Belt friction,	1	1,2	1-4
18.	Ladder friction	1	1,2	1-4
19.	Screw friction	1	1,2	1-4
	UNIT III: ANALYSIS OF TRUSSES AND CENTROIDS	**10**		
20.	Types of loads, type of supports, reaction	1	2,3	1-4
21.	simple trusses, method of joints	1	2,3	1-4
22.	Method of joints	1	2,3	1-4
23.	Method of sections (Numerical Problems)	1	2,3	1-4
24.	Method of Joints (Numerical Problems)	1	2,3	1-4

25.	Method of Joints (Numerical Problems)	1	2,3	1-4
26.	Center of gravity-lines, areas	1	2,3	1-4
27.	Volumes	1	2,3	1-4
28.	Determination of centroid-integration method	1	2,3	1-4
29.	Determination of centroid-integration method (Numerical Problems)	1	2,3	1-4
	UNIT IV: MOMENT OF INERTIAS OF SURFACE AND VOLUMES	**6**		
30.	Determination of moment of inertia using area integration method	1	3,4	1-4
31.	Determination of moment of inertia using area integration method	1	3,4	1-4
32.	Determination of moment of inertia using area integration method	1	3,4	1-4
33.	Analytical method, radius of gyration	1	3,4	1-4
34.	Polar moment of inertia,	1	3,4	1-4
35.	Moment of inertia of different sections	1	3,4	1-4
	UNIT V: DYNAMICS	**10**		
36.	Rectilinear motion	1	3,4	1-4
37.	Projectile motion, Newtons second law of motion,	1	3,4	1-4
38.	Projectile motion, Newtons second law of motion,	1	3,4	1-4
39.	D'Alemberts principle	1	3,4	1-4
40.	Work, energy	1	3,4	1-4
41.	Impulse momentum	1	3,4	1-4
42.	Impact/collision of elastic bodies	1	3,4	1-4
43.	oblique impact	1	3,4	1-4
44.	curvilinear motion	2	3,4	1-4
	Total contact hours - Theory	**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%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	20%		30%		10%		20%		20%	
	Understand										
Level 2	Apply	60%		50%		60%		60%		55%	
	Analyse										
Level 3	Evaluate	20%		20%		30%		20%		25%	
	Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. Vector Mechanics for Engineers: Statics and Dynamics by Ferdinand. P. Beer. E, Russell Johnston Jr., David Mazurek, Philip J Cornwell, McGraw - Hill, New Delhi, 10th Edition, 2013.
2. Engineering Mechanics by R. K. Bansal, Laxmi Publications Ltd, 2005
3. Engineering Mechanics by Meriam J.L and Kraige L.G., , Volume I - statics, Volume II - dynamics, 4. John Wiley & Sons, New York,7th Edition, 2012
4. Engineering Mechanics by Timoshenko, Young, Tata Mc-Graw Hill Book Company, 5th Edition, New Delhi

Course Designers

SRM University *AP*, Andhra Pradesh

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

Analytical Skills for Engineers

Course Code	AEC 105	Course Category	AEC	L	T	P	C
				1	0	1	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 categorize, apply and use thought process to distinguish between concepts of quantitative methods.
2. To prepare and explain the fundamentals related to various possibilities.
3. To critically evaluate numerous possibilities related to puzzles.
4. Explore and apply key concepts in logical thinking to business problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Use logical thinking and analytical abilities to solve quantitative aptitude questions from company specific and other competitive tests.	1	70%	60%
Outcome 2	Solve questions related to Aptitude from company specific and other competitive tests.	3	80%	70%
Outcome 3	Understand and solve puzzle questions from specific and other competitive tests	1	70%	60%
Outcome 4	Make sound arguments based on mathematical reasoning and careful analysis of data.	1	90%	80%

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

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Quantitative Aptitude**			
	Data interpretation – Introduction and basics to solve data interpretation	4	1,4	1,4
	Data interpretation line graphs, Data interpretation bar graph.	6	1,4	1,4
Unit II	**Quants**			
	Data interpretation – Pie charts,	2	1,4	1,4
	Data interpretation – Tabular, Data interpretation – case lets.	2	1,4	1,4
Unit III	Statistics	6	1,2	2,3
Unit IV	Functions and graphs	3	1,2	1,2
	graph theory with respect to coding	2	1,2	1,2
	math graph theory and coding problems	2	2,3	2,3
	discrete planar theory and coding problems.	3	1,2	2,4
Total Contact Hours		**30**		

Learning Assessment

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

Recommended Resources

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

Course Designers

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

Design Thinking and Product Design

Course Code	MCE 201	Course Category	CC	L	T	P	C
				0	1	1	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the importance of Design Thinking
2. Empathise to understand deeper and define the problem statement
3. Identify skills and personality traits of successful problem solving.
4. Apply standard problem-solving heuristics to aid in problem solving.
5. Apply problem-solving techniques to programming activities.
6. Formulate and successfully communicate the solutions to problems

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	use strong understanding of the Design Process and how it can be applied in a variety of product design settings	3	70%	65%
Outcome 2	Predict the unique needs of a company around specific challenges	3	70%	65%
Outcome 3	Employ empathy for target audiences from different "cultures"	3	70%	65%
Outcome 4	Apply innovative ideas through a rapid iteration cycle	3	70%	65%
Outcome 5	How to create physical prototypes / a visual representation of an idea	3	70%	65%
Outcome 6	prepare for challenging situations	3	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	3	2	1	2	2				2			3	3	2	3
Outcome 2	3	3	2	3	2				3			3	3	2	3
Outcome 3	3	3	3	3	2				3			3	3	2	3
Outcome 4	3	3	3	3	3				2			3	3	3	3
Outcome 5	3	3	3	3	2				3			3	3	2	3
Outcome 6	3	3	3	3	3				2			3	3	3	3
Average	3	3	3	3	3				3			3	3	2	3

Course Unitization Plan - Theory (Lecture/tutorial)

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Design Thinking**	**3**		
	What is Design Thinking and why is it popular?	1	1	1
	Innovative thinking		1,2	1,2
	What is a wicked problem and how can we solve it?	1	1,2	1,2
	The design thinking stages overview	1	1,2	1,2
Unit 2	**Design Thinking - Empathise**	**4**		
	Power of Empathy	1	3	1,2,3
	Probes for context mapping	2	1,2,3	1,2,3
	Power of stories in building empathy for the target group	1	1,3	1,2,3
Unit 3	**Design Thinking - Define**	**4**		
	Define problem	1	1,2,3,	1,3
	Frame insights	1	1,2,3	1,3
	Understand context	2	1,2,3	1,3
Unit 4	**Design Thinking - Ideate**	**4**		
	Brainstorm and ideate	2	1,2,3,4	1,2
	Divergence to Convergence	2	1,3,4	1,2
Unit 5	**Design Thinking – Prototype & Test**	**5**		
	Prototype to product	2	4,5,6,	1,2,5
	Prototyping methods	3	4,5,6	1,2,5
Total Contact Hours		**20**		

Course Unitization Plan - Project

Project Discussions	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	User Research methods (Interactive exercises) - Qualitative user research - Best practices of qualitative user research - Conducting user research exercises	2	1,2,3	1,2
2	CLA 1 - Project 1 (in teams) - Applying Design thinking	2	1,2,3	1,2,3

	- Empathy & Ideation principles & tools			
3	CLA 2 - Project 2 (in teams) - User research survey - Define project problem through analysis of survey	2	1,2,3	1,2,3
4	End project - Applying Design thinking/Innovation principles for product design - Product design	4	1,2,3,4,5,6	1,2,5
Total Contact Hours		**10**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**			**End Semester Project (50%)**
		CLA-1 (20%)	**CLA-2 (10%)**	**CLA-3 (20%)**	
Level 1	Remember	20%	40%	20%	20%
	Understand				
Level 2	Apply	40%	60%	40%	20%
	Analyse				
Level 3	Evaluate	40%	00%	40%	60%
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. The Design of Everyday Things by Don Norman
2. Change by Design by Tim Brown
3. The art of innovation by Tom Kelly
4. Creative Confidence: Unleashing the creative potential within us all by Tom Kelley and David Kelley
5. Product Design and Development by Karl T Urich, Steven D epinger, Maria C. Yang
6. Rethinking Design Thinking by GK VanPatter.

Course Designers

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

Differential Equations

Course Code	FIC 106	**Course Category**	FIC	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	MAT 111	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Introduction to the theory, qualitative & quantitative analysis of solutions of ordinary differential equations (ODEs).
2. Equip the student with various solution techniques and modelling of linear and non-linear first and second-order differential equations, including systems of equations.

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 the genesis of ordinary differential equations and geometrical interpretation.	2	70%	70%
Outcome 2	Solve first and higher order linear differential equations.	3	80%	70%
Outcome 3	Apply Picard's method of obtaining successive approximations of solutions to first order differential equations and power series method for higher order linear equations.	4	80%	70%
Outcome 4	Demonstrate the general solution of a linear differential equation using Laplace transformation technique.	4	70%	70%
Outcome 5	Formulate mathematical models for physical, chemical, and biological disciplines in the form of ordinary differential equations.	3	70%	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					3						
Outcome 2	3	3		1					3						
Outcome 3	2	3		1					3						
Outcome 4	3	3		2					3						
Outcome 5	3	2		2					3						
Average	3	2		2					2						

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit-I	**First Order Differential Equations**	**8**		
1	Geometric meaning of y'=f(x,y), Direction Fields	1	CO1	1
2	Euler's Method, Classification of ODEs (Linear, Non-linear, Exact, Separable	1	CO1, CO2	1,2
3	Integrating Factor, Bernoulli Equations	2	CO1, CO2	1,2
4	Existence of solution to initial value problem and Picard's approximation	2	CO1, CO3	1,2
5	Modelling (Free falling object, Radioactivity, RL-circuit).	2	CO5	1
Unit-II	**Second and Higher Order Linear ODEs**	**8**		
6	Homogeneous Linear ODEs	1	CO2	1,2
7	Modelling of Free Oscillations of a Mass-Spring System	2	CO5	1
8	Euler-Cauchy Equations	1	CO2	1,2
9	Non-homogeneous ODEs	2	CO2,CO4	1,2
10	Variation of Parameters, Modelling (Forced Oscillations, Electric Circuits)	2	CO2,CO5	1,2
Unit-III	**System of ODEs**	**9**		
11	Modelling physical problems as systems of ODEs	2	CO5	1
12	Wronskian, Phase-Plane Method	2	CO4	1,2
13	Qualitative Methods for Nonlinear Systems: Critical Points & Stability	3	CO4	1,2
14	Nonhomogeneous Linear Systems of ODEs	2	CO2, CO4	1,2
Unit-IV	**Series Solutions of ODEs**	**10**		
15	Introduction to power series method	1	CO1	1,2
16	Legendre's equation & polynomials	2	CO3	1,2
17	Properties of Legendre's polynomial and generating functio	2	CO3	1,2
18	Frobenius Method	2	CO2,CO3	1,2
19	Bessel's Equations & Functions and their properties	3	CO2,CO3	1,2
Unit-V	**Laplace Transforms**	**10**		
20	Existence of Laplace transform, and Laplace transform of standard functions	1	CO2,CO4	1,2
21	Shifting Theorems, Transforms of derivatives and integrals	2	CO3	1,2
22	Unit step function, Dirac's delta function	2	CO3	1,2
23	Inverse Laplace transforms, Convolution	2	CO3	1,2
24	Application: Solutions of ordinary differential equations using Laplace transforms	3	CO4,CO5	1,2
Total Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Assessments (40%)
		CLA-1 (15%)	Mid-1 (25%)	CLA-2 (10%)	CLA-3 (10%)	
Level 1	Remember	60%	50%	50%	50%	60%
	Understand					
Level 2	Apply	40%	50%	50%	50%	40%
	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-India.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India.

Other Resources

Course Designers

1. Dr. Tapan Kumar Hota, Assistant Professor, Dept. of Mathematics, SRM University-AP
2. Dr. Koyel Chakravarty, Assistant Professor, Dept. of Mathematics, SRM University-AP

SRM University *AP*, Andhra Pradesh

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

Mechanics of Materials

Course Code	MCE 202	Course Category	CC	L	T	P	C
				2	1	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand what the stresses and strains are and how to compute the stresses and strain in any components under different loading conditions
2. To learn how to compute shear force and bending moments for different types of beams and under different loading conditions
3. To understand how to compute the bending and shear stresses in means and apply to real world problems in mechanical engineering
4. To learn how to apply computer-based techniques in analyzing beams and similar structures.

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 stress, strain concepts and their relationships	2	70%	75%
Outcome 2	Compute shear forces and bending moments in the beams using SFD and BMD	3	70%	75%
Outcome 3	Compute deflections in the beams for given problems	3	70%	75%
Outcome 4	Utilize computer-based techniques to compute stress/strains in beams, and cylinders	3	70%	75%

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

Course Unitization Plan-Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Stress/Strains**	**9**		
	Stresses and strains- tensile, compressive, shear, bending, torsion	4	1,2,3,4	1,2
	Thermal stresses, hoop stresses, elastic constants, principal stresses, Mohr circle	5	1,2,3,4	1,2
Unit 2	**Beam bending**	**9**		
	Analysis of beams, type of beams	4	1,2	1,2
	Shear force and bending moment diagrams	2	1,2	1,2
	Analysis of beams subjected to different loads likes point load, uniformly distributed load, couples, etc	3	1,2	1,2
Unit 3	**Stresses in beams**	**9**		
	Bending stresses in beams	4	2	1,2
	Shear stresses in beams, combined stresses	5	2	1,2
Unit 4	**Deflection of beams**	**9**		
	Deflection, slope, radius of curvature in beams	3	1,2	1,2
	Macaulay method	3	1,2	1,2
	Double integration method	3	1,2	1,2
Unit 5	**Fixed and continuous beams**	**9**		
	Analysis of fixed beams	3	1,2,3	1,2
	Analysis of continuous beams	3	1,2,3	1,2
	Use of computer software like ansys to compute the stresses and strains in beams	3	1,2,3	1,2
Total Contact Hours		**45**		

Course Unitization Plan-Lab

Exp. No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	Tension spring	4	1, 2	1, 2, 3
2.	Compression spring	4	1, 2	1, 2,3
3.	Torsion	4	2, 3,4	1, 2, 3
4.	Fatigue	4	2, 3,4	1, 2, 3
5.	Charpy and izod impact test	4	2, 3,4	1, 2, 3
6.	Universal testing machine	4	2, 3,4	1, 2, 3
7.	Ansys software use	6	2, 3,4	1, 2, 3
Total contact hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)	
		CLA-1 (15%)	Mid-1 (15%)	CLA-2 (10%)	Prac int 10%		
		Th	Th	Th	Prac	Th 35%	Prac 15%
Level 1	Remember	40%	40%	30%	40%	30%	30%
	Understand						
Level 2	Apply	60%	60%	70%	60%	70%	70%
	Analyse						
Level 3	Evaluate						
	Create						
Total		100%	100%	100%	100%	100%	

Recommended Resources

1. Strength of materials by R.K. Rajput, S.Chand Publication, 2015
2. Strength of material, R K Bansal, Laxmi Pubication
3. Laboratory manual, Elements of Strucrure, SRM University AP

Course Designers

SRM University *AP*, Andhra Pradesh

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

Thermodynamics

Course Code	MCE 203	Course Category	CC	L	T	P	C
				2	1	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To acquire fundamental knowledge and understanding of thermal-mass interaction and many phenomena occurring in our surroundings which are based on these interactions.
2. To acquire abilities and capabilities in the area of basic principles of thermodynamics, entropy, and availability.
3. To understand the use of thermodynamics property data for use in engineering applications.
4. To gain the fundamentals of thermodynamic relations

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 thermodynamic laws to given engineering systems	3	70%	80%
Outcome 2	Describe entropy and availability	2	70%	80%
Outcome 3	Illustrate the properties of steam and fluids used for engineering applications based on steam properties and thermodynamics data book.	3	70%	80%
Outcome 4	Apply thermodynamic relations to engineering systems.	3	70%	80%

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

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

Course Unitization Plan-Theory

Unit No.	Unit Name	Required Contact Hours	CLOs addressed	References Used
UNIT I	**BASIC CONCEPTS of THERMODYNAMICS**	**5**		
	Basic Concepts Continuum and macroscopic approach.	1	1	1,2, 3,4
	Thermodynamic systems, thermodynamic properties and equilibrium.	0.5	1	1,2,4
	State of a system, state diagrams, paths and processes on state diagrams.	1.5	1, 4	1,2,3,4
	Concepts of heat and work, different modes of work.	1	1, 4	1,2, 3,4
	Zeroth law of thermodynamics and numerical problems.	1	1	1,2, 3,4
UNIT II	**First law of thermodynamics**	**12**		
	First Law of Thermodynamics, Concept of energy and various forms of energy.	2	1, 2	1, 2, 3
	Internal energy, enthalpy and specific heats.	2	1, 2	1, 2, 3
	First law applied to elementary processes and closed systems	2	1, 2	1, 2, 3
	First law of thermodynamics applied for a control volume	2	2, 3	1, 2, 4,5
	Steady and unsteady flow analysis.	2	1	1, 2, 3
	Perpetual motion machine I and numerical on first law of thermodynamics.	2	1	1, 2, 4, 5
UNIT III	**Second law of thermodynamics**	**12**		
	Limitations of the first law of thermodynamics.	0.5	1	1, 2, 3
	Concepts of heat engines, heat pumps/refrigerators and Perpetual motion machine II.	2.5	2	1, 2, 3
	Kelvin-Planck and Clausius statements and their equivalence.	2	2, 3	1, 2, 3
	Carnot cycle, Carnot principles/theorems and thermodynamic temperature scale.	3	2, 3	1, 2, 3,4
	Numerical problems.	2	2	1, 2, 4, 5
	Clausius inequality and concept of entropy.	1	2	1, 2, 4, 5
	Third law of thermodynamics and numerical problems.	1	2, 3	1, 2, 4, 5
UNIT IV	**Properties of steam**	**12**		
	Steam formation - Temperature entropy diagram-Mollier diagram.	2	1	1, 2, 4,5
	Specific properties of steam -Use of steam tables & Mollier chart.	4	1, 4	1, 2, 4, 5
	Methods of heating and expanding the steam - Constant volume heating, Constant pressure expansion, Isothermal expansion, Hyperbolic expansion, isentropic expansion and Polytrophic expansion.	3	1	1, 2, 3,4

	Throttling process and Dryness fraction measurement.	1	1, 4	1, 2, 3,4
	Numerical problems.	2	1, 4	1, 2, 4, 5
UNIT V	**Thermodynamic relations**	**4**		
	T-ds relations, Maxwell equations and Clapeyron equation.	2	4	1, 2, 3,4
	Joule-Thomson coefficient, coefficient of volume expansion.	1	4	1, 2, 3,4
	Adiabatic and isothermal compressibility.	1	1, 4	1, 2, 3,4
Total Contact hours		**45**		

Course Unitization Plan- Practical

S. No.	Experiment Name	Required Contact Hours	CLOs addressed	References Used
1.	Valve timing diagram for four stroke diesel or petrol engines	2	1, 3	1, 6
2.	Port timing of a two-stroke petrol engine	2	1, 3	1, 6
3.	Reciprocating air compressor	4	1, 3, 4	1, 6
4.	Determination of cop of a refrigeration system	4	1, 3, 4	1, 6
5.	Performance test on ac test rig	5	1, 3, 4	1, 6
6.	Study of steam boilers Part I: introduction to the types of steam boilers Part II: study of various types of boilers Part III: study of boiler mountings & accessories	10	1, 3, 4	1, 6
7.	Demonstration of various parts of BMW engine	3	1, 3, 4	1, 6
Total Contact hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (30%)				Practical (20%)		
		CLA-1 (5%)	Mid-1 (15%)	CLA-2 (5%)	CLA-3 (5%)		Th	Prac
Level 1	Remember	40%	30%	30%	40%	30%	40%	40%
	Understand							
Level 2	Apply	60%	70%	70%	60%	70%	60%	60%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Yunus A. Cengel and Michael A. Boles, Thermodynamics an Engineering Approach, McGraw Hill Education, 2015
2. P. K Nag, Engineering Thermodynamics, McGraw Hill Education (India) Private Limited, 2013
3. P. Chattopadhyay, Engineering Thermodynamics, Oxford University Press, 2015
4. Richard E. Sonntag, Claus Borgnakke, Fundamentals of Thermodynamics, John Wiley and Sons, 2009.
5. Claus Borgnakke, Gordon John Van Wylen, and Richard E Sonntag, THERMODYNAMICS DATABOOK, Wiley publishers, 2009
6. Laboratory Manual: Thermodynamics, Version 1.0, SRM University-AP, Aug 2018- Dec 2018

Other Resources

1. Enrico Fermi, Thermodynamics, Dover Publications Inc., 2012
2. Michael J. Moran & Howard N. Shapiro, Principles of Engineering Thermodynamics: SI Version, 5th Edition, John Wiley and Sons Inc.,
3. S.C Gupta, Thermodynamics, Pearson Education, 2009

Course Designers

SRM University *AP*, Andhra Pradesh

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

Material Science

Course Code	MCE 204	Course Category	CC	L	T	P	C
				3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand material behavior, their structures, and property will help in the process of identification of suitable material.
2. To learn the various methods used in powder processing.

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 the structure and properties of given materials	2	80%	75%
Outcome 2	Demonstrate heat treatment methods and implications on improving materials properties	3	70%	65%
Outcome 3	Discuss traditional materials, advanced materials, and composites	2	80%	70%
Outcome 4	Develop advanced/novel materials based on the principles of materials processing and characterization	4	85%	75%
Outcome 5	Describe the structure-property correlation of materials	2	85%	75%

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

Course Unitization Plan-Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	**Metal Structure**	**6**		
	Crystal structures	1	1-4	1,2
	Elastic-plastic behaviour	1	1	1,2
	Deformation mechanisms, Slip, twinning Imperfections	1	1	1,2
	Types of fracture	1	1	1,2
	Three Stages in creep	1	1	1,2
	Fatigue mechanism	1	1	1,2
UNIT II	**Material properties**	**6**		
	Testing of metals	1	2	1,2,3,4
	Properties, strength, plasticity, stiffness	1	2	1,2,3,4
	Properties, toughness, brittleness, ductility	1	2	1,2,3,4
	Hardness	1	2	1,2,3,4
	Creep and fatigue tests	2	2	1,2,3,4
UNIT III	**Heat Treatment**	**6**		
	Solidification, crystal growth, rule	1	2,3	1,2,3,4
	Phase diagram, Gibbs Phase rule, Equilibrium diagrams, lever rule	1	2,3	1,2,3,4
	Iron Carbon diagram, solidification of steel and cast irons	1	2,3	1,2,3,4
	Heat treatment, TTT curves, annealing, normalising, hardening, tempering inductin harening, age hardening	1	2,3	1,2,3,4
	Martempering, austempering, carburising, cyaniding, nitriding, flame and induction hardening, age hardening	1	2,3	1,2,3,4
	Ferrous, Non-ferrous metals, Cast Iron, Steel, Copper, Aluminium alloys	1	2,3	1,2,3,4
UNIT IV	**Composite materials**	**6**		
	Composites	1	3	1,2,3,4
	Fibre reinforced composites	1	3	1,2,3,4

	Manufacturing methods	2	3	1,2,3,4
	Metal matrix composites	2	3	1,2,3,4
UNIT V	**Powder Metallurgy**	**6**		
	Powder metallurgy: Powder characterization, size analysis, compaction and sintering	2	4	5
	Manufacturing methods: Mechanical, chemical and physical	2	4	5
	Additive manufacturing	2	4	5
Total contact hours		**30**		

Course Unitization Plan-Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	Introduction of material processing and characterization techniques	2	1,2,3	
2.	Polish the samples until one can see the microscopic phases clearly	4	1,2,3,4,5	1,2
3.	To determine the hardness of the given Specimen using Vicker's hardness test.	2	1,2,3,4,5	1,2
4.	To find the Brinell Hardness number for the given metal specimen	2	1,2,3,4,5	1,2
5.	To determine the Rockwell hardness number of the given specimen.	2	1,2,3,4,5	1,2
6.	Heat treat given materials at different levels	4	1,2,3,4,5	1,2
7.	Study micrographs of differently heat treated materials and compare them	4	1,2,3,4,5	1,2
8.	Measure the hardness of given materials using End Quench hardness tester	4	1,2,3,4,5	1,2
9.	Design of heat cycle to improve properties of given alloy.	6	1,2,3,4,5	1,2
Total contact hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (30%)				Practical (20%)		
		CLA-1 (5%)	Mid-1 (15%)	CLA-2 (5%)	CLA-2 (5%)		Th	Prac
Level 1	Remember	60%	70%	60%	70%	30%	60%	50%
	Understand							
Level 2	Apply	40%	30%	40%	30%	70%	40%	50%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. William D Callister, "Material Science and Engineering" John Wiley and Sons, 2014 edition
2. U.C.Jindal , "Material Science and Metallurgy " U.C.Jindal, Pearson Publication, 2011 edition
3. Allen Cottrell "Introduction to Metallurgy" University Press, 2000 edition
4. R. Srinivasan "Engineering materials and metallurgy", McGraw Hill, 2009 edition
5. Anish Upadhya and G S Upadhaya, "Powder Metallurgy: Science, Technology and Materials, Universities Press, 2011

Online Recourses

1. Practical Metallurgy and Materials for Industry, John E Neely & Thomas J Bertone, 5th Edition, 1999, Publisher – Pearson.

Course Designers

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

Digital Manufacturing And Industry 4.O

Course Code	MCE 210	**Course Category**	SEC	**L**	**T**	**P**	**C**
				0	1	1	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the Fundamentals of Digital Manufacturing
2. To know the principal methods, areas of usage, possibilities, and limitations as well as environmental effect of the digital manufacturing technologies.
3. Program and execute various operations on digital subtractive and additive manufacturing processes.
4. To expose the basic idea in Industry 4.0 and understand the recent manufacturing trends related to Industry 4.0 and its implementation.

