SRI VENKATESWARA COLLEGE OF ENGINEERING,

(An Autonomous Institution, Affiliated to Anna University, Chennai - 600025)

B.E. Automobile Engineering

CURRICULUM AND SYLLABUS

REGULATIONS 2022

CHOICE BASED CREDIT SYSTEM

Curriculum Revision No:	0	Board of Studies recommendation date:	06.10.2022 & 29.04.2024	Academic Council Approved date:	08.10.2022 & 09.05.2024
Salient Points of the revision	01.	The course "Biology for Engineers" is introduced in I Semester. It is very much important for engineering students to understand the problems related to biosystems. It is an emerging interdisciplinary field that focuses on the application of engineering principles for the analysis and solving problems of plant, animal, or microbiological with man-made machines, structures, processes, and instruments.			
	02.	The courses "Tamil Language and Heritage of Ancient Tamil Society" in Semester I and "Science and Technology in Ancient Tamil Society" in Semester II are introduced as per the recommendations of Anna University/Government of Tamil Nadu.			
	03.	The course "Computer Aided Engineering Drawing" is introduced in Semester I combining the subject "Engineering Drawing" and "Computer Aided Drafting Laboratory" of R2018 in view of making the students understand the basic concepts of Engineering Drawing effectively.			
	04.	The course "Computer Programming and Practice" is introduced in Semester II combining the subject "Programming for Problem Solving" and "Programming for Problem Solving Laboratory" of R2018 in view of making the students understand the basic concepts of Computer Programming effectively.			

	05.	The course "Production Processes" is shifted to Semester II from Semester III of R2018 and the course in Semester II "Applied Mechanics" of R2018 is shifted to Semester IV. This will help Lateral entry students to revisit Engineering Mechanics which is an important subject for Automobile students during the study of Vehicle Dynamics, Finite Element Analysis, Mechanics of Machines, etc.
	06.	The courses "Automotive Engines" and "Engine Performance and Emission Testing Laboratory" of R2018 are combined as "Automotive Engines: Theory and Practices" in view of making the students understand theoretical knowledge with hands-on experience for better understanding of complex concepts more clearly.
	07.	The courses "Automotive Fuels and Lubricants" and "Automotive Fuels and Lubricants Laboratory" of R2018 are combined as "Automotive Fuels and Lubricants: Theory and Practices" in view of making the students understand theoretical knowledge with hands-on experience for better understanding of testing of automotive fuels and lubricants more clearly.
	08.	The courses "Strength of Materials" and "Strength of Materials Laboratory" of R2018 are combined as "Mechanics of Solids: Theory and Practices" in view of making the students understand theoretical knowledge with hands-on experience for better understanding of testing of materials with different methods.
	09.	The courses "Vehicle Maintenance Laboratory I" and "Vehicle Maintenance Laboratory II" are introduced in place of the courses "Vehicle Maintenance" and "Vehicle Testing and Maintenance Laboratory" of R2018 in view of making the students to have more hands-on experience on vehicle maintenance.
	10.	The courses "Comprehension I" and "Comprehension II" are introduced in place of "Comprehension" of R2018 to refresh their fundamental knowledge in view of making the students face the recruitment interviews confidently.
	11.	The courses "Vehicle Dynamics" and "Vehicle Simulation Laboratory" of R2018 are combined as "Vehicle Dynamics: Theory and Practices" in view of making the students understand theoretical knowledge with hands-on experience for better understanding of complex concepts more clearly.
	12.	The courses "Electric Vehicle Laboratory I" and "Electric Vehicle Laboratory II" are introduced in view of making the

		students enhance their practical skills and industry readiness in electric vehicle technology.
	13.	The concept of Honours/Minor degree is introduced for the academic enhancements that allow students to gain deeper or broader knowledge in specific areas of interest.
	14.	The course "Essence of Indian Traditional Knowledge" is introduced as a Mandatory course to enrich the students' education and professional outlook.
	15.	The courses "Introduction to NCC for Engineers", "Yoga and Physical Culture" and "Introduction to Fine Arts" are introduced as General Engineering Courses.
	16.	The following courses are introduced as additional profession electives: • Option Trading Strategies • Automotive Sensors and Actuators • Autonomous and Connected Vehicles • Electric Two and Three Wheelers • Electric Vehicle Management Systems • Solar Energy Technology • Digital Manufacturing and Internet of Things • Failure Analysis and NDT Techniques • New Product Development • Novel Automotive Materials • Disaster Mitigation Management • Metrology and Measurement System

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CHOICE BASED CREDIT SYSTEM

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: To apply technical and professional skills in Automobile Engineering to meet the demanding and growing challenges of the industries.
PEO2: To apply professional and interpersonal skills by continuously focusing on learning towards higher education and research.
PE03: To direct learners to become successful entrepreneurs by inculcating professionalism, responsibility, and ethics.

PROGRAM OUTCOMES (POs)

PO	GRADUATE ATTRIBUTES

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

13. **PSO1**: Apply the concepts of theory of automotive powertrain and to design and develop the modern engines, transmission systems and alternative propulsion systems.
14. **PSO2**: Apply the concepts of various subsystems to design and analyze the performance of brakes, suspension, steering and electrical/electronic components.

PEOs-POs & PSOs MAPPING:

POs & PSOs	PEOs		
	I	II	III
PO1	3	2	1
PO2	3	3	1
PO3	3	2	2
PO4	3	3	1
PO5	3	2	1
PO6	2	2	3
PO7	2	2	3
PO8	2	1	3
PO9	2	2	3
PO10	2	2	3
PO11	3	2	2
PO12	2	3	2
PSO1	3	3	3
PSO2	3	3	2

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

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CHOICE BASED CREDIT SYSTEM

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIOD SPER WEEK				Total Periods	Prerequisite	Position
				L	T	P	C			
1	IP22151	Induction Programme (Common to all Branches)		--	--	--	--		NA	F
THEORY										
2	HS22151	Tamil Language and Heritage of Ancient Tamil Society (Common to all Branches)	HS	1	0	0	1	1	Nil	F
3	HS22152	Communicative English (Common to all Branches)	HS	3	0	0	3	3	Nil	F
4	MA22151	Applied Mathematics I (Common to all Branches except MR)	BS	3	1	0	4	4	Nil	F
5	PH22152	Engineering Physics (Common to AE, AM, CE, ME, MN, MR)	BS	3	0	0	3	3	Nil	F
6	CY22152	Engineering Chemistry (Common to AE, AM, ME, MN)	BS	3	0	0	3	3	Nil	F
7	BT22101	Biology for Engineers (Common to BT, AE, IT)	BS	3	0	0	3	3	Nil	F
8	AE22101	Computer Aided Engineering Drawing	ES	3	0	2	4	5	Nil	F
PRACTICAL										
9	CY22161	Chemistry Laboratory (Common to all Branches except AD, CS, IT)	BS	0	0	2	1	2	Nil	F
10	ME22162	Basic Mechanical Engineering Laboratory (Common to AE, AM, BT, CH)	ES	0	0	2	1	2	Nil	F
			Total	**19**	**1**	**6**	**23**	**26**		

(Recommended by BoS on 06.10.2022 and Approved by Academic Council on 08.10.2022)

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods	Prerequisite	Position
				L	T	P	C			
THEORY										
1	HS22251	Science and Technology in Ancient Tamil Society (Common to all Branches)	HS	2	0	0	2	2	Nil	F
2	HS22252	Technical English (Common to all Branches)	HS	3	0	0	3	3	Nil	F
3	MA22251	Applied Mathematics II (Common to all Branches except MR)	BS	3	1	0	4	4	MA22151	F
4	PH22253	Engineering Materials (Common to AE, AM, ME, MN)	BS	3	0	0	3	3	Nil	F
5	EE22151	Basic Electrical and Electronics Engineering (Common to all Branches except CH, EE, EC)	ES	3	0	0	3	3	Nil	F
6	AE22201	Production Processes	ES	3	0	0	3	3	Nil	F
7	IT22251	Computer Programming and Practice (Common to AE, AM, BT, CE, CH)	ES	2	0	2	3	4	Nil	F
PRACTICAL										
8	PH22161	Physics Laboratory (Common to all Branches except BT)	BS	0	0	2	1	2	Nil	F
9	EE22111	Basic Electrical and Electronics Engineering Laboratory (Common to all Branches except EC)	ES	0	0	2	1	2	Nil	F
			Total	**19**	**1**	**6**	**23**	**26**		

(Recommended by BoS on 06.10.2022 and Approved by Academic Council on 08.10.2022)

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods	Prerequisite	Position
				L	T	P	C			
THEORY										
1	AE22301	Basic and Applied Thermodynamics (Common to AE, AM)	ES	3	1	0	4	4	Nil	F
2	AE22302	Fluid Mechanics and Hydraulic Machines (Common to AE, AM)	ES	3	0	0	3	3	Nil	F
3	AE22303	Manufacturing Technology and Systems (Common to AE, AM)	PC	3	0	0	3	3	Nil	F
4	MA22355	Partial Differential Equations and Numerical Methods (Common to AE, AM, BT, MN)	BS	3	1	0	4	4	Nil	F
5	AE22308	Automotive Fuels and Lubricants: Theory and Practices	PC	3	0	2	4	5	Nil	F
6	AE22309	Automotive Engines: Theory and Practices	PC	3	0	2	4	5	Nil	F
PRACTICAL										
7	AE22311	Fluid Mechanics and HydraulicMachines Laboratory (Common to AE, AM)	ES	0	0	2	1	2	Nil	F
8	AE22312	Production Technology Laboratory	PC	0	0	2	1	2	Nil	F
			Total	**18**	**2**	**8**	**24**	**28**		

(Recommended by BoS – Meeting held on 12.04.2023 and Approved by Academic Council on 21.04.2023)

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods	Prerequisite	Position
				L	T	P	C			
THEORY										
1	AE22401	Applied Mechanics	ES	3	1	0	4	4	Nil	F
2	AE22402	Automotive Electrical, Electronics and Microcontroller Systems (Common to AE, AM)	PC	3	0	0	3	3	Nil	F
3	AE22403	Thermal Engineering and Heat Transfer (Common to AE, AM)	ES	3	1	0	4	4	AE22301	F
4	AE22408	Automotive Chassis Components: Theory and Practices (Common to AE, AM)	PC	3	0	2	4	5	Nil	F
5	AE22409	Mechanics of Solids: Theory and Practices (Common to AE, AM)	ES	3	0	2	4	5	Nil	F
6	GE22451	Environmental Sciences and Sustainability (Common to All Branches)	BS	3	0	0	3	3	Nil	F
PRACTICAL										
7	AE22411	Automotive Electrical, Electronics and Microcontroller Laboratory (Common to AE, AM)	PC	0	0	3	1.5	3	Nil	F
8	AE22412	Vehicle Maintenance Laboratory I	ES	0	0	3	1.5	3	Nil	F
			Total	**18**	**2**	**10**	**25**	**30**		

(Recommended by BoS - Meeting held on 12.04.2023 and Approved by Academic Council on 21.04.2023)

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods	Prerequisite	Position
				L	T	P	C			
THEORY										
1	AE22501	Automotive Transmission	PC	3	0	0	3	3	Nil	F
2	AE22502	Design of Machine Elements and Transmission Systems (Common to AE, AM)	PC	3	0	0	3	3	AE22401, AE22409	F
3	AE22503	Human Relations, Values and Ethics (Common to AE, AM)	BS	2	0	0	2	2	Nil	M
4	AE22504	Mechanics of Machines	PC	3	1	0	4	4	AE22401	F
5		Professional Elective I	PE	3	0	0	3	3	Nil	M
6		Professional Elective II	PE	3	0	0	3	3	Nil	M
7		Open Elective I	OE	3	0	0	3	3	Nil	M
PRACTICAL										
8	AE22511	CAD/CAM Laboratory	PC	0	0	3	1.5	3	Nil	F
9	AE22512	Vehicle Maintenance Laboratory II	PC	0	0	3	1.5	3	Nil	F
10	AE22513	Industrial Training / Internship	EEC	-	-	-	2*	-	Nil	M
			Total	**20**	**1**	**6**	**24**	**27**		

(Recommended by BoS - Meeting held on 29.04.2024 and Approved by Academic Council on 09.05.2024)

* The credit for the course is over and above the total credits to earn degree

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods	Prerequisite	Position
				L	T	P	C			
THEORY										
1	AE22601	Automotive Components Design	PC	3	1	0	4	4	AE22502	F
2	AE22602	Hybrid and Electric Vehicles (Common to AE, AM, ME, MN)	PC	3	0	0	3	3	Nil	F
3		Professional Elective III	PE	3	0	0	3	3	Nil	M
4		Professional Elective IV	PE	3	0	0	3	3	Nil	M
5		Professional Elective V	PE	3	0	0	3	3	Nil	M
6		Open Elective II	OE	3	0	0	3	3	Nil	M
PRACTICAL										
7	AE22611	Comprehension I	EEC	0	0	2	1	2	Nil	F
8	AE22612	Electric Vehicle Laboratory I	PC	0	0	2	1	2	Nil	F
9	HS22511	Interview and Career Skills Laboratory (Common to all branches except CE)	EEC	0	0	3	2	3	Nil	F
10	AE22613	Simulation of Engine and Chassis Components Laboratory (Common to AE, AM)	PC	0	0	2	1	2	Nil	F
			Total	**18**	**1**	**9**	**24**	**28**		

(Recommended by BoS - Meeting held on 29.04.2024 and Approved by Academic Council on 09.05.2024)

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods	Prerequisite	Position
				L	T	P	C			
THEORY										
1	AE22701	Artificial Intelligence for Automotive Applications (Common to AE, AM)	PC	3	0	0	3	3	Nil	M
2	AE22702	Mobility Engineering Management (Common to AE, AM)	PC	3	0	0	3	3	Nil	M
3	AE22703	Vehicle Dynamics: Theory and Practices (Common to AE, AM)	PC	3	0	2	4	5	AE22401	M
4		Mandatory Course	MC	3	0	0	0	3	Nil	M
5		Professional Elective VI	PE	3	0	0	3	3	Nil	M
PRACTICAL										
6	AE22711	Comprehension II	EEC	0	0	2	1	2	Nil	F
7	AE22712	Electric Vehicle Laboratory II	PC	0	0	2	1	2	Nil	F
			Total	**15**	**0**	**6**	**15**	**21**		

(Recommended by BoS - Meeting held on 29.04.2024 and Approved by Academic Council on 09.05.2024)

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods	Prerequisite	Position
				L	T	P	C			
PRACTICAL										
1	AE22811	Project Work	EEC	0	0	20	10	10	Nil	F
			Total	**0**	**0**	**20**	**10**	**20**		

(Recommended by BoS - Meeting held on 29.04.2024 and Approved by Academic Council on 09.05.2024)

SUMMARY

SL. NO.	CATEGORY	CREDITS IN SEMESTER								Total Credits	%
		I	II	III	IV	V	VI	VII	VIII		
1	Humanities and Social Sciences including Management courses (HS)	4	5							9	**5.4**
2	Basic Science courses (BS)	14	8	4	3	2				31	**18.5**
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc. (ES)	5	10	8	13.5					36.5	**21.7**
4	Professional Core courses (PC)			12	8.5	13	9	11		53.5	**31.8**
5	Professional Elective courses relevant to chosen specialization/branch (PE)					6	9	3		18	**10.7**
6	Open subjects - Electives from other technical and /or emerging subjects (OE)					3	3			6	**3.6**
7	Project work, seminar and internship in industry or elsewhere (EEC)						3	1	10	14	**8.3**
8	Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Knowledge Tradition] (MC)							0		0	**0**
Total		**23**	**23**	**24**	**25**	**24**	**24**	**15**	**10**	**168**	

LIST OF VERTICALS

Vertical I	Vertical II	Vertical III	Vertical IV	Vertical V	Vertical VI
Special Elective Group	**Electric Vehicles**	**Vehicle Research**	**Materials and Manufacturing**	**Diversified Group 1**	**Diversified Group 2**
Financial Statement Analysis	Automotive Safety and Ergonomics	Advanced Theory of IC Engines	Additive Manufacturing	Automotive Aerodynamics	Automotive Air Conditioning
Introduction to Securities Market	Automotive Sensors and Actuators	Alternative Fuels	Digital Manufacturing and Internet of Things	Automotive Automation	Computational Fluid Dynamics
Option Trading Strategies	Autonomous and Connected Vehicles	Automotive Control Systems for Driveline	Failure Analysis and NDT Techniques	Disaster Mitigation Management	Industrial Robotics
Corporate Finance	Battery and Fuel Cell Technology for Electric Vehicles	Automotive Noise, Vibration and Harshness	Finite Element Analysis for Automobile Engineers	Embedded Systems for Automotive Applications	Off Highway Vehicles
Managerial Economics	Electric Two and Three Wheelers	Automotive Pollution and Control	Fundamentals of Nano Science and Technology	Hydraulics and Pneumatics Systems	Principles of Management
Project Management	Electric Vehicle Management Systems / Hybrid and Electric Vehicles*	Design of Experiments	Manufacturing of Automotive Components	Metrology and Measurement System	Simulation of IC Engines
Mathematics for AI & ML	Motors and Controls for Hybrid and Electric Vehicles	Engine and Vehicle Management Systems	New Product Development	Operations Research	Vehicle Design Data characteristics
	Solar Energy Technology	Vehicle Body Engineering	Novel Automotive Materials	Total Quality Management	Virtual Instrumentation in Automobile Engineering
	Mini Project	Mini Project	Mini Project		

* Only for Minor Degree

PROFESSIONAL ELECTIVES

VERTICAL I SPECIAL ELECTIVE GROUP**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods
				L	T	P	C	
1	SE22001	Financial Statement Analysis (Common to All branches)	PE	3	0	0	3	3
2	SE22002	Introduction to Securities Market (Common to All branches)	PE	3	0	0	3	3
3	SE22003	Option Trading Strategies (Common to All branches)	PE	3	0	0	3	3
4	SE22004	Corporate Finance (Common to All branches)	PE	3	0	0	3	3
5	SE22005	Managerial Economics (Common to All branches)	PE	3	0	0	3	3
6	SE22006	Project Management (Common to All branches)	PE	3	0	0	3	3
7	SE22007	Mathematics for AI & ML (Common to All branches)	PE	3	0	0	3	3

** Refer the common curriculum and syllabus for the course content

VERTICAL II ELECTRIC VEHICLES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods
				L	T	P	C	
1	AE22021	Automotive Safety and Ergonomics	PE	3	0	0	3	3
2	AE22022	Automotive Sensors and Actuators	PE	3	0	0	3	3
3	AE22023	Autonomous and Connected Vehicles	PE	3	0	0	3	3
4	AE22024	Battery and Fuel Cell Technology for Electric Vehicles	PE	3	0	0	3	3
5	AE22025	Electric Two and Three Wheelers	PE	3	0	0	3	3
6	AE22602	Hybrid and Electric Vehicles	PE	3	0	0	3	3
7	AE22026	Electric Vehicle Management Systems	PE	3	0	0	3	3
8	AE22027	Motors and Controls for Hybrid and Electric Vehicles	PE	3	0	0	3	3
9	AE22028	Solar Energy Technology	PE	3	0	0	3	3
10	AE22020	Mini Project		0	0	4	2	4

VERTICAL III VEHICLE RESEARCH

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods
				L	T	P	C	
1	AE22031	Advanced Theory of IC Engines	PE	3	0	0	3	3
2	AE22032	Alternative Fuels	PE	3	0	0	3	3
3	AE22033	Automotive Control Systems for Driveline	PE	3	0	0	3	3
4	AE22034	Automotive Noise, Vibration and Harshness	PE	3	0	0	3	3
5	AE22035	Automotive Pollution and Control	PE	3	0	0	3	3
6	AE22036	Design of Experiments	PE	3	0	0	3	3
7	AE22037	Engine and Vehicle Management Systems	PE	3	0	0	3	3
8	AE22038	Vehicle Body Engineering	PE	3	0	0	3	3
9	AE22030	Mini Project		0	0	4	2	4