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	Strategic and operative thinking in digital manufacturing.	1	80%	75%
Outcome 2	Develop and manipulate digital models of physical objects.	2	70%	65%
Outcome 3	Introduction to various processes, capabilities and limitations, various applications of AM.	3	70%	65%
Outcome 4	Gain knowledge of Industry 4.0 principles and the integration of technologies such as the Internet of Things (IoT), artificial intelligence, and big data analytics into manufacturing systems.	2	80%	75%

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 ICT Usage	Society and Multicultural	Environment and	Moral, and Ethical	Individual and Teamwork	Communication Skills	Project Management	Self-Directed and Life Long	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	1	3	2				1			3	3	2	3
Outcome 2	3	3	1	3	3				1			3	3	3	2
Outcome 3	3	3	3	3	3				3			3	3	2	3
Outcome 4	3	3	2	3	3				3			3	3	3	3
Average	**3**	**3**	**2**	**3**	**3**				**2**			**3**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	History of Manufacturing: From classical to Digital/Additive manufacturing	1	1	1
	Basic concept and terminology	1	1	1,2
	Overview of Digital Manufacturing, Benefits of Digital	1	1	1,2
	Manufacturing – The Future of Digital Manufacturing	1	1	1,2
	Lab: Practice of Solid works software	2	1	1,2
Unit No. 2	Digital/Geometric design: Geometric design of curves, surfaces and solids, Shape digitization	1	1	1
	3-D object scanning, solid reconstruction from point cloud and tessellated data	1	1,2	1,2,3
	Conception and development of products	1	1,2	1,2,3
	Design processes and methods, CAD/CAM/CAE technologies	1	1,2	1,2,3
	Lab: CAD modelling: Concepts of CAD, Algorithms used in design, Introduction to G Code	2	1,2	1,2,3
Unit No. 3	Computer Aided Design (CAD), 3D Modeling	1	3	3,4
	Parametric design. Assembly Modeling, Render the appearance of a product. CAD and additive manufacturing	2	3	3,4
	Introductory lecture on 3D printer and Rapid Prototyping, Introduction to different types of 3D Printers, Materials used for printing	1	3	3,4,5
	Lab: CAM Skills, Mesh Repair, Design of Assembly (Spur gear), Design of Assembly (Helical screw)	2	3	3,4,5
Unit No. 4	Computer Aided Process Planning: CAPP and route sheet development	1	3,4	3,4,5
	Computer aided plant layout, Computer Aided Production Planning and Control	1	3,4	3,4,5
	Design for Additive Manufacturing (DFAM), Design for functionality and 3D printability	1	3,4	4,5
	Planning and slicing additive manufacturing software	1	3,4	4,5
	Lab: Hands on experience with and troubleshooting, Installation of 3DP, Bed levelling, Various techniques while printing the complex shapes	2	3,4	4,5

Unit No. 5	Introduction to Industry 4.0, Historical Context, General framework, Application areas, Industry 4.0 applications in Product Developmen	1	3,4	4,5
	IoT applications in Manufacturing, Cloud applications in manufacturing, Dissemination of Industry 4.0 and the disciplines that contribute to its development	1	3,4	4,5
	Artificial intelligence, The Internet of Things, Current situation of Industry 4.0. Introduction to Industry 4.0 to Industry 5.0	2	3,4	4,5
	Lab: Filament loading and unloading, preheating, nozzle cleaning, SLA, Bioprinting	2	3,4	4,5

Learning Assessment

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

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**			**End Semester Exam (Prac 50%)**
		Experiments (20%)	**Record / Observation Note (10%)**	**Viva + Model (20%)**	
Level 1	Remember	30%	30%	30%	40%
	Understand				
Level 2	Apply	70%	70%	70%	60%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Rapid Manufacturing: An Industrial Revolution for the Digital Age, N. Hopkinson, R. J. M. Hague and P. M. Dickens, 1st Ed., John Wiley & Sons, 2005.
2. Fundamentals of Digital Manufacturing Science, by Z. Zhou, S. Xie, D. Chen, Springer, 2012
3. Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, 6th Ed., McGraw-Hill Education, 2015.
4. Ibrahim Zeid and R Subramanian, CAD/CAM Theory and Practice, Tata McGraw Hill, (2010).
5. 3D printing Lab Manual, SRM-AP

Course Designers

1. Dr. Chandan Kumar, Assistant Professor, Department of Mechanical Engineering, SRM University AP.
2. Dr. Abhinav Kumar, Sceintist B, CMTI BangaloreDesign and Fabrication of components using 3D Printing

SRM University *AP*, Andhra Pradesh

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

Design of Machine Elements

Course Code	MCE 205	Course Category	CC	L	T	P	C
				2	1	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

- To understand the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components.
- To learn various mechanical components available and emphasize the need to continue learning.
- To conceptualize mechanical engineering design theory; identify and quantify machine elements in the design of commonly used mechanical systems.
- To understand how to apply computer-based techniques in the analysis, design and/or selection of machine components

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 design concepts to design machine elements	3	70%	75%
Outcome 2	Demonstrate the design process based on the given inputs	3	70%	75%
Outcome 3	Identify the technical, safety, and environmental issues in designing mechanical systems	3	70%	75%
Outcome 4	Apply computer-based techniques to design machine elements	3	70%	75%

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to design**	**9**		
	What is design? Selection of materials-weighted point method, Mechanical properties of materials, Manufacturing Considerations in design, DFMA, theories of failures	4	1,2,3,4	1,2
	Design for static load, axial, bending, torsion loads. Factor of safety, Design of knuckle joint	5	1,2,3,4	1,2
Unit 2	**Shaft, Keys and Coupling**	**9**		
	Design of shafts	4	1,2	1,2
	Design of keys, sunk, woodruff	2	1,2	1,2
	Design of couplings, rigid, flexible, bush pin couplings	3	1,2	1,2
Unit 3	**Clutches and Brakes**	**9**		
	Design of clutches, single, multiple, cone, centrifugal	4	2	1,2
	Design of brakes, shoe, band	5	2	1,2
Unit 4	**Bearings**	**9**		
	Design of sliding contact bearing- Journal	3	1,2	1,2
	Design of rolling contact bearings- ball, rollers, spherical	3	1,2	1,2
	Selection of bearings from catalogue.	3	1,2	1,2
Unit 5	**Design of gears**	**9**		
	Gear design considerations, gear trains, gear failure	2	1,2,3	1,2
	Design of spur gear	2	1,2,3	1,2
	Design of helical gear	2	1,2,3	1,2
	Design of bevel gear	2	1,2,3	1,2
	Design of worm gear	1	1,2,3	1,2
Total Contact Hours		**45**		

Course Unitization Plan-Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs addressed	References Used
1.	Whirling shaft	4	1, 2	1, 2, 3
2.	Journal bearing	4	1, 2	1, 2,3
3.	Photoelasticity apparatus	4	2, 3,4	1, 2, 3
4.	Vibration analysis	6	2, 3,4	1, 2, 3
5.	Cam analysis	4	2, 3,4	1, 2, 3
6.	Governor analysis	4	2, 3,4	1, 2, 3
7.	Rotation balancing	4	2, 3,4	1, 2, 3
Total contact hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)	
		CLA-1 (15%)	Mid-1 (15%)	CLA-2 (10%)	Prac int 10%		
		Th	Th	Th	Pract	Th 35%	Prac 15%
Level 1	Remember	40%	40%	30%	40%	40%	30%
	Understand						
Level 2	Apply	60%	60%	70%	60%	65%	70%
	Analyse						
Level 3	Evaluate						
	Create						
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Design of Machine Elements by V B Bhandari, McGraw hill, 2017
2. Design of Machine Element, M F Spotts, Pearson
3. Laboratory manual, Machine design, SRM University AP

Course Designers

SRM University *AP*, Andhra Pradesh

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

Fluid Mechanics

Course Code	MCE 206	Course Category	CC	L	T	P	C
				3	0	1	4
Pre-Requisite Course(s)	MEC 203	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To acquire fundamental knowledge and understanding of elements of fluid mechanics as applied to engineering problems.
2. To acquire abilities and capabilities in the area of fluid properties and fluid statics
3. To understand the concept of fundamentals laws of mass, momentum, and energy also to understand the inviscid flows applying the Bernoulli's theorem for use in engineering applications.
4. To gain the knowledge about the concept of internal flows and boundary layer formation to solve the practical engineering flow 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	Describe the principles of fluid mechanics such as properties, continuum concepts and fluid statics	2	70%	65%
Outcome 2	Solve given simple fluid flow problems based on mass, momentum, and energy conservation laws.	3	70%	65%
Outcome 3	Apply internal flow concepts for the given engineering flow problems	3	70%	65%
Outcome 4	Compute drag and lift coefficients using the theory of boundary layer flows	3	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	3	2	1	2	2				2			3	3	2	3
Outcome 2	3	3	2	3	2				3			3	3	2	3
Outcome 3	3	3	3	3	2				3			3	3	2	3
Outcome 4	3	3	3	3	3				2			3	3	3	3
Average	3	3	3	3	3				3			3	3	2	3

Course Unitization Plan-Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	**Introduction**	**2**		
	Introduction to Fluid Mechanics and fluid characteristics.	1	1	1,2,4,5
	Continuum concept, properties of fluids and application of fluid dynamics.	1	1	1,2,4
UNIT II	**Fluid Statics**	**6**		
	Pressure, Hydrostatic pressure distribution.	2	1	1, 2, 3
	Application to manometry.	1	1	1, 2, 3
	Hydrostatic forces on submerged plane and curved surfaces.	2	1,2	1, 2, 3
	Buoyancy and stability.	1	1,2	1, 2, 3,5
UNIT III	**Fluid kinematics**	**20**		
	Lagrangian and Eulerian description of fluid flow.	1	1,2	1, 2, 3
	Velocity and Acceleration Fields.	1	1,2	1, 2, 3
	Deformation of fluid element.	2	2	1, 2, 3
	Fundamentals of flow visualization.	1	2	1, 2, 3,4
	Integral relations for a control volume, linear and angular momentum for inertial and accelerating control volumes.	2	1,2	1, 2, 4, 5
	Reynolds transport theorem.	2	1,2	1, 2, 4, 5
	Bernoulli's equation.	2	1,2,3	1, 2, 4, 5
	Conservation equations for mass, momentum and energy.	2	1,2,3	1, 2, 3,4
	Conservation equations in differential form: Stream function, Velocity potential, Vorticity, Fluid translation, rotation and deformation.	3	1,2,3	1, 2, 3,4
	Dimensional analysis and Similitude: Buckingham Pi theorem;	2	2,3	1, 2, 3,4
	Modelling and Similarity.	1	2,3	1, 2, 4, 5
	Reynolds number regimes and flow classification.	1	2,3,4	1, 2, 4, 5
UNIT IV	**Internal Flows**	**10**		
	Concept of fully developed laminar flow in 2D geometries.	2	1,2,3	1, 2, 4,5
	laminar vs turbulent flows, turbulent velocity profiles in fully developed pipe flow.	3	1,2,3	1, 2, 4, 5
	Importance of friction factor.	1	1,2,3	1, 2, 3,4
	Major and minor losses in a pipe flow.	2	1, 2,3	1, 2, 4, 5

	Flow measurement -constriction meters, rotameters, anemometer.	2	1,2,3	1, 2, 4, 5
UNIT V	**External Flows**	**7**		
	Boundary layer concept (for flat plate & cylinder)	2	3,4	1, 2, 3,4,5
	Flows past immersed bodies	1	3,4	1, 2, 3,4,5
	Flow separation	1	2,3, 4	1, 2, 3,4,5
	Lift and Drag forces	2	2,3,4	1, 2, 3,4,5
	Friction and Form drag	1	2,3,4	1, 2, 3,4,5
Total Contact Hours		**45**		

Course Unitization Plan-Practical

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	Experiment on venturimeter.	4	1,2	6
2.	Reynolds flow apparatus.	4	1,2,3,4	6
3.	Experiment on orifice meter.	2	1,2	6
4.	Experiment on loss of head in pipe fittings - minor losses.	4	1,2,3	6
5.	Experiment on friction in pipes – major losses.	4	1,2,3	6
6.	Impact of jet on vanes.	4	1,2	6
7.	Free vortex flow experimental setup	4	1,2	6
8.	Pitot tube.	2	1,2	6
9.	Bernoulli’s theorem apparatus	2	1,2	6
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (30%)				Practical (20%)		
		CLA-1 (5%)	Mid-1 (15%)	CLA-2 (5%)	CLA 3 (5%)		Th	Prac
Level 1	Remember	40%	30%	30%	40%	30%	40%	40%
	Understand							
Level 2	Apply	60%	70%	70%	60%	70%	60%	60%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Yunus A Cengel& John M. Cimbala, Fluid Mechanics, Tata McGraw Hill Edition, New Delhi, 3rd
2. Edition, 2015
3. S. K. Som, G. Biswas and S. Chakraborty, "Introductions to Fluid Mechanics and Fluid Machines", 3rd edition, McGraw Hill publishing.
4. Frank M.White,"Fluid Mehanics", McGraw-Hill, 7th Edition, New Delhi, 2011.
5. Philip J. Pritchard, Alan T. McDonald and Robert W. Fox "Introduction to Fluid Mechanics", SI version 8th edition, John Wiley publishers
6. Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, "Introduction to Fluid Mechanics", Wiley, 8th Edition, 2013.
7. Fluid mechanics manual, SRM University AP

Other Resources

1. NPTEL video lecture by Prof Som, IIT KGP

Course Designers

SRM University *AP*, Andhra Pradesh

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

Kinematics And Mechanisms

Course Code	MCE 207	Course Category	CC	L	T	P	C
				3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To make the students gain the fundamentals of kinematics and mechanisms like kinematic pairs, inversions and degrees of freedom etc.
2. To train the students on how to perform motion (displacement, velocity and acceleration) analysis of mechanisms.
3. To construct velocity and acceleration diagrams using various approaches.
4. To impart the knowledge about various elements of motion transfer like cams, gears and gear trains etc.

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	Differentiate between mechanisms and machines and calculate degrees of freedom for given mechanisms.	3	80%	75%
Outcome 2	Draw velocity diagrams and acceleration diagrams for given mechanisms.	3	70%	65%
Outcome 3	Design mechanisms, based on the data provided.	2	70%	65%
Outcome 4	Select gears, cams, and gear trains suitable for the given task.	5	80%	75%

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

Course Unitization Plan - Theory

UNIT No.	Description of Topic	Contact hours required	CLO'S addressed	References Used
	INTRODUCTION TO MECHANISMS AND MACHINES	**8**		
1	Mechanisms and machines	1	1	1-3
	Rigid and resistant bodies, Link	1	1	1-3
	Kinematic pair, Degrees of Freedom or mobility	1	1,3	1-3
	Classifications of Kinematic pairs	1	1	1-3
	Kinematic-chain, Linkage	1	1	1-3
	Classification of mechanisms, Equivalent Mechanisms	1	1,3	1-3
	Four - Link (bar) Mechanism	1	1,3	1-3
	Inversions of Slider - Crank Chain, Double – Slider Chain.	1	1,3	1-3
	VELOCITY ANALYSIS & INSTANTANEOUS CENTRE METHOD	**12**		
2	VELOCITY ANALYSIS: Introduction, Absolute and Relative Motion	1	2	1,3
	Vectors, Addition and subtraction of Vectors	1	2	1,3
	Motion of a Link, Four Link Mechanism	1	2	1,3
	Angular Velocity of Links	1	2	1,3
	Velocity of Rubbing	1	2	1,3
	Slider - Crank Mechanism	1	2	1,3
	Crank and Slotted Lever Mechanism	1	2	1,3
	Instantaneous centre method: Introduction and Notation	1	2	1,3
	Number of I- Centre	1	2	1,3
	Kennedy's theorem	1	2	1,3
	Locating I -Centre	1	2	1,3
	Angular velocity by I - Centre Method	1	2	1,3
	ACCELERATION ANALYSIS	**8**		
3	Introduction	1	2	1,3
	Acceleration	1	2	1,3
	Four-Link Mechanism	1	2	1,3
	Angular acceleration of Links	1	2	1,3
	Acceleration of Intermediate and offset points	1	2	1,3

	Slider-Crank Mechanism	1	2	1,3
	Coriolis acceleration component	1	2	1,3
	Crank and slotted lever Mechanism	1	2	1,3
1.	**GEARS**	**8**		
4	Introduction, Classification of gears, gear terminology, Law of Gearing	1	3,4	1,3
	Velocity of Sliding, Forms of Teeth	1	3,4	1,3
	Cycloidal Profile Teeth	1	3,4	1,3
	Involute Profile Teeth	1	3,4	1,3
	Path of contact and arc of contact, Number of pairs of teeth in contact	1	3,4	1,3
	Interference in gears, Undercutting in gears	1	3,4	1,3
	Helical and spiral gears	1	3,4	1,3
	Worm and worm gear.	1	3,4	1,3
	GEAR TRAINS & CAMS	**9**		
5	Introduction	1	3,4	1,3
	Simple Gear Train	1	3,4	1,3
	Compound Gear Train	1	3,4	1,3
	Reverted Gear train	1	3,4	1,3
	Planetary or Epicyclic Gear Train, sun and planet gear	1	3,4	1,3
	Bevel epicyclic gear, Cycloid gear drive	1	3,4	1,3
	Cycloid gear drive, harmonic gear drive, differential gear.	1	3,4	1,3
	CAMS: Introduction, Types of cams, Types of Followers	1	3,4	1,3
	Definitions, high speed cams	1	3,4	1,3
Total contact hours		**45**		

Course Unitization Plan - Lab

S. No.	Experiment	Contact hours required	CLO'S addressed	References Used
Unit 1	Identification of various types of kinematic pairs and kinematic links	1	1	1
	Demonstration of different types of mechanisms, specifically: a) Slider crank mechanism (b) Whitworth quick return motion mechanism (c) Scotch yoke mechanism (d) Elliptical trammel mechanism	1	1	1

	(e) Double slider mechanism			
	Demonstration of various types of clutch mechanisms: (a) Single plate clutch (b) Multiple clutch (c) Cone clutch (d) Centrifugal clutch (e) Claw clutch	1	1	1
	Demonstration of various types of drives mechanisms, specifically: (a) Belt drive mechanism (b) Rope drive mechanism (c) Stepped or cone pulley drive	1	1	1
	Displacement analysis of mechanisms through forward kinematics for various mechanisms, specifically: (a) Watts's linkage mechanism (b) Pantograph mechanism (c) Chebyshev's mechanism (d) Hart straight line mechanism (e) Peaucellier mechanism	6	1	1
	Displacement analysis of mechanisms through inverse kinematics for various mechanisms, specifically for the ones listed above.	6	1	1
Unit 2	Velocity analysis of mechanisms, for various mechanisms, specifically for the ones listed above.	14	2	1
Total contact hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (10%)		**Mid-1 (15%)**		**CLA-2 (10%)**		**Mid-2 (15%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember Understand	20%	20%	30%	30%	10%	10%	20%	20%	20%	20%
Level 2	Apply Analyse	60%	60%	50%	50%	60%	60%	60%	60%	55%	55%
Level 3	Evaluate Create	20%	20%	20%	20%	30%	30%	20%	20%	25%	25%
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. Theory of Machines, by S.S.Rattan, Tata Mc-Graw Hill, New Delhi, , 2012.
2. Theory of machine and Mechanisms, 2nd Edition by J.E. Shigley, Mc-Graw Hill, New Delhi,1994.
3. Theory of machines, by R.S. Khurmi and J K Gupta, S. Chand Publications, 2020

Course Designers

SRM University *AP*, Andhra Pradesh

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

Digital product development-3D Printing

Course Code	MCE 208	Course Category	CC	L	T	P	C
				1	0	1	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce concepts of CAD and its usefulness in CAM.
2. To know the principal methods, areas of usage, possibilities, and limitations as well as environmental effect of the additive manufacturing technologies.
3. To be familiar with the characteristics of the different materials those are used in additive manufacturing.
4. To gain knowledge of the potential implications of AM technologies on product development and gain the hand on experience on various 3D printers.
5. To be familiar with the tessellation process, stl files and repair of stl file using mesh repair algorithms

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 CAD modelling and assemblies for 3D printing.	1	80%	75%
Outcome 2	Describe 3D printing techniques for product developments	2	70%	65%
Outcome 3	Demonstrate the materials and technologies used in 3D printing	3	70%	65%
Outcome 4	Illustrate the repair algorithms for damaged triangles in stl files.	2	80%	75%

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	**Cad modelling**	**8**	**1**	**1**
	Concepts of CAD, Algorithms used in design,	2	1	1
	Design of Assembly (Spur gear)	1	1	1
	Design of Assembly (Helical screw)	2	1	1
	Introduction to G Code	2	1	1
	Lab practice of Solid works software	1	1	1
UNIT II	**Introduction to 3DP**	**8**		
	What is a Mesh? Historical Review of 3DP	2	1	1,2,3
	From CAD to CAM, CAD Overview	2	1	1
	Introductory lecture on 3D printer and Rapid Prototyping	2	1,2	1,2,3
	Introduction to different types of 3D Printers,	1	1,2	1,2,3
	Introduction to RepRap, Materials used for printing	1	1,2	1,2,3
UNIT III	**Design for 3DP**	**7**		
	Design for 3DP	2	2,3,4	2,3
	Understand the basics of G code generation	2	2,3	2,3
	CAM Skills, Mesh Repair	2	2,3,4	2,3
	Get to Know the 3D Printer	1	2,3,4	2,3
UNIT IV	**Hands on experience with and trouble shooting**	**7**		
	Installation of 3DP, bed levelling	3	3	2,3
	Filament loading and unloading, preheating, nozzle cleaning	2	3	2,3
	Various techniques while printing the complex shapes	2	3	2,3
Total Contact hours		**30**		

Learning Assessment

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

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)		End Semester Exam (50%)
		Lab performance (35%)	Observation Note (15%)	Prac
Level 1	Remember	30%	40%	40%
	Understand			
Level 2	Apply	70%	60%	60%
	Analyse			
Level 3	Evaluate			
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. CAD/CAM: Principles and Applications by P N Rao
2. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
3. Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles & Applications", World Scientific, 2003

Course Designers

SRM University *AP*, Andhra Pradesh

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

Industrial Engineering and operation Research

Course Code	MCE 209	Course Category	CC	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Familiarize the students with standard methods of solving complex industry problems by choosing the trade-offs in the best way.
2. Impart important decision-making processes and analytical tools in design, planning and control of manufacturing.
3. Train the students on various industry practices that are fundamental and applied in nature.

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, formulate, and solve complex engineering problems by applying principles of industrial engineering.	1	70%	80%
Outcome 2	Apply industrial engineering to produce solutions that meet specified needs	2	70%	80%
Outcome 3	Understand the basics of operation research & optimization	1	70%	80%
Outcome 4	Apply operational problems with application of appropriate tools, techniques & programming skills	2	70%	80%

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

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

Course Unitization Plan - Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**9**		
	Objectives, Method study, Work measurement, various methods, time study, different methods of performance rating- allowances, standard time calculation, Work sampling, Therbligs.	3	1	1
	Productivity - Definition, Various methods of measurement of productivity, Factors effecting productivity, various methods of Job evaluation & merit rating	3	1	1
	Fixed and variable cost, break even quantity	3	1	
Unit 2	**Manufacturing System**	**11**		
	Types of layouts, types of manufacturing systems, Introduction to modern manufacturing systems,	2	1	2
	Quality management, Quality improvement tools. Total quality management.	2	2	1,2
	Types of inspections - Statistical Quality Control-techniques-variables and attributes assignable and non-assignable causes-variable control charts and R charts	3	2	1,2
	Inventory control models - Economic order quantity (EOQ)	4	2	
Unit 3	**Linear Programming Problem**	**7**		
	Problem formulation, solve two variables LP models by the graphical solution procedure	3	3	2
	Solving special cases using graphical methods	4	4	2
Unit 4	**Simplex Method**	**10**		
	Introduction to Simplex method	3	3	1,2
	Artificial starting solution and special cases	4	3	1,2
	Dual Solutions	3	4	
Unit 5	**Transportation/ Assignment Model**	**8**		
	Formulate transport problem as LPP and solve	4	4	2
	Formulate assignment problem as LPP and solve	4	4	2
Total contact hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (20%)	CLA-2 (10%)	CLA-3 (10 %)	
		Th	Th	Th	Th	Th
Level 1	Remember	80%	50%	30%	30%	
	Understand					
Level 2	Apply	20%	50%	70%	70%	100%
	Analyze					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Taha, Hamdy A, Operations Research: An Introduction, Pearson Education, 9th, Edition, 2012.
2. Ravi Shankar, "Industrial Engineering and Management, "Galgotia Publications Pvt Ltd, Delhi

Other Resources

1. Kjell Zandin, "Maynard's Industrial Engineering Handbook", McGraw-Hill Standard Handbooks, 5th edition, McGraw-Hill Education
2. Dr. Rajesh Purohit Dr. Swadesh Kumar Singh, "A Text Book on Industrial Engineering, Mechatronics & Robotics" 1st Ed, Made Easy Publications, Delhi

Course Designers

SRM University *AP*, Andhra Pradesh

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

Fluid Machinery

Course Code	MCE 301	Course Category	CC	L	T	P	C
				2	0	1	3
Pre-Requisite Course(s)	MEC 203, MEC 206	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the concepts of fluid dynamics and thermodynamics to analyse flows in fluid machines. To learn the applications of fluid machines in various industries
2. To learn the principles of dimensional analysis and their application in fluid machines
3. To understand the working of hydraulic turbines, their key components, their selection criteria, and their performance characteristics
4. To gain the knowledge of the working of centrifugal/axial pumps, and their performance characteristics pump and system matching.
5. To learn the working of hydrostatic and hydrodynamic fluid 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 thermodynamics and fluid dynamics conservation principles to fluid machines	3	70%	65%
Outcome 2	Discuss the performance of fluid machines	3	70%	65%
Outcome 3	Predict performance of fluid machines using model analysis	3	70%	65%
Outcome 4	Illustrate the working mechanisms of hydraulic turbines, pumps, and fluid machines	2	70%	65%
Outcome 5	Choose fluid machine for given application based on the machine characteristics	3	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	3	2	2	2	3				3			3	3	2	3
Outcome 2	3	3	2	3	3				3			3	3	2	3
Outcome 3	3	3	2	3	3				3			3	3	2	3
Outcome 4	3	3	3	3	3				3			3	3	3	3
Outcome 5	3	3	3	3	3				3			3	3	3	3
Average	3	3	3	3	3				3			3	3	2	3

Course Unitization Plan-Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	**Fundamentals of Fluid machines**	**11**		
	Introduction to fluid machines, their applications and their classification.	1	1	1
	Reynolds Transport Theorem (RTT), and its application for mass, momentum and energy conservation, Bernoulli. Impact of jets	4	1	1
	Euler Equation for a fluid machine, rothalpy, velocity triangles, energy transfer, slip, degree of reaction	3	1	1
	Losses (internal and external) in fluid machines. Efficiencies of Hydraulic machines and compressible flow machines	3	1	1
UNIT II	**Dimensional Analysis and Model Testing**	**6**		
	Buckingham's theorem, non-dimensional parameters for incompressible and compressible flow machines	2	2	1
	Model testing, Specific speed and specific diameter, Cordier diagram	2	2	1
	Unit quantities (unit speed, discharge and power)	2	2	1
UNIT III	**Hydraulic Turbines**	**14**		
	Hydroelectric power plant layout and terminology, classification of hydraulic turbines, Euler equation for hydro turbines	2	1,3	1
	Pelton wheel – working principle, key components and their functions; Pelton wheel analysis – velocity diagrams, power developed etc.	3	1,3	1
	Francis turbine – working principle, key components and their functions; Francis turbine analysis – velocity diagrams, power developed etc. cavitation	3	1,3	1
	Axial flow turbine (Propeller, Kaplan turbines) - working principle, key components and their functions; Kaplan analysis – velocity diagrams, power developed etc.	3	1,3	1
	Draft tube and its importance in reaction turbines. Performance characteristics of turbines, Selection of hydraulic turbines	3	1,3	1
UNIT IV	**Centrifugal and Axial Pumps**	**11**		
	Introduction on Pumps. Classification of Pumps.	1	4	1
	Centrifugal pump – working principle, key components and their functions, classification of centrifugal pumps; General pumping system, centrifugal pump analysis – velocity diagrams, specific work, discharge etc. cavitation.	3	1,4	1
	Axial pump – working principle, key components and their functions; Axial pump analysis – velocity diagrams, specific work, discharge etc. Comparison with centrifugal pumps	3	1,4	1

	Centrifugal and Axial pump characteristics – Losses, efficiencies, head vs discharge curve etc. Performance characteristics, iso-efficiency curves, operating characteristics	2	4	1
	Net positive suction head, Pump and system – matching of system characteristics, pumps in series/parallel	2	1,4	1
UNIT V	**Fluid Systems**	**3**		
	Introduction, advantages, and disadvantages of fluid systems	1	5	1
	Hydrostatic systems – hydraulic press, accumulator, intensifier, lift crane	1	1,5	1
	Hydrodynamic systems – fluid coupling, torque convertor	1	1,5	1
Total Contact Hours		**45**		

Course Unitization Plan-Practical

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	Reciprocating pump	4	1,2	2
2.	Centrifugal pump	4	1,2,3,4	2
3.	Centrifugal pump – series operation	4	1,2	2
4.	Centrifugal pump – parallel operation	4	1,2,3	2
5.	Pelton wheel	4	1,2,3	2
6.	Francis turbine	5	1,2	2
7.	Axial flow fan performance	5	1,2	2
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (30%)				Practical (20%)		
		CLA-1 (5%)	Mid-1 (15%)	CLA-2 (5%)	CLA-3 (5%)		Th	Prac
Level 1	Remember	40%	30%	30%	40%	30%	40%	40%
	Understand							
Level 2	Apply	60%	70%	70%	60%	70%	60%	60%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Maneesh Dubey, BVSSS Prasad and Archana Nema, Turbomachinery, Tata McGraw Hill Edition, 1st Edition, 2018
2. Fluid mechanics manual, SRM University AP.

Other Resources

1. R K Bansal, A Textbook of Fluid Mechanics And Hydraulic Machines, Laxmi Publications Pvt Ltd., 9th Edition, 2015

Course Designers

SRM University *AP*, Andhra Pradesh

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

IOT and Digital Twin for Mechanical Engineers

Course Code	MCE 302	Course Category	CC	L	T	P	C
				2	0	0	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand about the fundamentals of internet of things.
2. To learn the fundamentals of digital twin.
3. To learn about the applications of IOT in mechanical engineering.
4. To learn about the applications of Digital twin in mechanical engineering.

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 about internet of things	2	70%	75%
Outcome 2	Describe the digital twin concept	3	70%	75%
Outcome 3	Propose and develop a application of IOT to mech engineering	3	70%	75%
Outcome 4	Propose and develop a application of Digital twin to mech engineering	3	70%	75%

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to internet of things**	**6**		
	Concept, methodologies, techniques		1,2,3,4	1,2
Unit 2	**Introduction to digital twin**	**6**		
	Concept, methodologies, techniques		1,2	1,2
Unit 3	**Application of IOT in mech engineering**	**6**		
	Predictive maintenance using sensor based data		2	1,2
Unit 4	**Application of digital twin in mech engineering**			
	Dynamic simulations, predictive models and real time monitoring solutions, test and iterations in virtual environment, Predictive maintenance, process optimization, benefits and challenges in implementation	6	1,2	1,2
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)			End Semester Exam (50%)
		CLA-1 (20%)	Mid-1 (20%)	CLA-2 (10%)	
		Th	Th	Th	Th 50%
Level 1	Remember	40%	40%	30%	40%
	Understand				
Level 2	Apply	60%	60%	70%	65%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Internet of mechanical things, Kishen Rao, Gsangaya, CRC Press, 2022
2. Digital twin, Ranjan ganguly, CRC Press, 2023.

Course Designers

SRM University *AP*, Andhra Pradesh

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

Computational Methods

Course Code	MCE 303	Course Category	CC	L	T	P	C
				2	1	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Predict and derive the solution methodologies.
2. Identify advantages and disadvantages of various methods to solve a particular problem.
3. Apply the knowledge of the methods to engineering applications.
4. Study the computational implementation of the 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	Classify the numerical methods	2	80%	75%
Outcome 2	Solve given engineering problems based on numerical methods such as Gauss elimination, bisection, least squares regression and differential equations	3	70%	65%
Outcome 3	Solve given engineering problems using numerical techniques and Python programming	3	70%	65%
Outcome 4	Demonstrate index notation methods for given equations using Python	3	60%	55%

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

Course Unitization Plan-Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
	UNIT I	**3**		
1.	Numerical methods	0.5	1	1, 3
2.	Algorithms	1	1	1, 3
3.	Scientific notation, Precision effects, Error's	1	1	1, 3
4.	Syntax	0.5	1	1, 3
	UNIT II	**12**		
5.	Linear algebraic systems	1	2	1, 2, 4
6.	Gauss elimination method	1	2	1, 2,3
7.	LU decomposition, Tri diagonal Matrices, Thomas algorithm	3	2	1, 2
8.	Iterative solvers (Jacobi, Gauss-Siedel)	2	2	1, 2
9.	Convergence acceleration and stability using relaxation	2	2	1, 2
10.	Nonlinear equations solution using Bisection and Newton Raphson Nonlinear systems	3	2	1, 2
	UNIT III	**10**		
11.	Interpolation, extrapolation	1	2	1, 2, 3
12.	Linear, quadratic and cubic interpolation -- Direct methods	1	2	1, 2
13.	Newton divided differences interpolation	2	2	1, 2, 4
14.	Lagrange interpolation	1	2	1, 2
15.	Curve fitting and its applications	1	2,3,4	1, 2
16.	Regression analysis, error definitions	1	2	1, 2, 4
17.	Linear least squares regression single variable, multi variable	1	2,3,4	1, 2
18.	Polynomial regression	2	2,4	1,2
	UNIT IV-	**16**		
19.	Ordinary differential equations integration using Euler and Runge Kutta methods	2	2,3,4	1,2, 3
20.	Ordinary differential equations Predictor corrector methods, boundary, and initial value problems	3	2,4	1,2,4
21.	Discretisation, grid, and boundaries	2	2,3,4	1,2
22.	Finite differences (forward, backward, and central) formulas upto 6th order derivations	3	2,3,4	1, 2, 4

23.	Order of accuracy	2	2,4	1, 2
24.	Classification of partial differential equations (PDE)	1	2,4	1, 2
25.	Solution of elliptic, hyperbolic, and parabolic PDE using finite differences	3	2,4	1, 2, 4
	UNIT V	**4**		
26.	Application of linear and nonlinear system solutions to various engineering problems	1	4	1, 2, 3
27.	Application of Curve fitting and interpolation in Mechanical engineering	1	4	1, 2
28.	ODE and PDE applications specific to mechanical engineering	2	4	1, 2
	Total number of lecture hours - Theory	**45**		

Course Unitization Plan-Lab

Exp No	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	Plotting using Matplotlib	2	1	3
2.	Solution of linear algebraic equations using direct methods	4	3,4	1, 3,4
3.	Linear algebraic equations using iterative methods	4	3,4	3, 4
4.	Nonlinear equations, using Newton Raphson and Bisection	4	3,4	3, 4
5.	Regression implementation	6	3,4	3, 4
6.	Euler, Runge Kutta 2nd and fourth order methods	4	3,4	3, 4
7.	Finite differences	2	3,4	3, 4
8.	Partial differential equations	4	3,4	1, 3
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (40%)				End Semester Exam (30%)
		CLA-1 (10%)	Mid-1 (15%)	CLA-2 (10%)	CLA-3 (5%)	
		Th	Th	Th	Th	Th
Level 1	Remember	30%	35%	40%	40%	40%
	Understand					
Level 2	Apply	70%	65%	60%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Bloom's Level of Cognitive Task		Continuous Learning Assessments (15%)		End Semester Exam (15%)
		Experiments (10%)	Record / Observation Note (5%)	
Level 1	Remember	40%	40%	40%
	Understand			
Level 2	Apply	60%	60%	60%
	Analyse			
Level 3	Evaluate			
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Numerical methods for engineers by Steven C. Chapra and Raymond P. Canalem McGrawhill Publications
2. Numerical Methods with worked examples, Chris H. Woodford and Christopher Phillips, Springer
3. Numerical Methods in Engineering with Python, John Kiusalaas
4. Numerical Methods using Matlab, John H Mathews.