VERTICAL IV MATERIALS AND MANUFACTURING

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods
				L	T	P	C	
1	AE22041	Additive Manufacturing	PE	3	0	0	3	3
2	ME22031	Digital Manufacturing and Internet of Things	PE	3	0	0	3	3
3	AE22042	Failure Analysis and NDT Techniques	PE	3	0	0	3	3
4	AE22043	Finite Element Analysis for Automobile Engineers	PE	3	0	0	3	3
5	AE22044	Fundamentals of Nano Science and Technology	PE	3	0	0	3	3
6	AE22045	Manufacturing of Automotive Components	PE	3	0	0	3	3
7	AE22046	New Product Development	PE	3	0	0	3	3
8	AE22047	Novel Automotive Materials	PE	3	0	0	3	3
9	AE22040	Mini Project		0	0	4	2	4

VERTICAL V DIVERSIFIED GROUP 1

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods
				L	T	P	C	
1	AE22051	Automotive Aerodynamics	PE	3	0	0	3	3
2	AE22052	Automotive Automation	PE	3	0	0	3	3
3	CH22053	Disaster Mitigation Management	PE	3	0	0	3	3
4	AE22053	Embedded Systems for Automotive Applications	PE	3	0	0	3	3
5	AE22054	Hydraulics and Pneumatics Systems	PE	3	0	0	3	3
6	AE22055	Metrology and Measurement System	PE	3	0	0	3	3
7	AE22056	Operations Research	PE	3	0	0	3	3
8	AE22057	Total Quality Management	PE	3	0	0	3	3

VERTICAL VI DIVERSIFIED GROUP 2

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods
				L	T	P	C	
1	AE22061	Automotive Air Conditioning	PE	3	0	0	3	3
2	MN22071	Computational Fluid Dynamics: Theory and Practices	PE	2	0	2	3	4
3	AE22062	Industrial Robotics	PE	3	0	0	3	3
4	AE22063	Off Highway Vehicles	PE	3	0	0	3	3
5	ME22087	Principles of Management (Common to ME, AE, EE, IT and MN)	PE	3	0	0	3	3
6	AE22064	Simulation of IC Engines	PE	3	0	0	3	3
7	AE22065	Vehicle Design Data Characteristics	PE	3	0	0	3	3
8	AE22066	Virtual Instrumentation in Automobile Engineering	PE	3	0	0	3	3

OPEN ELECTIVES OFFERED

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods
				L	T	P	C	
1	OE22101	Automotive Fault Diagnostics	OE	3	0	0	3	3
2	OE22102	Fundamentals of Automobile Engineering	OE	3	0	0	3	3
3	OE22103	Fundamentals of Automotive Air Conditioning	OE	3	0	0	3	3
4	OE22104	Fundamentals of Automotive Pollution and Control Methods	OE	3	0	0	3	3

VALUE ADDED COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods
				L	T	P	C	
1	VD22101	Basics of ML Algorithms for Automotive Industries	VAD	1	0	2	2	3
2	VD22102	Big Data Analytics	VAD	1	0	2	2	3
3	VD22103	Hands on Programming with R	VAD	1	0	2	2	3
4	VD22104	Introduction to Internet of Things and Cloud Computing for Automobile Engineers	VAD	1	0	2	2	3
5	VD22105	Object Oriented Programming Concepts	VAD	1	0	2	2	3
6	VD22106	Recommender Systems for Automotive Industries	VAD	1	0	2	2	3
7	VD22107	Statistics for Engineers	VAD	2	0	0	2	2
COMMON**								
8	VC22001	Basics of Entrepreneurship Development (Common to all branches)	VAC	2	0	0	2	2
9	VC22002	Advances in Entrepreneurship Development (Common to all branches)	VAC	2	0	0	2	2
10	VC22003	Communicative German (Common to all branches)	VAC	2	0	0	2	2
11	VC22004	Communicative Hindi (Common to all branches)	VAC	2	0	0	2	2

12	VC22005	Communicative Japanese (Common to all branches)	VAC	2	0	0	2	2
13	VC22006	Design Thinking and Prototyping Laboratory (Common to all branches)	VAC	0	0	4	2	4

** Refer the common curriculum and syllabus for the course content

MANDATORY COURSES**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods
				L	T	P	C	
1	MC22001	Indian Constitution (Common to all branches)	MC	3	0	0	0	3
2	MC22002	Essence of Indian Traditional Knowledge (Common to all branches)	MC	3	0	0	0	3
3	MC22003	Gender Sensitization (Common to all branches)	MC	3	0	0	0	3

** Refer the common curriculum and syllabus for the course content

GENERAL ENGINEERING COURSES**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				Total Periods
				L	T	P	C	
1	GN22001	Introduction to NCC for Engineers (Common to all branches)	GE	2	0	2	0	4
2	GN22002	Yoga and Physical Culture (Common to all branches)	GE	0	0	2	0	2
3	GN22003	Introduction to Fine Arts (Common to all branches)	GE	2	0	0	0	2

** Refer the common curriculum and syllabus for the course content

HS22151	தமிழ் மொழியும் தமிழர் மரபும் **Tamil Language and Heritage of Ancient Tamil Society** (Common to all Branches)	L	T	P	C
		1	0	0	1

பாடத்தின்நோக்கங்கள்:

1. தமிழ் மொழியின் தோற்றம் பற்றியும், திணை கருத்துக்கள் வாயிலாக வாழ்வியல் முறைகளை பற்றியும் கற்றுக் கொள்வார்கள்.
2. இந்திய தேசிய சுதந்திர இயக்கத்தில் தமிழர்களின் பங்களிப்பு மற்றும் தமிழர்களின் மேலாண்மை முறைகளை பற்றியும் கற்றுக் கொள்வார்கள்.

அலகு I தமிழுக்கும் தொழில்நுட்ப கல்விக்கும் உள்ள தொடர்பு 3

மொழி மற்றும் பாரம்பரியம்:: இந்தியாவில் உள்ள மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழில் செம்மொழி இலக்கியம் - உ.வே. சுவாமிநாத ஐயர்., ஆறுமுக நாவலர் ஆகியோரின் பங்களிப்பு - தொழில் நுட்ப கல்வியில் தமிழ், மொழிக் கல்வியின் முக்கியத்துவம்.

LANGUAGE AND HERITAGE: Language families in India – Dravidian Languages – Tamil as a Classical language – Classical Literature in Tamil – Contribution of U. Ve. Saminathaiyar, Arumuka Navalar – Importance of Tamil language in technical education.

அலகு II திணை கருத்துக்கள் 9

திணை கருத்துக்கள் : - ஐந்து வகை நிலங்கள், தமிழர்களின் தாவரங்கள் மற்றும் விலங்கினங்கள், கடவுள்கள், தொழில்கள், வாழ்க்கை முறை, பண், கூத்து, உணவு முறை - தொல்காப்பியம் மற்றும் சங்க இலக்கியங்களில் இருந்து அகம் மற்றும் புறம் கருத்து - தமிழ் அறம் கருத்து - சங்க காலத்தில் கல்வி மற்றும் எழுத்தறிவு - பண்டைய நகரங்கள் மற்றும் சங்க காலத்தில் துறைமுகங்கள் - சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - சோழ மன்னர்களின் வெளிநாட்டு வெற்றிகள்.

Thinai Concepts : - Five types of lands, animals, Gods, occupation, life styles, music, dance, food style, Flora and Fauna of Tamils - Agam and puram concept from Tholkappiyam and Sangam Literature – Aram concept of Tamil – Education and Literacy during Sangam Age – Ancient cities and Ports of Sangam Age – Export and Import during Sangam Age - Overseas Conquest of Cholas.

அலகு III தமிழரின் மரபு 3

இந்திய தேசிய சுதந்திர இயக்கம் மற்றும் இந்திய கலாச்சாரத்திற்கு தமிழர்களின் பங்களிப்பு:- சுப்ரமணிய பாரதி, வாஞ்சிநாதன், சுப்பிரமணிய சிவா, வீரபாண்டிய கட்டபொம்மன், வ. உ. சிதம்பரம் பிள்ளை, தீரன் சின்னமலை, மருது பாண்டிய சகோதரர்கள், பூலித் தேவர், திருப்பூர் குமரன், வீர மங்கை வேலுநாச்சியார், தமிழர் இலக்கியங்களில் மேலாண்மை கருத்துக்கள் (கி. மு. 500 முதல் கி. பி 200 வரை) - அகநானூறு, புறநானூறு, திருக்குறள் ஆகியவற்றில் மேலாண்மைக் கருத்துகள்.

Contribution of Tamils to Indian National Freedom Movement and Indian Culture : Contributions of Subramanya Bharathi, Vanchinathan, Subramaniya Siva, Veerapandiya Kattabomman, V. O. Chidambaram Pillai, Dheeran Chinnamalai, The Maruthu Pandiyar, Puli Thevar, Tiruppur Kumaran, Veera Mangai Velunachiyar.

TOTAL: 15 PERIODS

பாடநெறிமுடிவுகள்:

பாடத்திட்டத்தின் வெளிப்பாடு		RBT LEVEL
CO1	மாணவர்கள் தமிழ் மொழி தோற்றம் பற்றி தெரிந்து கொள்வார்கள்.	**1**
CO2	தமிழர்களின் வாழ்வியல் முறைகளை தெரிந்து கொள்வார்கள்.	**2**
CO3	தமிழர்களின் சுதந்திர போராட்ட வீரர்களை பற்றியும், மேலாண்மை முறைகளை பற்றியும் தெரிந்து கொள்வார்கள்.	**2**

பாடநூல்கள்:

1. பொன். முத்துகுமாரன் (2002), **"தமிழ் மரபு",** காந்தளகம், 68, அண்ணா சாலை, சென்னை 600 002.
2. பி. டி ஸ்ரீனிவாச ஐயங்கார் (**தமிழக்கமும் திறனாய்வும்**) புலவர் கா. கோவிந்தன் (1988), "**தமிழர் வரலாறு (முதல் பகுதி**", திருநெல்வேலி தென்னிந்திய சைவ சித்தாந்த நூற்பதிப்பு கழகம்,154, TTK சாலை, சென்னை 18.
3. டாக்டர் கே கே பிள்ளை (2009), "**தமிழக வரலாறு மக்களும் பண்பாடும்**", உலக தமிழாராய்ச்சி நிறுவனம், தரமணி , சென்னை 600113
4. முனைவர். ச. இராஜேந்திரன் (2004), "தமிழில்சொல்லாக்கம்", தஞ்சாவூர் தமிழ் பல்கலைக் கழகம்வெளியீடு.

COURSE ARTICULATION MATRIX

COs													PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO1			3		3	3	2		3	3		2		
CO2			3	2	3	3		1	3	3				
CO3			3	2	3	3	2		3	3		2		
Average			**3**	**2**	**3**	**3**	**2**	**1**	**3**	**3**		**2**		

HS22152	COMMUNICATIVE ENGLISH (Common to all Branches)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Enable learners to interact fluently on everyday social contexts.
2. Train learners to engage in conversations in an academic/scholarly setting.
3. Instil confidence in learners to overcome public speaking barriers.
4. Develop learners' ability to take notes and in the process, improve their listening skills.
5. Enhance learners' reading skill through reading text passages for comprehension and contemplation.
6. Improve learners' skill to write on topics of general interest and drafting correspondences for general purposes.

UNIT I **9**

Listening - short video clips - conversational scenes from movies, celebrities' speeches/interviews. **Speaking** - several ways of introducing oneself at several situations, introducing others at several situations, inviting people for several occasions, describing people and their places. **Reading** - short comprehension passages - making inferences, critical analysis. **Writing** - completing the incomplete sentences - developing hints from the given information. Grammar - Wh-Questions and Yes or No questions - Parts of speech. Vocabulary development - prefixes - suffixes - articles - countable / uncountable nouns.

UNIT II **9**

Listening - customer care voice files, short narratives - identifying problems and developing telephone etiquettes. **Speaking** - speaking over skype/whatsapp, making business calls, making self-recorded informative videos, inquiring about a concept/activity, describing a concept/activity. **Reading** - reading the headlines on news magazines - slogans and taglines from advertisements. **Writing** - free writing - writing - headlines, slogans and taglines individual inspirations. Grammar - conjunctions, idioms, phrases, quotes. Vocabulary development - guessing the meanings of words in different contexts.

UNIT III **9**

Listening - courtroom scenes from movies, debates and talks from news channels, notes taking. **Speaking** - language and tone for arguments, discussion, deliberation, contemplation, expressing opinions, reacting to different situations in an alien country. **Reading** - language used in instruction manuals of household appliances, cookery and other basic instructions. **Writing** - understanding the structure of texts - use of reference words, discourse markers-coherence, rearranging the jumbled sentences. Grammar - adjectives - degrees of comparison, framing direct and indirect questions. Vocabulary development - concise approach, single word substitution.

UNIT IV **9**

Listening - Sports commentaries, advertisements with users' criticisms; **Speaking** - for social causes, for promoting a concept, negotiating and bargaining; **Reading** - review of a product, movie, movement or a system; **Writing** - writing for advertisements, selling a product; Grammar - Tenses - Simple Past, Present and Future, Continuous - Past, Present and Future; Vocabulary Development - synonyms, antonyms and phrasal verbs.

UNIT V **9**

Listening - video lectures, video demonstration of a concept; **Speaking** - presenting papers/concepts, delivering short speeches, discourses on health, suggesting natural home remedies, cleanliness, civic sense and responsibilities; **Reading** - columns and articles on home science; **Writing** - correspondences of requests, basic enquiry/observation and basic complaints; Grammar - modal verbs, perfect tenses - Vocabulary development - collocations.

TOTAL: 45 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
Upon successful completion of the course, the students should be able to:		
CO1	Acquire adequate vocabulary for effective communication.	**3**
CO2	Listen to formal and informal communication and read articles and infer meanings from specific contexts from magazines and news papers.	**3**
CO3	Participate effectively in informal/casual conversations; introduce themselves and their friends and express opinions in English.	**4**
CO4	Comprehend conversations and short talks delivered in English.	**6**
CO5	Write short write-ups and personal letters and emails in English.	**6**

REFERENCES:

1. Department of English, Anna University, "Mindscapes: English for Technologists and Engineers". Orient Black Swan, Chennai, 2017.
2. Downes, Colm, "Cambridge English for Job-hunting", Cambridge University Press, New Delhi. 2008.
3. Murphy, Raymond, "Intermediate English Grammar with Answers", Cambridge University Press 2000.
4. Thomson, A.J., "Practical English Grammar 1 & 2", Oxford, 1986.

Web Link:

1. http://www.usingenglish.com
2. http://www.uefap.com3
3. https://owl.english.purdue.edu/owl/
4. www.learnenglishfeelgood.com/esl-printables-worksheets.html

Software

1. CAMBRIDGE Preparation for the TOEFL TEST - Cambridge University Press, 2017.
2. English Advance Vocabulary - Cambridge University Press.
3. Face2Face Advance - Cambridge University Press, 2014.
4. IELTS test preparation - Cambridge University Press 2017.
5. Official Guide to the TOEFL Test With CD-ROM, 4th Edition.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.										3				
2.										3				
3.										3				
4.										3				
5										3				
Average										**3**				

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

MA22151 **APPLIED MATHEMATICS I**

L	T	P	C
3	1	0	4

(Common to all Branches except MR)

COURSE OBJECTIVES:

The student should be made to:

1. Compute Eigen values and Eigen vectors and use in diagonalization and in classifying real quadratic forms.
2. Study differential calculus and its applications to relevant Engineering problems.
3. Compute derivatives using the chain rule or total differentials.
4. Understand the rotation of two dimensional geometry using definite integrals.
5. Acquaint with the Mathematical tools needed in evaluating multiple integrals and their usage.

UNIT I MATRICES (9+3)

Eigen values and Eigen vectors of a real matrix - Characteristic equation - Properties of Eigen values and Eigen vectors - Statement and Applications of Cayley-Hamilton Theorem - Diagonalization of matrices - Reduction of a quadratic form into canonical form by orthogonal transformation - Nature of quadratic forms.

UNIT II APPLICATION OF DIFFERENTIAL CALCULUS (9+3)

Curvature and radius of Curvature - Centre curvature - Circle of curvature - Evolutes - Envelopes - Evolute as Envelope of Normals.

UNIT III DIFFERENTIAL CALCULUS FOR SEVERAL VARIABLES (9+3)

Limits and Continuity - Partial derivatives - Total derivatives - Differentiation of implicit functions - Jacobians and properties - Taylor's series for functions of two variables - Maxima and Minima of functions of two variables - Lagrange's method of undetermined multipliers.

UNIT IV APPLICATION OF DEFINITE INTEGRALS (9+3)

Integration by Parts - Bernoulli's formula for integration - Definite integrals and its Properties - Solids of Revolution - Disk Method - Washer Method - Rotation about both x and y axis and Shell method.

UNIT V MULTIPLE INTEGRALS (9+3)

Double integrals in Cartesian and polar coordinates - Change of order of integration - Area enclosed by plane curves - Change of variables in double integrals - Triple integrals - Volume of solids.

TOTAL(L:45+T:15): 60 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
Upon completion of the course, students will be able to:		
CO1	Solve the Eigen value problems in matrices.	**3**
CO2	Apply the basic notion of calculus in Engineering problems and to tackle for different geometries.	**3**
CO3	Perform calculus for more than one variable and its applications in Engineering problems.	**3**
CO4	Apply definite integrals for design of three dimensional components.	**3**
CO5	Evaluate multiple integral in Cartesian and polar coordinates.	**3**

TEXTBOOKS:

1. Erwin Kreyszing, Herbert Kreyszing, Edward Norminton, "Advanced Engineering Mathematics", 10th Edition, John Wiley, 2015.
2. Grewal. B.S, Grewal. J.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, Delhi, 2015.

REFERENCES:

1. Bali. N.P, and Manish Goyal, "A Text book of Engineering Mathematics", Ninth Edition, Laxmi Publications Pvt. Ltd., 2014.
2. Glyn James, "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, 2016.
3. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2013.

Web Link:

1. https://home.iitk.ac.in/~peeyush/102A/Lecture-notes.pdf
2. https://www.sydney.edu.au/content/dam/students/documents/mathematics-learning-entre/integration-definite-integral.pdf

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	3	3								3	2	
2.	3	3										3		
3.	3	3	3	3								3	2	
4.	3	3										3	1	
5.	3	3	2	2								3	1	
Average	**3**	**3**	**2.67**	**2.67**								**3**	**1.5**	

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

PH22152	ENGINEERING PHYSICS	L	T	P	C
		3	0	0	3

(Common to AE, AM, CE, ME, MN, MR)

COURSE OBJECTIVES:

1. To enhance the fundamental knowledge in Physics and its applications relevant to various Streams of Engineering.

UNIT I MECHANICS 9

Moment of inertia (M.I) - Radius of gyration - Theorems of M. I - M.I of circular disc, solid cylinder, hollow cylinder, solid sphere and hollow sphere - K.E of a rotating body - M.I of a diatomic molecule - Rotational energy state of a rigid diatomic molecule - centre of mass - conservation of linear momentum - Relation between Torque and angular momentum - Torsional pendulum.

UNIT II PROPERTIES OF MATTER AND THERMAL PHYSICS 9

Fluid - definition, distinction between solid and fluid - Units and dimensions - Properties of fluids - density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, capillarity and surface tension - Fluid statics: concept of fluid static pressure, absolute and gauge pressures - pressure measurements by manometers - forces on planes - centre of pressure - buoyancy and floatation.