Course Designers

SRM University *AP*, Andhra Pradesh

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

Manufacturing Technology

Course Code	MCE 304	Course Category	CC	L	T	P	C
				3	0	1	4
Pre-Requisite Course(s)	ME 103	Co-Requisite Course(s)		Progressive Course(s)	ME 401		
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Acquire fundamental knowledge and understanding of Manufacturing processes.
2. Acquire abilities and capabilities in the areas of advanced manufacturing methods, quality assurance and shop floor management.
3. Formulate relevant research problems, conduct experimental and/or analytical work and analyze results using modern mathematical and scientific methods.
4. Use the techniques, skills, and modern engineering tools necessary for engineering practice

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 Fabrication of engineering components	3	70%	80%
Outcome 2	Apply the concepts of conventional manufacturing processes for devices	3	70%	80%
Outcome 3	Demonstrate dimensional accuracies and dimensional tolerances pertaining to the manufacturing processes	3	70%	80%
Outcome 4	Design and validate technological solutions for given mechanical engineering applications	5	70%	80%

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

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

Course Unitization Plan - Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Metal Casting Process**	**10**		
	Introduction to metal casting, Solidification of Metals, Characteristics of sand casting, Patterns, Pattern allowances	2	1	1
	Pattern materials, Types of patterns, Molding materials, Molding sand properties, Types of sand molds, Cores, Gating system	2	3	1
	Casting Defects, Special casting processes, cast structures, Melting furnaces, Methods of Sand testing	2	2,3	1
	Pattern making	2	1,2	1
	Mould making and casting	2	1,2	1,2
Unit 2	**Metal Joining Process**	**10**		
	Classification of joining processes, Welding technique, Different welding processes: Gas Welding, Electric Arc Welding	2	2,	2
	Tungsten Inert-gas Welding (TIG), Gas Metal-Arc Welding (GMAW), Plasma Arc Welding (PAW), Submerged Arc Welding (SAW)	2	3,4	1,2
	Resistance Welding, Friction Stir Welding (FSW), Thermite welding, Electron Beam Welding (EBW), Laser Beam Welding (LBW), Weld Defects	2	3	1,2
	Lap joint using MMAW process	2	1,2	2
	Edge preparation and Butt joint using MMAW process	2	1,2	2
Unit 3	**Bulk Deformation Process**	**10**		
	Introduction to bulk deformation processes, Hot and cold working, Forging, Types of forging	2	2,3	2
	Forging defects, Rolling, Defects in rolled products, Extrusion, Metal flow in extrusion, Rod drawing, Wire and Tube drawing, Swaging	2	2,3	2
	Severe plastic deformation processes: Friction stir processing, Equal channel angular extrusion and high-pressure torsion.	2	4	2
	Pipe bending operation	4	1,2	1,2
Unit 4	**Metal Removal Process**	**10**		
	Mechanism of metal cutting, Types of tools, Tool Geometry, Tool Signature, Orthogonal and Oblique cutting	2	3	1,2
	Mechanics of chip formation, Chip morphology, Tool wear and failure, Machinability, Cutting-tool materials, Cutting fluids	2	2	1,2
	Brief description of metal removal processes: Turning, drilling, boring and Milling, Material removal rate and machining time	2	3,4	1
	Thread cutting operation using lathe machine	2	1,2	1,2
	Face milling operation using vertical milling machine	2	1,2	1,2
Unit 5	**Powder Metallurgy**	**5**		
	Production of metal powders, Particle size and shape, Blending of metal powders	2	3	2
	Compaction of metal powders, Shaping processes, Sintering	2	2,3	2
	Finishing operations, Design considerations for powder metallurgy	1	4	2
Total contact hours		**45**		

Course Unitization Plan - Lab

S. No.	Description of experiments	Required Contact Hours	CLOs Addressed	References Used
1	Performing plain turning, step turning and chamfering in Lathe	3	1	1-2
2	Performing taper turning by compound rest/offset method and drilling in Lathe	3	1	1-2
3	Performing External threading, Internal thread cutting and eccentric turning in Lathe.	2	1	1-2
4	Performing Taper boring and knurling in Lathe	2	1	1-2
5	Performing V block shaping in shaper machine	2	2	1-2
6	Performing Polygon milling in milling machine	2	3	1-2
7	Spur Gear cutting in milling machine	2	3	1-2
8	Helical Gear cutting in Hobbing machine	2	3	1-2

9	Performing surface grinding in Grinding machine	3	4	1-2
10	Performing cylindrical grinding in Grinding machine	3	4	1-2
11	Grinding of single point cutting tool in Tool and Cutter grinding machine	3	4	1-2
12	Preparation of Sand mold using solid/split pattern with loose-piece pattern	3	4	1-2
Total contact hours		**30**		

Learning Assessment - Theory

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 %)**	
		Th	**Th**	**Th**	**Th**	**Th**
Level 1	Remember	40%	40%	40%	40%	40%
	Understand					
Level 2	Apply	30%	30%	30%	30%	30%
	Analyze					
Level 3	Evaluate	30%	30%	30%	30%	30%
	Create					
Total		100%	100%	100%	100%	100%

Learning Assessment - Lab

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	20%	30%	20%	30%
	Understand				
Level 2	Apply	50%	40%	50%	40%
	Analyze				
Level 3	Evaluate	30%	30%	30%	30%
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Manufacturing Science, 2nd Edition, A. Ghosh and A.K. Mallik.
2. P.N. Rao, Manufacturing Technology, 3rd Edition, Tata McGraw Hill Edu Pvt Ltd, 2012

Other Resources

1. S. Nagendra Parashar and R.K. Mittal, Elements of Manufacturing Processes, PHI Learning Pvt Ltd, 2011.
2. R.L. Timings, Manufacturing Technology, 2nd Edition, Pearson Edu Ltd, 2010.
3. Hajra Choudhury, Elements of Workshop Technology, Vol. I and II, Media Promotors Pvt Ltd, 2001

Course Designers

SRM University *AP*, Andhra Pradesh

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

Mini Project

Course Code	MCE 309	Course Category	RDIP	L	T	P	C
				0	0	2	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To learn how to define the research objective.
2. To acquire skills to solve the problem statement.
3. To learn how to prepare scientific presentations.
4. To develop skills for project management and writing scientific reports.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Formulate the given engineering problem related to project	2	70%	80%
Outcome 2	Describe the method (experiments or simulation or theoretical to attain objective)	2	70%	80%
Outcome 3	Describe the project outcome through presentations	3	70%	80%
Outcome 4	Find out how to write project report and prepare a project report	2	70%	80%

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

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit-I	**Definition of Problem**			
	Clearly articulating the problem that the mini-project aims to solve, Describing the current state of affairs and why a solution is necessary	3	1	1,5
Unit-II	**Method**			
	Application of various methods and approaches to ensure successful execution of Mini -Project	3	2	1,5
Unit-III	**Description of results**			
	The obtained results must be interpreted utilising appropriate software, tools, and techniques. Validation of results with standard data base (if any)	4	3	2,3,5
Unit-IV	**Presentation**			
	Making a scientific presentation of the results obtained with appropriate reasoning and evaluated by reviews	2	3	2,3
Unit-V	**Writing of project report**			
	Obtained results are summarized in the form mini-project report	3	4	4,5
Total Contact Hours		**15**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)		End Semester Exam (50%)
		Project Review 1 (25%)	Project Review 2 (25%)	
Level 1	Remember	-	-	-
	Understand			
Level 2	Apply	50%	50%	50%
	Analyse			
Level 3	Evaluate	50%	50%	50%
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Problem Solving for Engineers and Scientists: A Creative Approach (https://doi.org/10.1007/978-1-4615-3906-3)
2. Matt Carter Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters, and More (ISBN: 0123859697)
3. Garr Reynolds Presentation Zen: Simple Ideas on Presentation Design and Delivery (ISBN: 0321811984)
4. Article, how to write consistently boring scientific literature by Kaj Sand-Jensen. doi/10.1111/j.0030-1299.2007. 15674.x
5. Keshav S. How to read a paper. ACM SIGCOMM Computer Communication Review. 2007 Jul 20;37(3):83-4.

Course Designers

1. Dr. Surfarazhussain S. Halkarni, Assistant Professor, Department of Mechanical Engineering, SRM University-AP

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

CO-CURRICULAR ACTIVITIES

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

Course Objectives / Course Learning Rationales (CLRs)

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

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate confidence in leading group activities, communicate clearly, and collaborate effectively with diverse teams.	2	80%	75%
Outcome 2	Apply theories to practical tasks by solving problems and adapting concepts to real-life situations through cocurricular activities	2	80%	70%
Outcome 3	Develop new experiences with an open approach through guided reflection to assess personal growth, skills, and learning for holistic development.	3	80%	70%

Learning Assessment

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

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

COMMUNITY SERVICE AND SOCIAL RESPONSIBILITY

Course Code	VAC 104	**Course Category**	VAC	**L**	**T**	**P**	**C**
				0	0	2	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CEL	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

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

Course Outcomes / Course Learning Outcomes (CLOs)

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

Learning Assessment

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

SRM University *AP*, Andhra Pradesh

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

Heat And Mass Transfer

Course Code	MCE 305	Course Category	CC	L	T	P	C
				3	0	1	4
Pre-Requisite Course(s)	ME 212 ME 222	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the fundamental heat transfer laws, modes of heat transfer and applications of
2. these modes to real life engineering systems
3. To give an overview of conduction, convection and radiation mode of heat transfer and their mechanisms.
4. To understand the utility of thermos-physical properties in different engineering systems, gain knowledge about phase change processes and mass transfer.
5. To implement fundamentals of heat transfer laws to several applications and perform analysis.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Solve the given engineering problems based on heat transfer modes.	3	70%	80%
Outcome 2	Discuss conduction, convection radiation modes of heat transfer and derive the equations	2	70%	80%
Outcome 3	Use the heat transfer data book to identify the properties of solids and fluids used in engineering systems and data charts for heat exchangers.	3	70%	80%
Outcome 4	Analyse heat transfer situations for given applications	4	70%	80%

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

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

Course Unitization Plan-Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	**Introduction**	**2**		
	Definitions of heat and heat transfer. Difference between heat transfer and thermodynamics. Basic Modes and Laws of Heat Transfer.	1.5	1	1, 3, 4
	Examples of Heat and Mass Transfer. Engineering Applications of Heat Transfer	0.5	1	1, 3, 4
UNIT II	**Conduction**	**14**		
	Fourier's law of heat conduction for homogeneous, isotropic media in Cartesian coordinates and its extension to heterogeneous, isotropic media (differential form).	2	2, 4	1, 2, 3, 4, 5
	Vectorial form of Fourier's law for heterogeneous, isotropic continua. Fourier's law in cylindrical and spherical coordinates.	1	2, 4	1, 2, 3, 4, 5
	Derivation of heat conduction equation in Cartesian coordinates for heterogeneous, isotropic materials. Heat conduction equation in Cartesian coordinates for (Case of constant thermal conductivity).	2	2, 4	1, 2, 3, 4, 5
	Significance of thermal diffusivity. Heat conduction equations in cylindrical and spherical coordinates for constant thermal conductivity.	2	2, 3, 4	1, 2, 3, 4, 5
	Simple One-dimensional (1D) Steady Heat Conduction Problems: Plane Wall, Cylinder, and Sphere, Hollow (cylinder and sphere). Temperature distribution and heat transfer.	2	2, 3, 4	1, 2, 3, 4, 5, 8
	Concepts of conductive and convective resistances. Conductive and Convective Resistances in Series.	1	2, 3, 4	1, 2, 3, 4
	Special one-dimensional steady state situations – Heat generation, pin fins, other fin configurations, Two-dimensional steady state situations (brief).	2	2, 3, 4	1, 2, 3, 4, 8
	Transient conduction: Lumped capacitance model, One dimensional transient problems analytical solution, One dimensional Heisler charts, Product solutions.	2	2, 3, 4	1, 2, 3, 4, 8
UNIT III	**Convection**	**10**		
	Forced Convection: Review of fluid mechanics (brief) fundamentals, order of magnitude analysis of momentum and energy equations	1	2, 3	1, 2, 3, 4, 7
	Laminar flow heat transfer in circular pipe – constant heat flux and constant wall temperature, thermal entrance region	2	3, 4	1, 2, 3, 4, 7
	Turbulent flow heat transfer in circular pipe, pipes of other cross sections.	2	3, 4	1, 3, 4, 7, 8
	Heat transfer in laminar flow and turbulent flow over a flat plate, Reynolds analogy	1	3, 4	1, 3, 4, 7, 8
	Flow across a cylinder and sphere, flow across banks of tubes.	1	3, 4	1, 3, 4, 7, 8
	Natural Convection: Introduction, governing equations	1	2, 3	1, 3, 4, 7

	Natural Convection: Vertical plate, horizontal cylinder, horizontal plate, enclosed spaces.	2	3, 4	1, 3, 4, 7, 8
UNIT IV	**Radiation**	**8**		
	Basic ideas, spectrum, basic definitions, Laws of radiation.	1	2, 3	1,2,3,6
	Black body radiation, Planck's law, Stefan Boltzmann law, Wien's Displacement law, Lambert cosine law	3	2, 3	1,2,3,6
	Radiation exchange between black surfaces, shape factor	2	2, 3	1,2,3,6,8
	Radiation exchange between gray surfaces – Radiosity-Irradiation method Parallel plates, Enclosures (non-participating gas), Gas radiation.	2	3, 4	1,2,3,6,8
UNIT V	**Heat exchangers, condensation and boiling**	**8**		
	Heat Exchangers: Types of heat exchangers, LMTD approach – parallel, counter-flow,	2	3	1,3,4,7
	Heat Exchangers: Multi-pass and cross flow heat exchanger, NTU approach – parallel and counter flow, shell and tube, cross flow heat exchanger.	2	2, 3, 4	1,3,7,8
	Condensation and Boiling: Dimensionless parameters, boiling modes	1	3	1,3,4,7
	Condensation and Boiling: Correlations Forced convection boiling, laminar film condensation on a vertical plate, turbulent film condensation.	3	2, 3, 4	1,3,7,8
UNIT VI	**Mass transfer**	**3**		
	Analogy between heat and mass transfer, mass diffusion, Fick's law of diffusion, boundary conditions	1	3	1,3,4,7
	Steady mass diffusion through a wall, transient mass diffusion, mass convection, limitations of heat and mass transfer analogy.	2	3	1,3,4,7
Total contact hours		**45**		

Course Unitization Plan- Practical

S.No.	Experiment Name	Required Contact Hours	CLOs addressed	References Used
1.	Thermal conductivity of insulating powder	4	1, 2	1, 3, 6
2.	Critical radius of insulating material	4	1, 2	1, 3, 6
3.	Heat transfer in natural convection	5	2, 3,4	1, 3, 6
4.	Heat transfer in forced convection	5	2, 3,4	1, 3, 6
5.	Unsteady state heat transfer apparatus	5	2, 3,4	1, 3, 6
6.	Pin fin apparatus	3	2, 3,4	1, 3, 6
7.	Cross flow experiment with heated cylinder	4	2, 3,4	1, 3, 6
Total contact hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (30%)				Practical (20%)		
		CLA-1 (5%)	Mid-1 (10%)	CLA-2 (5%)	Mid-2 (10%)		Th	Prac
Level 1	Remember	40%	30%	30%	40%	30%	40%	40%
	Understand							
Level 2	Apply	60%	70%	70%	60%	70%	60%	60%
	Analyze							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. F. P. Incropera, D. P. Dewitt, T. L. Bergman and A. S. Lavine, "Fundamentals of Heat and Mass Transfer", 7th Ed., John Wiley and Sons, 2011.
2. J. P. Holman, "Heat Transfer", 10th Ed., McGraw Hill, 2009.
3. Yunus A. Çengel, Afshin J. Ghajar, "Heat and mass transfer: fundamentals and applications", McGraw-Hill Education, 2015.
4. P. K. Nag, "Heat and Mass Transfer", 3rd Ed., McGraw Hill, 2005.
5. M. N. Ozisik, Heat Transfer-A Basic Approach, McGraw Hill, 1985.
6. Frank Kreith, Raj M. Manglik and Mark S. Bohn, "Principles of Heat Transfer", 7th Ed., Cengage Learning, 2011.
7. A. Bejan, Convective Heat Transfer, 3rd Ed., John Wiley and Sons, 2004.
8. C. P. Kothandaraman and S. Subramanyan, "Heat and Mass transfer data book 6th Ed. (Multi-color, edition)", New Age International Publishers, 2018
9. Laboratory Manual: Heat Transfer, Version 1.0, SRM University-AP, Dec 2019 - May 2020.

Course Designers

SRM University *AP*, Andhra Pradesh

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

Measurements And Instrumentation

Course Code	MCE 306	Course Category	CC	L	T	P	C
				2	0	1	3
Pre-Requisite Course(s)	ENG 111	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To learn the standards, units of measurements and architecture of the measurement system.
2. To understand the essentials of a measurement instrument's static and dynamic characteristics.
3. To appreciate the digital and data processing techniques in measurement systems.
4. To learn of various mechanical instruments, applications, principles of operation for measurement of displacement, strain, flow, pressure, temperature etc

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 principles of physics, electronics, and electrical circuits to measurement systems	3	70%	65%
Outcome 2	Explain calibration methodology and error analysis related to measuring instruments	2	70%	65%
Outcome 3	Demonstrate the given system/process for standard input responses based on the mathematical model	3	70%	65%
Outcome 4	Illustrate the features, working principle and limitations of given measuring instruments	2	70%	65%
Outcome 5	Identify the measuring instrument for given application	2	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	3	2	2	2	3				3			3	3	2	3
Outcome 2	3	3	2	3	3				3			3	3	2	3
Outcome 3	3	3	2	3	3				3			3	3	2	3
Outcome 4	3	3	3	3	3				3			3	3	3	3
Outcome 5	3	3	3	3	3				3			3	3	3	3
Average	3	3	3	3	3				3			3	3	2	3

Course Unitization Plan-Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	**Basic Concepts of Measurements**	**15**		
	Introduction to measurement and measuring instruments, their applications.	1	1	1
	Generalized measuring system and functional elements	1	1	1
	Sensors and Transducers and their classifications	1	1	1
	Static performance characteristics of measurement devices, sources of errors in measurements, classification, and error analysis	6	1,2	1
	Dynamic performance characteristics of measurement devices, Transient and steady state analysis of first and second order system. Time Domain specifications, step, ramp response of first and second order systems.	6	1,3	1
UNIT II	**Digital Techniques in Measurements**	**6**		
	Basics of digitization & number systems, binary logic gates & binary codes	2	1	1
	Analog-to-digital conversion, Digital-to-analog conversion	2	1	1
	Data Processing - Electromagnetic indicators, electronic amplifiers & filters	2	1	1
UNIT III	**Displacement, Stress and Strain Measurement**	**10**		
	Displacement measurement - Capacitive transducer, Potentiometer, LVDT, RVDT, Specification, Selection & application of displacement transducer.	4	1,4,5	1
	Various types of stress and strain measurements, gauge factor, temperature compensation, bridge circuit, orientation of strain gauge, method of usage of resistance strain gauge for bending compressive and tensile strains, Rosettes.	6	1,4,5	1
UNIT IV	**Pressure and Flow Measurement**	**10**		
	Diaphragm type pressure gauge, bourdon tube pressure gauge, manometers, high pressure, vacuum pressure gauges.	5	1,4,5	1
	Flow measurement – orifice plate, rotameter, magnetic, ultrasonic, turbine flow meter, hot - wire anemometer	5	1,4,5	1
UNIT V	**Temperature Measurement**	**4**		
	Classification, ranges, various principles of measurement, expansion, electrical resistance, thermistor, thermocouple.	4	1,4,5	1
Total Contact Hours		**45**		

Course Unitization Plan-Practical

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	Calibration of Micrometer using Slip Gauges	2	1,2,5	2
2.	Calibration of Vernier Caliper using Slip Gauges	2	1,2,5	2
3.	Measurement of Flatness using Autocollimator	4	1,2,5	2
4.	Measurement of Gear Tooth Profile using Gear Tooth Vernier	4	1,2,5	2
5.	Measurement of Taper Angle using Sine Bar	4	1,2,5	2
6.	Measurements of Surface Roughness using SJ 210	2	1,2,5	2
7.	Measurements using Profile Projector	2	1,2,5	2
8.	Two Wire Method of Effective Diameter Measurement using Floating Carriage Micrometer.	5	1,2,5	2
9.	Measurements using co-ordinate measuring machine (CMM)	5	1,2,5	2
Total Contact Hours			**30**	

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (35%)				Practical (15%)		
		CLA-1 (5%)	Mid-1 (10%)	CLA-2 (5%)	CLA-3 (15%)		Th	Prac
Level 1	Remember	30%	40%	30%	40%	30%	40%	40%
	Understand							
Level 2	Apply	70%	60%	70%	60%	70%	60%	60%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. T. G. Beckwith, R. D. Marangoni, John H. and Lienhard V, "Mechanical measurements", 6th Edition, Addison Wesley.
2. Measurements Lab Manual, SRM University AP.

Other Resources

1. E. O. Doebelin and D. N. Manik, "Measurement Systems", 6th Edition, McGraw Hill, 2017.

Course Designers

SRM University *AP*, Andhra Pradesh

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

AI and ML for Mechanical Engineers

Course Code	MCE 307	Course Category	CC	L	T	P	C
				2	0	0	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand about the fundamentals of artificial intelligence, its advantages and challenges in implementation.
2. To learn about the fundamentals of machine learning.
3. To learn about the applications of artificial intelligence in mechanical engineering
4. To learn about the applications of machine learning in mechanical engineering

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 Artificial intelligence	2	70%	75%
Outcome 2	Describe machine learning	3	70%	75%
Outcome 3	Propose and develop one application of AI in mechanical engineering	3	70%	75%
Outcome 4	Propose and develop one application of AI in mechanical engineering	3	70%	75%

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

Course Unitization Plan-Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Artificial Intelligence**	**6**		
	Concepts, methodologies, techniques, advantages, challenges in implementation.	6	1,2,3,4	1,2
Unit 2	**Introduction to Machine Learning**	**6**		
	Concepts, methodologies, techniques (structured, unstructured, reinforced), advantages, challenges in implementation	6	1,2	1,2
	Type of data (training, test, validation)		1,2	1,2
Unit 3	**Application to mechanical engineering I**	**6**		
	Predictive maintenance, Predict potential failures in mechanical systems using machine learning algorithms based on sensors data	6	2	1,2
Unit 4	**Application to mechanical engineering II**	**6**		
	Turbomachinery explorer: Predict the performance of turbomachinery components using machine learning algorithms based on sensor data	6	1,2	1,2
Unit 5	**Application to mechanical engineering III**	**6**		
	Autonomous vehicles: Detect obstacles, detect potential hazards, recognize traffic signals etc using sensors and machine learning algorithms	6	1,2,3	1,2
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)			End Semester Exam (50%)
		CLA-1 (20%)	Mid-1 (20%)	CLA-2 (10%)	
		Th	Th	Th	Th 50%
Level 1	Remember	40%	40%	30%	40%
	Understand				
Level 2	Apply	60%	60%	70%	65%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Kaushik Kumar, Artificial intelligence in mechanical and industrial engineering, CRC Press, 2021
2. Thenmozi, Machine learning for mechanical engineering

Course Designers

SRM University *AP*, Andhra Pradesh

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

Dynamics And Control

Course Code	MCE 308	Course Category	CC	L	T	P	C
				3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To make the students gain the fundamentals required for analytically deriving the equations of motions for a single particle and system of particles using fundamental principles.
2. To give a brief overview of various approaches for formulating the equations of motions of single rigid body and multi-body system.
3. To make the students understand the relation between the dynamic equations of motion of the system and its control approach.
4. To make the students gain the fundamentals of control theory.
5. To make students gain the knowledge of controlling a multibody system using state space approach.

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	Derive the equations of motion for a single particle and system of particles using the principles of dynamics.	3	80%	75%
Outcome 2	Derive equations of motions for system of rigid bodies using Newtonian and Lagrangian approach.	3	70%	65%
Outcome 3	Derive transfer function for a multibody system to be controlled.	3	70%	65%
Outcome 4	Derive the state space form from equations motion and apply to control a multibody system.	4	80%	75%

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

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

Course Unitization Plan – Theory

Session	Description of Topic	Contact hours Required	CLOs addressed	References Used
	UNIT I: DYNAMICS OF PARTICLES	**8**		
1.	Linear momentum, angular momentum, Linear momentum Principle for a single particle.	1	1	1, 3
2.	Linear momentum Principle for system of particles.	1	1	1, 3
3.	Angular momentum principle for a single particle.	1	1	1, 3
4.	Angular momentum principle for system of particles.	1	1	1, 3
5.	Work-energy principle for single particle	1	1	1, 3
6.	Work-energy principle for system of particles.	1	1	1, 3
7.	Newton laws for system of particles.	1	1	1, 3
8.	Conservation of energy.	1	1	1, 3
	UNIT II: DYNAMICS OF RIGID BODIES	**8**		
9.	2D motion of rigid bodied- Kinematics, Kinetics	2	2	1, 3
10.	Analytical examples of various systems.	1	2	1, 3
11.	Work energy principle for rigid bodies.	1	2	1, 3
12.	Moment of Inertia	1	2	1, 3
13.	Numerical examples of moment of inertia	1	2	1, 3
14.	Equations of motion of a rigid body.	2	2	1, 3
	UNIT III: LAGRANGIAN DYNAMICS	**10**		
15.	Generalized coordinates and frames	1	2	1, 3
16.	virtual work and generalized forces.	1	2	1, 3
17.	Lagrange's equations.	2	2	1, 3
18.	Lagrangian dynamics examples.	2	2	1, 3
19.	Equilibrium analysis	1	2	1, 3
20.	linearization of equations motion.	1	2	1, 3
21.	Fundamentals of vibrations.	2	2	1, 3
	UNIT IV- FUNDAMENTALS OF CONTROL SYSTEMS	**9**		
22.	Control systems: Terminology and basic structure.	1	3	2, 4
23.	Open loop control, close loop control, applications of control systems.	1	3	2, 4
24.	Elements of mechanical systems and equations.	1	3	2, 4

25.	Modelling of physical systems.	1	3	2, 4
26.	Block diagrams, algebra, numerical examples.	2	3	2, 4
27.	Revision of Laplace Transforms.	1	3	2, 4
28.	Transfer functions.	2	3	2, 4
	UNIT V- CONTROL SYSTEM DESIGN FUNDAMENTALS	**10**		
29.	Linear time invariant system.	1	4	2, 4
30.	System stability and eigenvalues	1	4	2, 4
31.	Linearizing about a fixed point.	2	4	2,4
32.	controllability, reachability	1	4	2, 4
33.	Eigenvalue placement.	1	4	2, 4
34.	System poles and zeros.	1	4	2, 4
35.	Effect of poles and zeros on the system response.	1	4	2, 4
36.	Control of inverted pendulum on a cart.	2	4	2, 4
Total contact hours		**45**		

Course Unitization Plan - Lab

Session	Description of Topic	Contact hours Required	CLOs addressed	References Used
1.	Motor control using 4-dof development platform	5	3	1, 3
2.	Control of magnetic levitation system	5	1	1, 3
3.	Control of cartwheel inverted pendulum	5	1, 2, 3, 4	1, 3
4.	Kinematic analysis of 3-dof robot	5	1, 2	1, 3
5.	Control of 3-dof robot	5	3, 4	1, 3
6.	Speed control of dc motor	5	3	1, 3
	Total contact hours	**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (20%)		CLA-2 (10%)		CLA-3 (10%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	20%		30%		10%		20%		20%	
	Understand										
Level 2	Apply	60%		50%		60%		60%		55%	
	Analyse										
Level 3	Evaluate	20%		20%		30%		20%		25%	
	Create										
Total		100%		100%		100%		100%		100%	

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

Recommended Resources

1. Dynamics and Control I. by Nicholas Hadjiconstantinou, Peter So, Sanjay Sarma, and Thomas Peacock. 2.003J Spring 2007. Massachusetts Institute of Technology: MIT OpenCourseWare, https://ocw.mit.edu. License: Creative Commons BY-NC-SA.
2. Dynamics and Control II by Derek Rowell. 2.004 Spring 2008. Massachusetts Institute of Technology: MIT OpenCourseWare, https://ocw.mit.edu. License: Creative Commons BY-NC-SA.
3. Fundamentals of Applied Dynamics by James H. Williams - John Wiley and Sons, Inc. (1996).
4. Control Systems Engineering by I.J. Nagrath and M. Gopal, New age international publishers (2009).

Course Designers

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

Technical Seminar

Course Code	MCE 402	Course Category		L	T	P	C
				0	0	1	1
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To learn how to write the seminars in an effective way
2. To learn what are the skills needed for presentation of science
3. To learn effective science communication

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 the features and characteristics seminars and presentations.	2	80%	80%
Outcome 2	Discuss methods of the presentation.	2	65%	60%
Outcome 3	Explain the parameters of conducting seminars.	3	65%	60%
Outcome 4	Discuss the responses to Q&A sessions in seminars.	2	60%	65%
Outcome 5	Explain conflict management during presentations and seminars.	3	80%	75%

Commented [SOU1]: Sir, there seems to be application inUnit 1 and 3, this can be level 3. Please consider

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 Lifelong	PSO 1	PSO 2	PSO 3
Outcome 1	2		2	3	2	1			3	3	2	3	1	2	2
Outcome 2	2		2	3	2	1			3	3	2	3	2	2	1
Outcome 3	2		2	3	2	1			3	3	2	3	2	2	1
Outcome 4	2		2	3	2	1			3	3	2	3	2	2	1
Outcome 5	2		2	3	2	3		3	3	3	2	3	2	2	1
Average	**2**		**2**	**3**	**2**	**1**		**3**	**3**	**3**	**2**	**3**	**2**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit-I	**Seminar -Structure**	**5**		
	Explanation on what is a seminar and what are expected during the seminar, followed by student presentations		1,3	1,2
Unit-II	**Ways and tools of presentation in the seminar**	**7**		
	Discussion on tools for effective presentation		1, 2	3,4,5
Unit-III	**Presentation skills**	8		
	Discussion and presentation demonstration		3	5
Unit-IV	**Handling questioning sessions of presentation**	**5**		
	How to answer the questions during the presentation. Student presentation and discussion		4,5	6
Unit-V	**Conflict management during presentation**	**5**		
	How to manage the conflicts during the presentation		1, 4, 5	6
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)						End Semester Exam (50%)	
		Abstract		Preliminary presentation		Seminar 1		Seminar 2	
		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%	

Recommended Resources

1. Brian Tracy, Speak to Win: How to Present with Power in Any Situation, Kindle Edition
2. Robert RH Anholt, Dazzle 'Em With Style: The Art of Oral Scientific Presentation, (ISBN: 0123694523)
3. Vernon Booth, Communicating in Science: Writing a Scientific Paper and Speaking at Scientific Meetings (ISBN: 0521429153)
4. Matt Carter Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters, and More (ISBN: 0123859697)
5. Garr Reynolds Presentation Zen: Simple Ideas on Presentation Design and Delivery (ISBN: 0321811984)
6. Herbert Fensterheim and Jean Baer, Don't Say Yes When You Want to Say No: Making Life Right When It Feels All Wrong, Mass Market, 1975

Other Resources

1. Article, How to write consistently boring scientific literature by Kaj Sand-Jensen. doi/10.1111/j.0030-1299.2007.15674.x

Course Designers

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

Internship

Course Code	MCE 401	Course Category	RDIP	L	T	P	C
				0	0	2	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	MCE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the application of academic knowledge to practical (Social, Environmental, Industrial and Scientific) problems	2	70	80
Outcome 2	Demonstrate essential soft skills and relevant technical abilities in managing practical tasks and projects within the internship setting.	3	70	80
Outcome 3	Understand and adhere to standard operating procedures and interpret quality control measures specific to the industry or organization.	2	70	80
Outcome 4	Build effective professional relationships by networking with supervisors, team members, and other departments.	3	70	80

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

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	1	1	2	2	2	1	2	1	0	3			
Outcome 2	3	3	1	3	2	2	1	1	3	3	2	3			
Outcome 3	3	3	2	2	2	1	2	1	2	2	2	2			
Outcome 4	1	1	1	1	1	3	1	1	3	3	0	2			
Average	2.5	2.25	1.25	1.75	1.75	2	1.5	1	2.5	2.25	1	2.5			

Course Unitization Plan

Unit No.	Unit Name	Required Weeks	CLOs Addressed
Unit 1	**Definition of Problem** This unit focuses on clearly articulating the problem that the project aims to solve. Interns will describe the current situation, analyze gaps or challenges, and explain why a solution is necessary. Establishing a clear problem statement is essential to set a precise project direction.	**2**	1
Unit 2	**Method** Interns will explore and apply various methods and approaches critical to the successful execution of the project. This unit includes planning, selecting suitable methods, and implementing best practices to achieve project objectives efficiently.	**2**	1,2
Unit 3	**Description of results** This unit requires interns to interpret the results obtained from their project using appropriate software, tools, and analytical techniques. Emphasis is on accuracy, relevance, and coherence in presenting findings that support the project objectives.	**1**	3
Unit 4	**Strategy Evaluation** Students assess and critique the effectiveness of strategies and methodologies employed that support the project objectives.	**1**	3
Unit 5	**Project Presentation and thesis report** Interns will prepare and deliver a scientific presentation of their results, providing well-supported reasoning. Additionally, they will compile their work into a thesis, manuscript, or report that summarizes the project, including methodology, results, and conclusions, adhering to academic or industry standards.	**1**	4

Learning Assessment

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

Recommended Resources

Other Resources

Course Designers

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

Major Project

Course Code	ME 602	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	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To provide a definite context, to apply the leanings from various courses of the program and solve unstructured and ill-defined problems
2. To develop an integrated approach for problem solving.
3. To provide an exposure to take up a real-life research problem / product development / industrial problem and arrive at meaningful conclusions / product design / solution
4. To teach students how to write a technical report and present the facts i precise manner.

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	Conceptualize a research and development idea specific to Mechanical Engineering	4	70%	75%
Outcome 2	Develop a solution methodology for the problem based on the literature	5	70%	75%
Outcome 3	Plan to implement the solutions through experiments/simulations and iterations	4	70%	75%
Outcome 4	Write a technical report and present the scientific findings	4	70%	75%

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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
	Capstone Project			
Unit 1	Ideation of project Theoretical analysis or modelling / simulation or experimental validation or prototype fabrication, analysis of data etc .	25	**1,2**	**1**
Unit 2	Literature survey and concept finalization	50	**1,2**	**1**
Unit 3	Devise the mathematical model/ numerical analysis approach/ build machine/prototype/fabrication etc	200	**3,4,**	**1**
Unit 4	Validation of the performance of model/prototype/machine etc	150	**3,4**	**1**
Unit 5	Prepare presentation the work and a technical report	25	**4**	**1**
Total Contact Hours		**450**		

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
1	**Capstone design project**	**450**	**1,2,3,4,**	**1**
2	Capstone Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, etc. or a combination of these. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations. The project can be performed either in the university laboratories or any national laboratory or any industry.			
Total Contact Hours		**450**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)			End Semester Exam (50%)
		Internal Review 1 (20%)	Internal Review 2(20%)	Report (10%)	
Level 1	Remember			20%	
	Understand				
Level 2	Apply	50%	50%	30%	50%
	Analyse				
Level 3	Evaluate	50%	50%	50%	50%
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Capstone design project manual, Machine design, SRM University AP

Course Designers

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

Introduction to Robotics

Course Code	MCE 454	Course Category	CE	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the basic concepts of the mechanical structure and performance measures of industrial robots.
2. To introduce the concepts of payload estimation for various types of ends effectors
3. To introduce the concepts and application of robot kinematics for industrial manipulators.
4. To introduce fundamentals of sensing and image processing for industrial robots.
5. To introduce the concepts of robot cell layout and robot programming.
6. To provide an exposure to the recent developments in robotics.

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	Be familiar with different types of robot manipulators, their technical specifications, current trends in robotics and sensing techniques	1	90%	75%
Outcome 2	Estimate the gripping force of an end effector for a given payload requirement	2	80%	60%
Outcome 3	Apply direct and inverse kinematics to robot manipulators	2, 3	80%	50%
Outcome 4	Plan joint trajectories and program the robot manipulator	2, 3	80%	60%
Outcome 5	Be familiar with various robot cell layouts, safety issues and applications of robot manipulators	1	80%	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	3	1	1	3	1				2			3	3	2	3
Outcome 2	3	3	1	2	1				2			1	3	2	3
Outcome 3	3	3	1	2	3				3			1	3	2	2
Outcome 4	3	3	1	2	3				3			2	3	3	3
Outcome 5	3	2	1	2	1				2			1	3	3	3
Average	3	2	1	2	2				2			2	3	2	3

Course Unitization Plan – Theory

Session	Description of Topic	Contact Hours Required	CLOs addressed	References Used
	UNIT I: INTRODUCTION	**10**		
1	Basic concepts of robotics (laws of robotics, robotic systems), RIA definition.	1	1	1, 2, 3
2	Robot anatomy (robot configurations, robot motions, joint notation scheme)	1	1	1, 2, 3
3	Manipulators precision movement (spatial resolution, accuracy, repeatability)	1	1	1
4	work volume, robot specifications	1	1	1, 2
5	Types of robot drives, electric drive, hydraulic, and pneumatic drives	1	1	1
6	Basic robot motions, point-to-point control and continuous path control	1	1	1, 2
7	Kinematics: forward and inverse kinematics	2	1	1, 2, 3
8	problems on kinematics	2	1	2, 3
	UNIT II: END EFFECTORS AND TRANSFORMATIONS	**12**		
9	End effectors - introduction, classification	1	2	1
10	Gripper force analysis and design	1	2	1
11	Problems on gripper design, problems on force calculation	1	2	1
12	2d transformation (scaling, rotation, translation)	1	3	1
13	3d transformation (scaling, rotation, translation)	4	3	2, 3
14	Homogeneous transformations.	4	3	2, 3
	UNIT III: SENSORS AND CONTROL SYSTEMS	**9**		
15	Sensor devices, types of sensors (Proximity / contact, position and displacement sensors)	2	1	1
16	Force and torque sensors	1	1	1
17	Range sensors, Acoustic sensor	1	1	1
18	Sensing and digitizing, image processing and analysis	1	1	1, 3
19	Robot vision systems	2	1	1, 3
20	Robot control system, unit control system,	1	1	1, 2
21	Adaptive and optimal control.	1	1	3
	UNIT IV- ROBOT CELL DESIGN	**7**		
22	Robot work cell design	1	5	1
23	Control considerations in cell design	1	5	1
24	Safety considerations in cell design	1	5	1
25	Robot cell layouts	1	5	1
26	Multiple robots	1	5	1
27	Machine Interface	1	5	1
28	Robot cycle time analysis.	1	5	1
	UNIT V- ROBOT PROGRAMMING AND APPLICATIONS	**7**		
29	Robot language, classification, Programming methods, off and online programming	0.5	4	1, 3
30	Lead through method, powered and Manual lead through, Teach pendent method	0.5	4	1, 3
31	VAL systems and language, Simple program.	1	4	1, 3
32	Application of Robots, Material handling, Constrains, Machine loading and unloading.	1	4	1
33	Assembly Robot, Assembly operation, RCC device, activities of an expert system	1	4	1
34	Benefits-Inspection robot ,used in Quality control	1	4	1
35	Welding Robot, features, sensors ,Advantages, -Painting Robot, Requirement, and Spray painting	1	4	1
36	Mobile and microbots, types, mobility and application ,Recent developments in robotics- safety considerations.	1	1	1, 2, 3
Total contact hours		45		

Learning Assessment

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

Recommended Resources

1. Groover, M. P., Weiss, M., Nagel, R. N., Odrey, N. G., & Dutta, A. (2017). Industrial Robotics: Technology, Programming, and Application. McGraw-Hill Higher Education.
2. Craig, J. J. (2006). Introduction to Robotics. Pearson Education.
3. Fu, K. S., Gonzalez, R. C., Lee, C. G., & Freeman, H. (1987). Robotics: Control, sensing, vision, and intelligence. New York: McGraw-Hill

Course Designers

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

Mechatronics

Course Code	MCE 455	**Course Category**	CE		**L**	**T**	**P**	**C**
					2	1	0	3
Pre-Requisite Course(s)	EEE 103 Basic Electrical and Electronics Engineering	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department		**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the concepts and applications of mechatronics system design and various communication protocols
2. To introduce various types of sensors and the relevance of signal conditioning
3. To provide the necessary fundamentals for fluid power systems design
4. To introduce the principle of programmable logic controllers and PLC programming
5. To impart the fundamentals of microcontrollers and microcontroller 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	Recognise the relevance of mechatronics system design and comprehend various communication protocols	1	80%	70%
Outcome 2	Identify different types of sensors and recognise the need for signal conditioning for specific sensing requirements	1, 2	70%	60%
Outcome 3	Combine different fluid power devices and design fluid power circuits for a given application	2, 3	70%	60%
Outcome 4	Implement ladder-logic program for PLC-based industrial automation	3	70%	60%
Outcome 5	Write a microcontroller program for basic tasks	2	70%	50%

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	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Outcome 2	3	1	-	3	-	-	-	-	-	-	-	-	1	1	-
Outcome 3	3	3	3	2	3	-	-	-	-	-	-	-	3	1	-
Outcome 4	3	3	3	2	3	-	-	-	-	-	-	-	3	1	-
Outcome 5	3	2	1	3	2								2	1	
Average	**3**	**3**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**-**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	INTRODUCTION TO MECHATRONICS: Definition, History, Evolution, Objectives and Advantages of Mechatronics.	1	1	1, 2, 3
	Philosophy of Mechatronics System Design. Mechatronics Design Process.	1	1	1, 2, 3
	Key Elements of a Mechatronic System. Open and Closed Loop Systems.	1	1	1, 2, 3
	Applications and Case Studies.	1	1	1, 2, 3
	COMMUNICATION PROTOCOLS: Network Standards	1	1	1
	Serial Communication Interfaces: RS-232, I^2C Bus.	2	1	1
	CAN, LIN and FlexRay protocols for automobile applications.	1	1	1
	GPIB Parallel Communication	1	1	1
Unit No. 2	SENSORS AND SIGNAL CONDITIONING: Proximity sensor, position sensors	2	2	1, 4
	Velocity sensing – Encoders	2	2	1, 4
	Temperature sensing	2	2	1, 4
	Strain gauges and signal conditioning.	2	2	1, 4
	Force and torque sensing.	1	2	1, 4
Unit No. 3	FLUID POWER SYSTEMS: Pneumatics Vs Hydraulics	1	3	1
	Fluid Power Devices and Symbols; Directional Control Valves; Pressure Control Valves	3	3	1
	Fluid Power Circuits	2	3	1
	Case Studies	3	3	1
Unit No. 4	PROGRAMMABLE LOGIC CONTROLLERS: Basic Architecture	1	4	1
	I/O Modules; I/O voltages; Relays Vs Optocouplers.	1	4	1
	I/O Processing; I/O Addressing Scheme; I/O Status – Normally Open Vs Normally Closed.	1	4	1
	PLC PROGRAMMING: Ladder Diagram and Logic Functions.	2	4	1
	Latching and internal relays; Timers and Counters	1	4	1
	Shift Registers: Master and Jump Controls	1	4	1
	Case studies using Ladder Logic Diagrams	2	4	1
Unit No. 5	MICROCONTROLLERS: General structure of Microprocessor System.	1	5	1
	Different types of buses and functions	1	5	1
	Internal architecture of a Microprocessor;	1	5	1
	Types of Registers and Functions	1	5	1
	Types of Memory; Microprocessor Vs Microcontroller;	1	5	1
	Microcontroller Programming: Instruction sets; Addressing Modes	2	5	1
	Programming Examples	2	5	1

Learning Assessment

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

Recommended Resources

1. Bolton, W. (2010). Mechatronics. Pearson.
2. Bishop, R. H. (2017). Mechatronics: an introduction. CRC Press.
3. Shetty, D., Kolk, R. A. (2010). Mechatronics System Design. Cengage Learning.
4. Doebelin, E. D. (2011). Measurement System. McGraw-Hill.

Course Designers

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

Flexible Manufacturing Systems and Automation

Course Code	MCE 456	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To deconstruct the anatomy of Flexible Manufacturing Systems
2. To craft agile production lines
3. To optimize the pulse of production
4. To navigate the crossroads of flexibility and feasibility and automate the manufacturing system

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	Unpack the core components, types, and operational principles of FMS	3	70%	75%
Outcome 2	Design and implementation of FMS	2	80%	75%
Outcome 3	Master the art of measuring and maximizing FMS performance metrics, navigate the FMS software	3	80%	70%
Outcome 4	Analyze the economic viability of FMS, automate the manufacturing systems	3	80%	75%

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Types of production system, comparison, plant layout, Functions in manufacturing, manufacturing support and system	2	1	1,2
	Automation in the production system,	2	1	1,2,3
	Production quantity and product variety, production concepts and mathematical model, tutorial on production rate, production, capacity, utilization, availability, manufacturing lead time for all types of production	2	1	1,3
	Tutorial on manufacturing lead time, work in progress for all types of production, single product scheduling	2	1	1,2
Unit No. 2	Introduction to GT	1	1	1,2,3
	Formation of part families, part classification and coding system, production flow analysis, machine cell design, clustering algorithm, GT benefits	2	1,2	1,2,3
	Introduction and evolution of FMS	1	1	1
	FMS need and economic justification, components and classification of fms	2	4	1,2,3
Unit No. 3	Physical planning for FMS, objective, guideline.	2	3	1,2,3
	User-supplier responsibilities in planning, user-supplier role in site preparation, machine tool selection and layout, computer control system, datafiles, types of reports, system description and sizing, factors affecting it.	2	3	1,2,3
	Human resources for FMS, objective, staffing, supervisor role.	2	3	1,2,3
	Quantitative analysis methods for fms, bottle neck and extended bottle neck model, tutorial, FMS benefits and limitations.	2	3	1,2,3
Unit No. 4	Introduction to manufacturing cells, Cell description and classifications, Unattended machining, Requirement and features	2	1,2	1,2,3
	Cellular versus FMS, System simulation, Hardware configuration	3	1,2,3	1,2,3
	PLC and computer controllers, Communication networks	2	1,2	1,2,3
	Lean production and agile manufacturing	3	1,2	1,2,3
Unit No. 5	Introduction to FMS software, General structure and requirements	3	3,4	3
	FMS installation, Automation strategies	3	3,4	1,2,3
	Acceptance testing, Performance goals, Robots used in machining, Sheet metal fabrication	3	3,4	1,2,3
	FMS development towards factories of the future	4	3,4	1,2,3

Learning Assessment

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

Recommended Resources

1. William W. Luggen, "Flexible Manufacturing Cells and Systems", Prentice Hall, New Jersey, 1991.
2. Mikell P. Groover, "Automation Production Systems & Computer Integrated manufacturing", Prentice, 2007.
3. Jha.N.K, "Handbook of Flexible Manufacturing Systems", Academic Press Inc.,1991.

Course Designers

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

AI for Robotics

Course Code	MCE 457	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	0	3
Pre-Requisite Course(s)	CSE 108 Introduction to Computer Science and Programming Using C	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the basic concepts of AI and impart a programming approach to AI
2. To introduce the concepts of image processing and its relevance to robotics.
3. To introduce the concepts of fuzzy logic.
4. To introduce the concepts of deep learning.
5. To introduce various algorithms for robot path planning

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 suitable AI techniques for a given application and identify suitable software for implementing AI for robotics applications	1	80%	70%
Outcome 2	Implement different image processing techniques for robot vision	2, 3	70%	60%
Outcome 3	Apply fuzzy logic for knowledge handling using software such as MATLAB	2	70%	60%
Outcome 4	Employ deep learning techniques for robotics applications	2	70%	60%
Outcome 5	Investigate various path planning techniques for mobile robots and robot manipulators	3	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	3	1	-	-	-	-	-	-	-	-	-	-	1	-	-
Outcome 2	3	3	-	3	3	-	-	-	-	-	-	-	2	1	-
Outcome 3	3	3	-	2	3	-	-	-	-	-	-	-	2	1	-
Outcome 4	3	3	-	2	3	-	-	-	-	-	-	-	2	1	-
Outcome 5	3	3	-	3	3								2	1	
Average	**3**	**3**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction to AI; Emulation of human cognitive process	1	1	1
	History of AI	1	1	1
	Definition and types of of AI	1	1	1
	Machine Learning Vs Deep Learning	1	1	1
	Introduction to Expert Systems	1	1	1
	Introduction to Evolutionary computing	1	1	1
	Tools for AI - Basic Introduction to MATLAB	1	1	1
	Tools for AI - Basic Introduction to Python Programming	1	1	1
Unit No. 2	COMPUTER VISION: Image processing fundamentals	2	2	2
	Spatial Domain processing	2	2	2
	Frequency Domain processing	2	2	2
	Morphological Image Processing	2	2	2
	3D Vision	1	2	2
	Introduction to OpenCV	1	2	3, 4, 5
Unit No. 3	FUZZY LOGIC: Introduction to fuzzy logic	1	3	6, 7
	Membership function and Fuzzy Set theory	1	3	6, 7
	Fuzzification	1	3	6, 7
	Defuzzification	1	3	6, 7
	Fuzzy Inferences	1	3	6, 7
	Type 1 and Type	1	3	6, 7
	Case Studies	1	3	6, 7
Unit No. 4	DEEP LEARNING: Introduction to Neural Network	1	4	8, 9
	Artificial neuron	2	4	8, 9
	Types of neural network models	2	4	8, 9
	Activation functions	1	4	8, 9
	Backward Propagation	2	4	8, 9
	Case Studies	2	4	8, 9
Unit No. 5	PATH PLANNING: Introduction to path planning algorithms	1	5	11
	A*, RRT	2	5	11
	PRM	1	5	11
	Robot Swarms	1	5	11
	Swarm Algorithms	2	5	11
	ABC	1	5	11
	ACO	1	5	11
	PSO	1	5	11

Learning Assessment

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

Recommended Resources

1. Russell, S. J., & Norvig, P. (2016). Artificial intelligence: a modern approach. Pearson.
2. Fu, K. S., Gonzalez, R. C., Lee, C. G., & Freeman, H. (1987). Robotics: Control, sensing, vision, and intelligence (Vol. 1). New York: McGraw-Hill.
3. Vaishya, A. (2023). Mastering OpenCV with Python. Orange Education Pvt Limited.
4. Chen, J. (2023). Learn OpenCV with Python by Examples. James Chen.
5. Gollapudi, S. (2019). Learn Computer Vision Using OpenCV: With Deep Learning CNNs and RNNs. Germany: Apress.
6. Shinghal, R. (2012). Introduction to fuzzy logic. PHI Learning.
7. Peckol, J. K. (2021). Introduction to Fuzzy Logic. Wiley.
8. Patterson, J., Gibson, A. (2017). Deep Learning: A Practitioner's Approach. O'Reilly Media.
9. Billard, A., Mirrazavi, S., Figueroa, N. (2022). Learning for Adaptive and Reactive Robot Control: A Dynamical Systems Approach. MIT Press.
10. Chatterjee, A., Rakshit, A., & Singh, N. N. (2012). Vision Based Autonomous Robot Navigation: Algorithms and Implementations. Springer.
11. Koubaa, A., Bennaceur, H., Chaari, I., Trigui, S., Ammar, A., Sriti, M.-F., Alajlan, M., Cheikhrouhou, O., & Javed, Y. (2018). Robot Path Planning and Cooperation: Foundations, Algorithms and Experimentations. Springer.

Course Designers

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

Machine Learning in Robotics

Course Code	MCE 458	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	0	3
Pre-Requisite Course(s)	CSE 108 Introduction to Computer Science and Programming Using C	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the fundamental concepts of machine learning
2. To provide understanding of the techniques and mathematical concepts in machine learning
3. To provide an algorithmic approach to machine learning
4. To facilitate the applications of machine learning techniques in robotics and other mechanical engineering areas

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Comprehend different types of machine learning	1	70%	60%
Outcome 2	State the applications and limitations of various machine learning techniques	1	60%	50%
Outcome 3	Utilize statistical and probabilistic machine learning algorithms	2	60%	50%
Outcome 4	Implement machine learning algorithms for classification and clustering problems	2, 3	60%	50%
Outcome 5	Examine various machine learning algorithms and tools for robotics and other mechanical engineering applications	2, 3	60%	55%

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	3	1	-	-	1	-	-	-	-	-	-	-	1	-	-
Outcome 2	3	2	-	2	2	-	-	-	-	-	-	-	2	1	-
Outcome 3	3	2	-	2	3	-	-	-	-	-	-	-	2	1	-
Outcome 4	3	3	-	3	3	-	-	-	-	-	-	-	2	1	-
Outcome 5	3	3	-	3	3								2	1	
Average	**3**	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Different forms of learning	1	1	1, 2
	. Supervised and unsupervised learning	2	1	1,2
	Loss functions	2	1	1,2
	Model training	2	1	1,2
	Backpropagation	2	1	1,2
Unit No. 2	. GENERATIVE LEARNING: Gaussian parameter estimation	1	1, 2, 3	1, 2, 3
	Maximum likelihood estimation	1	1, 2, 3	1, 2, 3
	MAP estimation	1	1, 2, 3	1, 2, 3
	Bayesian estimation	1	1, 2, 3	1, 2, 3
	Bias and variance of estimators	1	1, 2, 3	1, 2, 3
	Missing and noisy features	1	1, 2, 3	1, 2, 3
	Nonparametric density estimation	1	1, 2, 3	1, 2, 3
	Applications	2	1, 2, 3	1, 2, 3
Unit No. 3	CLASSIFICATION METHODS: Nearest neighbour	1	1, 2, 4	1,2, 6
	Decision trees	1	1, 2, 4	1,2, 6
	Linear Discriminant Analysis	1	1, 2, 4	1,2, 6
	Simple and multivariate regression	1	1, 2, 4	1,2, 6
	Logistic regression	1	1, 2, 4	1,2, 6
	K-means clustering	1	1, 2, 4	1,2, 6
	Perceptions; Large margin classification	1	1, 2, 4	1,2, 6
	Support Vector Machine	1	1, 2, 4	1,2, 6
	Kernel methods	1	1, 2, 4	1,2, 6
Unit No. 4	CLASSIFICATION AND REGRESSION TREES:	1	1, 2, 4	1,2, 6
	Graphical and sequential models	1	1, 2, 4	1,2, 6
	Bayesian networks	2	1, 2, 4	1,2, 6
	Conditional independence	1	1, 2, 4	1,2, 6
	Markov random fields	2	1, 2, 4	1,2, 6
	Inference in graphical models	1	1, 2, 4	1,2, 6
	Belief propagation	1	1, 2, 4	1,2, 6
Unit No. 5	MARKOV MODELS: Hidden Markov models; Decoding states from observations	1	1, 2, 4	1,2, 6
	Learning HMM parameters	1	1, 2, 4	1,2, 6
	CLUSTERING METHODS: Partition based Clustering	1	1, 2, 4, 5	1,2, 6
	K-means clustering	1	1, 2, 4, 5	1,2, 6
	K-medoids	1	1, 2, 4, 5	1,2, 6
	Hierarchical Clustering	1	1, 2, 4, 5	1,2, 6
	Agglomerative, Divisive, Distance measures	1	1, 2, 4, 5	1,2, 6
	Density based Clustering	1	1, 2, 4, 5	1,2, 6
	DBScan; Spectral clustering	1	1, 2, 4	1,2, 6

Learning Assessment

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

Recommended Resources

1. James, G., Witten, D., Hastie, T., Tibshirani, R., & Taylor, J. (2023). An introduction to statistical learning: With applications in python. Springer Text in Statistics.
2. Hastie, T., Tibshirani, R., & Friedman, J. (2009). An introduction to statistical learning. Springer.
3. Murphy, K. P. (2012). Machine learning: a probabilistic perspective. MIT press.
4. Alpaydin, E. (2020). Introduction to machine learning. MIT press.
5. Haque, E. (2020). The Ultimate Modern Guide to Artificial Intelligence. United Kingdom: Independently Published. ISBN:9798691930768
6. Shalev-Shwartz, S., Ben-David, S. (2014). Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press.
7. Ayyadevara, V. K. (2018). Pro Machine Learning Algorithms: A Hands-On Approach to Implementing Algorithms in Python and R. Germany: Apress.

Course Designers

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

Advanced Robotics

Course Code	MCE 459	Course Category	CE	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the concepts of dynamics of robot manipulators
2. To introduce various methods of derivation of equations of motion of robot manipulators.
3. To introduce the concepts of modelling and simulation of robotic systems.
4. To introduce the concepts of motion planning and robot control.