Modes of heat transfer - thermal conductivity - Newton's law of cooling - Linear heat flow - Lee's disc method - Radial heat flow - Rubber tube method - conduction through compound media (series and parallel).

UNIT III ACOUSTICS AND ULTRASONICS 9

Classification of Sound - decibel - Weber-Fechner law - Sabine's formula - derivation using growth and decay method - Absorption Coefficient and its determination - factors affecting Acoustics of buildings and their remedies. Production of Ultrasonics by Magnetostriction and Piezoelectric methods - Acoustic grating - Non-Destructive Testing - pulse echo system through transmission and reflection modes - A, B and C - scan displays, medical applications - Sonogram.

UNIT IV PHOTONICS AND FIBER OPTICS 9

Photonics: population of energy levels, Einstein's A and B coefficients derivation - resonant cavity, optical amplification (qualitative) - Nd-YAG laser - $C0_2$ Laser - Applications.

Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibers (material, refractive index, and mode) - losses associated with optical fibers - Fiber optic communication - fiber optic sensors: pressure and displacement - Endoscope.

UNIT V CRYSTAL PHYSICS 9

Single crystalline, polycrystalline and amorphous materials - single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices - interplanar

distances - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structure (qualitative) - crystal imperfections: point defects, line defects - Burger vectors, stacking faults.

TOTAL: 45 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
CO1	Gain knowledge in Mechanics.	**2**
CO2	Evaluate the concepts of properties of matter and thermal physics.	**3**
CO3	Learn to solve the issues related to defects in the buildings due to acoustic design and the significance of ultrasonic waves.	**3**
CO4	Develop an understanding about photonics and Fiber Optic communication system.	**2**
CO5	Classify and demonstrate the fundamentals of crystals and their defects.	**3**

TEXTBOOKS:

1. Arumugam M, "Materials Science", Anuradha Publications, 2015.
2. Gaur R.K. and Gupta S.L, "Engineering Physics", Dhanput Publications, 2015.
3. Rajendran V, "Engineering Physics", Tata McGraw Hill, 2009.
4. Shatendra Sharma and Jyotsna Sharma, "Engineering Physics", Pearson, 2006.

REFERENCES:

1. Arthur Beiser, Shobhit Mahajan, Rai Choudhury S, "Concepts of Modern Physics", 7th Edition, McGraw Hill Education, 2017.
2. David Halliday, Robert Resnick, Jearl Walker, "Principles of Physics", 10th Edition, Wiley, 2015.
3. Peter Atkins and Julio De Paula, "Physical Chemistry", 10th Edition, Oxford University Press, 2014.
4. Raghavan V, "Materials Science and Engineering", PHI Learning Pvt. Ltd., 2010.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	2		2						1			3	2
2.	3	2		2						1		2	2	2
3.	3		2		3	2	1			1				
4.	3		2		3	2	1			1		2	2	2
5.	3	2	2							1			1	
Average	**3**	**2**	**2**	**2**	**3**	**2**	**1**			**1**		**2**	**2**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

CY22152	ENGINEERING CHEMISTRY	L	T	P	C
		3	0	0	3

(Common to AE, AM, ME, MN)

COURSE OBJECTIVES:

1. To make the students to understand the importance of electrochemistry.
2. To appreciate the concepts of photochemistry and spectroscopy.
3. To impart knowledge on nanotechnology.
4. To understand the applications of engineering materials.
5. To familiarize the manufacture of fuels.

UNIT I ELECTROCHEMISTRY 9

Electrodes and electrochemical cells - electrode potential, standard electrode potential, single electrode potential and its determination, types of electrodes - calomel, quinhydrone and glass electrode. Nernst equation - determination of pH of a solution by using quinhydrone and glass electrode. Electrochemical series and its applications. Batteries - Primary (dry battery) and secondary batteries (Lead - acid storage battery and Lithium ion battery) and next generation batteries.

UNIT II PHOTOCHEMISTRY 9

Laws of photochemistry - Grotthuss-Draper law, Stark-Einstein law and Lambert Beer Law - determination iron by spectrophotometer. Quantum efficiency - Photo physical processes - internal conversion, inter-system crossing, fluorescence, phosphorescence and photo-sensitization-quenching of fluorescence and its kinetics, Stern - Volmer relationship. Applications of photochemistry.

UNIT III NANOCHEMISTRY 9

Basics and scale of nanotechnology, different classes of nanomaterials, Distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Synthesis of nanomaterials, fabrication (lithography) and its applications - Basics of nanophotonics and quantum confined materials (surface plasmon resonance).

UNIT IV ENGINEERING MATERIALS 9

Abrasives: definition, classification, grinding wheel, abrasive paper and cloth. Refractories: definition, characteristics, classification, properties - refractoriness and RUL, dimensional stability, thermal spalling, thermal expansion, porosity; Manufacture of alumina, magnesite and silicon carbide, Lubricants - classification, properties and applications. Basics of composite materials, properties and applications.

UNIT V FUELS AND COMBUSTION 9

Fuel: Introduction - classification of fuels - calorific value - higher and lower calorific values - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum - refining - manufacture of synthetic petrol (Bergius process) - knocking - octane number - diesel oil - cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gases (LPG) - producer gas - water gas.

Combustion of fuels: introduction - theoretical calculation of calorific value - calculation of stoichiometry of fuel and air ratio - flue gas analysis (ORSAT Method) - Uses of catalytic converters.

TOTAL: 45 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
On the successful completion of the course, students will be able to:		
CO1	Identify electrochemical cells, corrosion and fundamental aspects of batteries.	**2**
CO2	Interpret the photochemical reactions and make use of spectroscopic techniques.	**2**
CO3	Realize the structures, properties and applications of nanoparticles.	**2**
CO4	Acquire knowledge on the basic properties of engineering materials and its applications.	**2**
CO5	Illustrate the various types of fuels, its calorific value and significance of flue gas analysis.	**3**

TEXTBOOKS:

1. Jain P.C., and Monica Jain, "Engineering Chemistry", Dhanpat Rai & Sons, New Delhi, 17th Edition, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company, Ltd., New Delhi, 2008.

REFERENCES:

1. Ozin G. A. and Arsenault A. C., "Nanochemistry: A Chemical Approach to Nanomaterials", RSC Publishing, 2005.
2. Puri B.R., Sharma L.R., Pathania M.S., "Principles of Physical Chemistry", 47th edition, Vishal Publishing C., Jalandhar, 2018.
3. Sony P.L., and Chawla H.M., "Text Book of Organic Chemistry", Sultan Chand and Sons Publishers, New Delhi, 2000.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	2	3								3		
2.	3	3				3	3					3	3	
3.	3	3	2			3	3	3				3	2	
4.	3	3		3			3	3				3	1	
5.	3	3		3		3		3				3		
Average	**3**	**3**	**2**	**3**		**3**	**3**	**3**				**3**	**2**	

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

BT22101 **BIOLOGY FOR ENGINEERS**

L	T	P	C
3	0	0	3

(Common to BT, AE, IT)

COURSE OBJECTIVES:

1. To illustrate the unit of life and its function.
2. To study the implications of engineered products and process on living matters.
3. To understand biological function for the application in the product and process engineering.
4. To discuss the impact of the machine on human.
5. To understand the regulation and ethics.

UNIT I INTRODUCTION TO BIOLOGY 8

Origin of life and Evolution, Cells - Prokaryotes and Eukaryotes, Biochemical nuts and bolts - water, carbohydrates, lipids, proteins, DNA, RNA and enzymes, Introduction to metabolism, Mendelian genetics, Chromatin, DNA structure, replication, transcription and translation. Human system - skeletal structure, types of connective tissues, structure of joints, muscle and organ structure and function, cardiac physiology, blood properties and flow, nervous system. Plant system - organization of plants, Photosynthesis and Respiration, Growth and Development Hormones. Microbial system - Bacteria, yeast, fungi, protozoan, Algae and virus.

UNIT II APPLICATION OF BIOLOGICAL PRINCIPLES IN ENGINEERING 12

Biological functions for Camera for imaging, image recognition, visual information processing, Information and Communication Technologies, memristor, optoelectronic, speech recognition, smart sensing, sensorimotorics, neuromorphic and artificial intelligence. Biology in biomimicry - Sharkskin inspired swimsuits, Burr inspired Velcro, Whale fin inspired wind turbine blades, cooling fans, airplane wings and propellers, lotus inspired paintbrushes, Stenocara shell inspired water collection, skeleton structure of blowfish inspired designing of vehicles, termites and Scyliorhinus canicular inspired architecture and natural colour inspired nanophotonic crystal.

UNIT III BIOLOGICALLY INSPIRED PRODUCTS, PROCESS, AND MATTERS 12

Case study on workload ergonomics, system ergonomics and information ergonomics, Ultrasound imaging, X-Ray and PET scanning, Bioelectromagnetism - Touch Screen Technology, Force and torque sensor, inertial sensing technology and motion capture systems, Human-in-the-loop process, Bioactuators, Biocybernetics, Biotelemetry, Bionic (rehabilitation), Bioreactor, Bioremediation, Biofertilizer, Bioenergy, Biosensors, Biopolymers, Biofilters, Biochips, Microbial fuel cells in vehicles. Biotechnological reliance in space, agriculture and nuclear energy.

UNIT IV IMPACT OF MACHINE/DEVICES ON HUMAN 5

Biological effects - Somatic and genetic effect, Exposure and health effects - microwaves, radiation, radiofrequency and electronic gadgets, Man-made and Technological hazards, Impact on ecosystem - Chemical, nuclear, radiological, transportation and e-waste hazards.

UNIT V REGULATIONS 8

International and National regulatory bodies - Radiation in the electromagnetic spectrum, Electronic devices, Cell phones, Smart meters, Medical use of radiation and Nuclear power plants, Labeling Regulatory Requirements for Medical Devices, Ethics and privacy cameras and surveillance system, Regulation of Human Cloning and Embryonic Stem Cell Research, Privacy and ethical issues in 3D whole body scanning, Regulation of emerging gene technologies.

TOTAL: 45 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
After completion of this course the students will be able to:		
CO1	Distinguish the structure and function of prokaryotic and eukaryotic cells.	**4**
CO2	Explains the usage of biological principles in engineering.	**2**
CO3	Integrate the concepts of biology with engineering through case studies.	**3**
CO4	Describe the influence of biologically inspired materials/machines/devices on environment and society.	**2**
CO5	Understand the regulations, ethics, security and safety of engineering applications.	**2**

TEXTBOOKS:

1. Johnson, A.T., "Biology for engineers", CRC Press, 2011.
2. Khandpur, R.S., "Biomedical instrumentation: Technology and applications", Vol. 1, New York: Mcgraw-hill, 2005.
3. Salvendy, G., "Handbook of human factors and ergonomics", 4th edition, John Wiley & Sons, 2012.
4. Vaccari, D.A., Strom, P.F., & Alleman, J.E., "Environmental biology for engineers and scientists", Vol. 7, p. 242, New York: Wiley-Interscience, 2006.
5. Waite, G.N., & Waite, L.R. "Applied cell and molecular biology for engineers", McGraw-Hill Education, 2007.

REFERENCES:

1. Kindt, T.J., Goldsby, R. A., Osborne, B. A., & Kuby, J., "Kuby immunology", Macmillan, 2007.
2. Nelson, D.L., Lehninger, A.L., & Cox, M.M., "Lehninger principles of biochemistry", Macmillan, 2008.
3. Subrahmanyam, S.A., "Textbook Of Human Physiology", S. Chand Limited, 1987.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	2											1		
2.	3	2				1							1	1
3.		2	1			2				2		1		
4.		1		2			3						1	1
5.						3	3	3				1	1	1
Average	**2.5**	**1.7**	**1**	**2**		**2**	**3**	**3**		**2**		**1**	**1**	**1**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22101 COMPUTER AIDED ENGINEERING DRAWING (Common to AE, AM)

L	T	P	C
3	0	2	4

COURSE OBJECTIVES:

1. To introduce students concept of Engineering Drawing and build their ability to read drawings.
2. To interpret the position and form of simple geometry, culminating into understanding of simple technical assemblies.
3. To provide the students with the fundamentals of Computer Aided Drafting (CAD) software package to draw 2D projections and 3D models.

UNIT 0 ENGINEERING DRAWING FUNDAMENTALS (Not for Examination) (2+3)

Drawing standard: BIS, Lettering, ASME Y14.5 dimensioning and tolerancing, Types of lines, Conventions, Geometrical constructions using drawing tools. Study the capabilities of CAD software for Drafting and Modeling - Coordinate systems - Drafting of simple geometries like polygon and general multi-line figures. Construction of Title block manually and CAD software.

UNIT I CURVES AND PROJECTION OF POINTS AND LINES (6+12)

Construction and drafting of Engineering Curves: Cycloid, Involutes of Circle and Pentagon. Projection: Principal Planes, Projections of Points using Four Angles of Projection - Projection of Straight Lines parallel and inclined to one or both planes using Rotating Line Method in First Angle Projection.

Computer Drafting of Projection of Straight lines using Rotating Line Method in First Angle Projection.

UNIT II PROJECTION OF PLANES AND SOLIDS (6+12)

Projection of Plane Figures (Manual and using CAD software) - Inclined to any one Principal Plane.

Projections and drafting of orthographic views of Solids (Manual and using CAD software) - Simple Solids (Prisms, Pyramids, Cone and Cylinder) when the axis is inclined to any one Principal Plane.

UNIT III SECTION OF SOLIDS & DEVELOPMENT OF SURFACES (6+12)

Introduction to Conic sections (Manual and using CAD software) - Sections of Solids and drafting the sectional views of simple vertical solids when the solids are cut by section plane inclined to any one Principal Plane.

Development of Surfaces (Manual and using CAD software) of simple solids.

UNIT IV PICTORIAL PROJECTION (6+12)

Introduction to Pictorial Projection - Isometric Projection - Principle, Isometric Planes, Isometric Scales - Isometric Projection of simple solids (Manual and using CAD software).

Free Hand Drawing - Orthographic Projection - Orthographic views of simple blocks from their Isometric view, Isometric view of simple blocks from their Orthographic views. Creation of 3D models of Simple Solids using Isometric Principles from orthographic views using CAD software.

UNIT V PERSPECTIVE PROJECTION (4+9)

Perspective Projection of solids in simple positions with respect to projection planes - Creation of 3D models of simple solids by visual ray method (Manual and using CAD software).

TOTAL(L:30+T:60): 90 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
CO1	Perform the sketching of basic geometrical constructions and Draw orthographic projections of lines, plane surfaces and solids.	**3**
CO2	Draw the views of sectioned surfaces and development of surfaces of simple solids.	**3**
CO3	Prepare isometric and perspective sections of simple solids.	**3**
CO4	Draw the 2D sketches of lines, planes and simple solids from their orthographic projections using the different commands in CAD software.	**3**
CO5	Model the 3D views of solids applying isometric and perspective projection principles using the different commands in CAD software.	**4**

TEXTBOOKS:

1. Bhatt N.D, Panchal Pramod V.M and Ingle R, "Engineering Drawing", Charotar Publishing House, 2014.
2. Gopalakrishna K.R., Sudhir Gopalakrishna, "Textbook Of Computer Aided Engineering Drawing", Subhas Publications, 2017.

REFERENCES:

1. George Omura and Brian C. Benton, "Mastering AutoCAD 2016 and AutoCAD LT 2016: Autodesk Official press", Wiley Publishers, 2015.
2. Gopalakrishna K.R, "Engineering Drawing" (Vol. I & II), Subhas Publications, 2017.
3. Gowri S and Jeyapoovan T, "Engineering Graphics", Vikas Publishing House Pvt. Ltd., 2019.
4. James D. Bethune, "Engineering Graphics with AutoCAD 2017", PEACHPIT Press, 2016.
5. Natrajan K.V, "A Textbook of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2006.
6. Venugopal. K and Prabhu Raja. V, "Engineering Graphics", New Age International (P) Limited, 2009.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	3	3	3					3			3	2
2.	3	3	3	3	3					3			2	2
3.	3	3	3	3	3					3			2	2
4.	3	3	3	3	3					3				
5.	3	3	3	3	3					3			3	3
Average	**3**	**3**	**3**	**3**	**3**					**3**			**2.5**	**2.25**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

CY22161	CHEMISTRY LABORATORY	L	T	P	C
		0	0	2	1

(Common to all Branches except AD, CS, IT)

COURSE OBJECTIVES:

The objective of the Chemistry Laboratory is to acquaint the students with the basic phenomenon/concepts of chemistry, the student face during course of their study in the industry and engineering field.

1. To appreciate the need and importance of water quality parameters for industrial and domestic use.
2. To gain the knowledge on electrochemical instrumentation techniques like potential and current measuring used in electrochemistry applications.
3. To impart knowledge on separation of components using paper chromatography.
4. To enhance the thinking capability about polymer and properties like molecular weight.

LIST OF EXPERIMENTS:
(Minimum 8 Experiments)

1. Determination of DO content of water sample by Winkler's method.
2. Determination of strength of given hydrochloric acid using pH meter.
3. Determination of strength of acids in a mixture using conductivity meter.
4. Estimation of iron content of the water sample using spectrophotometer (phenanthroline / thiocyanate method).
5. Determination of total, temporary & permanent hardness of water by EDTA Method.
6. Estimation of iron content of the given solution using potentiometer.
7. Determination of alkalinity in water sample.
8. Determination of Single electrode potential.
9. Separation of components from a mixture of red and blue inks using Paper chromatography.
10. Determination of molecular weight of polymer by using Ostwald's/Ubbelohde viscometer.

TOTAL: 30 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
Upon successful completion of the course, students should be able to:		
CO1	Distinguish hard and soft water, solve the related numerical problems on water, purification and its significance in industry and daily life.	**3**
CO2	Interpret the knowledge of instruments to measure potential and current related parameters.	**2**

CO3	Demonstrate the basic principle for separation of components using paper chromatography.	**3**
CO4	Evaluate the molecular weight of polymer using Ostwald's/Ubbelohde viscometer.	**3**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

Common apparatus: Pipette, Burette, conical flask, porcelain tile, dropper (each 30 nos)

1	Iodine flask	30 Nos
2	pH meter	5 Nos
3	Conductivity meter	5 Nos
4	Spectrophotometer	5 Nos
5	Oswald/Ubbelohde Viscometer	30 Nos

REFERENCES:

1. Daniel R. Palleros, "Experimental organic chemistry", John Wiley & Sons, Inc., New York 2001.
2. Furniss B.S. Hannaford A.J, Smith P.W.G and Tatchel A.R., "Vogel's Textbook of practical organic chemistry", LBS Singapore 1994.
3. Jeffery G.H., Bassett J., Mendham J. and Denny Vogel's R.C, "Text book of quantitative analysis chemical analysis", ELBS 5th Edn. Longman, Singapore publishers, Singapore, 1996.
4. Kolthoff I.M., Sandell E.B. et al. "Quantitative chemical analysis", Mcmillan, Madras 1980.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	2				3	3	3	1		1	2	1	1
2.	3	2	1			3	3	3					1	1
3.	3					3	3					2	1	1
4.	3			1		3	3	3					1	1
Average	**3**	**2**	**1**	**1**		**3**	**3**	**3**	**1**		**1**	**2**	**1**	**1**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

ME22162 **BASIC MECHANICAL ENGINEERING LABORATORY**

L	T	P	C
0	0	2	1

(Common to AE, AM, BT, CH)

COURSE OBJECTIVES:

1. To provide exposure and hands on experience to the students on various basic mechanical engineering processes.

LIST OF EXPERIMENTS:

1. Welding - Butt joint and lap joint using Electric Arc and Gas welding.
2. Machining - Turning and facing using Centre Lathe.
3. Sheet metal work - Making of a cylinder using GI sheet and finishing using rivets.
4. Drilling and Tapping - Drilling of holes precisely and making internal threads by Tapping for various sizes.
5. Casting - Mould preparation using simple solid pattern and casting.
6. Plumbing - Making household pipeline PVC pipes, valves, taps, couplings, unions, reducers, elbows.
7. Fuel testing - Determination of Flash point and Fire point of fuels.
8. Refrigeration and Air Conditioning - Determination of Coefficient of Performance (COP) of refrigeration and air conditioning systems.
9. Automation - Basic pneumatic circuit using single and double acting cylinder.
10. 3D printing - Demonstration of printing of simple solids using Additive Manufacturing/3D printing.

TOTAL: 30 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
CO1	Students will be able to ***Fabricate*** components by various manufacturing processes.	**3**
CO2	Students will be able to ***Prepare*** pipeline for a given application.	**3**
CO3	Students will be able to ***Evaluate*** the ignition properties of fuels.	**3**
CO4	Students will be able to ***Determine*** the efficiency of refrigeration and air conditioning systems.	**3**
CO5	Students will be able to ***Understand*** the principles of low cost automation using pneumatic circuits.	**2**
CO6	Students will be able to ***Understand*** the principle of additive manufacturing/3D printing.	**2**

REFERENCES:

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education, 7th edition, 2009.
2. Bawa H.S., "Workshop Practice", Tata McGraw Hill Publishing Company Limited, 2007.
3. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

4. Jeyachandran K., Natarajan S. & Balasubramanian S., "A Primer on Engineering Practices Laboratory", Anuradha Publications, 2007.
5. Jeyapoovan T., Saravanapandian M. & Pranitha S., "Engineering Practices Lab Manual", Vikas Publishing House Pvt.Ltd, 2006.
6. Mechanical engineering practices lab manual, SVCE, 2022.
7. Rajput. R.K., "Thermal Engineering", Laxmi Publications, Tenth Edition, 2017.

LIST OF EQUIPMENT REQUIRED FOR A BATCH OF 30 STUDENTS

S. No.	Equipment	Qty.
1	Welding transformers, booths with exhaust and Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 sets
2	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 sets
3	Centre lathe	2
4	Standard GI sheet working tools	10 sets
5	Drilling machine	2
6	Taps (various sizes)	5
7	Furnace	1
8	Moulding tools and accessories	5 sets
9	Assorted components for plumbing consisting of pipes, couplings, unions, elbows, plugs and other fittings.	15 sets
10	Flash point and fire point apparatus	1
11	Refrigeration and Air conditioning testing setup	1
12	Basic Pneumatic trainer kit	1
13	3D printing machine	1

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	2												1	1
2.	2													
3.	2												3	
4.	2												2	
5.	1				2									1
6.	1				2								2	2
Average	**1.7**				**2**								**2**	**1.3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

HS22251	அறிவியல் மற்றும் தொழில்நுட்பத்தில் தமிழ் Science and Technology in Ancient Tamil Society	L	T	P	C
		2	0	0	1

(Common to all Branches)

பாடத்தின்நோக்கங்கள்:

1. அறிவியலில் தமிழின் பயன்பாடு பற்றி தெரிந்து கொள்வார்கள்.
2. தொழில்நுட்பத்தில் தமிழ் பாரம்பரியத்தின் தாக்கம் பற்றி அறிந்து கொள்வார்கள்.

அலகு I அறிவியலில் தமிழ் 5

கருவி உருவாக்கம் - ஆராய்ச்சி மேம்பாடு - கல்வி வளர்ச்சி - அறிவியல் தமிழ் சொற்கள் உருவாக்கம்.

Scientific Tamil : Tool Development - Research Development - Educational Development - Scientific Tamil words Creation.

அலகு II தொழில் நுட்பத்தில் தமிழ் 25

வடிவமைப்பு மற்றும் கட்டுமான தொழில்நுட்பம் : சங்க காலத்தில் கட்டுமானப் பொருட்கள் - சோழர்களின் பெரிய கோவில்கள் மற்றும் பிற வழிபாட்டு தலங்கள் - பல்லவர்களின் சிற்பங்கள் மற்றும் கோவில்கள் (மாமல்லபுரம்) - நாயக்கன் கால கோவில்கள் (மதுரை மீனாட்சி அம்மன் கோவில்), திருமலை நாயக்கர் மஹால், செட்டி நாட்டு வீடுகள்.

Design and Construction Technology : Building materials in Sangam age – Great temples of Cholas and other worship places – Sculptures and Temples of Pallavas (Mamallapuram) – Temples of Nayakas period (Madurai Meenakshi Amman Temple), Thirumalai Nayakar Mahal, Chetti Nadu Houses.

உற்பத்தி தொழில்நுட்பம் : கப்பல் கட்டும் கலை, உலோகவியல் ஆய்வுகள், தங்கம், தாமிரம், இரும்பு பற்றிய அறிவு - தொல்பொருள் சான்றுகள் - சுட்டக் களிமண் மணிகள், சங்கு மணிகள், எலும்பு மணிகள்.

Manufacturing Technology : Art of Ship building, Metallurgical studies, Knowledge about Gold, Copper, Iron – Archeological evidences – Terracotta beads, Shell beads, Bone beads.

விவசாயம் மற்றும் நீர்ப்பாசன தொழில்நுட்பம் : அணைகள், ஏரிகள், குளங்கள், மதகுகள், சோழர் கால குமுழி தூம்பு ஆகியவற்றின் முக்கியத்துவம் - கால்நடை பராமரிப்பு, கால்நடைகளின் பயன்பாட்டிற்காக வடிவமைக்கப்பட்ட கிணறுகள். விவசாயம் மற்றும் வேளாண் செயலாக்கம் - கடல் பற்றிய அறிவு - மீன்பிடித்தல், முத்து குளித்தல், சங்கு சேகரித்தல்.

Agriculture and Irrigation Technology: Dams, Tank, ponds, sluice, Significance of Kumuzhi Thoompu of Cholas period- Animal Husbandry, Wells designed for cattle use. Agriculture and Agro processing, - Knowledge about Sea – Fisheries, Pearl, Conche diving.

தமிழ் கணினி: அறிவியல் தமிழ் வளர்ச்சி - தமிழ் கணினி, தமிழ் புத்தகங்களின் டிஜிட்டல் மயமாக்கல், தமிழ் டிஜிட்டல் நூலகம், தமிழ் மென்பொருள் உருவாக்கம் - தமிழ் மெய்நிகர் அகாடமி - சொற்குவை திட்டம்.

Tamil Computing : Development of Scientific Tamil – Tamil Computing, Digitization of Tamil books, Tamil Digital Library, Development of Tamil Softwares – Tamil virtual Academy – Sorkuvai project.

தமிழின் எதிர்காலமும் தகவல் தொழில்நுட்பமும்- உலகமயமாக்கலும் தகவல் தொழில் நுட்பமும் - கணினிக்கு தமிழ் கற்று கொடுத்தல் - தமிழ் மொழித் தொழில் நுட்பத்தில் வளங்கள்.

Future of Tamil and Information Technology- Globalization and Information Technology - Teaching Tamil for Computer - Resources in Tamil Language Technology.

TOTAL: 30 PERIODS

பாடநெறிமுடிவுகள்:

பாடத்திட்டத்தின் வெளிப்பாடு		RBT LEVEL
CO1	அறிவியலில் தமிழ் மொழியின் பயன்பாடு பற்றி தெரிந்து கொள்வார்கள்.	**2**
CO2	பல்வேறு தொழில்நுட்பத்தில் தமிழ் மொழியின் தாக்கம் பற்றி அறிந்து கொள்வார்கள்.	**3**

பாடநூல்கள்:

1. **டாக்டர், வா.செ .குழந்தைசாமி (1985), "** அறிவியல் தமிழ் " , பாரதி பதிப்பகம், 126/108, உஸ்மான் சாலை, தியாகராய நகர், சென்னை 600017.
2. **சுப. திண்ணப்பன்**, (1995), "கணினியும்தமிழ்கற்பித்தலும்", புலமைவெளியீடு, 38-Bமண்ணத்நதோட்டத்தெரு, ஆழ்வார்பேட், சென்னை 600018.
3. **மு. பொன்னவைக்கோ**, (2003), "வளர்தமிழில்அறிவியல்-இணையத்தமிழ்", அனைத்திந்தியஅறிவியல்தமிழ்க்கழகம், தஞ்சாவூர்615 005.
4. **துரை. மணிகண்டன்**, (2008), "இணையமும்தமிழும்", நல்நிலம்பதிப்பகம், 7-3, சிமேட்லிசாலை, தியாகராயநகர், சென்னை 600 017.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.			3	2	3	3	2	2	3	3		2		
2.			3	2	3	3	2		3	3		2		
Average			**3**	**2**	**3**	**3**	**2**	**2**	**3**	**3**		**2**		

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

HS22252 **TECHNICAL ENGLISH** (Common to all Branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. Enable learners to define and understand technical communication and scientific writing.
2. Expose learners to the technicalities of seminar presentation, group discussion, and public speaking.
3. Develop learners' writing skills for scientific and documenting purposes.
4. Improve learners' ability to draft correspondences for business purposes.
5. Cultivate learners' ability to holistically understand the nuances of job interviews and recruiting process.

UNIT I **9**

Listening - AV files pertaining to manufacturing processes of products, scientific documentaries; **Speaking** - syllable division and word stress, intonation, sharing opinions; **Reading** - news articles related to science and technology; **Writing** - definitions, instruction, recommendation, data interpretation, resume; **Grammar** - tenses and their aspects, sentence connectors - discourse markers, sequential words, active and passive voice, subject-verb agreement.

UNIT II **9**

Listening - AV pertaining to marketing strategies, peer reading and pronunciation; **Speaking** - turn taking, sharing opinions; conducting and attending a meeting, understanding the nuances of spoken communication among internal audience and external audience; **Reading** - analytical documents, descriptive documents; **Writing** - fliers, brochures, resume - letter of application, checklists; **Grammar** - modal verbs, clauses - types and uses, conditional clauses, articles.

UNIT III **9**

Listening - AV related to how to use components, scientific description, **Speaking** - speaking for motivation and initiation, speaking at a seminar presentation; **Reading** - scientific journals, papers; **Writing** - Technical descriptions - process description, purpose and function, PowerPoint, Google forms, user manuals; **Grammar** - phrasal verbs, prepositions, technical and scientific affixes.

UNIT IV **9**

Listening - scientific debates, crisis management; **Speaking** - handling conflicts, speaking about the loss of benefits, progress or decline of business, identifying the connotative meanings, **Reading** - documented evidences of uses and functions of a product, review of a product, **Writing** - memos, follow-up letters, reports - proposal, project, progress reports, sales reports, reports on industrial visits, executive summary. **Grammar** - reported speech and tag questions, sentence structure - comparative, imperative, cause and effect, infinitive of result.

UNIT V **9**

Listening - AV of Group discussions, panel discussions, face to face interviews for recruitment purposes; **Speaking**- speaking at group discussions, interviewing a personality, answering at the interviews; **Reading** - WebPages of topnotch engineering companies, **Writing** - blogging, e-mails, letter of complaint, minutes of the meeting; **Grammar** - one word substitution, collocations, better word/sentence substitution (rephrasing the content/improvising ideas).

TOTAL: 45 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
Upon successful completion of the course, the students should be able to:		
CO1	Understand the nuances of technical communication and scientific writing.	**3**
CO2	Present papers and give seminars.	**6**
CO3	Discuss in groups and brainstorm.	**6**
CO4	Draft business correspondences and write for documenting purposes.	**6**
CO5	Face job interviews with confidence.	**6**

REFERENCES:

1. Department of English, Anna University. "Mindscapes: English for Technologists and Engineers", Orient Blackswan, Chennai, 2012.
2. Downes, Colm, "Cambridge English for Job-hunting", Cambridge University Press, New Delhi, 2008.
3. Herbert A J, "The Structure of Technical English", Longman, 1965.
4. Murphy, Raymond, "Intermediate English Grammar with Answers", Cambridge University Press, 2000.
5. Thomson, A.J., "Practical English Grammar 1 & 2", Oxford, 1986.

Web Link:

1. http://www.usingenglish.com
2. http://www.uefap.com3
3. https://owl.english.purdue.edu/owl/
4. www.learnenglishfeelgood.com/esl-printables-worksheets.html

Software

1. CAMBRIDGE Preparation for the TOEFL TEST - Cambridge University Press, 2017.
2. English Advance Vocabulary - Cambridge University Press.
3. Face2Face Advance - Cambridge University Press, 2014.
4. IELTS test preparation - Cambridge University Press, 2017.
5. Official Guide to the TOEFL Test With CD-ROM, 4th Edition.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.										3				
2.										3				
3.										3				
4.										3				
5.										3				
Average										**3**				

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

MA22251 **APPLIED MATHEMATICS II** **L T P C**
3 1 0 4

(Common to all Branches except MR)

COURSE OBJECTIVES:

The student should be made to:

1. Acquire the concepts of vector calculus needed for problems in all engineering disciplines and compute different types of integrals using Green's, Stokes' and Divergence theorems.
2. Skilled at the techniques of solving ordinary differential equations that model engineering problems.
3. Extend their ability of using Laplace transforms to create a new domain in which it is easier to handle the problem that is being investigated.
4. Explain geometry of a complex plane and state properties of analytic functions.
5. Understand the standard techniques of complex variable theory so as to apply them with confidence in application areas such as heat conduction, elasticity, fluid dynamics and flow of electric current.

UNIT I VECTOR CALCULUS (9+3)

Gradient, divergence and curl - Directional derivative - Vector identities - Irrotational and solenoidal vector fields - Line integral over a plane curve - Surface integral - Area of a curved surface - Volume integral - Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) - Verification and application in evaluating line, surface and volume integrals.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS AND ITS APPLICATIONS (9+3)

Differential equations of first order - Equations of the first order and first degree - Linear equations - Higher order linear differential equations with constant coefficients - Method of variation of parameters - Cauchy's and Legendre's linear equations - Simultaneous first order linear equations with constant coefficients - Applications of Linear differential equations - Oscillatory electrical circuit - Deflection of beams.

UNIT III LAPLACE TRANSFORM (9+3)

Conditions for existence - Transform of elementary functions - Transforms of unit step function and impulse functions - Basic properties - Shifting theorems - Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Initial and final value theorems - Transform of periodic functions. Inverse Laplace transforms - Convolution theorem - Application to solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

UNIT IV ANALYTIC FUNCTIONS (9+3)

Analytic functions - Necessary and sufficient conditions (Cauchy-Riemann equations) - Properties of analytic function - Harmonic conjugates - Construction of analytic functions -

Conformal mapping - Mapping by functions W = Z + C, CZ, 1/Z, Z^2 - Joukowski's transformation - Bilinear transformation.

UNIT V COMPLEX INTEGRATION (9+3)

Cauchy's integral theorem - Cauchy's integral formula - Taylor's and Laurent's series expansions -Singular points - Residues - Cauchy's Residue theorem - Application of residue theorem for evaluation of real integrals - Use of circular contour and semi-circular contour.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
Upon completion of the course, students will be able to:		
CO1	Interpret the fundamentals of vector calculus and execute evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems.	**3**
CO2	Solve first order linear, homogeneous differential equations and use series solution method to solve second order differential equations.	**3**
CO3	Determine the methods to solve differential equations using Laplace transforms and Inverse Laplace transforms.	**3**
CO4	Explain Analytic functions and Categorize transformations.	**3**
CO5	Perform Complex integration to evaluate real definite integrals using Cauchy integral theorem and Cauchy's residue theorem.	**3**

TEXTBOOKS:

1. Erwin Kreyszing, Herbert Kreyszing, Edward Norminton, "Advanced Engineering Mathematics", 10th Edition, John Wiley, 2015.
2. Grewal. B.S, Grewal. J.S, "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, Delhi, 2015.

REFERENCES:

1. Bali. N.P., and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt. Ltd., 2014.
2. Dass, H.K., and Rajnish Verma, "Higher Engineering Mathematics", S. Chand Private Ltd., 2011.
3. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2013.

Web Link:

1. https://nptel.ac.in/courses/111/105/111105134/
2. https://nptel.ac.in/courses/111/105/111105121/

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	2	2								3	1	1
2.	3	3	3	3								3	3	3
3.	3	3	3	3								3	3	3
4.	3	3										3		
5.	3	3										3	1	
Average	**3**	**3**	**2.33**	**2.33**								**3**	**2**	**2.3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

PH22253	ENGINEERING MATERIALS (Common to AE, AM, ME, MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To impart the knowledge about the properties of engineering and ceramic materials to the students.
2. To enhance the knowledge about the electron behaviour in the semiconductor and dielectric materials.

UNIT I PHASE DIAGRAMS AND NON-FERRROUS ALLOYS 8

Solid solutions - Hume Rothery's rules - Phase rule - single component system - one-component system of Iron - binary phase diagrams - Isomorphous systems - Tie-line rule - the Lever rule - application to Isomorphous system - Cu - Ni system - Eutectic phase diagram - Peritectic phase diagram - other invariant reactions - Cu - Zn system -Microstructural change during cooling.

UNIT II FERROUS ALLOYS AND HEAT TREATMENT 10

Fe-C equilibrium diagram: phases, invariant reactions - microstructure of slowly cooled steels - Eutectoid steel, hypo and hypereutectoid steels - effect of alloying elements on the Fe-C system - **Diffusion in solids:** Fick's laws -phase transformations - T-T-T-diagram for eutectoid steel - Pearlite, Baintic and Martensitic transformations - tempering of Martensitic. **Heat treatment of steels:** Annealing - Normalizing - Quenching and Tempering - Casehardening - Induction, Flame and Laser hardening - Carburizing, Cyaniding, Carbonitriding and Nitriding.

UNIT III SEMICONDUCTING MATERIALS 8

Introduction - classification of materials based on band theory (metals, semiconductors and insulators) - intrinsic and extrinsic semiconductors - carrier concentration in intrinsic semiconductor (derivation) - effect of temperature on Fermi level - compound semiconductors - variation of electrical conductivity in intrinsic semiconductors with temperature - Band gap determination of intrinsic semiconductor (derivation and experiment) - Hall effect (derivation and experiment).

UNIT IV DIELECTRIC, MAGNETIC AND SUPERCONDUCTING MATERIALS 10

Dielectric materials: Dielectric constant - Polarization of dielectric materials - Types of Polarization (Polarisability) - Equation of internal fields in solid (One-Dimensional) (Derivation) - Claussius-Mosotti Relation for elemental dielectric materials - Dielectric Breakdown - Frequency dependence of dielectric constant, Dielectric Losses - Important applications of dielectric material.

Magnetic materials: Dia, Para and Ferro magnetic material - Domain theory for Ferro magnetic materials - Phenomena of Hysteresis and its applications - Ferrites and its structures.

Introduction to Superconductivity: Meissner effect - Properties of superconductors - Type I and Type II superconductors - BCS theory (Qualitative) - Low Tc and High Tc (alloy) superconductors - Ceramic superconductors (oxide superconductors) - Applications of Superconductors.

UNIT V CERAMIC AND NEW MATERIALS 9

Ceramics: types and applications, **Composites:** Ceramic Fibres - Fibre reinforced Plastics - Fibre reinforced Metal - **Metallic glasses:** preparation, Properties and applications - **Shape memory alloys:** shape memory effect, phases, pseudo elastic effect, NiTi alloy, Properties and applications - **Nanomaterials:** preparation, properties and applications.