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	Derive and Analyse the dynamic equations of robot manipulator using Newton-Euler and Lagrangian formulation.	3	70%	75%
Outcome 2	Model and simulate the dynamic equations of the parallel manipulator, wheeled robots and drones.	3	70%	75%
Outcome 3	Use various trajectory planning schemes and manipulability indexes for robot planning.	3	70%	75%
Outcome 4	Apply linear control and computer torque control techniques for control of robot manipulator.	3	70%	75%

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 Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	1	1	-	1	-	-	-	3	1	-	-	1	1	2
Outcome 2	3	3	2	2	3	-	-	-	2	1	-	-	3	-	1
Outcome 3	3	3	2	2	3	-	-	-	2	1	-	-	3	-	1
Outcome 4	1	1	1	-	1	-	-	-	2	1	-	-	1	1	2
Average	2	2	2	2	2	-	-	-	2	1	-	-	2	1	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No.1	**Velocity and acceleration of robot manipulator**	**9**		
	Review of forward kinematics and DH parameters	2	1	1
	Velocity of robot manipulator	2	1	1
	Velocity propagation	1	1	1
	Review of Jacobian and static force analysis	2	1	1
	Acceleration analysis	2	1	1
Unit No.2	**Robot Dynamics**	**10**		
	Review of Newton-Euler dynamics	1	1	1,3
	Récursive Newton-Euler Dynamics formulation for robot manipulator.	2	1	1,3
	Numerical problems	1	1	1,3
	Lagrangian Formulation for robot dynamics	2	1	1,3
	Numerical problems	1	1	1,3
	Properties of Inertial matrix	1	1	1,3
	Constraint Jacobian	1	1	1,3
	Lagrangian formulation with constraint equations	1	1	1,3
Unit No.3	**Modelling and Simulation**	**10**		
	Kinematics of parallel manipulator	1	2	4, 5
	Dynamics of parallel manipulator	2	2	4, 5
	Dynamics of cooperative manipulator	2	2	2
	Types of wheeled robot and their kinematic models	1	2	5
	Dynamics of wheeled robots	2	2	5
	Kinematics of drones	1	2	3

	Dynamics of quadrotor type drones	1	2	3
Unit No.4	**Trajectory planning**	**7**		
	Cubic joint trajectory planning	1	3	1,2,3
	Joint trajectory planning with via points	1	3	1,2,3
	Numerical problems of joint trajectory	1	3	1,2,3
	Higher order trajectory planning	2	3	1,2,3
	Cartesian trajectory planning	1	1	1,2,3
	Manipulability measures	1	3	1,2,3
Unit No.5	**Robot control**	**9**		
	Introduction to linear control	1	4	1,3
	Control system model using transfer function	2	4	1,3
	PID control of robot manipulator	2	4	1,3
	Computer torque control of robot manipulator	2	4	1,3
	Introduction to Nonlinear control	2	4	1,3
Total Hours		**45**		

Learning Assessment

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

Recommended Resources

1. Craig, J. J. (2006). Introduction to robotics. Pearson Education
2. Sciavicco, L., & Siciliano, B. (2001). Modelling and control of robot manipulators. Springer Science & Business Media.
3. Spong, M. W., Hutchinson, S., & Vidyasagar, M. (2020). Robot modelling and control. John Wiley & Sons.
4. Tsai, L. W. (1999). Robot analysis: the mechanics of serial and parallel manipulators. John Wiley & Sons.
5. Ghosal, A. (2006). Robotics: Fundamental concepts and analysis. Oxford University Press

Other Resources

1. https://modernrobotics.northwestern.edu/nu-gm-book-resource/foundations-of-robot-motion/
2. https://www.futurelearn.com/programs/robotics
3. https://archive.nptel.ac.in/courses/112/105/112105249/
4. https://www.youtube.com/watch?v=a6_fgnuuYfE

Course Designers

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

Automation in Manufacturing

Course Code	MCE 460	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	0	3
Pre-Requisite Course(s)	Manufacturing Processes	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the principles and concepts of manufacturing automation and Industry 4.0
2. To apply automation technologies in manufacturing processes
3. To design, program, and implement automation solutions for diverse manufacturing applications
4. To integrate and leverage Industry 4.0 technologies to enhance data-driven decision-making

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Expalin smart manufacturing systems, cyber-physical systems, and the Industrial Internet of Things (IIoT).	3	80%	75%
Outcome 2	Apply automation technologies, such as programmable logic controllers (PLCs), robotic systems, and sensor networks, in manufacturing processes.	3	75%	75%
Outcome 3	Design, and implement automation solutions for improving efficiency and flexibility	2	80%	70%
Outcome 4	Integrate and leverage Industry 4.0 technologies	3	80%	75%

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction: Concept and scope of industrial automation	3	1	1,2
	Socio-economic considerations, Types of automation	1	1	1,2,4
	Automation strategies, Automation Technologies	2	1	1,2,4
	Fluid Power Control: Fluid Power Control elements and standard graphical symbols for them	2	1,2	1,2,3,4
Unit No. 2	Construction and performance of fluid power generators,	2	1,2	1,2,3,4
	Hydraulic & pneumatic cylinders -construction, design and mounting	2	1,2	1,2,3,4
	Hydraulic & pneumatic valves for pressure	2	1,2	1,2,3
	Flow & direction control, Simple hydraulic and pneumatic circuits;	2	1,2,3	1,2,3
Unit No. 3	Pneumatics: Pneumatic Logic Circuits:	3	2,3	1,2,3
	Boolean Algebra, Truth tables	2	2,3	1,2,3
	Un-complementation algorithm and Karnaugh Maps,	2	3,4	1,2,3
	Design of pneumatic logic circuits for a given time displacement diagram or sequence of operation;	3	3	1,2,3
Unit No. 4	High Volume Production Systems: Transfer devices	3	1,2,3	1,2,3
	Vibratory bowl feeders, Non-vibratory feeders	3	3,4	1,2,3,4
	Part orienting, feed track, Part placing and part escapement systems; Automation strategies,	2	4	1,2,3
	Analysis of flow lines, Automated assembly systems	2	1,4	1,2,3
Unit No. 5	Mechatronics: Mechanical system interfacing	3	2,4	1,2,3
	Simple mechatronic devices: Stepping motors	2	1,2	1,2,3
	DC motors, Analog / digital conversion and Programmable automation	2	4	1,2,3
	CNC, industrial robotics; Flexible manufacturing systems.	2	4	1,2,3

Learning Assessment

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

Recommended Resources

1. A. Esposito, Fluid Power with Applications, Prentice Hal of India, New Delhi, 2008.
2. S.R. Majumdar, Pneumatic Systems, McGraw Hill, 2017
3. Geoffrey Boothroyd, Assembly Automation and Product Design, CRC press, 2005
4. M. P. Groover, Automation, Production System and Computer Integrated Manufacturing, Prentice Hal of India, New Delhi, 2017.

Course Designers

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

CAD CAM

Course Code	MCE 461	Course Category	CE	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the theory and tools of Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) with an emphasis on the central role of the geometric model in their integration.
2. Integration of CAD/CAM tools and the automation of the product development cycle.
3. Acquire fundamental knowledge and understanding of geometric modeling techniques, data structure design and algorithms for solid modeling
4. Obtain the fundamental knowledge of machining theory, automated CNC machining, and process control.

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 concepts of modelling in engineering applications	2	80%	75%
Outcome 2	Demonstrate geometry of complex engineering systems and its applications	3	80%	75%
Outcome 3	Explain the basic concepts of CNC programming and machining	3	70%	65%
Outcome 4	Extend CAD/CAM technology for research and development purposes	3	80%	75%

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	What is CAD & CAM ? Applications of CAD/CAM. What is Geometric Modelling and its applications.	2	1	1
	Introduction to computer graphics and it application. Computer Graphics Softwares useful for Mechanical engineers. Introduction, representation of points, transformations and matrices, transformation of points, transformation of straight lines, midpoint transformation, transformation of parallel lines, transformation of intersecting lines.	1	1	1
	Rotation, Reflection, Scaling, Combined transformations, Transformation of the unit square, Rigid body transformations.	2	1	1
	Translations and Homogeneous Coordinates, Rotation About an Arbitrary Point, Homogeneous Coordinate system and Overall Scaling.	2	1	1
Unit No. 2	Three-Dimensional Scaling, Shearing, Rotation, Reflection, Translation, Combined transformations	1	1	1
	Rotations about an axis parallel to a coordinate axis, rotation about an arbitrary axis in space.	1	1,2	1,2
	Reflection through an arbitrary plane, affine and perspective geometry	1	1,2	1,2
	Orthographic projections, axonometric projections, oblique projections, perspective transformations.	2	1,2	1,2
Unit No. 3	Introduction about plane and space curves. Curve Representation, Implicit and Explicit representation of curves, Parametric and Non-parametric curves	1	1,2	1,2
	General and parametric representation for conic sections (Circle, Ellipse, Parabola, Hyperbola.	1	1,2	1,2
	Representation of space curves, Cubic Splines and Hermite cubic curve, normalized cubic splines Bezier Curves	2	1,2	1,2
	B-spline Curves and end conditions for periodic B-spline curves, B-spline Curve Fit, B-spline Curve Subdivision, Rational B-spline Curves, NURBS, Introduction about surfaces.	1	1,2	1,2
Unit No. 4	Manufacturing Processes – Removing, Forming, Deforming and joining – Integration equipments.	1	1,2,3,4	1,2
	Integrating CAD, NC and CAM – Machine tools. Role of process planning in CAD/CAM Integration	1	1,2,3,4	1,2
	Computer Aided Process Planning – Development, Benefits, Model and Architecture – CAPP Approaches.	1	2,3	1,2
	G codes and CAM programming for lathe machine	1	3,4	1,2
Unit No. 5	Point to point and continuous path machining	1	3,4	1,2
	NC, CNC and DNC – NC Programming – Basics, Languages	3	3,4	1,2
	G Code, M Code, APT – Tool path generation and verification, CAD/CAM NC Programming	1	3,4	1,2
	Production Control – Cellular Manufacturing	3	3,4	1,2

Learning Assessment

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

Recommended Resources

1. David Rogers, J. Alan Adams, "Mathematical Elements for Computer Graphics" McGraw-Hill, c1990.
2. P N Rao, "CAD/CAM: Principles and Applications" Tata McGraw-Hill education Pvt. Ltd, 2022.

Course Designers

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

Laser based AM

Course Code	MCE 462	Course Category	CE	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the basic principle, various techniques of Additive Manufacturing
2. Identify the need of design for additive manufacturing
3. To understand the principles of laser technology
4. To understand the laser powder bed fusion and directed energy deposition processes
5. To understand the suitable post processing 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	Define the concept of additive manufacturing and file formats required in additive manufacturing.	**1**	**80%**	**75%**
Outcome 2	Understand the working principles and process parameters of additive manufacturing processes.	**2**	**70%**	**75%**
Outcome 3	Apply the additive manufacturing in the application of	**3**	**80%**	**70%**
Outcome 4	rapid tooling and reverse engineering.	**2**	**80%**	**75%**

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	3	2	2	2	3				3			3	3	2	3
Outcome 2	3	3	2	3	3				3			3	3	2	3
Outcome 3	3	3	2	3	3				3			3	3	2	3
Outcome 4	3	3	3	3	3				3			3	3	3	3
Average	3	3	3	3	3				3			3	3	3	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Fundamentals of Additive Manufacturing (AM); Additive manufacturing process chain; Application levels of additive manufacturing	2	1	1
	Need of additive manufacturing technology, Layered manufacturing, Principles of layer-based manufacturing	1	1	1,2
	Benefits enabled by additive manufacturing; Current areas of additive manufacturing	1	1	1,2
	Overview of design for additive manufacturing (DFAM)	2	1	1,2
	Potential of additive manufacturing on design; Generalizable DFAM strategies; Design strategies of AM	2	1	1,2
Unit No. 2	Introduction to Laser Technology, Basic principle of laser generation, Laser beam delivery systems	2	3	3,4
	Laser beam interaction with metal, Global scenario of laser-based manufacturing process, Introduction to laser based additive manufacturing	2	3	3,4
	Components of laser additive manufacturing (LAM) system, Beam and job manipulation system, Classification of laser additive manufacturing process, Materials for LAM	3	3	3,4,5
	Process parameters in LAM, Processing issues in LAM	2	3	3,4,5
Unit No. 3	Powder production techniques, Powder characteristics, Powder characterization techniques, Particle size & shape distribution, Electron microscopy of powder, Inter particle friction, Powder structure	2	1	1
	Theory of sintering, Sintering of single & mixed phase, Liquid phase sintering, Sintering variables	2	1,2	1,2,3
	Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process modelling, SLS metal and ceramic part creation	2	1,2	1,2,3
	Electron beam melting (EBM), Process modelling, Benefits and drawbacks	2	1,2	1,2,3
	Applications of powder bed fusion processes	2	1,2	1,2,3
Unit No. 4	Process description, Material delivery, Laser engineered net shaping (LENS)	2	3,4	3,4,5
	Directed Energy Deposition (DED), Electron beam-based Metal deposition, Processing-structure-properties relationships, Benefits and drawbacks	2	3,4	3,4,5
	Applications of Directed Energy Deposition Processes, process parameters, advantages, limitations and applications	2	3,4	4,5
	Materials science for AM – Multifunctional and graded materials in AM, Role of solidification rate, Evolution of nonequilibrium structure, microstructural studies, Structure property relationship	2	3,4	4,5
	Wire Arc Additive Manufacturing, Process parameters, applications, advantages and disadvantages, case studies	2	3,4	3,5
Unit No. 5	Support material removal, Surface texture improvements	2	3,4	4,5
	Accuracy improvement, Aesthetic improvement, Preparation for use as a pattern	2	3,4	4,5
	Property Enhancements using Non-thermal and Thermal Techniques, Case studies	2	3,4	3,5
	Guidelines for Process Selection: Introduction, Selection Methods for a Part, Challenges of Selection, Example System for Preliminary Selection, Process Planning and Control.	2	3,4	3,5

Learning Assessment

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

Recommended Resources

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Martin Leary, "Design for Additive Manufacturing", Springer, 2019.
3. Olaf Diegel, Axel Nordin, Damien Motte, "A Practical Guide to Design for Additive Manufacturing", Springer, 2020.
4. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGrawHill, 2021.
5. Amit Bandyopadhyay, Susmita Bose, "Additive Manufacturing: Second Edition", Taylor & Francis, CRC Press, 2019

Course Designers

SRM University *AP*, Andhra Pradesh

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

Design and Modelling Aspects of Additive Manufacturing

Course Code	MCE 463	Course Category	CE	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)	CAD/CAM	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the basic principle and terminology of rapid prototyping.
2. Understand the various techniques of additive manufacturing.
3. Understand the optimum part deposition technique in 3D printing.
4. To understand the application of additive manufacturing in rapid tooling and reverse engineering

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Define the concept of additive manufacturing and file formats required by additive manufacturing.	1	80%	75%
Outcome 2	Understand the unique capabilities and various techniques of Additive Manufacturing.	2	70%	75%
Outcome 3	Develop and slice CAD model for printing with any kind of Additive Manufacturing technique.	3	80%	70%
Outcome 4	Apply the additive manufacturing in the application of rapid tooling and reverse engineering.	2	80%	75%

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT-I	**ADDITIVE MANUFACTURING (AM)**	**8**	**1**	**1**
1.	Fundamentals of Additive Manufacturing; Additive Manufacturing Process chain; Application levels of additive manufacturing	2	1	1
2.	Need of Additive Manufacturing Technology, Additive Manufacturing (AM) – Layered manufacturing, Principles of layer-based manufacturing	1	1	1,2
3.	Benefits enabled by additive manufacturing; Current areas of additive manufacturing	2	1	1,2
4.	Overview of Design for Additive Manufacturing (DFAM)	1	1	1,2
5.	Motivation; Potential of additive Manufacturing on Design; Generalizable DFAM strategies; Different design strategies of AM	2	1	1,2
UNIT-II	**DESIGN FOR MANUFACTURING AND ASSEMBLY**	**8**		
6.	Core DFAM Concepts and Objectives	1	1	1
7.	Complex Geometry, Customized Geometry, Integrated Assemblies, Elimination of Conventional	1	1,2	1,2,3
8.	DFM Constraints; AM Unique Capabilities: Shape Complexity, Hierarchical Complexity, Functional Complexity	2	1,2	1,2,3
9..	Material Complexity; Exploring Design Freedoms: Part Consolidation and Redesign	2	1,2	1,2,3
10.	Hierarchical Structures, Industrial Design Applications	2	1,2	1,2,3
UNIT-III	**U TOPOLOGY OPTIMIZATION FOR AM**	**9**		
11.	Motivation towards topology optimization for AM design	2	3	3,4
12.	Topology optimization methods	1	3	3,4
13.	Opportunities for Topological Optimization applied to AM	2	3	3,4,5
14.	Parametric optimization	1	3	3,4,5
15.	Topology optimization and generative design	2	3	3,4,5
16.	Steps for topological optimization in AM; Case study	1	3	3,4,5
UNIT-IV	**ADVANCED DESIGN FOR ADDITIVE MANUFACTURING**	**10**		
17.	3D CAD slicing	1	3,4	3,4,5
18..	Unidirectional slicing; Multidirectional slicing	1	3,4	3,4,5
19..	2D path planning; Raster path; Zigzag path	2	3,4	4,5
20.	Contour path; Spiral path; Hybrid path	2	3,4	4,5
21.	Continuous path; Hybrid and continuous path; Medial axis transformation (MAT) path	2	3,4	4,5
22.	Adaptive MAT path	2		
UNIT – V	**DESIGN ANALYSIS AND OPTIMISATION**	**10**		
23.	Aims of Using Design Analysis for AM; Special Considerations for Analysis of AM Parts: Material Data, Surface Finish, Geometry, Simplifying Geometry	3	3,4	4,5
24.	Mesh-Based Versus Parametric Models, Geometry Distortion; Mesh: Parametric Models, Mesh-Based Models	2	3,4	4,5
25.	Boundary Conditions; Optimisation; Topology Optimisation: Objective and Constraints, Common Settings, Post-processing and Interpreting Results	3	3,4	4,5
26.	Parametric or Size Optimisation; Build Process Simulation: Layer-by-Layer Simulation; Scan Pattern Simulation; Limitations	2	3,4	4,5
Total Contact hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (15%)		CLA-2 (10%)		CLA-3 (10%)		Midterm (15%)			
		Th.	Prac	Th.	Prac	Th.	Prac	Th.	Prac	Th.	Prac
Level 1	Remember	50%		40%		50%		45%		30%	
	Understand										
Level 2	Apply	50%		60%		50%		55%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Martin Leary, "Design for Additive Manufacturing", Springer, 2019.
3. Olaf Diegel, Axel Nordin, Damien Motte, "A Practical Guide to Design for Additive Manufacturing", Springer, 2020.
4. Igor Shishkovsky, "New Trends in 3D Printing", Intech Open, 2016.
5. Amit Bandyopadhyay, Susmita Bose, "Additive Manufacturing: Second Edition", Taylor & Francis, CRC Press, 2019

Course Designers

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

Digital Manufacturing

Course Code	MCE 464	Course Category	CE	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the principles of digital manufacturing
2. Learn about various digital manufacturing technologies and their applications
3. To explore the integration of CAD and CAM in digital manufacturing processes
4. Explain the principal and process involved in development of parts by additive manufacturing
5. Analyze the impact of Industry 4.0 on manufacturing processes

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 explain the core concepts of digital manufacturing	**3**	**70%**	**75%**
Outcome 2	Develop proficiency in using CAD software for creating digital models of products	**2**	**80%**	**75%**
Outcome 3	Explain the principal and process involved in development of parts by additive Manufacturing	**3**	**80%**	**70%**
Outcome 4	Gain knowledge of Industry 4.0 principles and the integration of technologies such as the Internet of Things (IoT), artificial intelligence, and big data analytics into manufacturing systems	**2**	**80%**	**75%**

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	History of Manufacturing: From classical to Digital/Additive manufacturing, Basic concept and terminology, Benefits of digital manufacturing, Challenges and limitations	2	1	1
	Introduction to Industry 4.0, Definition and Components, Evolution of Industrial Revolutions	1	1	1,2
	Components of Digital Manufacturing Systems: Digital twins Cyber-physical systems, Internet of Things (IoT)	2	1	1,2
	Organization Model and Function Model of Digital Manufacturing System	2	1	1,2
	Future Development of Digital Manufacturing Science: Precision of Digital Manufacturing, Environmental Protection of Digital Manufacturing	1	1	1,2
Unit No. 2	Introduction to Computer-Aided Design (CAD), Definition and importance, Historical perspective and advancements	**2**	**1**	**2,3**
	CAD Modeling: Design process and role of CAD Types and applications of design models, Overview of popular CAD software	**3**	**1**	**2,3**
	Three-dimensional modelling schemes, Wire frames and surface representation schemes	**3**	**1**	**2,3**
	Solid modelling - Parametric modelling, Assembly modelling	**3**	**1**	**2,3**
Unit No. 3	Reverse Engineering: Need, Reverse engineering process, applications and selection of reverse engineering systems	**2**	**1**	**1,2,3**
	Reverse engineering hardware and software, Geometric model development	**2**	**1,3**	**1,2,3**
	Computer Aided Manufacturing: Component modelling, Machine and tool selection	**2**	**1,3,4**	**1,2,3**
	Defining process and parameters, Tool path generation, Simulation, Post processing.	**3**	**1,4**	**1,2,3**
Unit No. 4	Computer Aided Process Planning: CAPP and route sheet development	**3**	**1,3**	**1,2,3**
	CAPP system, Computer aided plant layout	**2**	**1,3**	**1,2,3**
	Computer Aided Production Planning and Control	**2**	**1,3**	**1,2,3**
	Algorithms for CAPP, Product Database Management Systems: Types, Management Information	**2**	**1**	**1,2,3**
Unit No. 5	Additive Manufacturing (3D Printing): Introduction to Additive Manufacturing, Definition and Principles	**2**	**1,4**	**1,4**
	Comparison with Traditional Manufacturing Strengths, weaknesses, challenges, and limitations of additive manufacturing technologies	**2**	**4**	**1,4**
	Types of Additive Manufacturing Technologies: Stereolithography (SLA), Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), Other Emerging Technologies	**2**	**1,4**	**1,4**
	Design for Additive Manufacturing (DFAM): Design for functionality and 3D printability, Planning and slicing additive manufacturing software	**2**	**4**	**1,4**

Learning Assessment

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

Recommended Resources

1. Fundamentals of Digital Manufacturing Science, by Z.Zhou,S.Xie, D. Chen, Springer, 2012
2. Ibrahim Zeid and Sivasubramanian R, "CAD/CAM - Theory and Practice", Tata McGraw Hill Education, 2011
3. M P Groover, "Automation, production systems, and computer-aided manufacturing" Pearson, 2016
4. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010

Other Resources

Course Designers

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

Materials for Additive Manufacturing

Course Code	MCE 465	**Course Category**	CE		**L**	**T**	**P**	**C**
					2	1	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the fundamental principles and applications of materials in additive manufacturing.
2. To explore the properties, processing techniques, and applications of different types of materials used in AM.
3. To investigate the challenges and solutions associated with using various materials in AM.
4. To explore the latest advancements and research in AM materials.

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 and classify materials used in additive manufacturing.	**NA**	**NA**	**NA**
Outcome 2	Explain the properties and processing techniques of polymers, metals, ceramics, and composites in AM.	**NA**	**NA**	**NA**
Outcome 3	Analyze the advantages and limitations of different AM materials.	**NA**	**NA**	**NA**
Outcome 4	Evaluate the applications of various materials in different industries.	**NA**	**NA**	**NA**
Outcome 5	Recognize emerging materials and trends in additive manufacturing.	**NA**	**NA**	**NA**

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	3	2	2	2	3				3			3	3	2	3
Outcome 2	3	3	2	3	3				3			3	3	2	3
Outcome 3	3	3	2	3	3				3			3	3	2	3
Outcome 4	3	3	3	3	3				3			3	3	3	3
Outcome 5	3	3	3	3	3				3			3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**				**3**			**3**	**3**	**2**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction to Additive Manufacturing (AM): Definitions, Historical development and future trends and applications	2	1	1
	Classification of AM Processes: Stereolithography (SLA), Selective Laser Sintering (SLS), Fused Deposition Modeling (FDM), etc	2	1	1,2
	Introduction to AM Materials: Categories and general properties. Material Selection Criteria for AM processes: Factors influencing the choice of materials for AM, Comparison of AM materials with those used in traditional manufacturing.	2	1	1,2
	Material Properties Relevant to AM: Mechanical, thermal, electrical, and chemical properties relevant to AM.	2	1	1,2
Unit No. 2	Polymers for Additive Manufacturing, Thermoplastics: Common types (ABS, PLA, Nylon), properties, and applications.	2	1	3,4
	Thermosets: Properties, preparation methods, and applications.	2	1	3,4
	Elastomers: Characteristics, use cases, and challenges.	1	1,2	3,4
	Polymer Blends and Composites: Enhancing properties for specific applications.	2	1,2	3,4
	Processing Techniques: Extrusion, curing, and sintering of polymers.	2	1,2	3,4
Unit No. 3	Metals for Additive Manufacturing, Metallic Materials: Common metals such as Titanium alloys, Aluminum alloys, Stainless steels Nickel-based superalloys alloys, and their properties (Mechanical properties, Thermal properties, Corrosion resistance).	2	1,2	1,2,3
	Powder Metallurgy in AM: Powder production, characterization, and handling, Processing Techniques for Metals: Powder Bed Fusion (PBF), Directed Energy Deposition (DED), Binder Jetting, Electron Beam Melting (EBM).	2	3	3,4
	Microstructure and Properties: Influence of AM processes on the microstructure and mechanical properties of metals.	2	3	3,4
	Challenges and Solutions in Metal AM: Powder handling and safety, Residual stresses and distortion, Post-Processing: Heat treatment, machining, and surface finishing of metal AM parts.	3	3	3,4,5
	Applications of Metal AM: Aerospace, Automotive, Medical implants.	2	3	3,4,5
Unit No. 4	Ceramics and Composite Materials for Additive Manufacturing: Types, Properties and Characteristics of Ceramics, Mechanical properties, Thermal stability, Electrical insulation, and applications.	2	3	3,4,5
	Processing Techniques for Ceramics: Binder Jetting, Stereolithography (SLA) for ceramics, Direct Ink Writing (DIW), Challenges in Ceramic AM: Cracking, sintering, and densification.	3	3	2,3,5
	Composite Materials: Definition, types, and significance in AM. Processing Techniques for Composites: Fused Deposition Modeling (FDM) with fiber reinforcement, Continuous Fiber Reinforcement (CFR), Selective Laser Sintering (SLS) for composites and challenges in processing composite materials for AM.	2	3,4	2,3,5
	Applications of Ceramics and Composites in AM: High-temperature applications, Wear-resistant parts, Biomedical applications.	2	3,4	2,3,5
Unit No. 5	Future Trends and Emerging Materials in Additive Manufacturing: Smart Materials in AM: Shape memory alloys, Self-healing materials, Conductive polymers	2	3,4	2,3,5
	Biomaterials in AM: Biocompatible polymers, Hydroxyapatite for bone scaffolds, Bioprinting techniques, Nanomaterials in AM, Nanocomposites, Graphene and carbon nanotubes.	2	3,4	4,5
	Sustainable Materials and Green Manufacturing: Recyclable materials, Bio-based polymers, Energy-efficient AM processes.	2	3,4	4,5
	Future Directions and Research Opportunities: Innovations in material science for AM, Integration of AM with traditional manufacturing, Advances in multi-material and hybrid AM techniques	2	3,4	4,5

Learning Assessment

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

Recommended Resources

1. Gibson, I., Rosen, D. W., & Stucker, B. (2015). Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing (2nd ed.). Springer
2. Bártolo, P. J. (Ed.). (2011). Stereolithography: Materials, Processes and Applications. Springer
3. Sheku Kamara, Kathy S. Faggiani. (2021). Fundamentals of Additive Manufacturing for the Practitioner. John Wiley & Sons.
4. Chua, C. K., Leong, K. F., & Lim, C. S. (2010). Rapid Prototyping: Principles and Applications (3rd ed.). World Scientific Publishing.
5. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications.

Course Designers

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

Bioprinting

Course Code	MCE 466	Course Category	CE	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the fundamentals of 3D printing, 3D design, scanning and digitization.
2. Understand bioprinting, biofabrication devices, challenges in translating 3D printing to biofabrication.
3. Acquire 3D tissue designing and 3D tissue/organ printing, bioink formulation.
4. Understand 4D bioprinting, biofabrication-based strategies from bench-to-bed to address specific clinical problems and analyze future direction.

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 concepts of 3D printing in bio fabrication and engineering components.	2	80%	75%
Outcome 2	Highlight the challenges in translating 3D printing to bio fabrication, such as bioink development and processing control.	3	80%	75%
Outcome 3	Explain the applications of bio fabrication from research to clinical use.	3	70%	65%
Outcome 4	Analyze tissue engineering, in vitro modelling, and organ development.	3	80%	75%

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction to 3D printing, Importance of 3D printing in Product Development,	2	1	1
	Classification of 3D printing processes	2	1	1
	Material Extrusion, Powder bed Fusion	2	1	1
	Directed Energy Deposition,	2	1	1
Unit No. 2	Photo Polymerization, Binder Jetting,	2	1	1
	Material Jetting, Laminated Object Manufacturing (LOM)	2	1	1
	CAD Modelling for 3D printing: 3D Scanning and digitization,	3	1	1
	Introduction to Bioprinting; different types of bioprinting techniques and their advantages and disadvantages	2	1,2	2
Unit No. 3	3D tissue designing and 3D tissue/organ printing	3	1,2	2
	Various process parameters and their role in bioprinting	2	1,2	2,3
	Introduction to bioinks	1	1,2	2,3
	Biomaterials used for bioink development with their merits and demerits	2	1,2	2,3
Unit No. 4	Critical parameters of bioink formulations for bioprinting	3	1,2	2,3
	Modulation of bioink properties to control different processing conditions	2	1,2	2,3
	3D bioprinted in vitro, in vivo, and ex vivo research models and techniques	2	2,3	2,3
	In vitro manipulation of cells and biomaterials with a bioprinter to engineer tissues for regenerative medicine or in vitro tissue/organ models	3	3,4	2,3
Unit No. 5	In situ bioprinting and 4D bioprinting with examples from recent literature	3	3,4	2,3
	Biofabrication-based strategies from bench-to-bed to address specific clinical problems	3	3,4	2,3
	Next step in bioprinting (challenges and future direction)	2	3,4	2,3
	Ethical issues related to bioprinting	2	3,4	2,3

Learning Assessment

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

Recommended Resources

1. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
2. Jeremy M. Crook, "3D Bioprinting Principles and Protocols", Springer, 2020.
3. Maika G. Mitchell, "Bioprinting Techniques and Risks for Regenerative Medicine", Elsevier, 2017

Course Designers

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

Fundamentals of Combustion Technology

Course Code	MCE467	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	0	3
Pre-Requisite Course(s)	Thermodynamics Fluid Mechanics, Heat Transfer	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To enable students to apply the knowledge of thermodynamics to combustion.
2. To emphasize the basics of fuels, stoichiometry, chemical kinetics and equilibrium, mass transfer, and different types of combustion process.
3. To explain the mathematics in transport processes of a reactive flow, simplifications involved and the parameters affecting different types of combustion processes.

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	Enable students to apply the knowledge of thermodynamics to combustion.	**2**	**70%**	**80%**
Outcome 2	Understand the fundamentals aspects namely thermochemistry, chemical kinetics and the role of elementary and global reactions	**3**	**70%**	**80%**
Outcome 3	Understand and calculate the structure and properties of Laminar and Turbulent Flames	**4**	**70%**	**80%**
Outcome 4	Basics of Internal combustion engines, pollutants	**4**	**70%**	**80%**

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

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction: Scope and application of combustion, Modes of Combustion and Types of Flames	1.5	1	1,2,3
	Types of fuels and oxidizers, their properties. Conventional Fuels: Coal, Gasoline, Diesel Fuels, Natural Gas, Aviation Fuels	1.5		
	Alternative Fuels: Hydrogen, Biofuels, Liquid Fuels			
Unit No. 2	**Thermodynamics of Combustion:** Review of basic thermodynamics of ideal gas mixture, property relations	1	1, 4	1, 2
	First and Second Laws of thermodynamics applied to combustion; Heat, temperature and composition of combustion products	2	1, 2, 3	
	Reactant and Product mixtures: Stoichiometry, Enthalpy of Formation, Enthalpy of Combustion and Heating values, Combustion Equilibrium, Chemical Equilibrium	3		1, 2
Unit No. 3	**Thermochemistry for combustion**		2, 3	1 ,2, 3
	Basics Reaction kinetics, Elementary reactions, Chain reactions, Multistep reactions, Reduced mechanisms,	3		
	Simplification of reaction mechanism, Heterogeneous Reactions, Global Kinetics	3		
Unit No. 4	**Physics of Combustion-** Simplified governing equations for reacting flows: Mass, Momentum, Energy conservation, Multicomponent diffusion, Concept of conserved scalar.	3	1, 3	1, 3
	Laminar Premixed Flames: Physical Description, Factors influencing flame velocity, Flame speed correlations, Quenching, Flammability, and Ignition, Flame Stability	3		
	Laminar Diffusion Flames: Nonreacting Constant-Density Laminar Jet, Jet Flame, Flame lengths for circular port and slot burners, Soot Formation, Counterflow Flames	4		
	Turbulent Premixed Flames, Non-premixed flames	1.5		
Unit No. 5	**Internal Combustion Engines:** combustion phenomena in SI and CI engines and Analyze the effect of various operating variables on engine performance	2.5	1, 4	1, 4
	Emission: Combustion-generated pollutants, Emissions from Premixed and non-premixed Combustion,	1		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid Term (25%)	CLA-2 (5%)	CLA-3 (10%)	
		Th	Th	Th	Th	Th
Level 1	Remember	30%	40%	40%	40%	30%
	Understand					
Level 2	Apply	70%	60%	60%	60%	70%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Turns, Stephen R. Introduction to combustion. Vol. 287. New York, NY, USA: McGraw-Hill Companies, 1996.
2. Kuo, Kenneth K. "Principles of combustion." 1986.
3. Warnatz, Jurgen, Ulrich Maas, Robert W. Dibble, and J. Warnatz. Combustion. Springer-Verlag Berlin Heidelberg, 2006.
4. Heywood, John B. "Internal combustion engine fundamentals." McGraw-Hill, 1988.