TOTAL: 45 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
Students will be able to:		
CO1	Demonstrate about the Phase diagrams of various alloys	3
CO2	Enhance knowledge about the heat treatment of alloys and alloy steels.	3
CO3	Demonstrate an understanding of various properties of Semiconducting materials and their internal structure	3
CO4	Summarize basics of magnetism and superconductivity. Explore a few of their technological applications. Analyse the properties of dielectric materials and apply them in various fields.	3
CO5	Develop an understanding about ceramics and various new engineering materials	2

TEXTBOOKS:

1. Arumugam. M, "Materials Science", Anuradha Publications, 2015.
2. Raghavan. V, "Materials Science and Engineering - A first course", Sixth Edition, PHI publications, 2015.
3. Rajendran. V, "Engineering Physics", Tata McGraw Hill, 2015.
4. Suresh. R and Jayakumar. V, "Materials Science", Lakshmi Publications, 2003.

REFERENCES:

1. Avadhnaulu. M.N and Kshirsagar, "A Text book of Engineering Physics", S. Chand & Co. 2006.
2. Azaroff. L.V and Brophy. J.J, "Electronic Processes In Materials", McGraw Hill., 1963.
3. Gaur. R.K and Gupta. S.L, "Engineering Physics", Dhanpat Publications, 2015.
4. Kittlel. C, "Introduction to Solid State Physics", 7th Edition, Wiley Eastern Ltd., 2004.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	2	2							1		2	2	2
2.	3	2	2	2	2	2			2	1		2	2	2
3.	3					2				1		2	2	2
4.	3		2			2				1		2	2	2
5.	3	2	2	2	2	2			2	1		2	2	2
Average	**3**	**2**	**2**	**2**	**2**	**2**			**2**	**1**		**2**	**2**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

EE22151	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
		3	0	0	3

(Common to all Branches except CH, EE, EC)

COURSE OBJECTIVES:

1. To understand the basic theorems used in Electrical circuits.
2. To educate on the different concepts and functions of electrical machines
3. To introduce electron devices and its applications.
4. To explain the principles of digital electronics.
5. To impart knowledge on the principles of measuring instruments.

UNIT I ELECTRICAL CIRCUITS 9

Ohm's Law - Kirchhoff's Laws - Steady State Solution of DC Circuits using Mesh and Nodal Analysis - Introduction to AC Circuits - Waveforms and RMS Value - Power and Power factor - Single Phase and Three Phase AC Balanced Circuits.

UNIT II ELECTRICAL MACHINES 9

Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors, Single phase induction Motor, Single Phase Transformer.

UNIT III SEMICONDUCTOR DEVICES AND APPLICATIONS 9

Characteristics of PN Junction Diode - Zener Effect - Zener Diode - LED, Photo diode and its Characteristics - Half Wave and Full Wave Rectifiers - Voltage Regulation. Bipolar Junction Transistor - Common Emitter Configuration, Characteristics and CE as an Amplifier - Photo transistors.

UNIT IV DIGITAL ELECTRONICS 9

Number System Conversion Methods - Simplification of Boolean Expression using K-Map - Half and Full Adders - Flip-Flops - Shift Registers - SISO, SIPO, PISO, PIPO and 4-bit Synchronous and Asynchronous UP Counters.

UNIT V MEASURING INSTRUMENTS 9

Types of Signals: Analog and Digital Signals - Construction and working Principle of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters), Dynamometer type Watt meters and Energy meters. Instrumentation Amplifier - R-2R ladder Type D/A Converter - Flash Type and Successive Approximation Type A/D Converter.

TOTAL: 45 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
CO1	Compute the electric circuit parameters for simple problems.	**4**
CO2	Understand the construction and characteristics of different electrical machines.	**4**
CO3	Describe the fundamental behavior of different semiconductor devices and circuits.	**4**
CO4	Design basic digital circuits using Logic Gates and Flip-Flops.	**4**
CO5	Analyze the operating principle and working of measuring instruments.	**4**

TEXTBOOKS:

1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", Second Edition, McGraw Hill Education, 2020.
2. Mehta VK, "Principles of Electronics", S. Chand & Company Ltd, 2010.
3. Sedha R.S., "A Text Book of Applied Electronics", S. Chand & Co., 2014.

REFERENCES:

1. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, Fourth Edition, 2007.
2. Mehta V.K., "Principles of Electronics", S. Chand & Company Ltd, 2010.
3. Morris Mano M, "Digital Logic & Computer Engineering", Prentice Hall of India, 2004.
4. Muthu Subramanian R, Salivahanan S, and Muraleedharan K A, "Basic Electrical, Electronics Engineering", Tata McGraw Hill, 2013.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	3	3			2					2	1	1
2.	3	3	3	3			2					2	2	2
3.	3	3	3	3			2					2	2	2
4.	3	3	3	3			2					2	1	1
5.	3	3	3	3			2					2	1	1
Average	**3**	**3**	**3**	**3**			**2**					**2**	**1.4**	**1.4**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22201	PRODUCTION PROCESSES	L	T	P	C
		3	0	0	3

(Common to AE, AM)

COURSE OBJECTIVES:

1. To introduce the concepts of basic manufacturing processes and fabrication techniques such as metal casting, metal joining, metal forming and manufacture of plastic components.

UNIT I CASTING 9

Casting steps, types of pattern, core making, Cupola and Induction furnaces, procedure to make sand mould, moulding tools, machine moulding, special moulding processes - CO_2moulding, shell moulding, investment moulding, permanent mould casting, pressure die casting, centrifugal casting, continuous casting, casting defects.

UNIT II WELDING 9

Classification of welding processes. Principles of Oxy-acetylene gas welding. AC metal arc welding, resistance welding, submerged arc welding, tungsten inert gas welding, metal inert gas welding, plasma arc welding, thermit welding, friction welding, electron beam welding, laser beam welding, defects in welding, soldering and brazing.

UNIT III METAL FORMING AND POWDER METALLURGY 9

Hot and Cold working - Principles and applications of the following processes: Forging, Rolling, Extrusion, Wire drawing.

Powder metallurgy - Principal steps involved advantages, disadvantages and applications of powder metallurgy.

UNIT IV SHEET METAL PROCESSES 9

Sheet metal characteristics - shearing, bending and drawing operations - Stretch forming operations - Formability of sheet metal - Test methods - Special forming processes - Metal spinning - Explosive forming, Magnetic pulse forming, Electro-Hydraulic forming, Super plastic forming - Micro forming.

UNIT V PLASTIC MATERIALS AND PROCESSES 9

Types of plastics - Characteristics of the forming and shaping processes - Injection moulding - Blow moulding - Rotational moulding - Film blowing - Extrusion - Thermoforming - Compression moulding - Transfer moulding - typical industrial applications, Laminated plastics. Bonding of Thermoplastics - Fusion and solvent methods - Induction and Ultrasonic methods.

TOTAL: 45 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
Students will be able to:		
CO1	Select the best casting process for a component to be manufactured based on the economy of manufacture and its application	**3**
CO2	Identify the best joining process involved in the fabrication of components based on the simplicity, application and cost	**3**
CO3	Choose the best metal forming or powder metallurgy process for a component to be manufactured based on the economy of manufacture and its application	**3**
CO4	Select the best sheet metal process for a component to be manufactured based on its application	**3**
CO5	Choose the best method of moulding/joining of plastics of a part based on cost and its use.	**3**

TEXTBOOKS:

1. Hajra Choudhary S K, Hajra Choudhury A K and Nirjhar Roy, "Elements of workshop Technology", Volume I, Media promoters & Publishers Pvt. Ltd., Mumbai, 2008.
2. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson EducationIndia Edition, 2013.

REFERENCES:

1. Jain R.K., "Production Technology", 21st Edition, Khanna Publishers, 2005.
2. Paul Degarma E, Black J.T and Ronald A. Kosher, "Materials and Processes, in Manufacturing", 8th Edition, Prentice-Hall of India, 1997.
3. Rao, P.N. "Manufacturing Technology: Foundry, Forming and Welding", 4th Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2017.
4. Roy. A. Lindberg, "Processes and Materials of Manufacture", Fourth Edition, PHI/Pearson Education 2015.
5. Sharma, P.C., "A Text book of Production Technology", S. Chand and Co. Ltd., 2014.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	2	2			2	1	2				1	1	
2.	3	2	2			2	1	2				1	1	
3.	3	2	2			2	1	2					1	
4.	3	2	2			2	1	2					1	
5.	3	2	2			2	2	2					1	
Average	**3**	**2**	**2**			**2**	**1.2**	**2**					**1**	

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

IT22251	COMPUTER PROGRAMMING AND PRACTICE	L	T	P	C
		2	0	2	3

(Common to AE, AM, BT, CE, CH)

COURSE OBJECTIVES:

1. To know the basics of algorithmic problem solving.
2. To learn programming using a structured programming language.
3. To implement programs with basic features of C.

UNIT I FUNDAMENTALS OF COMPUTING (6+3)

Computing Devices - Identification of Computational Problems - Algorithms - Building Blocks of Algorithms - Pseudocodes and Flowcharts - Notion of memory, addresses, variables, instructions, execution of instructions - Operating system commands, file editing, compiling, linking, executing a program, Introduction to different programming languages.

Suggested Activities:

Practical

Use of operating system commands and file editing operations.

UNIT II BASICS OF C (6+9)

Data types - constants, variables - operators - expressions - basic input/output. Statements and blocks - Selection - if-else construct - iteration - while - for constructs.

Suggested Activities

Practical

Demonstration of programs using data types, operators and basic input/output.

Demonstration of programs using if-else, else-if, switch.

Demonstration of programs using, while, for, do-while, break, continue.

UNIT III ARRAYS AND STRINGS (6+6)

Array, declaration, initialization. Multi dimensional arrays. Strings and character arrays, string operations on arrays.

Suggested Activities

Practical

Demonstration of programs using arrays and operations on arrays.

Demonstration of programs implementing string operations on arrays.

UNIT IV FUNCTIONS AND STRUCTURES (6+6)

Functions, definition, call, arguments, call by value. Call by reference. Recursion, Introduction to structures and unions.

Suggested Activities

Practical

Demonstration of programs using functions.

Demonstration of programs using recursion.
Demonstration of programs using Structures and Unions.

UNIT V POINTERS AND FILE HANDLING IN C (6+6)

Introduction to Pointers - pointers to basic variables, pointers and arrays. Pointers to strings, Dynamic Memory Allocation, Files - binary, text - open, read, write, random access, close. Preprocessor directives.

Suggested Activities

Practical

Demonstration of programs using pointers.
Demonstration of programs using files.

TOTAL (L:30+T:30): 60 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
Upon successful completion of the course, the students should be able to:		
CO1	Apply appropriate programming constructs to solve problems.	**3**
CO2	Design, implement, test and debug programs that use the basic features of C.	**5**
CO3	Design modularized applications in C to solve real world problems.	**6**
CO4	Use C pointers and dynamically allocated memory to solve complex problems.	**4**
CO5	Apply file operations to develop solutions for real-world problems.	**3**

TEXTBOOKS:

1. Dromey R.G., "How to Solve it using Computer", Pearson, 2006.
2. Pradip Dey, Manas Ghosh, "Programming in C", First Edition, Oxford University Press, 2018.

REFERENCES:

1. Byron S Gottfried, "Programming with C", Schaum's Outlines, Third Edition, Tata McGraw Hill, 2010.
2. Kernighan, B.W and Ritchie, D.M, "The C Programming language", Second Edition, Pearson Education, 2015.
3. Reema Thareja, "Programming in C", 2nd ed., Oxford University Press, 2016.
4. Yashavant P. Kanetkar, "Let Us C", BPB Publications, 2011.

Evaluation Method

60% theory+40% practical

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	1	3						2	3			2	2	2
2.	1	3						2	3			2		
3.	1		3	2	1			2	3			2	2	2
4.	1		3	2	1			2	3			2		
5.	1		3	2	1			2	3			2	1	1
Average	**1**	**3**	**3**	**2**	**1**			**2**	**3**			**2**	**1.7**	**1.7**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

PH22161 **PHYSICS LABORATORY**

(Common to all Branches except BT)

L	T	P	C
0	0	2	1

COURSE OBJECTIVES:

1. To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics and properties of matter.

LIST OF EXPERIMENTS: (Any EIGHT Experiments)

1. a) Determination of Wavelength, and particle size using Laser.

   b) Determination of acceptance angle in an optical fiber.
2. Determination of velocity of sound and compressibility of liquid - Ultrasonic Interferometer.
3. Determination of wavelength of mercury spectrum - spectrometer grating.
4. Determination of thermal conductivity of a bad conductor - Lee's Disc method.
5. Determination of Young's modulus by Non uniform bending method.
6. Determination of specific resistance of a given coil of wire - Carey Foster's Bridge.
7. Determination of Rigidity modulus of a given wire - Torsional Pendulum.
8. Energy band gap of a Semiconductor.
9. Determine the Hysteresis loss of a given Specimen.
10. Calibration of Voltmeter & Ammeter using potentiometer.

TOTAL: 30 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
CO1	Analyze the physical principle involved in the various instruments; also relate the principle to new application.	**4**
CO2	Comprehend the Experiments in the areas of optics, mechanics and thermal physics to nurture the concepts in all branches of Engineering.	**3**
CO3	Apply the basic concepts of Physical Science to think innovatively and also improve the creative skills that are essential for engineering.	**3**
CO4	Evaluate the process and outcomes of an experiment quantitatively and qualitatively.	**3**
CO5	Extend the scope of an investigation whether or not results come out as expected.	**3**

REFERENCES:

1. Physics Laboratory practical manual, 1st Revised Edition by Faculty members, 2018.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	2	3	2				3	1		2	1	1
2.	3	3		3		2			3	1		2	1	1
3.	3	3	2	3	2	2			3	1		2	1	1
4.	3	3		3					3	1		2	1	1
5.	3	3		3	2				3	1		2	1	1
Average	**3**	**3**	**2**	**3**	**2**	**2**			**3**	**1**		**2**	**1**	**1**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

EE22111 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

L	T	P	C
0	0	2	1

(Common to all Branches except EC)

COURSE OBJECTIVES:

1. To provide exposure to the students with hands on experience in basic of Electrical and Electronics wiring connection and measurements.
2. To introduce the students to Electrical Machines and basic laws of Electrical Circuits.

LIST OF EXPERIMENTS:

1. Wiring - Residential house wiring and Stair case wiring.
2. (a) AC Analysis - Measurement of electrical quantities - voltage, current, power, and power factor using RLC.

   (b) Study of three phase system.
3. Energy conservation - Measurement and comparison of energy for incandescent lamp and LED lamp.
4. (a) Identification of circuit components (Resistor, Capacitor, Diode and BJT) and soldering practice.

   (b) Signal Measurement - Measurement of peak to peak, RMS, average, period, frequency of signals using CRO.
5. (a) VI Characteristics of Solar photovoltaic panel.

   (b) Design of Solar PV Array and Battery sizing for Residential solar PV system.
6. Design a 5V/12V Regulated Power Supply using FWR and IC7805 / IC7812.
7. DC Analysis - Verification of Ohm's Law and Kirchhoff's Laws.
8. Study of Transformer and motor characteristics.

TOTAL: 30 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
CO1	Wiring of basic electrical system and measurement of electrical parameters.	**4**
CO2	Verifying the basic laws of Electric circuits and select various Electrical Machines.	**4**
CO3	Construct electronic circuits and design solar photovoltaic system.	**4**
CO4	Apply the concept of a three-phase system.	**4**
CO5	Construct a fixed voltage regulated power supply.	**4**

REFERENCES:

1. Mittle V.N, Arvind Mittal, "Basic Electrical Engineering", Tata Mc Graw Hill (India), Second Edition, 2013.
2. Sedha R.S., "A Text Book of Applied Electronics", S. Chand & Co., 2014.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	3	3					2			2	2	1
2.	3	3	3	3					2			2	2	1
3.	3	3	3	3					2			2	3	2
4.	3	3	3	3					2			2	1	1
5.	3	3	3	3					2			2	1	1
Average	**3**	**3**	**3**	**3**					**2**			**2**	**1.8**	**1.2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22301	BASIC AND APPLIED THERMODYNAMICS	L	T	P	C
	(Common to AE, AM)	3	1	0	4

(Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychrometric Chart permitted)

COURSE OBJECTIVES:

- To familiarize the students to understand the fundamentals of thermodynamics.
- To make the students perform thermal analysis of equipment on their behavior and performance.
- To prepare the students to understand the behaviour of gas mixtures and thermodynamic relations related to real gases.
- To make the learners to understand the steam and its generation and use as working fluid in thermal power plants.
- To make the learners to realize the importance of study of refrigeration and refrigeration cycle.

UNIT I BASIC CONCEPTS AND FIRST LAW (9+3)

Basic concepts - concept of continuum, comparison of microscopic and macroscopic approach. Path and point functions. Intensive and extensive properties, total and specific quantities. System and their types. Thermodynamic Equilibrium State, path and process. Quasi-static, reversible and irreversible processes. Heat and work transfer, definition and comparison, sign convention. Displacement work and other modes of work. Zeroth law of thermodynamics. First law of thermodynamics - application to non-flow and steady flow systems. Unsteady flow processes (Descriptive only).

UNIT II SECOND LAW AND AVAILABILITY ANALYSIS (9+3)

Heat reservoirs - source and sink. Heat Engine, Refrigerator, Heat pump. Statements of second law and its corollaries. Carnot and reversed Carnot cycles. Concept of entropy, T-s diagram, Entropy changes for ideal gases - different processes. Available and unavailable energy. Exergy and Irreversibility (Descriptive Only). I and II law Efficiency.

UNIT III GAS MIXTURES AND THERMODYNAMIC RELATIONS (9+3)

Ideal and real gas - properties and comparison - Equations of state for ideal and real gases - Reduced properties - Compressibility factor - Simple calculations using Generalised Compressibility Chart. Properties of gas mixture - Molar mass, gas constant, density, change in internal energy, enthalpy, entropy. Maxwell relations, T ds Equations, Difference and ratio of heat capacities, Energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation.

UNIT IV STEAM, STEAM NOZZLES AND STEAM POWER CYCLE (9+3)

Formation of steam and thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, supersaturated flow. Ideal and actual Rankine cycles, Reheat and Regenerative cycles. Binary and Combined cycles (Description Only).

UNIT V REFRIGERATION AND REFRIGERATION CYCLES (9+3)

Fundamentals of refrigeration, C.O.P., simple vapour compression refrigeration system, T-s, p-h diagrams, simple problems. Simple vapour absorption refrigeration system (Description Only), desirable properties of an ideal refrigerant.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
Students will be able to		
CO1	Analyze various energy transferring / transforming equipment using I law of thermodynamics.	3
CO2	Analyze various energy transforming equipment and Heat and Reversed heat engines using II law of thermodynamics.	3
CO3	Obtain different thermodynamic relations & equations for ideal and real gases from basics and to estimate the properties of gas mixtures.	3
CO4	Discuss the process of steam generation and analyze steam flow through nozzles and steam power cycles.	3
CO5	Analyze thermodynamically the refrigeration and refrigeration cycles.	3

TEXTBOOKS:

1. Nag. P.K., "Engineering Thermodynamics", 6th Edition, Tata McGraw-Hill, New Delhi,2017.
2. Natarajan. E., "Engineering Thermodynamics: Fundamentals and Applications", Anuragam Publications, 2012.
3. Rajput. R.K., "Thermal Engineering", Laxmi Publications, Tenth Edition, 2017.

REFERENCES:

1. Cengel. Y and M. Boles, "Thermodynamics - An Engineering Approach", 8th Edition, TataMcGraw Hill, 2014.
2. Holman. J.P., "Thermodynamics", 3rd Edition, McGraw-Hill, 1995.
3. Rathakrishnan. E., "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice-Hall of India Pvt. Ltd, 2006.
4. Chattopadhyay. P, "Engineering Thermodynamics", Oxford University Press, 2010.
5. Arora. C.P, “Thermodynamics”, Tata McGraw-Hill, New Delhi, 2003.
6. Van Wylen and Sonntag, “Classical Thermodynamics”, Wiley Eastern, 1987.
7. Venkatesh. A, “Basic Engineering Thermodynamics”, Universities Press (India) Limited,2007.
8. Kau-Fui Vincent Wong, "Thermodynamics for Engineers", CRC Press, Indian Reprint,2010.
9. Prasanna Kumar, "Engineering Thermodynamics", 1st Edition, Pearson Education, 2013.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	3	3	2	3	2	2	3	1	2	2	1	2	2	2
2	3	3	2	3	2	2	3	1	2	2	1	2	2	2
3	3	3	2	3	2	1	2	1	2	2	1	2	2	2
4	3	3	2	3	2	2	3	1	2	2	1	2	1	1
5	3	3	2	3	2	2	3	1	2	2	1	2	2	2
Average	**3**	**3**	**2**	**3**	**2**	**1.8**	**2.8**	**1**	**2**	**2**	**1**	**2**	**1.8**	**1.8**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22302	FLUID MECHANICS AND HYDRAULIC MACHINES (Common to AE, AM)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1 To apply the knowledge of properties and characteristics of fluid in automotive applications.
2 To analyze the major and minor losses in pipes and boundary layer concept.
3 To perform the dimensional analysis in automotive applications.
4 To classify and discuss the working principles of pumps.
5 To classify and discuss the different types of turbines.

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 9

Units and dimensions, Properties of fluids- density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity. Pressure measurement devices - U-tube manometers, pressure gauges. Flow characteristics - concept of control volume - application of continuity equation, energy equation and momentum equation - venturi, airfoil, spoiler.

UNIT II FLOW THROUGH CIRCULAR CONDUITS AND BOUNDARYLAYER 9

Hydraulic and energy gradient, Laminar flow through circular conduits, Darcy Weisbach equation -friction factor, Moody diagram, series and parallel pipes - major losses and minor losses, Boundary layer concepts - types of boundary layer thickness, Drag and Lift.

UNIT III DIMENSIONAL ANALYSIS 9

Need for dimensional analysis - methods of dimensional analysis, Similitude - types of similitude, Dimensionless parameters - application of dimensionless parameters, Model analysis - Similarity between Model and Prototype Vehicle.

UNIT IV PUMPS 9

Theory of roto-dynamic machines - various efficiencies - velocity components at entry and exit of the rotor - velocity triangles - Centrifugal pumps - working principle - work done by the impeller - performance curves, Reciprocating pumps - working principle, Rotary pumps - Gear, Vane and Lobe types.

UNIT V TURBINES 9

Classification of turbines - heads and efficiencies - velocity triangles, Axial, radial and mixed flow turbines, Pelton wheel turbine, Francis turbine and Kaplan turbines - working principles - work done by water on the runner, draft tube. Specific speed - unit quantities - performance curves for turbines.

TOTAL: 45 PERIODS

OUTCOMES:

COURSE OUTCOMES		RBT LEVEL
	Students will be able to	
CO1	Describe the fluids in static, kinematic and dynamic equilibrium.	**3**
CO2	Analyze the applicability of physical laws in addressing problems of hydraulics.	**3**
CO3	Apply dimensional analysis and modeling to describe fluid properties and dimensionless quantities.	**3**
CO4	Critically analyze the performance of rotodynamic pumps and reciprocating pumps used in automotive application.	**3**
CO5	Explain the working principle of turbines and select the type of turbine for particular application.	**3**

TEXTBOOKS

1. Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", 5th edition, Laxmi Publications Pvt. Ltd, New Delhi, 2008.
2. Rajput, R. K., "Fluid Mechanics and Hydraulic Machines", 6th edition, S. Chand Pvt. Ltd, New Delhi, 2017.

REFERENCES

1. Fox W.R. and McDonald A.T., "Introduction to Fluid Mechanics", John-Wiley and Sons, Singapore, 1995.
2. Jain A. K., "Fluid Mechanics", Khanna Publishers, 2010.
3. Roberson J.A and Crowe C.T., "Engineering Fluid Mechanics", Jaico Books Mumbai, 2000
4. Streeter, V.L., and Wylie, E.B., "Fluid Mechanics", McGraw Hill, 2000.
5. White, F.M., "Fluid Mechanics", Tata McGraw Hill, 5th Edition, New Delhi, 2003.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	3	2	1	2	1	1	1	1	1	1		1	1	1
2	3	3	2	2	2	2	2	1	2	2	1	2	2	2
3	3	3	2	2	2	1	2	1	2	2	1	2	1	1
4	3	3	2	3	2	2	2	1	2	2	1	2	3	3
5	3	3	2	2	2	2	2	1	2	2	1	2	2	2
Average	**3**	**2.8**	**1.8**	**2.2**	**1.8**	**1.6**	**1.8**	**1**	**1.8**	**1.8**	**1**	**1.8**	**1.8**	**1.8**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22303	MANUFACTURING TECHNOLOGY AND SYSTEMS (Common to AE, AM)	L 3	T 0	P 0	C 3

COURSE OBJECTIVES

1 To understand the working of standard machine tools such as lathe, shaper, planer, milling, drilling, broaching, grinding and allied machines.
2 To familiarize with the concepts of gear manufacturing and thread making.
3 To provide knowledge on the correct procedure to be adopted to measure the dimension of gears and screw threads.
4 To understand the process capabilities of unconventional machining.
5 To understand the application of computers in various aspects of manufacturing.

UNIT I MACHINING 9

General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe, Shaper, Planer, Horizontal milling machine, Universal drilling machine, Broaching machines, Cylindrical grinding machine, Capstan and Turret lathe. Super finishing processes

UNIT II MANUFACTURING AND TESTING OF GEAR, SCREW THREADS 9

Gear cutting - forming and generation principle and construction of gear milling, hobbing and gear shaping processes - finishing of gears. Thread Rolling.

Measurement of elements of screw thread and gear - techniques and measuring instruments - Screw thread Micrometers, Tool maker's microscope, Gear Tooth Vernier Caliper, Rolling gear tester, Co-ordinate measuring machine.

UNIT III COMPUTER AIDED MANUFACTURING 9

Introduction to NC systems and CNC - Machine axis and Co-ordinate system - CNC machine tools- Principle of operation CNC- Introduction of Part Programming, types - Detailed Manual part programming on Turning centres and Vertical Milling centres using G codes and M codes- Cutting Cycles, Loops, Sub program.

UNIT IV UNCONVENTIONAL MACHINING PROCESSES 9

General principles and applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining, Electro chemical grinding, Plasma arc machining, Chemical machining, Electron beam machining and Laser beam machining.

UNIT V ADVANCED MANUFACTURING PROCESSES AND SYSTEMS 9

Group Technology (GT), Part Families - Parts Classification and coding - Cellular Manufacturing - Types of Flexibility - Flexible Manufacturing System (FMS) - FMS Components - FMS Application and Benefits.

Robot Anatomy - Classification of Robots - Robot Control systems - Sensors in Robotics - Industrial Robot - Applications, Additive Manufacturing, Lean Manufacturing

TOTAL: 45 PERIODS

CO	COURSE OUTCOMES	RBT Level
1	Identify the capabilities of conventional machining processes and will select a suitable process for a particular application.	3
2	Outline the concepts of manufacturing, testing, measurement of gears and screw threads.	3
3	Apply NC and CNC programming concepts to develop part program for Lathe and Milling Machines.	3
4	Identify the capabilities of unconventional machining processes and will select a suitable process for a particular application.	3
5	Summarize the various concepts in advanced manufacturing processes and systems.	3

TEXTBOOKS

1 Hajra Choudhary S K, Hajra Choudhury A K and Nirjhar Roy, "Elements of workshop Technology", Volume II, Media promoters & Publishers Pvt. Ltd., 14th edition, 2014.

2 Rao. P.N "Manufacturing Technology: Metal Cutting and Machine Tools", 4th edition, McGraw Hill Education (India) Private Limited, New Delhi, 2018.

REFERENCES

1 I.C. Gupta, "A Textbook on Engineering Metrology", 7th Edition, Dhanpat Rai Publications, 2018.

2 Pandey P.C. and Shan H.S. "Modern Machining Processes" Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.

3 Richerd R Kibbe, John E. Neely, Roland O. Merges and Warren J. White "Machine Tool Practices", 10th edition, Pearson education, 2015.

4 HMT, "Production Technology", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2001.

5 Radhakrishnan P, Subramanyan S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Limited, New Delhi, 2004

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	2	2	2	1	1	1	1	1	1	1		1	2	2
2	2	2	1	1	1	1	1	1	1	1		1	1	1
3	3	3	2	2	2	1	1	1	2	2		2	3	2
4	2	2	2	1	1	1	1	1	1	1		1	2	2
5	2	1	1	1	1	1	1	1	1	1		1	2	1
Average	**2.2**	**2**	**1.6**	**1.2**	**1.2**	**1**	**1**	**1**	**1.2**	**1.2**		**1.2**	**2**	**1.6**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

MA22355	PARTIAL DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS (Common to AE, AM, BT, MN)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1. To introduce the effective mathematical tools for the solutions of partial differential equations forlinear and non-linear systems.
2. To provide the necessary basic concepts of a few numerical methods and give procedures forsolving numerically different kinds of problems occurring in engineering and technology.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS (9+3)

Formation of partial differential equations - Singular integrals - Solutions of standard types of first order partial differential equations - Lagrange's linear equation - Linear homogeneous partial differential equations of second and higher order with constant coefficients.

UNIT II APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS (9+3)

Classification of PDE - Method of separation of variables - Solutions of one dimensional wave equation - One dimensional equation of heat conduction - Steady state solution of two dimensional equation ofheat conduction (excluding insulated edges).

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS (9+3)

Solution of algebraic and transcendental equations - Newton Raphson method - Solution of linear system of equations - Gauss elimination method - Pivoting - Gauss Jordan method - Iterative methods of Gauss Jacobi and Gauss Seidel - Matrix Inversion by Gauss Jordan method - Eigen values of a matrixby Power method.

UNIT IV INTERPOLATION AND APPROXIMATION (9+3)

Interpolation with unequal intervals - Lagrange's interpolation - Newton's divided difference interpolation - Interpolation with equal intervals - Newton's forward and backward difference formulae.

UNIT V INITIAL AND BOUNDARY VALUE PROBLEMS IN PARTIALDIFFERENTIAL EQUATIONS (9+3)

Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

TOTAL: 45 PERIODS

CO	COURSE OUTCOMES	RBT Level
Students will be able to		
1	Express proficiency in handling higher order Partial differential equations	3
2	Develop skills in classification, formulation, solution, and interpretation of PDE model	3
3	Apply numerical technique to solve algebraic and trancendental equations.	3
4	Apply the knowledge and skills of numerical methods to do interpolation and approximation.	3
5	Acquire the skill to solve partial differential equation numerically	3

TEXT BOOKS

1 Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2011.

2 Grewal. B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, Delhi, 2012.

REFERENCES

1 Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007.

2 Glyn James, "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, 2011.

3 Veerarajan. T., "Transforms and Partial Differential Equation", Tata McGraw Hill Publishing Company Limited, New Delhi, 2012.

4 Ray Wylie. C and Barrett.L.C, "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.

5 Peter V.O' Neil, "Advanced Engineering Mathematics", Cengage Learning India pvt. Ltd. 7th Edition, New Delhi, 2012.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	3								3			
2.	3	3	3	2							3			
3.	3	3	3								3			
4.	3	3	3	2							3			
5.	3	3	3								3			
Average	**3**	**3**	**3**	**2**							**3**			

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22308	AUTOMOTIVE FUELS AND LUBRICANTS: THEORY AND PRACTICES	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES

1 To understand the extraction process of fuels and lubricants from crude oil.
2 To explore the importance of friction and in automotive engines.
3 To familiarize the requirements and properties of automotive lubricants.
4 To explore the properties and testing of automotive fuels.
5 To understand the importance choosing the fuel rating and additives.

UNIT I MANUFACTURE OF FUELS AND LUBRICANTS 9+2

Types of Fuel, Chemical structure of petroleum, refining process, thermal cracking, catalytic cracking, polymerization, reforming, alkylation, isomerisation, blending, products of refining process. Manufacture of lubricating oil base stocks, manufacture of finished automotive lubricants.

Practical - ASTM distillation test of liquid fuel

UNIT II THEORY OF LUBRICATION 9

Engine friction: introduction, total engine friction, effect of engine variables on friction, hydrodynamic lubrication, elasto-hydrodynamic lubrication, boundary lubrication, bearing lubrication, functions of the lubrication system

UNIT III LUBRICANTS 9+8

Specific requirements for automotive lubricants, oxidation deterioration and degradation of lubricants, additives and additive mechanism, synthetic lubricants, lubricating oils. Grease - classification and properties.

Practical – Flash & Fire point tests of lubricating oil, Testing of Grease - Drop point test and Mechanical penetration test.

UNIT IV PROPERTIES AND TESTING OF FUELS 9+16

Thermo-chemistry of fuels, properties of fuels - relative density, flash point, fire point, distillation, vapour pressure, spontaneous ignition temperature, viscosity, pour point, flammability, ignitability, diesel index, API gravity, aniline point, carbon residue, copper strip corrosion etc.

Practical - Testing of liquid fuels - Aniline Point test, Ash content and Carbon residue test, Cloud & Pour point tests, Copper strip corrosion test, Flash & Fire point tests, Reid vapour pressure test, Viscosity index measurement by Redwood Viscometer and Saybolt Viscometer,

UNIT V FUEL RATING AND ADDITIVES 9+4

Specifications of fuels, fuel rating - octane number – motor octane number and research octane number, cetane number, calorific value, Additives - requirements of an additive, mechanism, petrol fuel additives and diesel fuel additives.

Practical - Study of Octane and Cetane Number of fuels, Calorific value test of gaseous and liquid fuel,

TOTAL(L:45+P:30): 75 PERIODS

CO	COURSE OUTCOMES	RBT Level
1	Explain the process of manufacturing of fuels and lubricants from crude oil.	3
2	Explain the sources of friction in engine components and discuss the different types of lubrication systems in managing the friction.	3
3	Discuss the characteristics of lubricants when in use and outline the need for requirements and additives of lubricants.	3
4	Outline various properties and testing of automotive fuels.	3
5	Explain and compare the mechanism of combustion, knocking, fuel additives in spark ignition and compression ignition engines.	3

TEXTBOOKS

1 Mathur. M.L., Sharma. R.P. "Internal Combustion Engines", Dhanpatrai publication,2014.

2 Obert.E.F "Internal Combustion Engineering and Air Pollution", International book Co., 1988.

REFERENCES

1 Brame, J.S.S. and King, J.G. – "Fuels Solids, Liquids, Gaseous". Edward Arnold, 1961.

2 Francis, W, "Fuels and Fuel Technology", Vol. I & II, Pergamon, 1965.

3 Hobson, G.D. & Pohl.W, "Modern Petroleum Technology", 1974.

4 Lansdown. A.R., Lubrication, "A practical guide to lubricant selection", Pergamon press, 1982.

5 Raymond. C. Gunther, "Lubrication", Chilton Book Co., 1971.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	2	1	1	2		1	2	1	1	1		1	2	1
2.	2	2	2	1	1	1	1	1	1	1		1	2	1
3.	2	1	1	1		1	2	1	1	1		1	1	1
4.	2	1	1	1		1	2	1	1	1		1	1	1
5.	2	1	1	1		1	1	1	1	1		1	2	1
Average	**2**	**1.2**	**1.2**	**1.2**	**1**	**1**	**1.6**	**1**	**1**	**1**		**1**	**1.6**	**1**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22309 AUTOMOTIVE ENGINES : THEORY AND PRACTICES

L	T	P	C
3	0	2	4

COURSE OBJECTIVES

To make the students to

1 understand the construction and basic principles of operation of IC engines used in automobiles.
2 realize the phenomena of combustion and to understand different combustion chambers of IC engines and the experimental prediction of cylinder pressure.
3 understand the concept of forced induction and the importance of cooling and lubrication in IC engines.
4 be familiar with various loading devices used in the determination of performance parameters experimentally.
5 carryout testing on IC engines and analyze their performance and emission parameters.

UNIT I IC ENGINES CONSTRUCTION AND OPERATION 12+2

Introduction and classification of IC engines. Constructional details of spark ignition (SI) and compression ignition (CI) engines. Working principles of Four stroke and Two stroke SI and CI engines with P-V and T-S diagrams. Firing order, Comparison of SI and CI engines and four stroke and two stroke engines. Introduction to modern automotive engines - Multi Point Fuel Injection systems and CRDI systems.

Practical: Laboratory demonstration - Obtaining valve timing and port timing diagram.

UNIT II COMBUSTION AND COMBUSTION CHAMBERS 10+4

Combustion of SI and CI engines - Introduction and stages of combustion. Factors affecting flame propagation. Knock in SI and CI engines - Formation, factors affecting and comparison.

Combustion chambers of SI and CI engines - Requirements, types and factors controlling combustion chamber design. Importance of swirl, squish and turbulence.

Practical: Experimentally obtaining p-θ and p-V diagrams of IC engine.

UNIT III FORCED INDUCTION, COOLING AND LUBRICATION SYSTEMS 11+2

Concept of Supercharging and Turbocharging, Construction and Working of Superchargers and Turbochargers, Turbocharger controls - waster gate, variable geometry, variable nozzle types.

Need for engine cooling, Cooling system - Requirements and Types - air and liquid cooling systems. Thermo-syphon and forced circulation and pressurized cooling systems. Properties of coolants, coolants used in modern automotive engines.

Need for engine lubrication, Lubrication system - Requirements and Types - mist, pressure feed, dry and wet sump systems. Properties of lubricants, lubricants used in modern automotive engines.

Practical: Laboratory demonstration.

UNIT IV LOADING DEVICES AND PERFORMANCE PARAMETERS 9+2

Loading devices - Mechanical, Hydraulic and Electrical Dynamometers, Performance Test - Load test and Speed test, Mechanical, Thermal and Volumetric efficiencies, Measurement of Air flow, Fuel flow, Friction and Cylinder pressure. Engine performance maps, Engine testing standards.

Practical: Laboratory demonstration of loading devices and testing Procedure.,

UNIT V PERFORMANCE AND EMISSION TESTING 3+20

Introduction to engine emissions. Practical: Performance and emission test on two-wheeler SI engine - Performance and emission test on automotive multi-cylinder SI and CI engines - Retardation test on I.C. Engines - Heat balance test on automotive multi-cylinder SI and CI engines - Morse test on multi-cylinder SI engine.

TOTAL(L:45+P:30): 75 PERIODS

CO	COURSE OUTCOMES	RBT Level
1	Describe the construction and operation of automotive engines.	3
2	Discuss and compare the combustion process and different types of combustion chambers in automotive engines.	3
3	Discuss and compare the forced induction, cooling and lubrication systems of automotive engines.	3
4	Describe different procedures employed in the testing of automotive engines.	3
5	Measure and analyse the performance, combustion, and emission characteristics of IC engines.	3

TEXTBOOKS	
1	Ganesan V., "Internal Combustion Engines", Fourth Edition, Tata McGraw Hill, 2012.
2	Ramalingam K.K., "Internal Combustion Engines", Second Edition, SciTech Publications, 2009.
REFERENCES	
1	Heisler, "Advanced Engine Technology", SAE Publication, 1995.
2	Edward F. Obert "Internal Combustion Engines", 3rd Edition, 1970.
3	Gupta. H.N. "Fundamentals of Internal Combustion Engines", 2nd Edition, PHI Learning Pvt. Ltd. 2012.
4	Mathur and Sharma "Internal Combustion Engines", Dhanpat Rai and Sons, 2010.
5	John B. Heywood, "Internal Combustion Engine Fundamentals", 1st Edition, McGraw Hill Education, 2011

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	2	1	1			1	1	1	1	1		1	2	1
2	2	1	1			1	1	1	1	1		1	2	1
3	2	1	1			1	1	1	1	1		1	2	1
4	2	1	1			1	1	1	1	1		1	2	1
5	2	2	1		1	1	2	1	1	1		1	2	1
Average	**2**	**1.2**	**1**		**1**	**1**	**1.2**	**1**	**1**	**1**		**1**	**2**	**1**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22311	FLUID MECHANICS AND HYDRAULIC MACHINES LABORATORY	L	T	P	C
		0	0	2	1

(Common to AE, AM)

COURSE OBJECTIVES:

- Upon Completion of this subject, the students can be able to have hands on experience in flow measurements using different devices and also perform calculation related to losses in pipes and also perform characteristic study of pumps, turbines etc.,

LIST OF EXPERIMENTS:

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturi meter.
3. Calculation of the rate of flow using Rota meter.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of centrifugal pump
6. Conducting experiments and drawing the characteristic curves of reciprocating pump.
7. Conducting experiments and drawing the characteristic curves of Gear pump.
8. Conducting experiments and drawing the characteristic curves of Pelton wheel.
9. Conducting experiments and drawing the characteristics curves of Francis turbine.
10. Conducting experiments and drawing the characteristic curves of Kaplan turbine.