Other Resources

1. https://nptel.ac.in/courses/101104070

Course Designers

SRM University *AP*, Andhra Pradesh

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

Introduction to Automobile Engineering

Course Code	MCE 468	Course Category	CE	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the basic concepts of automobile systems, parts and their functions. Performance criteria for automobiles.
2. To learn various suspension systems, tyres and wheels, Steering Systems, Braking system, Transmission system.
3. To understand how automotive electrical and electronics systems work, it is essential to identify their various components.
4. To understand the basic principles of the Air conditioning, heating and ventilation systems.
5. To understand the working process of automotive engines, it is essential to explore their cooling and lubrication 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	Theoretical understanding about the working and performance of the automobile systems and sub-systems.	3	70%	75%
Outcome 2	Understand the principles of transmission, suspension, steering and braking systems of the automobile.	3	70%	75%
Outcome 3	Understand the concept of charging and lighting systems of different automobiles.	3	70%	75%
Outcome 4	Understand the basic principles of the Air conditioning, heating and ventilation systems.	3	70%	75%
Outcome 5	Understand the working and lubrication of the engines for different automobiles.	3	70%	75%

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to automobile systems**	**9**		
	Introduction to automobile systems, parts and their functions	5	1,2,3,4	1,2,3
	Performance criteria for automobiles	4	1,2,3,4	1,3
Unit 2	**Suspension, Transmission and Their Parts**	**9**		
	Suspension systems	3	1,2	1,2
	Tyres and wheels	2	1,2	1,2
	Steering Systems	2	1,2	1,2
	Braking and Transmission system	2		
Unit 3	**Automotive electrical and electronics systems**	**9**		
	Battery and Charging System	5	2	1,2,3
	Starting and Lighting System	4	2	1,2,3
Unit 4	**Air conditioning, heating and ventilation systems**	**9**		
	Principle, working, components of Air-Conditioning	5	1,2	1
	Heating and Ventilation systems	4	1,2	1
Unit 5	**Engines, Cooling and lubrication systems**	**9**		
	Working principles of Engines i.e. CI and SI engines	3	1,2,3	1,2
	Cooling and Lubrication	2	1,2,3	1,3
	Engine Fuels	2	1,2,3	1,3
	Air intake and exhaust systems	1	1,2,3	1
	Ignition system	1	1,2,3	1,3
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(15%)	CLA-2 (10%)	
		Th	Th	Th	Th
Level 1	Remember	40%	40%	30%	50%
	Understand				
Level 2	Apply	60%	60%	70%	50%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Automobile engineering by S K Gupta, S Chand Publication.
2. Automobile Engineering: Basic Fundamentals to Advanced Concepts of Automobile Engineering by T. Prabhu.
3. A Textbook of Automobile Engineering by S.K. Saxena, Laxmi Publications

Course Designers

SRM University *AP*, Andhra Pradesh

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

Electric Vehicle Technology

Course Code	MCE 469	Course Category	CE	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To familiarize with the basic electric configuration for the electric propulsion unit.
2. To expose utilization of different Energy storage system and Hybridization.
3. To inculcate the knowledge while resolving issue of Energy management system

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	Contemplate the architecture and vehicle dynamics of electric vehicles	3	70%	65%
Outcome 2	Analyze and model the power management systems for electric vehicles	3	70%	65%
Outcome 3	Devise power electronics-based control strategies for electric vehicles	3	70%	65%
Outcome 4	Analyze and design various components of electric vehicles with environment concern.	3	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	3	2	1	2	2				2			3	3	2	3
Outcome 2	3	3	2	3	2				3			3	3	2	3
Outcome 3	3	3	3	3	2				3			3	3	2	3
Outcome 4	3	3	3	3	3				2			3	3	3	3
Average	3	3	3	3	3				3			3	3	2	3

Course Unitization Plan - Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	9		
1	A brief history of Electric vehicles	1	1	1,3
2	Basic architecture of hybrid drive train and analysis of series drive train	2	1,2	1,3
3	Vehicle motion and the dynamic equations for the vehicle	2	1,2	1,3
4	Types of Electric vehicles,	1	1,2	1,3
5	Advantages over conventional vehicles	1	1,2	1,3
6	Limitations of Electric vehicle	1	1,2	1,3
7	Disposal of battery, cell and hazardous material and their impact on environment.	1	1,4	1,3,4
Unit 2	**Power Management and Energy Sources of Electric vehicle**	9		
1	Power and Energy management strategies and its general architecture of Electric vehicle	1	1,2,4	1, 3, 4
2	Various battery sources, energy storage, battery based energy storage and simplified models of battery	2	1, 2, 3	1, 2, 3
3	Battery Management Systems	1	1,2,3	1, 2, 3, 4
4	Fuel cells, their characteristics and simplified models	2	1,2,3	1, 2, 3, 4
5	Super capacitor based energy storage	1	1, 2, 3	1,2,3
7	Selection of the energy storage technology.	1	1,3,4	1, 3
Unit 3	**Power Electronics in Electric vehicle**	9		
1	Introduction: various power electronics converter topologies and its comparisons	3	1,2,4	1, 3
2	Control of convertor operations in Electric vehicle	2	1,3,4	1, 2, 3
3	Battery chargers used in Electric vehicle	2	1,2,4	1, 2, 3
4	Emerging power electronic devices.	2	1,2,3	1, 2, 3
Unit 4	**DC and AC Machines & Drives in Electric vehicle**	9		
1	Various types of motors,	1	1,2,3,4	1, 2, 3
2	Permanent magnet motor drives and characteristics	2	1,2,3	1, 2, 3
3	Selection and size of motors	1	1,2,3	1, 2, 3
4	Induction motor drives and control characteristics	1	1,2,3	1, 2, 3
5	Brushed & Brushless DC motor drive and characteristics	1	1,2	1, 2, 3
6	Switched reluctance motors and characteristics	1	1,2	1, 2, 3,4
7	IPM motor drives and characteristics	1	1,2,3	1, 2, 3,4
8	Mechanical and electrical connections of motors	1	1,2,3	1, 2, 3

Unit 5	**Components & Design Considerations of Electric vehicle**	4		
1	Design parameters of batteries	1	1,3,4	1, 2, 3,4
2	Ultra-capacitors and fuel cells, aerodynamic considerations	2	1,3,4	1, 2, 3,4
3	Calculation of the acceleration force, total tractive effort, torque required on the drive wheel, transmission efficiency, consideration of vehicle mass,	3	1,2,4	1, 2, 3,4
4	Electric vehicle chassis & body design,	1	1,2,4	1, 2, 3,4
5	General issues in design,	1	1,2,3,4	
6	Specifications and sizing of components	1	1,2,3,4	1, 2, 3
Unit 6	**Electric Vehicles and Grid interconnection Issues**	5		
1	Introduction to smart charging: Grid to vehicle and vehicle to grid	1	1,2,3	
2	Smart metering and ancillary services		1,2,3	1, 2, 3
3	Preliminary discussion on vehicle to vehicle and vehicle to personal communication systems	1	1,3,4	1, 2, 3
4	Introduction to battery charging stations and its installation and commissioning	1	1,3,4	
5	Preliminary discussion on estimation on station capacity and associated technical issues	1	1,2,4	1, 2, 3
6	Policy regulations and standards for EV		1,2,4	1, 2, 3
7	BEE standards,	1	1,3,4	1, 2, 3
8	Indian and Global scenario, case studies.		1,2,3,4	1, 2, 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	40%	30%	30%	40%	40%
	Understand					
Level 2	Apply	60%	70%	70%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Iqbal Hussain, "Electric and Hybrid Vehicles Design Fundamentals", 1st Edition, CRC Press, 2003.
2. James Larminie, John Lowry "Electric Vehicle Technology Explained", 1st Edition, John Wiley and Sons, 2003.
3. Chris Mi, M. Abul Masrur, David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", Wiley publication ,2011.
4. Allen Fuhs, "Hybrid Vehicles and the future of personal transportation", CRC Press, 2009

Course Designers

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

Heavy Vehicle Technology

Course Code	MCE 470	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	0	3
Pre-Requisite Course(s)	IC Engine, Thermodynamics	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department		**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Learn Fundamentals of Heavy Vehicle Technology
2. Learn Heavy Vehicle Propulsion Systems and Transmission Systems
3. Learn Heavy Vehicle Chassis and electrical Systems
4. Learn Vehicle Diagnostics Systems & Maintenance

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 fundamentals of heavy vehicle technology	3	70%	65%
Outcome 2	Apply the knowledge of heavy vehicle propulsion and transmission systems	3	70%	65%
Outcome 3	Apply the knowledge of heavy vehicle chassis and electrical systems	3	70%	65%
Outcome 4	Determine faults in heavy vehicles using vehicle diagnostics systems & maintenance	3	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	3	2	1	2	2				2			3	3	2	3
Outcome 2	3	3	2	3	2				3			3	3	2	3
Outcome 3	3	3	3	3	2				3			3	3	2	3
Outcome 4	3	3	3	3	3				2			3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**				**3**			**3**	**3**	**2**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Fundamentals of Heavy Vehicle Technology (9 hours)** Overview of heavy vehicles: types, classifications, and applications; Axle Configurations, Application types, Tandem axle drive for heavy vehicles; Propellor Shafts, Differentials, Hub reduction; Heavy vehicle rear axle; Steering axles for heavy vehicles; Safety precautions in heavy vehicle maintenance; Fuel Cell based Heavy Vehicles	**5.5**	**1**	**1,2,3**
	Vehicle Cabin & Transport Body : Vehicle Cabin Overview ; Regulation ; Crash Safety; Vehicle Application; Vehicle application body types and global standards; Vehicle transport management; Electronics safety systems for anti-theft; Logged vehicle data ; Tachometer	**4.54**	**1**	**1,2,3**
Unit No. 2	**Heavy Vehicle Propulsion Systems and Transmission Systems (9 hours)** Engine Systems : Types, configurations and components; Engine lubrication and cooling systems; Engine Braking, Engine Sensors and Vehicle Controls; Engine performance and diagnostics. Ignition Systems - Electronic ignition – Advantages, Solid-state ignition systems Operation and Types, Contactless electronic ignition system, Electronic spark timing control;	**5.5**	**1,2**	**1,2,3**
	Transmission Systems: Heavy vehicle gearboxes; manual, automatic, and semi-automatic; Overdrive gears; Continuously variable transmissions; Clutch operation and maintenance; Control Functions & ECU; Retardation & Power Take Off; Transmission troubleshooting and repair. Transfer Ger Box for all wheel Drives	**4.5**	**1,2**	**1,2,3**
Unit No. 3	**Heavy Vehicle Chassis Systems** Braking Systems: Heavy Vehicle Pneumatic Braking system over view ; Air over Hydraulic systems ; Components ; Feed system; Response time; Braking regulations ; Requirement and Types-Block Brakes, Band Brakes, Hydraulic brake, Service Braking vs Auxiliary Braking & Environmental Impact (Volvo tech Talk)ABS;EBS; Braking regulations & Safety	**4.5**	**1,2,3**	**1,2,3**
	Suspension Systems: Suspension System; Heavy vehicle Ladder Chassis configuration and introduction to Vehicle Agility basics; Basic ride considerations; Types of suspension systems; Types of suspension spring; Tandem axle Steering systems, suspension; Shock dampers; Adaptive suspension systems; Active roll control systems; Active suspension systems.	**4.5**	**1,2,3**	**1,2,3**
Unit No. 4	**Heavy Vehicle Electrical Systems (9 hours)** Power Supply & Starting systems (batteries, alternators, ultra capacitors and starters); Lighting Systems, Electrical Components (DC-DC Converters, Inverters) Introduction, basic sensor arrangement, types of sensors, Hall Effect, emission sensors; thermistor, piezoelectric, Various sensors, relays	**7**	**1,2,3**	**1,2,3**
Unit No. 5	**Vehicle Diagnostics Systems & Maintenance (9 hours)** Introduction to Diagnostic System- Overview of diagnostics system in ECU - Diagnostic control system architecture in vehicles - inter system (Types of CAN) ECU diagnostics - error detection	**4.5**	**1,2,3,41**	**1,2,3**
	Diagnostic protocols - UDS (Unified diagnostic services), On-Board Diagnostics - Diagnostic Devices and Practical Diagnostics System, Conventional Powertrain System Diagnostics, Advanced Vehicle Systems Related Diagnostics, Chassis System Diagnostics, Vehicle maintenance and service.	**4.5**	**1,2,3,4**	**1,2,3**

Learning Assessment

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

Recommended Resources

1. Light and Heavy Vehicle Technology, M.J. Nunney, Elsevier, Fourth Edition 2006.
2. Automotive Technology, Jack Erjavec, Cengage Learning, Fifth Edition, 2009
3. Automotive Braking, Thomas W. Birch, Cengage Learning, Third Edition, 1999

Course Designers

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

Noise and Vibration - NVH

Course Code	MCE 471	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	0	3
Pre-Requisite Course(s)	ENG 115 Engineering Mechanics	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the basic concepts of mechanical vibrations and noise.
2. To introduce the various methods of modeling of free and damped single-dof vibrations.
3. To demonstrate the concepts of for vibration isolation and instrumentation.
4. To demonstrate the analysis of undamped multi-dof 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	Model single-dof free and undamped vibration systems and analyse the same using the quantitative parameters	1	80%	70%
Outcome 2	Apply the concepts of single-dof forced vibration in the design of mechanical systems subjected to forced vibration	2	70%	65%
Outcome 3	Apply eigenvalue formulation and numerical methods in the modeling and analysis of undamped multi-dof vibrating systems	3	70%	60%
Outcome 4	Be familiar with the basic concepts of noise control.	1	80%	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	3	2	1	1	-	-	-	-	-	-	-	-	2	1	-
Outcome 2	3	3	1	3	1	-	-	-	-	-	-	-	2	1	-
Outcome 3	3	3	1	3	1	-	-	-	-	-	-	-	2	1	-
Outcome 4	3	1	1	1	1	-	-	-	-	-	-	-	1	1	-
Average	3	2	1	2	1	-	-	-	-	-	-	-	2	1	-

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction to vibration terminologies and types of vibration	1	1	1
	Equation of motion for free undamped single degree of and energy method	2	1	1
	Tutorials on single degree of freedom undamped free vibration systems	1	1	1
	Equation of motion for free damped single degree of freedom systems	1	1	1
	Tutorials on free damped single degree of freedom systems, torsional vibration of two rotor and three rotor systems	2	1	1
	Tutorials on torsional vibration of two rotor and three rotor systems.	2	1	1
	Torsional vibration of geared systems with two and three rotor system.	1	1	1
Unit No. 2	Equation of motion for harmonically excited single degree of freedom system	1	2	1
	Tutorials on harmonically excited single degree of freedom system	1	2	1
	Forced vibration due to unbalanced rotating and reciprocating systems	1	2	1
	Constraint equations	1	2	1
	Tutorials on forced vibration due to unbalanced rotating and reciprocating systems.	2	2	1
	Forced vibration due to base excitation by absolute and relative amplitude method.	2	2	1
	Tutorials on forced vibration due to base excitation by absolute and relative amplitude method	2	2	1
	Force transmissibility and vibration isolation	1	2	1, 2
	Tutorials on force transmissibility and vibration isolation, whirling of shaft and tutorials.	2	2	1, 2
Unit No. 3	Equation of motion for free undamped two and three degrees of freedom systems and tutorials, equation of motion for two and three.	2	2	1, 2
	DOF using Lagrangian energy method for undamped free vibration	1	2	1
	Tutorials on Lagrangian energy method for undamped free vibration.	1	2	1
	Coordinate coupling and tutorials, concept of linear and torsional undamped vibration absorber.	2	2	1, 2
	Tutorials on linear and torsional undamped vibration absorbers.	1	2	1, 2
Unit No. 4	Stiffness and flexibility influence coefficients and tutorials	1	3	1, 2
	Eigenvalue, Eigenvector and orthogonal Properties and Tutorials	1	3	1
	Concepts of Dunkerley's and Reyleigh's method	1	3	1
	Concept of Holzer's method for far coupled and tutorials	1	3	1
	Concept of Holzer's method for closed coupled systems and tutorials	1	3	1
Unit No. 5	Vibration measuring devices and Vibration exciters	1	4	1,2
	Free and Forced vibration Tests	1	4	1
	Balancing Machines	1	4	1,2
	Single plane and two plane balancing	1	4	1,2
	Condition monitoring techniques and signal analysis	1	4	1
	Basics of Noise terminologies and their relations.	1	4	3, 1
	Noise Control Methods at source, along Path and at receiver.	1	4	3, 1

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (40%)
		CLA-1 (15%)	Mid-1 (15%)	CLA-2 (15%)	CLA-3 (15%)	Th
Level 1	Remember	50%	50%	20%	20%	35%
	Understand					
Level 2	Apply	50%	50%	50%	50%	40%
	Analyse					
Level 3	Evaluate	-	-	30%	30%	25%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Rao, S. S. (2009). *Mechanical vibrations*. Pearson
2. Thomson, W., Dahleh, M.D. & Chandramouli, P. (2008). *Theory of vibration with applications*. Pearson
3. Pujara, K. (2018) *Vibration and noise for engineers*. Dhanpat Rai & Co

Course Designers

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

Vehicle Dynamics

Course Code	MCE 472	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Introduction to Automotive	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the fundamentals of engineering dynamics and vibrations.
2. Study the force generation mechanism in automotive tires.
3. Learn the forces involved in the vertical coordinate and the influence of suspension system.
4. Understand the balance of forces in the longitudinal motion of vehicle.
5. Understand the concept of cornering forces and their influence on vehicle stability.

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 fundamental problems in dynamics and vibration	1, 3	70%	65%
Outcome 2	Estimates the slip generation of tires in longitudinal and lateral directions	2, 3	70%	65%
Outcome 3	Formulate the equation of motion of a vehicle in longitudinal direction	3, 4	70%	65%
Outcome 4	Analyse the stability of vehicles under cornering conditions	2, 3	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	3	**3**	-	-	**3**	-	-	-	-	-	-	-	3	-	-
Outcome 2	3	3	-	-	**3**	-	-	-	-	-	-	-	3	-	-
Outcome 3	3	**3**	-	-	**3**	-	-	-	-	-	-	-	3	-	-
Outcome 4	3	3	-	-	**3**	-	-	-	-	-	-	-	3	-	-
Average	**3**	**3**	-	-	**3**	-	-	-	-	-	-	-	3	-	-

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Fundamental of dynamics and vibration:** Kinematics and Kinetics of particles-Newtons Laws of Motion Fundamentals of vibration-Energy Methods, Types of Vibrations, Procedure for vibration analysis. Single degree of Freedom System-Dumped Undamped, Free and Forced Vibrations. Vibration analysis-Formulation of Governing equation	5	1	1,2,3
	Vibration measurement-Methods and types of vibration measuring equipment's.	4	1 1,2	1,2,3 1,2,3
	Coordinate systems in dynamics-Transformations in coordinate systems, Tire coordinate system directions and forces.			
Unit No. 2	**Tire Dynamics:** Tire Mechanics-Construction of tires, Importance of tires in vehicle motion	4.5	1,2 1,2,3	1,2,3 1,2,3
	Rolling resistance of tires-Expression for sling resistance. Factors influencing rolling resistance Tire Slip-Longitudinal slip and slip angle concept			
	Aquaplaning of tires-Cause and effects of aquaplaning.	4.5	1,2,3 1,2,3	1,2,3 1,2,3
	Modelling of tires -Magic formulas model Expression for magic formula			
Unit No. 3	**Vertical Dynamics:** Need for vertical dynamics analysis-Human tolerance to vibration Criteria for ride comfort. Types of Suspension Systems.	5	1,2,3, 41 1,2,3, 4	1,2,3 1,2,3
	Shock absorbers - Importance in vehicle dynamics. Types of damping. Magnetorheological and Electrorheological shock absorbers.			
	Modelling of vehicles, Formulation of governing equations	4	1 1	1,2,3 1,2,3
	Control algorithms -Implementation of a control strategies like PID, Skyhook, LOR, etc in quarter car model.			
Unit No. 4	**Longitudinal Dynamics:** Forces acting - Resistance forces, Traction force supplied by power plant, load transfer during braking	4	1,2 1,2	1,2,3 1,2,3
	Equation of Motion-Newtons law of motion in longitudinal direction, Formulation of equation of motion.			
	Drive configurations-Estimation of maximum acceleration, reaction forces for drive configurations of Rear wheel drive, Front wheel and all-wheel drive.	5	1,2,3 1,2,3	1,2,3 1,2,3
	Antilock braking system and traction control system – Need implementation and control strategies employed			
Unit No. 5	**Lateral Dynamics:** Steady state handling of two axle vehicles - Definition, Understeer coefficient estimation and its importance	4.5	1,2,3 1,2,3, 41	1,2,3 1,2,3
	Transient response characteristics- Definition, Equations of motion, Directional stability.			
	Single track model-Single track representation of vehicles, Linear and Nonlinear single-track models, Equations of motion	4.5	1,2,3, 4	1,2,3
	Roll dynamics - Concept of roll centre and roll axis, Roll centres for different suspension types. Effect of roll on vehicle dynamics.			

Learning Assessment

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

Recommended Resources

1. Rao SS, Yap FF. Mechanical vibrations. New York: Addison-Wesley; 1995 Mar.
2. Wong JY. Theory of ground vehicles. John Wiley & Sons; 2022 Aug 23.
3. Schramm D, Hiller M, Bardini R. Vehicle dynamics. Modeling and Simulation. Berlin, Heidelberg. 2014;151.

Course Designers

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

Thermal Power Engineering

Course Code	MCE 430	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	0	3
Pre-Requisite Course(s)	Thermodynamics	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the applications of the first law of Thermodynamics to various air standard thermodynamic cycles relevant to I.C. Engines and assess engine performance.
2. To learn the applications of the first law of Thermodynamics to various gas power cycles relevant to gas turbine engines (GTE) and aircraft propulsion and assess GTE performance.
3. To understand the applications of the first law of Thermodynamics to various vapour power cycles relevant to thermal power generation and its performance.
4. To gain the knowledge of the working of boiler, steam condenser and steam turbine, their functions, in the power plant, their classifications and sub-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	Analyse the performance of air standard cycles such as Otto, Diesel and Dual cycle based on thermodynamic principles	4	**70%**	**65%**
Outcome 2	Analyse the performance of forms of Brayton cycle for power generation and aircraft propulsion based on the concepts of thermodynamic	4	**70%**	**65%**
Outcome 3	Analyse the performance of vapor power cycles using thermodynamic concepts	4	**70%**	**65%**
Outcome 4	Describe different types of steam generators, their functions and performance	2	**70%**	**65%**
Outcome 5	Illustrate the working and performance of steam turbine and condenser	2	**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	3	2	2	2	3	-	-	-	3	-	-	-	3	2	3
Outcome 2	3	3	2	3	3	-	-	-	3	-	-	-	3	2	3
Outcome 3	3	3	2	3	3	-	-	-	3	-	-	-	3	2	3
Outcome 4	3	3	3	3	3	-	-	-	3	-	-	-	3	2	3
Outcome 5	3	3	3	3	3	-	-	-	3	-	-	-	3	2	3
Average	3	3	2	3	3	-	-	-	3	-	-	-	3	2	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction to air standard cycles. Air standard Efficiency; Assumptions	1.5	1	1,2
	Otto cycle: p-v and T -s diagrams, Air standard efficiency, mean effective pressure, Power developed	2.5	1	1,2
	Diesel cycle: p-v and T -s diagrams, Air standard efficiency, mean effective pressure and power developed	3	1	1,2,3
	Dual cycle: p-v and T -s diagrams, Air standard efficiency, Mean Effective, pressure and power developed	3	1	1,2
	IC engine components, their functions, engine performance and efficiency	3	1	1,2
Unit No. 2	Gas turbine (Brayton) cycle; description and analysis.	2	2	1,2
	Regenerative gas turbine cycle. Intercooling and reheating in gas turbine cycles, description, and analysis.	2	2	1,2
	Introduction to Jet Propulsion cycles – Turbojet, Turbofan, Turboprop, Afterburner, description, and analysis; Rockets	3	2	1,2
	Carnot vapour power cycle, drawbacks as a reference cycle.	2	2,3	1,2
Unit No. 3	Simple Rankine cycle; description, T-S diagram, analysis for performance.	2	3	1,2
	Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance	2	3	1,2
	Actual vapour power cycles. Ideal and practical regenerative Rankine cycles, open and closed feed water heaters. Reheat Rankine cycle	3	3	1,2
	Cogeneration, Combined Gas-Vapor Cycles, Binary Vapor Cycles, Characteristics of an Ideal working fluid in vapour power cycles	3	3,4	1,2,3
Unit No. 4	Working of the industrial scale thermal power plant, key components, and their functions	1.5	3,4	1,2,3
	Boiler types, applications, and comparison; Boiler system requirements, its effect on Rankine efficiency	2	4	1,23
	Water Tube Boiler, Fire Tube Boiler, Mountings and Accessories	1.5	4,5	1,3
	Condenser system elements; types and their advantages/disadvantages; its effect on Rankine efficiency	3	4,5	1,3
Unit No. 5	Impulse and reaction turbine, velocity triangle, degree of reaction, efficiencies, losses	2.5	5	3
	Velocity and Pressure compounding	2.5	5	3

Learning Assessment

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

Recommended Resources

1. Cengel, Yunus A., Michael A. Boles, and Mehmet Kanoğlu. Thermodynamics: an engineering approach. Vol. 5. New York: McGraw-hill, 2011.
2. Nag, P. K., Engineering Thermodynamics Tata McGraw Hill 6th Edition 2018
3. Nag, P. K. Power plant engineering. New Delhi, India: Tata McGraw-Hill, 2008.
4. Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margaret B. Bailey. Fundamentals of engineering thermodynamics. John Wiley & Sons, 2010

Course Designers

SRM University *AP*, Andhra Pradesh

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

Refrigeration And Air Conditioning

Course Code	MCE 423	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	0	3
Pre-Requisite Course(s)	ME 141 & ME 230	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Learning the fundamental principles and different methods of refrigeration and air conditioning.
2. Study of various refrigeration cycles and evaluate performance using Mollier charts and/ or refrigerant property tables.
3. Understand the basic air conditioning processes on psychometric charts, calculate cooling load for its applications in comfort and industrial air conditioning.
4. Study of various equipment operating principles employed in refrigeration and air conditioning 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	Illustrate the fundamental principles and applications of refrigeration and air conditioning system	2	70%	65%
Outcome 2	Obtain cooling capacity and coefficient of performance of a vapour compression refrigeration systems	3	70%	65%
Outcome 3	Obtaining the knowledge on vapour absorption system and comparing the performance with vapour compression refrigeration systems	3	70%	65%
Outcome 4	Calculating the cooling load for the air conditioning system for various applications.	3	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	Modem Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	1	2	2				2			3	3	2	3
Outcome 2	3	3	2	3	2				3			3	3	2	3
Outcome 3	3	3	3	3	2				3			3	3	2	3
Outcome 4	3	3	3	3	3				2			3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**				**3**			**3**	**3**	**2**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	**Vapour Compression on Refrigeration Systems**	**10**		
	Review of thermodynamic principles of refrigeration.	2	1	1,2,4,5
	Simple vapour compression system, Calculation: COP of VCR system.	2	1	1,2,4
	Multistage and multiple evaporator system, Cascade system, COP comparison with sub cooling and superheating	3	1,2	1,2,4,5
	Tutorial: problem on sub-Cooling, and super heating.	3	1,2	1,2,4
UNIT II	**Absorption Refrigerations Systems**	**10**		
	Absorption refrigeration cycle, Water lithium bromide systems, Tutorial:LiBr COP calculation	3	1,2,3	1, 2, 3
	Ammonia Absorption Refrigeration system, Tutorial: ammonia COP calculation.	3	1,2,3	1, 2, 3
	Refrigeration absorbent combinations, Comparison of absorption system with vapor compression systems.	2	1,2,3	1, 2, 3
	Tutorial: COP comparison of vapor compression systems with vapor absorption system.	2	1,2,3	1, 2, 3,5
UNIT III	**Refrigeration Equipments & Control**	**8**		
	Compressors –type, Condensers type, Cooling towers type.	4	1,2,3	1, 2, 3
	Evaporators, Expansion devices type, Refrigerants: properties.	2	1,2,3	1, 2, 3
	Refrigeration plant controls, Testing and charging of refrigeration units.	2	1,2,3	1, 2, 3,4
UNIT IV	**Design of air Conditioning Systems**	**10**		
	Different heat sources of Conduction and radiation.	2	2,3,4	1, 2, 4,5
	Load: occupants load, equipment load, fresh air load, infiltration air load.	4	2,3,4	1, 2, 4, 5
	Tutorial: conduction, radiation, Tutorial: load calculation, Estimation of total heat load (SHL+LHL), Bypass factor (BPF), Effective sensible heat factor (ESHF), Tutorial: SHF& ESHF.	4	1,2,3,4	1, 2, 3,4
UNIT V	**Applications of Refrigeration and Air Conditioning Systems**	**7**		
	Preservation of different products, Ice factory, Dairy plant refrigeration systems.	2	3,4	1, 2, 3,4,5
	Application of air conditioning in hotels, Application of air conditioning in restaurants.	1	3,4	1, 2, 3,4,5
	Application of air conditioning in theatres, Application of air conditioning in auditorium.	2	2,3, 4	1, 2, 3,4,5
	Application of air conditioning in hospitals, Cryogenics applications.	2	2,3,4	1, 2, 3,4,5
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		Internal (50%)				
		CLA-1 (10%)	Mid-1 (15%)	CLA-2 (10%)	Mid-2 (15%)	
Level 1	Remember	40%	35%	30%	40%	40%
	Understand					
Level 2	Apply	60%	65%	70%	60%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Arora.S.C and Domkundwar.S, "A course in Refrigeration and Air conditioning", DhanpatRai(P) Ltd., New Delhi, 2012.
2. Ananthanarayanan.P.N, "Basic Refrigeration and Air Conditioning", Tata McGraw Hill, 3rd Edition, New Delhi, 2006.
3. Manohar Prasad, "Refrigeration and Air conditioning", New Age International (P) Ltd, New Delhi, 2010.
4. Roy J. Dossat," Principles of Refrigeration", Pearson Education Asia, 4th Edition, 2001.
5. Arora, C. P., "Refrigeration and Air Conditioning", Tata McGraw Hill, New Delhi, 2006