TOTAL: 45 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
Students will be able to:		
CO1	Use the flow measurement equipment.	**3**
CO2	Analyze the performance of various pumps.	**3**
CO3	Analyze the performance of various turbines.	**3**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Orifice meter setup — 1 No.
2. Venturi meter setup — 1 No.

3.Rotameter setup	1 No.
4.Pipe Flow analysis setup	1 No.
5.Centrifugal pump	1 No.
6.Reciprocating pump setup	1 No.
7.Gear pump setup	1 No.
8.Pelton wheel setup	1 No.
9.Francis turbine setup	1 No.
10.Kaplan turbine setup	1 No.

REFERENCES:

1 Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 2004.

2 Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co., 2010.

3 Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi, 2004.

4 Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, “Fluid Mechanics and Machinery”,2011.

5 Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	2	1	1		1	1	1	1	1	1		1	1	
2	2	1	1		1	1	1	1	1	1		1	1	
3	2	1	1		1	1	1	1	1	1		1	1	
Average	**2**	**1**	**1**		**1**	**1**	**1**	**1**	**1**	**1**		**1**	**1**	

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22312 PRODUCTION TECHNOLOGY LABORATORY **L T P C**

(Common to AE, AM) **0 0 2 1**

OBJECTIVES:

- Demonstration and study of the various machines with emphasis will be on a complete understanding of the machine capabilities and processes.

LIST OF EXPERIMENTS:

LATHE PRACTICE

a. Plain Turning
b. Taper Turning
c. Thread Cutting

Estimation of machining time for the above turning processes.

DRILLING PRACTICE

a. Drilling
b. Tapping
c. Reaming

MILLING AND GEAR MANUFACTURING

a. Round to hexagon in a Milling machine
b. Gear milling
c. Gear hobbing

PLANING AND SHAPING

a. Cutting Key Ways
b. Dove tail machining

GRINDING

a. Grinding of Cylindrical components using cylindrical grinding
b. Grinding of cylindrical components using centreless grinding

TOTAL: 45 PERIODS

Course Outcomes		RBT LEVEL
Students will be able to:		
CO1	Acquire the requisite skills to use different conventional machines to produce objects with required dimensions	**3**
CO2	Perform the finishing operations for typical components in different machines	**3**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Lathe 15 Nos.
2. Drilling Machine 1 No.
3. Milling Machine 2 Nos.
4. Planing Machine 1 No.
5. Shaping Machine 2 Nos.
6. Gear hobbing Machine 1 No.
7. Cylindrical Grinding Machine 1 No.
8. Centreless Grinder 1 No.

REFERENCES:

1. Hajra Choudhury, "Elements of Workshop Technology", Vol. I and II, Media Promoters and Publishers Pvt., Ltd., Mumbai, 2005.
2. Nagendra Parashar B.S. and Mittal R.K., "Elements of Manufacturing Processes", Prentice-Hall of India Private Limited, 2007.

COURSEARTICULATIONMATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	2	1	1		1	1	1	1	1	1		1	1	
2	2	1	1		1	1	1	1	1	1		1	1	
Average	**2**	**1**	**1**		**1**	**1**	**1**	**1**	**1**	**1**		**1**	**1**	

w), 2: Moderate (Medium), 3: Substantial (High)

AE22401	APPLIED MECHANICS	L	T	P	C
	(Common to AE, AM)	3	1	0	4

OBJECTIVES:

- To develop capability to predict the effect of force on statics of particles
- To study the basic concepts of moment and its effects on the bodies at rest or in motion
- To predict the behavior of a moving body when acted on by gravity
- To determine the effects of friction on static and moving bodies and also to analysis the forces acting on the vehicle.
- To study the relationship between energy, work, power which causes the motion of connected bodies.

UNIT I INTRODUCTION & STATICS OF PARTICLES 9 +3

Fundamental Concepts and Principles, Systems of Units, forces in a plane - force on a particle. resultant of two forces, vectors, resultant of several concurrent forces, resolution of a force into components, rectangular components of a force -unit vectors, equilibrium of a particle, forces in space - rectangular components of a force in space

UNIT II EQUIVALENT SYSTEMS OF FORCES & EQUILIBRIUM OF RIGID BODIES 9+3

External and Internal Forces, Principle of Transmissibility, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Moment of a Couple, Addition of Couples, Resolution of a Given Force into a Force and Couple. Free-Body Diagram, Equilibrium in Two Dimensions, Equilibrium in Three Dimensions

UNIT III CENTROIDS AND CENTERS OF GRAVITY 9+3

Centroids - Theorem of Pappus - Centroids of Composite figures - Centre of Gravity of a vehicle - Area moment of Inertia of vehicle frame: - polar Moment of Inertia - Transfer - Theorems - Moments of Inertia of Composite Figures - product of Inertia - Transfer Formula for product of Inertia. Moment of Inertia of Masses - Transfer Formula for Mass Moments of Inertia - Mass moment of inertia of connecting rod and crankshaft.

UNIT IV FRICTION & MOTION OF VEHICLES 9+3

The Laws of Dry Friction. Coefficients of Friction, Wedges, Wheel Friction. Rolling Resistance, Belt Drivers - Open, Crossed, compound belt and camshaft timing belt drives, Belt Friction, Types of Motions of Vehicles, Motion of a Vehicle Along a Level Track when the Tractive Force Passes Through its Centre of Gravity. Driving of a Vehicle, Motion of Vehicles on an Inclined Plane.

UNIT V KINETICS OF PARTICLES 9+3

Kinetic Energy of a Particle. Principle of Work and Energy, Power and Efficiency, Principle of Impulse and Momentum, Plane Motion of a Rigid Body. D'Alembert's Principle, Newton's Laws of Motion of Rotation, Torque and Angular Acceleration, Relation Between Kinetics of Linear Motion and Kinetics of Motion of Rotation, Flywheel, Motion of Two Bodies Connected by a String and Passing Over a Pulley.

TOTAL(L:45+T:15): 60 PERIODS

	COURSE OUTCOMES	RBT Level
CO1	Explain the different principles applied to solve engineering problems dealing with force, displacement, velocity and acceleration.	3
CO2	Analyze the frictional forces acting on a system and examine the velocity and acceleration inducing on a body with rectilinear and curvilinear motions.	4

CO3	Identify and examine the centroid, center of gravity, area moment of inertia and mass moment of inertia.	4
CO4	Identify and analyze the application of friction force on various belt drives and vehicle motions.	4
CO5	Investigate the dynamic forces subjected to a rigid body.	4

TEXTBOOKS

1 Rajput. R.K., "A Textbook of Applied Mechanics", 3rd Edition, Laxmi Publications, 2016.

2 Timashenko. S, Young. D.H., Rao. J.V. and Sukumar Pati, "Engineering Mechanics", 1 St Edition, McGraw Hill Education, 2017.

REFERENCES

1 Arthur P. Boresi and Richard J. Schmidt, "Engineering Mechanics (Statics and Dynamics)", 1st Edition, Cengage Learning India Pvt. Ltd, 2007.

2 Tayal. A.K, "Engineering Mechanics Statics and Dynamics", 14th Edition, Umesh Publications, 2011.

3 Nelson E.W, Charles L. Bes, McLean W.G. and Merle Potter, "Engineering Mechanics Dynamics (Schaum's Outlines)",McGraw-Hill Education; 1st edition, 2010.

4 Hibbeler R.C, "Engineering Mechanics - Statics and Dynamics", Pearson Education India; 11th edition, 2009.

5 R. S. Khurmi and N. Khurmi, "A Textbook of Applied Mechanics", S. Chand Publication, 2010.

Web Link

https://dvr1980.files.wordpress.com/2020/01/applied_mechanics_theory_by_r_k_rajput-1.pdf

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	2	2	2	1	1	1	1	1	1	2	3	3
2.	3	3	2	2	2	1	1	1	1	1	1	2	3	3
3.	3	3	2	2	2	1	1	1	1	1	1	2	3	3
4.	3	3	2	2	2	1	1	1	1	1	1	2	3	3
5.	3	3	2	3	2	1	1	1	1	1	1	2	3	3
Average	**3**	**3**	**2**	**2.2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**3**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22402 **AUTOMOTIVE ELECTRICAL, ELECTRONICS AND MICROCONTROLLER SYSTEMS**

(Common to AE, AM)

L	T	P	C
3	0	0	3

OBJECTIVES:

- It is essential to know the working of electrical and electronic systems.
- To understand the working of starting system, charging system of an engine for smooth operation.
- To understand the working of ignition and injection system of an engine.
- To enhance the knowledge of sensor and microprocessor applications in vehicle control systems.
- To gain knowledge in modern safety systems.

UNIT I INTRODUCTION TO ELECTRICAL AND ELECTRONICS ACCESSORIES **9**

Basic electrical principles, electronic components and circuits, digital electronics, microprocessor systems, electrical wiring, terminals and switching, circuit diagrams and symbols, dashboard instruments, horn, trafficator.

UNIT II STARTING SYSTEM, CHARGING SYSTEM, LIGHTING SYSTEM **9**

Starter motor characteristics, drive mechanisms, DC Generators, Alternators and their characteristics, electronic regulators. Vehicle interior lighting system, vehicle exterior lighting system, lighting design.

UNIT III ELECTRONIC IGNITION AND INJECTION SYSTEM 9

Spark plugs, different types of ignition systems, Electronically controlled advance mechanisms, Electronic fuel injection systems, mono and multi point fuel injection systems.

UNIT IV SENSORS AND MICROPROCESSORS IN AUTOMOBILES **9**

Basic sensor arrangements, Types of sensors – Manifold absolute pressure sensor, Engine coolant sensor, Air temperature sensor, TMAP sensor, oxygen sensor, Mass air flow sensor, vehicle speed sensor, detonation sensor, accelerometer sensor, crank position sensor, engine speed sensor, Microprocessor and microcomputer controlled devices in automobiles such as voice warning system, travel information system, keyless entry system, and electronic steering system.

UNIT V SAFETY SYSTEMS **9**

Antilock braking system, air bag restraint system, voice warning system, seat belt system, road navigation system, anti-theft system.

TOTAL: 45 PERIODS

OUTCOMES		
COURSE OUTCOMES		**RBT LEVEL**
	Students will be able to	
CO1	Describe the basic principles of electrical, electronics and automotive dashboard instruments	**3**
CO2	Identify the requirements and discuss the automotive starting system, charging system and lighting system.	**3**
CO3	Outline the application of electronics in automotive ignition and injection system.	**3**
CO4	Illustrate the working of sensors and microcomputer controlled devices in automobiles.	**3**
CO5	Outline the working principle of safety systems employed in vehicles.	**3**

TEXTBOOKS

1 Judge A.W, "Modern Electrical Equipment of Automobiles", Chapman & Hall, London, 1992.

2 William Ribbens, "Understanding Automotive Electronics", 8th Edition, Butterworth Heinemann, 2017.

REFERENCES

1 Crouse W.H, "Automobile Electrical Equipment", Mc Graw Hill Book Co Inc. New York, 2005.

2 Robert N Brady, "Automotive Computers and Digital Instrumentation", A Reston Book, Prentice Hill, Eagle Wood Cliffs, New Jersey, 1988.

3 Spread bury F.G, "Electrical Ignition Equipment", Constable & Co Ltd., London, 1962.

4 Tom Denton, "Automotive Electrical and Electronics Systems", 5th edition, Routledge, 2017.

5 Young A.P, & Griffiths L, "Automobile Electrical Equipment", English Language Book Society & New Press, 1990.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	2	2	2	1	2	1	1	1	1	2	1	2	2	3
2.	3	2	3	2	2	1	1	1	1	2	1	2	2	3
3.	3	2	3	2	3	1	2	1	1	2	1	2	3	3
4.	3	2	3	2	3	2	2	1	1	2	1	2	2	3
5.	3	2	3	2	3	3	1	2	1	2	1	2	2	3
Average	**2.8**	**2**	**2.8**	**1.8**	**2.6**	**1.6**	**1.4**	**1.2**	**1**	**2**	**1**	**2**	**2.2**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22403	THERMAL ENGINEERING AND HEAT TRANSFER	L	T	P	C
	(Common to AE, AM)	3	1	0	4

COURSE OBJECTIVES:

1. To familiarize the students to know thermodynamic cycles for analyzing IC engines and air compressors.
2. To make the students understand the properties of moist air and its importance and impact on the designing of air conditioning systems.
3. To prepare the students to understand various modes of heat transfer and analyse the conduction heat transfer in various applications.
4. To make the students exposed to various regions in the thermal boundary layer and analyse various flow conditions and also to make the students understand mass transfer concepts.
5. To make the students understand the radiation and various modes of heat transfer in heat exchangers.

UNIT I GAS POWER CYCLES AND AIR COMPRESSORS 9 +3

Air standard cycles: Otto, Diesel, Dual - Work output, Efficiency and MEP calculations. Comparison of the cycles for same compression ratio and heat addition, same compression ratio and heat rejection, same peak pressure, peak temperature and heat rejection, same peak pressure and heat input, same peak pressure and work output, Simple Brayton cycle.

Single acting and double acting air compressors, work required, effect of clearance volume, volumetric efficiency, isothermal efficiency, free air delivery. Rotary compressors (Descriptive only).

UNIT II PSYCHROMETRY AND AIR CONDITIONING 9+3

Psychrometric properties and chart. Property calculations of air vapour mixtures by using chart and expressions. Psychrometric processes - adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing.

Air conditioning system - Processes, Types and Working Principles - Concept of RSHF, GSHF, ESHF - Cooling load estimation (Descriptive only).

UNIT III CONDUCTION 9+3

Basic Concepts, Mechanism of Heat Transfer: Conduction, Convection and Radiation. General Differential equation of Heat Conduction, Fourier Law of Conduction in Cartesian Coordinates, One Dimensional Steady State Heat Conduction through Plane Wall, Cylinders and Spherical systems and Composite Systems. Conduction with Internal Heat Generation. Extended Surfaces. Unsteady Heat Conduction: Lumped analysis, Simple problems. Use of Heisler chart (Descriptive only).

UNIT IV CONVECTION 9+3

Basic Concepts, Convective Heat Transfer Coefficients, Boundary Layer Concept. Forced Convection: Flow over Plates, Cylinders and Spheres and Bank of tubes. Laminar and Turbulent Flow through tubes. Free Convection: Flow over Vertical Plate.

Introduction to Mass Transfer – Basic concepts.

UNIT V RADIATION AND HEAT EXCHANGERS 9+3

Basic Concepts, Laws of Radiation: Stefan Boltzman Law, Kirchoff Law. Black Body Radiation, Grey body radiation, Shape Factor, Electrical Analogy, Radiation Shields, Introduction to Gas Radiation.

Heat Exchangers: Parallel, Counter and Cross flow, LMTD, simple problems. Heat exchangers in automotive applications. Introduction to NTU concept.

TOTAL (L:45+T:15) : 60 PERIODS

OUTCOMES:

COURSE OUTCOMES		RBT LEVEL
CO1	Analyse the thermodynamic cycles of internal combustion engines, and air compressors.	3
CO2	Discuss the properties of moist air and use Psychrometric chart to analyse the properties of moist air and explain the basic working principles of various types of air conditioning systems.	3
CO3	Classify the various modes of heat transfer and estimate the rate of heat transfer by steady state and unsteady state conduction.	3
CO4	Discuss the phenomenon of boundary layer and estimate the rate of heat transfer by convective heat transfer.	3
CO5	Discuss the concept of radiation and estimate the rate of heat transfer by radiation heat transfer. Also analyse the performance of heat exchangers based on flow pattern.	4

TEXTBOOKS:

1. R.K. Rajput, "Applied Thermodynamics", 2nd edition, Laxmi Publishing (P) Ltd., New Delhi, 2016.
2. J.P. Holman, "Heat Transfer", 10th edition, Tata McGraw Hill, 2009.
3. Kothandaraman. C.P., Domkundwar. S, Domkundwar. A.V., "A course in Thermal Engineering", Fifth Edition, Dhanpat Rai & Sons, 2002.

REFERENCES:

1. P.K. Nag, "Heat Transfer", 3rd edition, Tata McGraw Hill, New Delhi, 2011.
2. C.P. Kothandaraman, "Fundamentals of Heat and Mass Transfer", 6th edition, New Age International, New Delhi, 2010.
3. P.K. Nag, "Basic and Applied Thermodynamics", 2nd edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2009.
4. Arora. C.P, "Refrigeration and Air Conditioning", Tata McGraw-Hill Publishers, 1994.
5. Rajupt. R.K., "Thermal Engineering", Laxmi Publications, Tenth Edition, 2017.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	3	2	3	2	2	1	1	2	1	2	3	2
2.	2	2	3	2	3	2	2	1	1	2	1	2	0	1
3.	3	3	3	2	3	2	2	1	1	2	1	2	2	1
4.	3	3	3	2	3	2	2	1	1	2	1	2	2	1
5.	3	3	3	2	3	2	2	1	1	2	1	2	0	1
Average	**2.8**	**2.8**	**3**	**2**	**3**	**2**	**2**	**1**	**1**	**2**	**1**	**2**	**1.4**	**1.2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22408	AUTOMOTIVE CHASSIS COMPONENTS: THEORY AND PRACTICES (Common to AE, AM)	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES

1. To make the student to be familiar with the Constructional details of chassis vehicle frames, front axles and steering systems
2. To familiarize the student in Constructional details and Theory of important drive line and differential
3. To understand the constructional feature of wheels and tyres.
4. To gain knowledge about the requirement of suspension and its types.
5. To make the student to be understand with the concept and various types of brake system.

UNIT I FRAME, FRONT AXLE AND STEERING SYSTEM 9+6

Basic construction of chassis, Types of chassis layout with reference to power plant location and drive, various types of frames, Loads acting on vehicle frame, types of front axles and stub axles, Front wheel geometry. Condition for true rolling motion, Ackerman's and Davi's steering mechanisms, Steering linkages, Different types of steering gear boxes, Slip Angle, over–Steer and under–Steer, Reversible and Irreversible steering, Power Steering. ‘

Practical –dismantling and assembling of front axle and steering system of automotive vehicle.

UNIT II DRIVE LINE, FINAL DRIVE AND DIFFERENTIAL 9+6

Driving thrust, Torque reactions and Side thrust and its effects, Hotchkiss drive, Torque tube drive, Radius rods and Stabilizers, Propeller shaft, Universal Joints, Constant velocity universal Joints. Final drive and its types, double reduction final drive, twin speed rear axle, Differential principle, constructional details of differential unit, differential housings, non–slip differential, differential locks.

Practical – dismantling and assembling of driveline system of automotive vehicle.