Course Designers

SRM University *AP*, Andhra Pradesh

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

Thermal Design for Electronics Equipment's

Course Code	MCE 445	Course Category	CE	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)	Fluid Mechanics and Heat Transfer	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To provide an overview of introduction of thermal design for electronics devices.
2. To give introduction of data centre cooling and other applications.
3. To understand thermos-physical properties in different engineering systems, gain knowledge about different cooling technologies for electronics.
4. To implement the fundamental knowledge of heat transfer, fluid mechanics and thermodynamics laws to thermal design of electronics applications and perform analysis

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Apply fluid mechanics, heat transfer laws and heat transfer modes to electronics engineering systems	3	70%	80%
Outcome 2	Describe electronics packaging, data centres, and conjugate heat conduction & thermal spreading	2	70%	80%
Outcome 3	Discuss the cooling techniques for thermal management of electronics.	2	70%	80%
Outcome 4	Apply fluid mechanics and heat transfer techniques for thermal design and management of electronic devices electronics devices.	3	70%	80%
Outcome 5	Design primitive thermal management methods for electronics packaging.	4	70%	80%

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

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modem Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	3	2	-	-	-	2	-	-	3	3	2	3
Outcome 2	3	3	3	3	3	-	-	-	3	-	-	3	3	3	3
Outcome 3	3	3	3	3	3	-	-	-	3	-	-	3	3	2	3
Outcome 4	3	3	3	3	3	-	-	-	3	-	-	3	3	3	3
Outcome 5	3	3	3	3	3	-	-	-	3	-	-	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	-	-	-	**3**	-	-	**3**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Fundamentals of Heat Transfer: Review of Conduction, Convection and Radiation heat transfer.	**2**	**1**	**1,2,5**
	Introduction to electronics packaging	**1**	**1**	**1,4**
	Basic definitions of electronics packaging,	**1**	**1**	**1,4**
	classification of electronics packaging and self- heating in electronics packaging.	**1**	**1**	**1,4**
Unit No. 2	Introduction to thermal management of electronics packages and datacentres: Basic definitions of thermal management, classification of thermal management of electronics packages and datacentres	**2**	**2, 4**	**1, 2, 3, 4**
	Concept of Contact resistance elastic-elastic contacts and elastic plastic contacts.	**3**	**2, 5**	**1, 2, 3, 8**
	Conjugate heat conduction and thermal spreading: Derivation of analytical solution of heat spreading in heat sink base.	**4**	**2, 5**	**1, 2, 3, 8**
	Fin analysis and heat sink design: Derivation of general thermal resistance network.	**4**	**2, 5**	**1, 2, 3, 4,7,8**
Unit No. 3	Natural convection in electronics packaging, Radiation in electronic packages. Forced convection in electronics,	**4**	**1,3,4**	**1, 2, 3, 5, 6**
	Liquid cold plates for electronics, Jet impingement analytical solution derivation,	**3**	**3,4,5**	**1, 2, 3, 5, 6**
	Boiling and Condensation, Immersion cooling of electronics, design considerations.	**3**	**3,4,5**	**1, 2, 3, 5, 6**
	Introduction to heat pipes, Phase change energy storage with PCM's. Microchannel heat exchangers, Piezoelectric fans and synthetic jets.	**2**	**3,4,5**	**1, 2, 3, 5, 6, 8**
Unit No. 4	Thermoelectric modules, derivation of analytical solution, Acoustic challenges,	**2**	**3, 4**	**1, 2, 3, 6, 8**
	thermal modelling of electronics packages and printed circuits	**2**	**3, 4**	**1, 2, 3, 6, 8**
	Thermal design of fan heat sinks: fan/blower curves, parallel plate fins,	**3**	**3, 4**	**1, 2, 3, 6, 8**
	manufacturing processes, design for manufacturability.	**3**	**3, 4**	**1, 2, 3, 6, 8**
Unit No. 5	Thermal design of smartphones and tablets: case studies	**1**	**4**	**1, 2, 4, 8**
	Thermal design of IT data centers Part 1 (IT equipment loop).	**1**	**4**	**1, 2, 4, 8**
	Thermal design of IT data centers Part 2 (IT facilities loop) chip to cooling tower Thermal design.	**2**	**3, 4, 5**	**1, 2, 4, 6, 8**
	Thermal design of IT data centers Part 2 (IT facilities loop) chip to cooling tower Thermal design.	**1**	**3, 4, 5**	**1, 2, 4, 6, 8**

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (05%)		CLA-2 (10%)		CLA-3 (10%)		Mid Term (25%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	20%	-	20%	-	30%	-	30%	-	30%	-
	Understand										
Level 2	Apply	80%	-	80%	-	70%	-	70%	-	70%	-
	Analyse										
Level 3	Evaluate	-	-	-	-	-	-	-	-	-	-
	Create										
Total		**100**		**100**		**100**		**100**		**100**	

Recommended Resources

1. Lian-Tuu Yeh, Richard C. Chu, Dereje Agonafer, "Thermal management of microelectronic equipment heat transfer theory, analysis methods and design practices", ASME press, 2002
2. F. P. Incropera, D. P. Dewitt, T. L. Bergman and A. S. Lavine, "Fundamentals of Heat and Mass Transfer", 7th Ed., John Wiley and Sons, 2011.
3. Allen D. Kraus and Avram Bar Cohen, "Design and Analysis of Heat Sinks", Wiley-Interscience, 2008
4. Tummala Rao R., "Fundamentals of Microsystems packaging", McGraw Hill, 2004
5. Yunus A. Çengel, Afshin J. Ghajar, "Heat and mass transfer: fundamentals and applications", McGraw-Hill Education, 2015
6. Ho Sung Lee, "Thermal Design: Heat Sinks, Thermo-electrics, Heat Pipes, Compact Heat Exchangers, and Solar Cells", John Wiley and Sons, 2010
7. Adrian Bejan, Allan D. Kraus, "Heat Transfer Handbook", Wiley-Inter-science, 2003
8. Ralph Remsburg, "Thermal Design of Electronic Equipment", CRC Press LLC, 2001

Other Resources

1. Moore's Law: https://www.visualcapitalist.com/visualizing-moores-law-in-action-1971-2019
2. Property data: http://www.mhtlab.uwaterloo.ca

3. Packaging: https://www.intel.com/content/www/us/en/silicon-innovations/silicon-innovations- technology.html

Course Designers

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

Computational Fluid Dynamics

Course Code	MCE 448	**Course Category**	CE	**L**	**T**	**P**	**C**
				1	1	1	3
Pre-Requisite Course(s)	Numerical methods, Fluid Mechanics	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Predict and derive the solution methodologies.
2. Identify advantages and disadvantages of various methods to solve a particular problem.
3. Apply the knowledge of the methods to engineering applications.
4. Study the computational implementation of the 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	Derive the equations of fluid motion	2	80%	75%
Outcome 2	Derive the discretised equations	2	70%	65%
Outcome 3	Demonstrate the discretisation techniques for fluid flow equations	3	70%	65%
Outcome 4	Demonstrate Transformation of the governing equations and grid generation	3,4	60%	55%

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction to computational fluid dynamics	0.5	1	1, 2,3, 4
	Types of flow	1	1	1
	Material derivative, divergence	1.5	1	1, 3
	Continuity, momentum and energy equations differential form	3	1	1
	Integral form of governing equations	2	1	2,3
Unit No. 2	Finite difference methods	1	2	1
	Discretisation of wave equation	2	2	1, 2
	Numerical error, stability	1	2	1, 3
	Transient heat conduction equation	1	2	1, 3
	Explicit, Crank Nickolson and Pure implicit schemes	3	2	1, 2
	Grid independence	1	2	1
Unit No. 3	Semi Implicit Method for Pressure linked equations (SIMPLE)	3	2	1, 3
	Stream function and vorticity	2	2	1
Unit No. 4	FVM basics	2	3	2, 3
	Central, upwind biased and hybrid schemes	1	3	2, 3
	One dimensional conduction problem	0.5	3	2, 4
	One dimensional convection and convection-diffusion	1	3	2, 3
	Boundary conditions	1	3	1, 2, 3, 4
Unit No. 5	Steady and transient problems	0.5	3	4
	Practical tool usage	3	3	3,4
	In the Project students demonstrate modern tool usage (OpenFOAM/ANSYS)			
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (55%)								End Semester Exam (45%)	
		CLA-1 (10%)		CLA-2 (10%)		CLA-3 (15%)		Mid Term (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%		30%				40%		30%	
	Understand										
Level 2	Apply	60%		50%				60%		70%	
	Analyse										
Level 3	Evaluate			20%							
	Create										
Total		**100%**		**100%**				**100%**		**100%**	

Recommended Resources

1. Anderson J.D., "Computational Fluid dynamics", McGraw Hill Int., New York, 2010.
2. Computational Fluid Dynamics, An Open-Source Approach. Brian C. Vermeire, Carlos A.Pereira and

Other Resources

1. Hamidreza Karbasian. https://users.encs.concordia.ca/~bvermeir/files/CFD%20-%20An%20Open-Source%20Approach.pdf
2. Versteeg H.K., and Malalasekera W., "An introduction to computational fluid dynamics, The finite volume method", Longman, 2007.
3. ANSYS© guide

Course Designers

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

Artificial Intelligence for Mechanical Engineers

Course Code	MCE 421	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	0	1	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the historic evolution and basic concepts of AI.
2. To introduce various search methods of AI and algorithms suitable for robot path planning.
3. To introduce the concepts of knowledge manipulation and fuzzy systems.
4. To impart a programming approach to AI 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	Aware of the basic concepts of AI and its relevance to robotics	1	80%	75%
Outcome 2	Apply various search methods and path planning techniques for robotics	1, 2	70%	65%
Outcome 3	Apply fuzzy logic for knowledge handling	1, 2	70%	60%
Outcome 4	Implement AI techniques for some basic applications	2, 3	70%	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	3	3	1	1	2				1			3	3	2	3
Outcome 2	3	3	1	3	3				3			3	3	2	3
Outcome 3	3	3	1	1	3				2			3	3	2	2
Outcome 4	3	3	1	2	3				2			3	3	3	3
Average	**3**	**3**	**2**	**2**	**3**				**2**			**3**	**3**	**2**	**3**

Course Unitization Plan

Session	Description of Topic	Contact hours Required	CLOs addressed	References Used
	UNIT I: INTRODUCTION TO AI	**12**		
1	History, Definition of AI	3	1	1, 2, 3
2	Emulation of human cognitive process	3	1	1, 2, 3
3	Agents: types	1	1	1, 2, 3
4	An abstract view of modeling and Elementary knowledge,	1	1	1, 2, 3
5	Computational and Predicate logic	1	1	1, 2, 3
6	Analysis of compound statements using simple,	1	1	1, 2, 3
7	logic connectives	1	1	1, 2, 3
8	Nature of Environments	1	1	1, 2, 3
	UNIT II: PROBLEM-SOLVING AGENTS	**12**		
9	Problem Definition, formulating problems and searching for solutions, Examples using production rules	2	2	1, 2, 3
10	Search Strategies: Uninformed or Blind search and Breadth first search,	2	2	1, 2, 3
11	Uniform cost search: Depth first search, Depth limited search, Iterative deepening, Depth first search and Bidirectional search.	2	2	1, 2, 3
12	Comparing uninformed search strategies and informed search strategies	2	2	1, 2, 3
13	Heuristic information and Hill climbing methods, Best First Search	2	2	1, 2, 3
14	Greedy Best First Search, Branch-and-Bound Search, Optimal search algorithm A* and iterative, deepening A*.	2	2	1, 2, 3
	UNIT III: KNOWLEDGE ORGANISATION AND COMMUNICATION	**5**		
15	Knowledge organization, manipulation, and acquisition.	0.5	3	4, 5
16	Indexing and Retrieval techniques and Integration of knowledge in Memory Organization Systems	0.5	3	4, 5
17	Matching Techniques: Need for matching and simple matching problems, Partial matching, Fuzzy matching	1	3	4, 5
18	RETE matching algorithm Perception	1	3	4, 5
19	Natural language: Overview of linguistics	0.5	3	4, 5
20	Basics semantic analysis, Representation structures, and Natural language generation uncertainty	0.5	3	4, 5
21	Bayesian Networks and Bayesian Inference.	1	3	4, 5
	UNIT IV- PROGRAMMING LANGUAGE	**11**		
22	Introduction to LISP: syntax, Input-output statements	4	4	4, 5
23	Numeric functions	1	4	4, 5
24	User-defined Functions	2	4	4, 5
25	Predicate Logic and declaration of local variables	1	4	4, 5
26	Interaction functions Property list	1	4	4, 5
27	recursion functions Property list	1	4	4, 5
28	Arrays	1	4	4, 5
	UNIT V- EXPERT SYSTEMS	**5**		
29	Introduction to expert systems	0.5	3	4, 5
30	activities of an expert system	0.5	3	4, 5
31	interpretation, prediction, and diagnosis	0.5	3	4, 5
32	design, planning, and monitoring	0.5	3	4, 5
33	debugging and repair, instruction and control	0.5	3	4, 5
34	acquisition module frames of expert systems	0.5	3	4, 5
35	knowledge base, production rules	1	3	4, 5
36	semantic nets and inference engines, backward chaining, and forward chaining.	1	3	4, 5
Total contact hours		**45**		

Learning Assessment

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

Recommended Resources

1. Elaine Rich and Kelvin Knight, "Artificial Intelligence", Tata McGraw Hill, New Delhi, 1991.
2. Stuart Russell and Peter Norvig, "Artificial Intelligence: A modern approach". Prentice Hall, NewJersey, 1995.
3. Eugene Charniak and Drew McDermot, "Introduction to Artificial Intelligence", Addison WesleyLongman Inc., 1998.
4. Patterson, "Introduction to Artificial Intelligence and Expert systems", Prentice Hall of India, NewDelhi, 1990.
5. Donald A. Waterman, "A Guide to Expert Systems", Addison-Wesley Longman Publishing Co.,Inc. Boston, MA, USA ©1985 ISBN:0-201-08313-2.

Course Designers

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

Machine Learning for Mechanical Engineers

Course Code	MCE 422	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	0	3
Pre-Requisite Course(s)	CSE 108 Introduction to Computer Science and Programming Using C	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the fundamental concepts of machine learning
2. To provide understanding of the techniques and mathematical concepts in machine learning
3. To provide an algorithmic approach to machine learning
4. To facilitate the applications of machine learning techniques in robotics and other mechanical engineering areas

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Comprehend different types of machine learning	1	70%	60%
Outcome 2	State the applications and limitations of various machine learning techniques	1	60%	50%
Outcome 3	Utilize statistical and probabilistic machine learning algorithms	2	60%	50%
Outcome 4	Implement machine learning algorithms for classification and clustering problems	2, 3	60%	50%
Outcome 5	Examine various machine learning algorithms and tools for robotics and other mechanical engineering applications	2, 3	60%	55%

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

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modem Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	-	-	1	-	-	-	-	-	-	-	1	-	-
Outcome 2	3	2	-	2	2	-	-	-	-	-	-	-	2	1	-
Outcome 3	3	2	-	2	3	-	-	-	-	-	-	-	2	1	-
Outcome 4	3	3	-	3	3	-	-	-	-	-	-	-	2	1	-
Outcome 5	3	3	-	3	3								2	1	
Average	**3**	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Different forms of learning	1	1	1, 2
	. Supervised and unsupervised learning	2	1	1,2
	Loss functions	2	1	1,2
	Model training	2	1	1,2
	Backpropagation	2	1	1,2
Unit No. 2	. GENERATIVE LEARNING: Gaussian parameter estimation	1	1, 2, 3	1, 2, 3
	Maximum likelihood estimation	1	1, 2, 3	1, 2, 3
	MAP estimation	1	1, 2, 3	1, 2, 3
	Bayesian estimation	1	1, 2, 3	1, 2, 3
	Bias and variance of estimators	1	1, 2, 3	1, 2, 3
	Missing and noisy features	1	1, 2, 3	1, 2, 3
	Nonparametric density estimation	1	1, 2, 3	1, 2, 3
	Applications	2	1, 2, 3	1, 2, 3
Unit No. 3	CLASSIFICATION METHODS: Nearest neighbour	1	1, 2, 4	1,2, 6
	Decision trees	1	1, 2, 4	1,2, 6
	Linear Discriminant Analysis	1	1, 2, 4	1,2, 6
	Simple and multivariate regression	1	1, 2, 4	1,2, 6
	Logistic regression	1	1, 2, 4	1,2, 6
	K-means clustering	1	1, 2, 4	1,2, 6
	Perceptions; Large margin classification	1	1, 2, 4	1,2, 6
	Support Vector Machine	1	1, 2, 4	1,2, 6
	Kernel methods	1	1, 2, 4	1,2, 6
Unit No. 4	CLASSIFICATION AND REGRESSION TREES:	1	1, 2, 4	1,2, 6
	Graphical and sequential models	1	1, 2, 4	1,2, 6
	Bayesian networks	2	1, 2, 4	1,2, 6
	Conditional independence	1	1, 2, 4	1,2, 6
	Markov random fields	2	1, 2, 4	1,2, 6
	Inference in graphical models	1	1, 2, 4	1,2, 6
	Belief propagation	1	1, 2, 4	1,2, 6
Unit No. 5	MARKOV MODELS: Hidden Markov models; Decoding states from observations	1	1, 2, 4	1,2, 6
	Learning HMM parameters	1	1, 2, 4	1,2, 6
	CLUSTERING METHODS: Partition based Clustering	1	1, 2, 4, 5	1,2, 6
	K-means clustering	1	1, 2, 4, 5	1,2, 6
	K-medoids	1	1, 2, 4, 5	1,2, 6
	Hierarchical Clustering	1	1, 2, 4, 5	1,2, 6
	Agglomerative, Divisive, Distance measures	1	1, 2, 4, 5	1,2, 6
	Density based Clustering	1	1, 2, 4, 5	1,2, 6
	DBScan; Spectral clustering	1	1, 2, 4	1,2, 6

Learning Assessment

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

Recommended Resources

1. James, G., Witten, D., Hastie, T., Tibshirani, R., & Taylor, J. (2023). An introduction to statistical learning: With applications in python. Springer Text in Statistics.
2. Hastie, T., Tibshirani, R., & Friedman, J. (2009). An introduction to statistical learning. Springer.
3. Murphy, K. P. (2012). Machine learning: a probabilistic perspective. MIT press.
4. Alpaydin, E. (2020). Introduction to machine learning. MIT press.
5. Haque, E. (2020). The Ultimate Modern Guide to Artificial Intelligence. United Kingdom: Independently Published. ISBN:9798691930768
6. Shalev-Shwartz, S., Ben-David, S. (2014). Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press.
7. Ayyadevara, V. K. (2018). Pro Machine Learning Algorithms: A Hands-On Approach to Implementing Algorithms in Python and R. Germany: Apress

Course Designers

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

Multibody Dynamics

Course Code	MCE 428	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	0	3
Pre-Requisite Course(s)	ENG 115 Engineering Mechanics	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the basic concepts of multibody systems and their relevance.
2. To review the kinematics of particles and rigid bodies
3. To introduce mathematical modelling of various types of joints
4. To introduce the modelling of dynamics of multiple rigid bodies connected by joints

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 vectors and matrices to represent the kinematics of rigid bodies and relate multibody systems to various engineering applications	1, 2	80%	70%
Outcome 2	Analyse the motion of the particles and rigid bodies mathematically in relation to a specified coordinate frame of reference	2	70%	65%
Outcome 3	Model the joints mathematically using equations of constraints	2	70%	60%
Outcome 4	Formulate the equations of motion of multiple rigid bodies connected by joints using the method of Lagrange multipliers and constraint Jacobian	3	70%	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	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Outcome 2	3	3	-	2	1	-	-	-	-	-	-	-	-	-	-
Outcome 3	3	3	-	3	2	-	-	-	-	-	-	-	2	-	-
Outcome 4	3	3	-	3	3	-	-	-	-	-	-	-	3	-	-
Average	**3**	**3**	**-**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	What is MBD, Applications and scope of MBD, Objectives of MBD.	1	1	1, 2
	PRELIMINARIES OF MBD: Kinematics- Position, velocity, acceleration	1	1	1, 2
	momentum, angular momentum.	1	1	1, 2
	Kinetics- Force, moment, torque, equations of motion.	1	1	1, 2
	Methods of formulations for MBD.	1	1	1, 2
	MATHEMATICAL BACKGROUND FOR MBD: Vectors, Scalars, Arrays, Matrix operations,	1	1	1, 2
	Differentiation of vectors, arrays and matrices	1	1	1, 2
	Differential equations.	1	1	1, 2
Unit No. 2	Fundamentals of Kinematics: Kinematics of particles	1	2	1
	Kinematics of a rigid body- position, velocity and acceleration of a rigid body	1	2	1
	Array of coordinates, degrees of freedom	1	2	2
	Constraint equations	1	2	2
	kinematics of joints	2	2	2
	Numerical problems	2	2	1, 2
Unit No. 3	Newton's laws of motion- Dynamics of particle and system of particles.	1	2	1, 2
	Dynamics of rigid body- Centroidal equations of motion	1	2	1, 2
	Numerical problems	1	2	1, 2
	Non centroidal equations of motion	1	2	1, 2
	Force elements; Applied forces: Gravitational forces, point to point actuator, point to point spring, point to point damper	1	2, 3	2
	Combined elements, rotational elements, viscous friction.	1	2, 3	2
	Reaction Force: Method of Lagrange multipliers, Coulomb friction.	1	3	2
	Numerical problems.	1	2, 3	1, 2
Unit No. 4	BODY COORDINATE FORMULATION: KINEMATICS - General Procedure	1	3	2
	Formulation of kinematic joint constraints - Revolute, translational, composite and rigid joints. Numerical examples.	3	3	2, 3
	Velocity and acceleration of joint constraints. Numerical examples	3	3	2, 3
	Formation of system Jacobian. Numerical examples	3	3	2, 3
	BODY COORDINATE FORMULATION: DYNAMICS	1	1, 3, 4	2, 3

Unit No. 5	Dynamics of system of unconstrained bodies	2	4	2, 3
	Dynamics of two body system	2	4	2, 3
	Dynamics general unconstrained bodies	1	4	2, 3
	Numerical problems.	1	4	2, 3
	Dynamics of System of constrained bodies. Numerical Problems.	3	4	2, 3
	Analysis of MBD system	2	4	2, 3

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**				**End Semester Exam (40%)**
		CLA-1 (15%)	**Mid-1 (15%)**	**CLA-2 (15%)**	**CLA-3 (15%)**	**Th**
Level 1	Remember	50%	50%	30%	30%	30%
	Understand					
Level 2	Apply	50%	50%	40%	40%	35%
	Analyse					
Level 3	Evaluate	-	-	30%	30%	35%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Beer, F., Johnston, E., & Mazurek, D. (2012). *Vector Mechanics for Engineers*. McGraw-Hill.
2. Shabana, A. A. (2009). *Computational dynamics*. John Wiley & Sons.
3. Nikravesh, P. (2018). *Planar multibody dynamics: formulation, programming with MATLAB®, and applications*. CRC press.
4. Shabana, A. A., Zaazaa, K. E., Sugiyama, H. (2007). *Railroad Vehicle Dynamics: A Computational Approach*. CRC Press.
5. Amirouche, F. (2006). *Fundamentals of Multibody Dynamics: Theory and Applications*. Birkhäuser Boston.
6. Nikravesh, P. E. (1988). *Computer-aided analysis of mechanical systems*. Prentice-Hall, Inc

Other Resources

Course Designers

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

Industrial Engineering

Course Code	MCE 434	Course Category	CE		L	T	P	C
					2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. Familiarize the students with standard methods of solving complex industry problems by choosing the trade-offs in the best way
2. Impart important decision-making processes and analytical tools in design, planning and control of manufacturing
3. Train the students on various industry practices that are fundamental and applied in nature

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, formulate, and solve complex engineering problems by applying principles of industrial engineering.	**1**	**80%**	**75%**
Outcome 2	Apply industrial engineering to produce solutions that meet specified needs	**2**	**80%**	**65%**
Outcome 3	Understand the basics of operation research & optimization	**1**	**75%**	**70%**
Outcome 4	Apply operational problems with application of appropriate tools, techniques & programming skills	**2**	**80%**	**75%**

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Objectives, Method study, Work measurement, various methods, time study, different methods of performance rating- allowances,	3	1	1,2
	standard time calculation, Work sampling, Therbligs.	2	1,2	1,2
	Productivity - Definition, Various methods of measurement of productivity,	2	1,2	1,2
	Factors effecting productivity	2	1,2	1,2
Unit No. 2	various methods of Job evaluation & merit rating	4	1,2	1,2
	Fixed and variable cost, break even quantity	2	1,2	1,2
	Types of layouts, types of manufacturing systems,	2	1,2	1,2
	Introduction to modern manufacturing systems,	3	1,2	1,2
Unit No. 3	Quality management, Quality improvement tools.	2	3	1,2
	Total quality management.	2	3	1,2
	Types of inspections - Statistical Quality Control-techniques-	2	3	1,2
	variables and attributes assignable and non-assignable causes-variable control charts and R charts	1	3	1,2
Unit No. 4	Inventory control models - Economic order quantity (EOQ)	2	3	1,2
	Problem formulation, solve two variables LP models by the graphical solution procedure	4	3	1,2
	Solving special cases using graphical methods	2	3,4	1,2
	Introduction to Simplex method	2	3	1,2
Unit No. 5	Artificial starting solution and special cases	2	3	1,2
	Dual Solutions	2	3	1,2
	Formulate transport problem as LPP and solve	2	4	1,2
	Formulate assignment problem as LPP and solve	2	4	1,2

Learning Assessment

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

Recommended Resources

1. Taha, Hamdy A, Operations Research: An Introduction, Pearson Education, 9th, Edition, 2012.

2. Ravi Shankar, "Industrial Engineering and Management, "Galgotia Publications Pvt Ltd, Delhi, 2020

Course Designers

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

New product development

Course Code	MCE 424	Course Category	CE	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the key phases of new product development.
2. Learn methods for generating and evaluating new product ideas.
3. Develop skills in market research and customer analysis.
4. Understand the importance of design, prototyping, and testing, and explore strategies for successful product launch and commercialization

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 key phases of new product development	**2**	**80%**	**75%**
Outcome 2	Develop and evaluate new product ideas	**1**	**70%**	**65%**
Outcome 3	Analyze market and customer needs	**3**	**70%**	**65%**
Outcome 4	Model and prototype commercial products	**3**	**80%**	**75%**

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction to New Product Development (NPD)	2	1	1
	Market Research and Customer Needs Analysis	2	1	1
	Idea Generation and Screening	2	1	1
	Concept Development and Testing	3	1	1
Unit No. 2	Product Design and Prototyping	2	1	1
	Business Case and Feasibility Analysis	2	1,2	1,2,3
	Development Process and Methodologies	2	1,2	1,2,3
	Intellectual Property and Patent Considerations	3	1,2	1,2,3
Unit No. 3	Product Lifecycle Management	2	1,2	1,2,3
	Risk Management in NPD, Project Management for NPD	2	1,2	1,2,3
	Cross-functional Team Collaboration, Marketing Strategies for New Products	2	1,2	1,2,3
	Go-to-Market Strategy and Launch Planning, Supply Chain and Manufacturing Considerations	3	1,2	1,2,3
Unit No. 4	Quality Assurance and Control	2	1,2,3,4	2,3
	Customer Feedback and Iterative Development	2	1,2,3,4	1,2,3
	Post-launch Review and Product Optimization	2	2,3	1,2,3
	Sustainability and Ethical Considerations in NPD	3	3,4	1,2,3
Unit No. 5	Concepts of CAD, Algorithms used in design, From CAD to CAM, CAD Overview,	2	3,4	1,2,3
	CAM Skills, Mesh Repair	2	3,4	1,2,3
	Design for 3DP, Understand the basics of G code generation	2	3,4	1,2,3
	Basics of 3D Scanner, 3D Product to CAD model generation, Case Studies and Real-world Applications	3	3,4	1,2,3

Learning Assessment

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

Recommended Resources

1. Karl T. Ulrich and Steven D. Eppinger, "Product Design and Development", McGraw Hill, 2019
2. C. Merle Crawford and C. Anthony Di Benedetto, "New Products Management", McGraw Hill, 2014
3. Eric Ries, "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses", Crown Business, 2011

Course Designers

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

Sustainable product development

Course Code	MCE 425	Course Category	CE	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the key concepts and principles of sustainability in product development.
2. Learn to integrate environmental, social, and economic considerations into product design and development.
3. Develop skills in conducting life cycle assessments and evaluating the environmental impact of products.
4. Explore the use of sustainable materials and technologies, and examine case studies of successful sustainable product innovations

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 and apply sustainable design principles in product development	**1**	**80%**	**75%**
Outcome 2	Understand and conduct life cycle assessments to evaluate the environmental impacts of products	**2**	**70%**	**65%**
Outcome 3	Select sustainable materials and processes for product design	**1**	**70%**	**65%**
Outcome 4	Design and Develop strategies for creating sustainable products	**3**	**80%**	**75%**

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction to Sustainable Product Development	2	1	1
	Principles of Sustainability in Product Design	2	1	1
	Environmental Impact Assessment and Life Cycle Analysis	2	1	1
	Eco-friendly Materials and Green Design	3	1	1
Unit No. 2	Sustainable Manufacturing Processes	2	1	1
	Energy Efficiency in Product Development	2	1,2	1,2,3
	Sustainable Supply Chain Management	2	1,2	1,2,3
	Circular Economy and Product Lifecycle Extension	3	1,2	1,2,3
Unit No. 3	Design for Disassembly and Recycling	2	1,2	1,2,3
	Social and Ethical Considerations in Sustainable Design	2	1,2	1,2,3
	Regulations and Standards in Sustainable Product Development	2	1,2	1,2,3
	Sustainable Packaging Solutions, Green Marketing and Consumer Behavior**	3	1,2	1,2,3
Unit No. 4	Innovation and Technology in Sustainable Design	2	1,2,3,4	2,3
	Corporate Social Responsibility (CSR) in Product Development, Case Studies in Sustainable Products	2	1,2,3,4	1,2,3
	Challenges and Barriers in Implementing Sustainability, Economic Considerations in Sustainable Development**	2	2,3	1,2,3
	Future Trends in Sustainable Product Development	3	3,4	1,2,3
Unit No. 5	Concepts of CAD, Algorithms used in design, From CAD to CAM, CAD Overview,	2	3,4	1,2,3
	CAM Skills, Mesh Repair	1	3,4	1,2,3
	Understand the basics of G code generation	1	3,4	1,2,3
	Project: Designing a Sustainable Product	5	3,4	1,2,3

Learning Assessment

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

Recommended Resources

1. Jacqueline A. Stagner and David S.-K. Ting, "Sustainable Product Development: Tools, Methods and Examples", CRC Press, 2019
2. Paul A. T. Higgins and Malcolm A. Lewis, "Green Design, Materials and Manufacturing Processes", Springer, 2018
3. Anne-Marie Bonneau and Elizabeth L. Cline, "The Zero Waste Chef: Plant-Forward Recipes and Tips for a Sustainable Kitchen and Planet", Avery, 2021

Course Designers

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

Surface Engineering

Course Code	MCE 436	Course Category	CE		L	T	P	C
					2	0	1	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department		Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce surface engineering processes and their applications.
2. To understand the surface degradation process for engineering components.
3. To introduce a coating technique for protecting surfaces for engineering components.
4. To learn characterization methods for evaluating the properties and performance of engineered surfaces

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 the need for surface engineering	**2**	**80%**	**70%**
Outcome 2	Describe and develop the coating for surface engineering	**2**	**70%**	**70%**
Outcome 3	Evaluate the types of wear and corrosion leading to surface degradation and predict remedial measures.	**3**	**80%**	**70%**
Outcome 4	Able to characterize coating, interpret results, and predict properties	**3**	**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	3	1	3	3	3		2		3	3	3	3	3	2	3
Outcome 2	3	2	3	3	3		1		3	2	3	3	3	2	3
Outcome 3	3	2	3	3	3		2		3	3	3	3	3	2	3
Outcome 4	3	3	3	2	3		2		3	3	3	3	3	3	3
Average	3	2	3	3	3		2		3	3	3	3	3	2	3

Course Unitization Plan

Unit No.	Syllabus topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction to Surface Engineering, Application of Surface Engineering, Purpose of Surface Engineering	**2**	**1**	**1,2**
	Differences between surface and bulk properties of materials. .	**1**	**1**	**1,2**
	Degradation of surfaces, wear and its type, Adhesive, Abrasive, Fretting, Erosion, Corrosion	**2**	**1**	**1,2**
Unit No. 2	Changing the surface metallurgy: Localized surface hardening (flame, induction, laser, electron-beam hardening, Laser melting, shot peening)	**3**	**2**	1,2
	Carburizing, Nitriding, Ion implantation, Laser alloying, boriding, Organic coatings (paints and polymeric or elastomeric coatings and linings)	**3**	**2**	1,2
	Hot-dip galvanizing (zinc coatings), Ceramic coatings (glass linings, cement linings, and porcelain enamels)	1	**2**	1,2
	Advanced surface coating methods: Gaseous State (CVD, PVD, etc)	1	**2**	1,2
	Solution State (Chemical solution deposition, Electrochemical deposition, Sol-gel, electroplating), Molten or semi-molten State (Laser cladding and Thermal spraying)	2	**2**	1,2
	Molten or semi-molten State (Laser cladding and Thermal spraying, HVOF, Cold Spraying, High-pressure cold spraying)	2	**2**	1,2
	Changing the surface metallurgy: Localized surface hardening (flame, induction, laser, electron-beam hardening, Laser melting, shot peening)	2	**2**	1,2
Unit No. 3	Wear and Assessing Surface damage types and categories, Fundamentals of friction and lubrication,	**2**	**3**	**3,4**
	Investigating and characterization of the surface damage due to Abrasive wear and adhesive wear, Design of Surface Modification,	**2**	**3**	**3,4**
Unit No. 4	Corrosion: Different types of Corrosion and its prevention	**1**	**3**	**4**
	Galvanic corrosion, Passivation, Pitting, Crevice, Microbial, High-temperature corrosion	**2**	**3**	**4**
Unit No. 5	Phase and structure of coating by X-ray diffraction	**1**	**3**	**5**
	Surface Characterization (, RAMAN, etc)	**1**	**4**	**5**
	Metallographic Preparation of Samples for Microscopy Characterization of Surface- Optical and Scanning Electron Microscopy	**2**	**4**	**5**

Course Unitization Plan (Laboratory)

Expt No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
1	Introduction to the working process of various coating setups.	**3**	**2**	**1,2**
2	Depositing of coating using Physical Vapor Deposition	**2**	**2**	**1,2**
3	Deposition of coating using Chemical Vapor Deposition	**2**	**2**	**1,2**
4	Preparation of coating using Sputtering	**2**	**2**	**1,2**
5	Metallographic preparation of thin film for microscopy.	**6**	**4**	**5**
6	Characterization of Coating (XRD, RAMAN Spectroscopy, UV-Visible)	**5**	**4**	**5**
7	To investigate the properties of Coating (Hardness, Surface Roughness, Wear test, Friction in the presence of lubricant, Corrosion in Salt).	**10**	**4**	**5**

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments								End Semester Exam (50%)	
		CLA-1 (15%)		CLA-2 (10%)		CLA-3(10%)		Mid Term (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	30%		40%		40%		50%		40%	
	Understand		30%		30%		30%				30%
Level 2	Apply	70%	60%	60%	50%	60%	50%	50%		60%	30%
	Analyse										20%
Level 3	Evaluate		10%		20%		20%				20%
	Create										
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**		**100%**	**100%**

Recommended Resources

1. Introduction to Surface Engineering and Functionally Engineered Materials, Peter Martin; Wiley, 2011
2. Materials degradation and its control by surface engineering, A. W. Batchelor, L. N. Lam and M. Chandrasekaran, Imperial college press
3. Tribology for Scientists and Engineers", Pradeep L. Menezes, "Springer, 2013
4. Handbook, Friction, Lubrication and Wear Technology, Vol. 18, ASM
5. Krishna, R., Anantraman, T.R., Pande, C.S., Arora, O.P., Advanced techniques for microstructural characterization (ed), Trans Tech Publication

Other Resources

1. https://archive.nptel.ac.in/courses/112/107/112107248/

Course Designers

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

Operation Research

Course Code	MCE 438	Course Category	CE	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the fundamentals of production and operations management.
2. To learn about capacity planning, plant layout, scheduling, and sequencing
3. To learn about operation management, work-study, time study
4. To understand about Inventory control, supply chain management

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 explain the basic concepts and principles of production and operations management (POM)	**1**	**80%**	**75%**
Outcome 2	Develop proficiency in capacity planning, plant layout etc.	**2**	**70%**	**75%**
Outcome 3	Able to perform work study, time study, gantt chart	**3**	**80%**	**70%**
Outcome 4	Explain supply chain management functions and applications	**2**	**80%**	**75%**

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Production planning and control	**5**	**1**	**1**
	New product development	**3**	**1,2**	**1**
Unit No. 2	Capacity planning, facility planning	**2**	**1,2**	**1,2**
	Plant location and layout	**4**	**1,2**	**1,2**
	Scheduling and sequencing	**2**	**1,2**	**1,2**
Unit No. 3	PERT, CPM	**3**	**3**	**2**
	Gantt chart	**3**	**3**	**1**
	Work study, time study	**3**	**3**	**2**
Unit No. 4	ABC analysis, EOQ	**4**	**1**	**2**
	Supply chain management	**4**	**3,4**	**1**
	Preventive maintenance	**2**	**4**	**1,2**
Unit No. 5	Six Sigma, Poka-yoke	**2**	**4**	**1,2**
	BPR, ERP	**2**	**4**	**1,2**
	Kanban, ISO 9000, JIT	**3**	**2,4**	**1**
	TQM, FMS, Push/Pull, Kaizen, CAD CAM	**3**	**4**	**1,2**

Learning Assessment

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

Recommended Resources

1. S. K. Bhattacharyya, Production and Operations Management, 2nd edition, Universal Press

2. R. Panneerselvam, Production and Operations Management, Prentice Hall of India

Course Designers

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

Nanotechnology

Course Code	MCE 439	Course Category	CE	L	T	P	C
				2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the fundamentals of nanotechnology
2. To learn various synthesis methods of nanomaterials
3. To introduce characterization techniques involved in nanotechnology.
4. To Familiarize with the potentialities of nanotechnology

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	Classify the nanomaterials based on dimensions and describe their properties.	2	80%	75%
Outcome 2	Describe the method of production of nanomaterials of different dimensions.	2	70%	65%
Outcome 3	Describe the basic characterization techniques of nanomaterials	3	80%	70%
Outcome 4	Produce nanomaterials for suitable applications.	3	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	3	1	3	3	3		2		3	3	3	3	3	2	3
Outcome 2	3	2	3	3	3		1		2	3	3	3	3	2	3
Outcome 3	3	2	3	2	3		2		2	3	3	3	3	2	3
Outcome 4	3	3	3	2	3		2		2	3	3	3	3	3	3
Average	3	2	3	3	3		2		2	3	3	3	3	2	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No.1	Basics of Nanotechnology: Introduction to bulk and nanomaterials Importance of Nanotechnology and scientific revolution	**2**	**1**	**1**
	Dimensionality and size-dependent phenomena, Surface to volume ratio.	1	1	1
	Properties at the nanoscale – optical & mechanical, electronic and magnetic	**2**	1	**1**
	Hazards and risks of exposure to nanoparticles, Toxicity of nanoparticles	**2**	1	**1**
	Classification based on dimensionality- Quantum dots, wells and wires	**1**	1	**1**
Unit No. 2	Introduction to zero-dimensional nanostructures: (Quantum Dots) and Nanoparticles. Nanoparticles through homogeneous nucleation growth	**2**	**2**	**2**
	Kinetically confined synthesis of nanoparticles, Classification of nanoparticle synthesis techniques:	**2**	**2**	**2**
	solid-state synthesis of nanoparticles, Mechanical alloying and mechanical milling, Solution processing of nanoparticles: sol-gel processing, solution precipitation	**4**	**2**	**2**
	Vapor-phase synthesis of nanoparticles, inert gas condensation of nanoparticles, Plasma-based, flame-based synthesis of particles, Spray pyrolysis-based synthesis of nanoparticles	**4**	2	**2**
	Water–oil microemulsion (reverse micelle) method commercial production and use of nanoparticles	**1**	2	**2**
Unit No. 3	Introduction to One-Dimensional Nanostructures: Nanowires and Nanorods and their applications	**1**	2	**2**
	Fundamentals of evaporation (dissolution) condensation growth, Spontaneous growth - evaporation (dissolution) condensation Growth, Evaporation-condensation growth mechanism	**3**	2	**2**
	Dissolution-condensation growth, fundamental aspects of (vapor-liquid-solid) VLS and (solid-liquid-solid) SLS growth	3	2	**2**
	Stress-induced recrystallization. Template based synthesis	**1**	2	**2**
Unit No. 4	Introduction to two-Dimensional Nanostructures: Thin Films and Special nanomaterials, Fundamentals of film growth.	**2**	2	**2**
	Physical vapor deposition (PVD), Chemical vapours deposition (CVD) , Sol-Gel Films; spin coating and dip coating	**2**	2	**2**
	Atomic layer deposition (ALD), self-assembly, LB technique - electrochemical deposition	**2**	2	**2**
	Electrochemical deposition and electrophoretic deposition	**1**	2	**2**
	Micro and mesoporous material and core shell structure- Nanocomposites and nanograined materials	**2**	2	**2**
	Introduction to characterization techniques of nanomaterials. X-ray diffraction (XRD), Field emission scanning electron microscopy	4	3	3

Unit No.	(FESEM), Transmission electron microscope (TEM), UV-Vis Spectroscopy			
5	**Applications in Nanotechnology:** Solar Energy conversion and catalysis, Chemical and biosensors, Nanomedicine and nanobiotechnology, Nanorobotics	4	4	2

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (__%)**								**End Semester Exam (50%)**	
		CLA-1 (15%)		**CLA-2 (10%)**		**CLA-3 (10%)**		**Mid Term (15%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	40%		50%		30%		20%		30%	
	Understand										
Level 2	Apply	60%		50%		70%		80%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. T. Pradeep, "*A Textbook of Nanoscience and Nanotechnology*", Tata McGraw Hill Education Pvt. Ltd.,2012
2. Guozhong Cao, "Nanostructures and Nanomaterials: Synthesis, properties, and applications" 2nd Edition
- World Scientific Publishing Company 2011..
3. Douglas A. Skoog, James Holler, "*Principles of Instrumental Analysis",* Sauder's college publication, CBS publishers and distributors1998

Course Designers

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

Advanced Material

Course Code	MCE 446	**Course Category**	Core Elective		**L**	**T**	**P**	**C**
					2	0	1	3
Pre-Requisite Course(s)	MCE 204	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To familiarize with the concepts of design, performance, and failure of materials
2. To create a new material that will have some desirable properties
3. To gain knowledge of properties and applications of different Advanced Materials to build a career in Materials Engineering

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	Select and compare steels and cast iron for given metallurgical applications	4	85%	75%
Outcome 2	Describe light alloys & super Alloys, strengthening mechanism, composition properties and applications	2	85%	75%
Outcome 3	Demonstrate metallurgical aspects of amorphous alloys and High entropy alloys, techniques to synthesis metallic glasses & high entropy alloy and their applications.	3	85%	70%
Outcome 4	Predict smart material or biomaterial for a given application.	3	85%	75%
Outcome 5	Select and compare steels and cast iron for given metallurgical applications	4	85%	75%

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1 Special steels and alloy cast Iron	Special Steels -Metallurgical aspects, Composition, Properties and applications of: different types of Stainless steels, Dual phase steels, TRIP steels, Maraging steels, High speed steels, Hadfield steels, Free cutting steels, Ausformed steels, Tool Steels, manganese steels, chrome steels, electrical steels, bearing steels, spring steels, heat resistant steels, creep steels, HSLA steels and ODS steel etc.	6	1	1,2
	Alloy Cast Iron- Need of alloying. Silal, Nicrosilal, High silicon cast iron, Ni-hard, Heat resistant cast iron: Composition, Properties, and their applications	6	1	1
Unit No. 2 Light Metals and their alloys	Aluminium and its alloys- Metallurgical aspects, properties, and application	3	2	1,3
	Magnesium and its alloys – Metallurgical aspects, properties and application	3	2	1,3
	Titanium & its alloys- Metallurgical aspects, Properties and applications.	3	2	1,3
Unit No. 3 Super alloys	Iron base, nickel base and cobalt base super alloys: Strengthening mechanism, Composition, Properties and their applications.	6	2	1,5
Unit No. 4 Metallic Glasses and HEA	Introduction to Metallic glasses, Atomic arrangement, Comparison with crystalline alloys, properties & applications	3	3	4
	Glass transition temperature, Glass forming ability	3	3	4
	Techniques for Production of metallic glasses	3	3	4
	High Entropy alloys(HEA)- Introduction, metallurgical aspects, properties and application	3	3	c
Unit No. 5 Smart Materials and Bio Materials	Shape memory alloys, Piezoelectric materials, Electro-rheological fluid, Magneto- rheological fluids.	3	4	7
	Bio-Materials -Property requirement, biocompatibility, bio functionality, Important bio metallic alloys like: Ni-Ti alloy and Co-Cr-Mo alloys. Applications	3	4	8

Learning Assessment

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

Recommended Resources

1. The Science and Engineering of Materials by D. R. Askeland and P. P. Phule, Thomson Publication
2. Steels: Microstructure & Properties - H.K.D.H. BHADESHIA R.W.K. HONEYCOMBE, Butterworth-Heinemann
3. Light Alloys: Metallurgy of Light Metals by I. J. Polmear, Butterworth-Heinemann
4. Bulk Metallic Glass: C. Suryanarayana & A. Inoue, CRC Press
5. The Superalloys: Fundamentals and Applications, Roger Reed, Cambridge University Press
6. High Entropy alloys: B.S. Murty, J.W. Yeh, S. Ranganathan & PP Battacharya, Elsevier publication
7. Fundamentals of Smart Materials: Mohsen Shahinpoor, RSC Publication
8. Introduction to Biomaterials: Basic theory with Engineering applications, C. Mauli Agarwal, Joo L Ong, Mark Appleford, Gopinath Mani, Cambridge University Press

Course Designers

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

Mechanics of Composite Materials

Course Code	MCE 447	**Course Category**	Core Elective		**L**	**T**	**P**	**C**
					2	1	0	3
Pre-Requisite Course(s)	MCE 204	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To learn the fundamental concept of composite materials starting from manufacturing methods, micromechanics to micromechanics.
2. To understand the concepts of structural analysis, failure analysis of the structure made up of composite materials

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Explain the effect of the constituent of composites and their mechanical properties	2	80%	75%
2	Compute the elastic modulus and strength of unidirectional laminates	3	70%	65%
3	Apply manufacturing methods and the concepts of the mechanics of composites to given materials	3	80%	70%
4	Demonstrate coupling effects in laminated composite beams/plates	3	85%	75%
5	Apply the failure criteria in design of composite materials	3	85%	75%

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1 Introduction to composites	Definition & General Characteristics, Application	1	1	1
	fibre Glass, Carbon, Ceramic and Aramid fibres	3	1	1
	Matrices – Polymer, Metal, Ceramic & Graphite	3	1	1
	Characterizing of fibres and matrices	2	1	1
Unit No. 2 Mechanics & Performance	Characteristics of fibre reinforced Lamina & laminates	4	2,3	1,2,3
	Inter-laminar stresses & Static Mechanical Properties	3	2,3	1,2,3
	Environmental effects, fracture behaviour & damage tolerance	3	2,3	1,2,3
	Fatigue & Impact properties	2	2,3	1,2,3
Unit No. 3 Manufacturing	Fabrication of fibre reinforced Polymer matrix composites, Thermo-plastic and Thermosetting polymers matrix preparation – Matrix preforms/precursor preparation	2	3	1,2,3
	Hand layup techniques, Bag moulding, Compression moulding, Pultrusion, filament winding techniques	2	3	1,2,3
	Fabrication of Metal matrix composites	1	3	1,2,3
	Fabrication of Ceramic matrix composites	1	3	1,2,3
Unit No. 4 Analysis	Analysis of Orthotropic lamina, Hooke's Law	3	4,5	1,2,3
	Stiffness and Compliance matrices	3	4,5	1,2,3
	Strengths of orthotropic lamina	3	4,5	1,2,3
	Stress analysis of laminated composite Beams, Plates, Shells	2	4,5	1,2,3
Unit No. 5 Design	Failure predictions in composites	2	4,5	1,3
	Laminated design consideration	2	4,5	1,3
	Bolted joints and Bonded joints	1	4,5	1,3
	Design examples	1	4,5	1,3
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 (15%)	CLA-2 (10%)	CLA-3 (10%)	
		Th	Th	Th	Th	Th
Level 1	Remember	30%	40%	30%	20%	30%
	Understand					
Level 2	Apply	60%	50%	60%	60%	50%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. P.K. Mallick, "Fibre Reinforced Composite: Materials, Manufacturing & Design", Marcel Dekker Inc., 1993
2. B. D. Agarwal and L. J. Broutman, "Ananlysis and Performance of Fiber Composites", John Wiley and Sons, Newyork, 1990
3. P. K. Mallick and S. Newman (eds), "Composite Materials Technology", Hansen Publisher, Munich, 1990

Course Designers

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

Non-conventional manufacturing

Course Code	MCE 449	Course Category	CE			L	T	P	C
						2	1	0	3
Pre-Requisite Course(s)	Manufacturing Science	Co-Requisite Course(s)	Manufacturing Processes	Progressive Course(s)					
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards							

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the basic principle of advanced machining processes
2. Understand the several techniques of the advanced welding processes.
3. Understand the metal casting processes with their applications.
4. Understand the metal forming processes with their 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	Distinguish various metal removing processes based on surface finish.	1	80%	75%
Outcome 2	Distinguish various metal joining processes based on principle of working.	2	70%	75%
Outcome 3	Distinguish various metal casting processes based on principle of working.	3	80%	70%
Outcome 4	Distinguish various metal forming processes based on principle of working.	2	80%	75%

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Non-conventional machining, imitation of conventional manufacturing process, Difference between conventional and non-conventional process, need of NCM	3	1	1,2
	Classification of NCM, advantages and disadvantages of NC, Hybrid processes. Parametric analysis and applications of processes such as ultrasonic machining (USM),	2	1	1,2
	Abrasive jet maching (AJM), Water jet machining (WJM), Abrasive water jet machining (AWJM), Electrochemical machining (ECM),	2	1	1,2
	Electro discharge machining (EDM), Electron beam machining (EBM), Laser beam machining (LBM) processes, Plasma arc machining (pam)	2	1	1
Unit No. 2	Introduction to laser beam welding, Laser surfacing, laser hardening and cladding	2	2	1,2,3
	Electron beam welding, process, ultrasonic welding,	2	2	1,2,3
	Plasma arc welding, explosive welding,	2	2	1,2,3
	Cladding process, under water welding	2	2	1,2,3
Unit No. 3	Process parameters, advantages, limitations and application of Metal mould casting,	2	3	1,2,3
	Continuous casting, Squeeze casting	2	3	1,2,3
	Vacuum mould casting, Evaporative pattern casting	2	3	1,2,3
	Ceramic shell casting, Stir casting process, Centrifugal casting	3	3	1,2,3
Unit No. 4	Introduction forming processes, advantages, limitations and applications, Vacuum forming	3	4	1,2,3
	Explosive forming, and hydro forming, advantages and applications	3	4	1,2,3
	High velocity forming and Mar forming, advantages and applications	2	4	1,2,3
	Electromagnetic forming, advantages and applications, Electro-hydraulic forming	2	4	1,2,3
Unit No. 5	Photolithography, Thin Film Deposition,	3	4	1,2,3
	Thermal Oxidation of Silicon	2	2,4	1,2,3
	Wet Etching, Silicon Anisotropic Etching	2	2,4	1,2,3
	Plasma Etching and Reactive Ion Etching	3	2,4	1,2,3

Learning Assessment

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

Recommended Resources

1. P. N. Rao, "Manufacturing Technology", Mc Grawhill, 2020.
2. V. K. Jain, "Advanced machining processes", Allied Publications, 2022.
3. A. Ghosh, and A. K. Mallik, "Manufacturing Science", East-West Press Pvt. Ltd, 2017

Course Designers

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

Multi-Physics Modelling and Analysis

Course Code	MCE 450	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the principles and applications of multi-physics modeling in manufacturing.
2. Develop skills in creating and interpreting multi-physics simulations.
3. Apply multi-physics analysis to real-world manufacturing problems.
4. Explore advanced topics and case studies in multi-physics modelling.

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 and apply the principles of multi-physics modeling to various manufacturing processes.	**1**	**80%**	**75%**
Outcome 2	Use simulation software for multi-physics analysis	**2**	**70%**	**65%**
Outcome 3	Analyze and optimize manufacturing processes through multi-physics simulations	**2**	**70%**	**65%**
Outcome 4	Understand the challenges and limitations of multi-physics modeling in practical applications	**3**	**80%**	**75%**

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Definition and Scope of Multi-Physics, Key Physical Phenomena in Manufacturing (Thermal, Structural, Fluid, Electromagnetic), Importance of Multi-Physics in Modern Manufacturing	2	1	1
	Governing Equations (Continuity, Navier-Stokes, Heat Transfer, Electromagnetism), Coupling Mechanisms between Different Physics, Boundary Conditions and Initial Conditions	2	1	1
	Finite Element Method (FEM), Computational Fluid Dynamics (CFD)	2	1	1
	Overview of Multi-Physics Simulation Software (ANSYS, COMSOL, Abaqus)	3	1	1
Unit No. 2	Heat Transfer Mechanisms (Conduction, Convection, Radiation) Thermal Stress and Deformation, Applications: Welding, Casting, Additive Manufacturing	2	1	1
	Stress-Strain Relationships, Elasticity, Plasticity, and Failure Analysis, Coupled Thermal-Structural Analysis	2	1,2	1,2,3
	Analysis of Residual Stresses in Welding, Heat Treatment Processes and Material Properties	2	1,2	1,2,3
	Thermomechanical Fatigue in Manufacturing Components	3	1,2	1,2,3
Unit No. 3	Basics of Fluid Flow (Laminar, Turbulent, Compressible, Incompressible), Fluid-Structure Interaction (FSI), Applications: Cooling Systems, Material Flow in Casting, Metal Forming	2	1,2	1,2,3
	Convective Heat Transfer, Cooling Techniques and Thermal Management, Coupled Fluid-Thermal Analysis	2	1,2	1,2,3
	CFD Simulation Techniques, Modeling of Heat Exchangers and Cooling Channels	2	1,2	1,2,3
	Case Study: Cooling Optimization in Injection Molding	3	1,2	1,2,3
Unit No. 4	Basics of Electromagnetic Fields, Induction Heating and Electromagnetic Forming, Electromagnetic Interference and Shielding	2	1,2,3,4	2,3
	Fundamentals of Acoustics and Vibration, Noise and Vibration Control in Manufacturing Equipment, Coupled Electromagnetic-Acoustic Analysis	2	1,2,3,4	1,2,3
	Non-Destructive Testing (NDT) using Electromagnetic Techniques Vibration Analysis in CNC Machining,	2	2,3	1,2,3
	Electromagnetic Compatibility in Manufacturing Environments	3	3,4	1,2,3
Unit No. 5	Multiscale Modeling and Simulation, Hybrid Simulation Approaches, Challenges in Multi-Physics Simulations	2	3,4	1,2,3
	Optimization Techniques in Multi-Physics Modeling, Design of Experiments (DOE) and Sensitivity Analysis, Case Studies in Process Optimization	3	3,4	1,2,3
	Machine Learning and AI in Multi-Physics Modeling	2	3,4	1,2,3
	Digital Twins and Virtual Prototyping, Course Review and Final Project Presentations	2	3,4	1,2,3

Learning Assessment

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

Recommended Resources

1. Jacob Fish, "Computational Methods for Multiphysics Models", Wiley, 2015
2. Rajesh R. Nair and R. R. Roy, "Multiphysics Modeling with Finite Element Methods", CRC Press, 2017
3. Paul A. Beckman and Mark F. M. Gordon, "Introduction to Computational Mechanics for Multiphysics Modeling", Springer, 2020.

Course Designers

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

Introduction to Additive Manufacturing

Course Code	MCE 451	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	0	3
Pre-Requisite Course(s)	CAD/CAM	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the basic principle and terminology of rapid prototyping
2. Understand the various techniques of the additive manufacturing
3. Understand the optimum part deposition technique in 3D printing
4. To understand the application of additive manufacturing in rapid tooling and reverse engineering

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Define the concept of additive manufacturing and file formats required by additive manufacturing.	1	80 %	75 %
Outcome 2	Understand the unique capabilities and various techniques of Additive Manufacturing.	2	70 %	75 %
Outcome 3	Develop and slice CAD model for printing with any kind of Additive Manufacturing technique.	3	80 %	70 %
Outcome 4	Apply the additive manufacturing in the application of rapid tooling and reverse engineering.	2	80 %	75 %

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

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction to layered manufacturing, Importance of Additive Manufacturing Additive Manufacturing in Product Development	2	1	1
	Classification of additive manufacturing processes	1	1	1,2
	Common additive manufacturing technologies; Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Stereolithography (SLA)	2	1	1,2
	Selection Laser Melting (SLM), Jetting, 3DPrinting, Laser Engineering Net Shaping (LENS)	1	1	1,2
	Laminated Object Manufacturing (LOM), Electron Beam Melting (EBM), Capabilities, materials, costs, advantages and limitations of different systems	2	1	1,2
Unit No. 2	Material science for additive manufacturing	1	1	1
	Mechanisms of material consolidation-FDM, SLS, SLM	1	1,2	1,2,3
	3D printing and jetting technologies. Polymer's coalescence and sintering, photo polymerization	2	1,2	1,2,3
	Solidification rates, Meso and macro structures, Process evaluation	2	1,2	1,2,3
	Process structure relationships, structure property relationships	2	1,2	1,2,3
Unit No. 3	Applications: Prototyping, Industrial tooling, Aerospace, Automotive, Medical etc.	2	3	3,4
	Quality control and reliability	1	3	3,4
	Defects in FDM, SLS and SLM	2	3	3,4,5
	Critical process parameters: geometry, temperature, composition, phase transformation	1	3	3,4,5
	Numerical and experimental evaluation: roles of process parameter combination	2	3	3,4,5
	Process optimization	1	3	3,4,5
Unit No. 4	CAD Modelling for 3D printing	1	3,4	3,4,5
	3D Scanning and digitization, data handling &reduction Methods	1	3,4	3,4,5
	AM Software: data formats and standardization	2	3,4	4,5
	Slicing algorithms: -uniform flat layer slicing, adaptive slicing	2	3,4	4,5
	Process-path generation: Process-path algorithms, rasterization	2	3,4	4,5
	Part Orientation and support generation	2	3,4	4,5
Unit No. 5	Lab: CAD Modeling: Introduction to CAD environment	3	3,4	4,5
	Sketching, Modeling and Editing features	2	3,4	4,5
	Different file formats, Export/Import geometries, Part orientation	3	3,4	4,5
	Layer slicing, Process path selection, Printing, Numerical and experimental evaluation	2	3,4	4,5

Learning Assessment

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

Recommended Resources

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
3. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2011.
4. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
5. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications

Course Designers