UNIT III REAR AXLES, WHEELS, RIMS AND TYRES 9+6

Construction of rear axles, Types of loads acting on rear axles, Full –floating, Three–Quarter floating and Semi–floating axles, Multi axles vehicles. Wheels and Rims, types of tyres and their constructional details. Fifth wheel coupling and tow hitch.

Practical - dismantling and assembling of rear axle system of automotive vehicle.

UNIT IV SUSPENSION SYSTEM 9+6

Requirement of suspension system, types of suspension springs, Constructional details and characteristics of single leaf, multi–leaf spring, coil and torsion bar springs, rubber, pneumatic and hydro – elastic suspension spring systems. Independent suspension system, Shock absorbers, Active suspension system.

Practical - dismantling and assembling of suspension system of automotive vehicle.

UNIT V BRAKE SYSTEMS 9+6

Need for Brake systems, Stopping Distance, Braking Efficiency, Effect of Weight Transfer during Braking, Classification of brakes, Braking Torque, drum brake and disc Brake Theory, Types and Construction of Hydraulic Braking System, Mechanical Braking System, Pneumatic Braking System, Power–Assisted Braking System, Servo Brakes, Retarders- Principles and its types – Antilock braking systems (ABS). Principle of Electronic Brake force distribution, Corner Stability Program.

Practical -dismantling and assembling of braking system of automotive vehicle.

TOTAL (L:45 +T:30) : 75 PERIODS

OUTCOMES		
	COURSE OUTCOMES	**RBT LEVEL**
CO1	Compare the different types of chassis layout, frames, steering systems and explain the front wheel geometry.	**3**
CO2	Explain the concepts of drive line and its components.	**3**
CO3	Select the rear axle, wheel, rim and tyre for a given vehicle.	**3**
CO4	Compare the characteristics of different types of suspension springs and explain the construction/working of different types of suspension systems.	**3**
CO5	Explain the construction/working of different types of braking systems and its components.	**3**

TEXTBOOKS

1. Devaradjane. Dr. G., Dr. M. Kumaresan, "Automobile Engineering", AMK Publishers, 2013.
2. Newton Steeds and Garret, "Motor Vehicles" 13th Edition, Butterworth, London, 2005.
3. Heinz Hazler, "Modern Vehicle Technology", Butterworth, London, 2005.

REFERENCES

1. Giri. N.K., "Automotive Mechanics", Khanna Publishers, New Delhi, 2005.
2. Heldt P.M., "Automotive Chassis" Chilton Co., New York, 1990.
3. Milliken & Milliken, "Race Car Vehicle Dynamics", SAE, 1995.
4. R.K. Rajput, "A Text–Book of Automobile Engineering", Laxmi Publications Private Limited, 2007.

E-BOOKS

1. https://books.google.co.in/books?id=nBVefxD_0agC&printsec=frontcover&dq=Automobile+engineering&hl=en&sa=X&ved=0ahUKEwjvgs3Por3gAhVQcCsKHQbTANYQ6AEIKDAA#v=onepage&q&f=false

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	3	2	3	2	2	1	1	2	1	2	2	3
2.	3	3	3	2	3	2	2	1	1	2	1	2	3	2
3.	3	3	3	2	3	2	2	1	1	2	1	2	2	3
4.	3	3	3	2	3	2	2	1	1	2	1	2	2	3
5.	3	3	3	2	3	2	2	1	1	2	1	2	2	3
Average	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**1**	**1**	**2**	**1**	**2**	**2.2**	**2.8**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE 22409 MECHANICS OF SOLIDS: THEORY AND PRACTICES L T P C

(Common to AE, AM) **3 0 2 4**

COURSE OBJECTIVES

1 To develop the relationship between the loads applied to a non-rigid body and the internal stresses and deformations induced in the body along with testing of metals.
2 To demonstrate to the student in calculating shear force bending stresses and bending moment diagrams.
3 To make the students learn Deflection and slopes in various types of beams for different loading conditions.
4 To solve practical problems related to springs and shafts.
5 To do the analysis of stresses in two dimensions.

UNIT I STRESS, STRAIN, AND DEFORMATION OF SOLIDS 9+6

Elementary definition of stress and strain – Tension, Compression, Shearing stress, and Strain-stress-strain relationship - Hooke's law - Deformation of simple and compound bars – Composite bars – Thermal stresses – Poisson's ratio – Elastic constants.

Practical - Tension test and Hardness test on metals.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9+6

Beams – types transverse loading on beams, Shear force, and bending moment in beams. Construction of Shear force and Bending moment diagrams for different types of static loading on the cantilever, simple supported and overhanging beams.

Theory of simple bending, bending stresses, section modulus, bending stress, and shear stress distribution in beams.

Practical - Double shear test on mild steel and aluminum rods.

UNIT III DEFLECTION OF BEAMS 9+6

Governing differential equation – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam method.

Practical - Deflection test on the cantilever and simply supported beams.

UNIT IV TORSION OF SHAFTS AND SPRINGS 9+6

Torsion formulation stresses and deformation in circular and hollow shafts – Stepped shafts– Deflection in shafts fixed at both ends-Stresses in helical springs – Deflection of helical springs subjected to tension only, Leaf springs.

Practical - Compression test on helical springs and Torsion test on the mild steel rod.

UNIT V ANALYSIS OF STRESSES IN TWO DIMENSIONS 9+6

Biaxial state of stress – Stress at a point – stresses on inclined planes – Principal stresses and Principal strains and Mohr's circle of stress.

Stresses in thin cylindrical shells due to internal pressure - circumferential and longitudinal stresses - Deformation in Thin cylinders and Thin spherical shells.

Practical - Impact test on metals.

TOTAL (L:45+P:30) : 75 PERIODS

OUTCOMES		
Course Outcomes		**RBT LEVEL**
Upon completion of the course, students will be able to:		
CO1	Predict the behavior of the materials for different loading conditions and characteristics of materials.	**3**

CO2	Select suitable cross-sections for the beams and springs based on theoretical and experimental work.	**3**
CO3	Estimate the Deflection of beams under a different types of loading conditions.	**3**
CO4	Select the dimensional parameters for the shafts and springs under torsion loads through the different types of testing.	**3**
CO5	Develop a basic understanding of Biaxial Stresses and impact tests on metals.	**3**

TEXTBOOKS

1. Bansal, R.K., "A Textbook of Strength of Materials", Laxmi Publications (P) Ltd., 2017
2. R S Khurmi Strength of Materials, KHANNA Publications New-Delhi 2014.
3. Jindal U.C., "Strength of Materials", Pearson Education **,** 2012.

REFERENCES

1. Rattan, “Strength of Materials”, McGraw Hill Education, 3rdEdition, 2017.
2. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, 10thEdition, 2016.
3. Popov E.P, "Engineering Mechanics of Solids", Prentice-Hall of India, New Delhi 2014.
4. Ferdinand P. Beer, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", McGraw Hill Education, 2005.
5. Ramamrutham S and Narayan R, "Strength of Materials", Dhanpat Rai and Sons, New Delhi, 1997.

Web Link

https://books.google.co.in/books?id=QV3qBwAAQBAJ&pg=PA193&lpg=PA193&dq=mohr%27s+circles+simulation&source=bl&ots=KX1uJDqIVX&sig=WvLFnPPiTRfq8Sv463CExdkMO7g&hl=en&sa=X&ved=0ahUKEwi-k7rjhd_ZAhXLMo8KHWICdEQ6AEIczAI#v=onepage&q=mohr's%20circles%20simulation&f=false

https://books.google.co.in/books?id=2IHEqp8dNWwC&printsec=frontcover&dq=strength+of+materials&hl=en&sa=X&ved=0ahUKEwiSstLJiN_ZAhVBRY8KHY2iCVgQ6wEIJzAA#v=onepage&q=strength%20of%20materials&f=false

https://books.google.co.in/books?id=UUAi8JrJqDIC&printsec=frontcover&dq=strength+of+materials&hl=en&sa=X&ved=0ahUKEwiSstLJiN_ZAhVBRY8KHY2iCVgQ6wEIMzAC#v=onepage&q=strength%20of%20materials&f=false

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	3	3	3	2	2	1	1	2	1	2	2	3
2.	3	3	3	3	3	2	2	1	1	2	1	2	2	3
3.	3	3	3	3	3	2	2	1	1	2	1	2	2	3
4.	3	3	3	3	3	2	2	1	1	2	1	2	3	3
5.	3	3	3	3	3	2	2	1	1	2	1	2	2	2
Average	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**2**	**1**	**2**	**2.2**	**2.8**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

GE22401	ENVIRONMENTAL SCIENCES AND SUSTAINABILITY (Common to All Branches)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution.
- To study and understand the various types of renewable sources of energy and their applications.
- To familiarize the concept of sustainable development goals, economic and social aspects of sustainability, recognize and analyze climate changes, and environmental management challenges.
- To inculcate and embrace sustainability practices, develop a broader understanding of green materials and energy cycles, and analyze the role of sustainable urbanization.

UNIT I ENVIRONMENT AND BIODIVERSITY 9

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– food chains, food webs and ecological pyramids, ecological succession. Biodiversity- types- genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: fragmentation and habitat loss, poaching of wildlife, human-wildlife conflicts – endangered and endemic species of India –conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION 9

Definition, causes, effects and preventive measures of air, water and soil pollution. Marine and thermal pollution - causes, effects and control measures. Light and noise pollution-effect on flora and fauna. Nuclear pollution- Sources, effects and control measures. Disposal of radioactive wastes (Nuclear hazards). Pollution case studies. Role of an individual in the prevention of pollution. Solid, hazardous and E-waste management. Occupational health and safety management system (OHASMS). Environmental protection, Environmental protection acts, categorization of spices according to IUCN.

UNIT III RENEWABLE SOURCES OF ENERGY 9

Energy resources: Growing energy needs, Nonrenewable resources – types, uses. Energy management and conservation - New energy sources, Need of new sources - geo suitability of establishing renewable energy sources, different types new energy sources. Applications of hydrogen energy, ocean energy resources, Tidal energyconversion. Concept, origin and power plants of geothermal energy. Role of an individual in conservation of energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT 9

Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols, Sustainable Development Goals-targets, indicators and intervention areas - Principles of green chemistry, Climate change- Global, Regional and local environmental issues and possible solutions-case studies - Role of non-governmental organization,Concept of carbon credit, carbon footprint - Environmental management in industry-A case study,

UNIT V SUSTAINABILITY PRACTICES 9

Zero waste and R concept, circular economy, ISO 18000 series, material life cycle assessment, environmental impact assessment. Wasteland reclamation,Sustainable habitat: green buildings, green materials, energy efficiency and energy audit, sustainable transports. Energy cycles,

carbon cycle, emission and sequestration, Green engineering: sustainable urbanization- socio-economical and technological change. Rainwater harvesting, watershed management, environmental ethics: Issues and possible solutions.

TOTAL: 45 PERIODS

OUTCOMES		
COs	**COURSE OUTCOMES**	**RBT LEVEL**
After completion of this course, the students will be able to		
CO1	Explain the fundamental role of ecosystems and biodiversity and discuss the importance of their conservation.	2
CO2	Describe the different types of pollution, their effects and strategies to minimize or eliminate pollution.	2
CO3	Identify the need of renewable and non-renewable resources and describe energy management measures to preserve them for future generations.	2
CO4	Explain the various goals of sustainable development applicable for suitable technological advancement and societal development.	2
CO5	Demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.	2

TEXT BOOKS:

1. AnubhaKaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 7th Edition, NewAge International Publishers, 2022.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd edition,Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Pearson. 2011.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design anddevelopment, CL Engineering, 2015.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

REFERENCES

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House,Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 3rdedition, 2015.
5. ErachBharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient BlackswanPvt. Ltd. 3rd edition, 2021.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3					3	3	2		2		1		
2.	3					3	3	2		2		2		
3.	3		1			3	3	1		2		1		
4.	3					3	3	3		2		2		
5.	3					3	3	3		2		2		
Average	**3**		**1**			**3**	**3**	**2.2**		**2**		**1.6**		

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE 22411	AUTOMOTIVE ELECTRICAL, ELECTRONICS AND MICROCONTROLLER LABORATORY	L	T	P	C
	(Common to AE, AM)	0	0	3	1.5

COURSE OBJECTIVES	
1	To train the Students on various test equipment for automotive electrical and electronics systems.
2	To familiarize the students on fundamentals of working on electronics systems.
3	To familiarize the students on fundamentals of working on various microcontrollers and controllogic.

LIST OF EXPERIMENTS:

LIST OF EXPERIMENTS	
ELECTRICAL LABORATORY	
1.	Testing of batteries and battery maintenance
2.	Testing of Starter motor and alternator
3.	Testing of regulators
4.	Diagnostics of ignition system faults
5.	Study of Automobile Electrical wiring
6.	Study of electric horn and wiper motor
7.	Study of components of electric two wheeler
ELECTRONICS LABORATORY	
8.	Study of 8 bit Microcontroller architecture and programming.
9.	Perform 8 bit arithmetic and logic operations.
10.	Perform code conversion.
11.	Interfacing of ADC with Microcontroller.
12.	Interfacing of DAC with Microcontroller.
13.	Interfacing Programmable Keyboard and Display Controller with Microcontroller.
14.	Sensor interfacing with Microcontroller.
15.	Stepper motor interfacing with Microcontroller.
16.	DC motor interfacing with Microcontroller.

TOTAL: 45 PERIODS

OUTCOMES:

Course Outcomes		RBT LEVEL
Students will be able to:		
CO 1	Identify and troubleshoot the faults in various automotive electrical systems.	**3**
CO 2	Develop programs for arithmetic and logical operations in 8051.	**3**
CO 3	Develop programs for various peripheral interfacing with 8051.	**3**
CO 4	Develop programs for sensor and actuator interfacing with 8051.	**3**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Batteries, hydrometer, refractometer, multimeter	3 No. each
2. Starter motor, regulator,	1 No. each
3. Distributor, ignition coil, sparkplug	1 No. each
4. Auto electrical wiring system	1 No.
5. Electric horn and wiper motor	2 No. each
6. Starter motor alternator test rig	1 No.
7. Electric Two Wheeler	1 No.
8. 8051 Microcontroller development Kit	10 Nos.
9. ADC Interfacing Kit	3 Nos.
10. DAC Interfacing Kit	3 Nos.
11. Stepper Motor Interfacing Kit	3 Nos.
12. DC Motor Interfacing Kit	3 Nos.
13. Keyboard Interfacing Kit	3 Nos.
14. Sensor Interfacing Kit	3 Nos.
15. CRO	3 Nos.
16. Stepper Motor & DC Motor	3 Nos.

REFERENCES:

1. Judge. A.W., "Modern Electrical Equipment of Automobiles", Chapman & Hall, London, 1992.
2. Robert N Brady "Automotive computers and Digital Instrumentation". A Reston Book, Prentice Hill, Eagle Wood Cliffs, New Jersey, 1988.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	3	3	3	3	3	2	2	1	2	3	1	2	2	3
2	2	2	2	1	3	1	1	1	2	2	1	3	1	3
3	2	2	3	1	3	1	1	1	2	2	1	3	1	3
4	2	2	3	1	3	1	1	1	2	2	1	3	1	3
Average	**2.25**	**2.25**	**2.75**	**1.5**	**3**	**1.25**	**1.25**	**1**	**2**	**2.25**	**1**	**2.75**	**1.25**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22412 VEHICLE MAINTENANCE LABORATORY I

L	T	P	C
0	0	3	1.5

OBJECTIVES:

- Demonstrate and study of the various vehicle components for servicing them.
- To impart the technical knowledge for servicing the various electrical components

LIST OF EXPERIMENTS:

1. a) Inspection and replacement of engine oil and transmission oil.
   b) Inspect and replacing of coolant, air filter and oil filter.
2. Inspection and servicing of sliding controlled and vacuum controlled carburetor.
3. Cleaning and servicing of two wheeler braking and clutch system.
4. Inspection and adjustment of inlet and exhaust valve clearance.
5. Decarburizing the piston and checking the engine compression (Cylinder pressure).
6. Inspection and adjustment of chain drive used in final drive.
7. Study of DVOM with simple measurements.
8. Diagnosing of various electrical circuits like headlight, horn, trafficators, tail lamp and brake light, etc.
9. Diagnosing of various components of fuel injection system and obtain the waveform of various sensors.
10. Diagnosing of various sensors using on board diagnostics tool.

TOTAL: 45 PERIODS

OUTCOMES:

	Course Outcomes	RBT LEVEL
Students will be able to:		
1	Acquire the requisite skills to service the vehicle	**3**
2	Diagnose the various vehicle components	**3**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Two wheeler 1 No
2. Four wheeler 1 No
3. Carburators 2 Nos.
4. DVOM 2 Nos.
5. Osciloscope 1 No.
6. OBD tool 1 No.

REFERENCES:

1. William M. Metts, "Vehicle Maintenance Book", Independently Published, 2019.
2. William H Crouse, Donald L Anglin, "Automotive Mechanics", 10th edition, McGraw Hill Education, 2017.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	1	1	1	1	2	1	1	1	2	2	1	3	1	3
2	2	3	1	2	3	1	1	1	3	3	1	2	1	3
Average	**1.5**	**2**	**1**	**1.5**	**2.5**	**1**	**1**	**1**	**2.5**	**2.5**	**1**	**2.5**	**1**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22501	AUTOMOTIVE TRANSMISSION	L	T	P	C
	(Common to AE, AM)	3	0	0	3

OBJECTIVES:

- To familiarize the students to understand the basics of the clutch, gearbox and its types.
- To impart the knowledge to the students about the various hydrodynamic transmission.
- The detailed concept, construction, and principle of operation of various types of automatic transmission systems will be taught to the students.
- To understand the need and different applications of automatic transmission.
- To know about the various hydrostatic transmission and electric drive units of automobiles.

UNIT I CLUTCH AND GEAR BOX 9

Requirement of transmission system, Clutch - requirements, construction and working principle - single plate coil spring and diaphragm spring, multi-plate.

Gear box - need, objectives, construction and operation of Sliding mesh, Constant mesh and Synchromesh gearbox, Performance characteristics, Determination of gear ratios and performance of automobile - resistance to motion, tractive effort, engine speed, power and acceleration.

UNIT II HYDRODYNAMIC TRANSMISSION 9

Fluid coupling - Principle, constructional details, torque capacity, performance characteristics, reduction of drag torque.

Torque converter - Principle, constructional details, performance characteristics, Multistage torque converter and Polyphase torque converter.

UNIT III EPICYCLIC GEARBOXES USED IN AUTOMATIC TRANSMISSION 9

Principle of Planetary gear trains - Wilson Gear box, Simpson planetary gear train, Ravigneaux planetary gear train, Lepelletier gear train, Cotal electromagnetic transmission, Hydraulic control system for Automatic Transmission.

UNIT IV AUTOMATIC TRANSMISSION APPLICATIONS 9

Need for automatic transmission, Four speed longitudinally mounted automatic transmission - Chevrolet Turboglide Transmission, Continuously Variable Transmission (CVT) - Types - operations of a typical CVT, ShiftFX electronic shift transmission.

UNIT V HYDROSTATIC AND ELECTRIC DRIVE 9

Hydrostatic drive - Various types of hydrostatic system - Principles of Hydrostatic drive system, advantages and limitations, Comparison of hydrostatic drive with hydrodynamic drive, construction and working of typical Janny hydrostatic drive.

Electric drive - types - Principle of early and modified Ward Leonard Control system, advantages and limitations.

TOTAL: 45 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to:		
CO1	Apply the basic concepts in selection of the clutch and gear box for a vehicle.	**3**
CO2	Select the elements of automatic transmission based on the simplicity, application and cost.	**3**
CO3	Compare the salient features of various automatic transmission systems.	**3**
CO4	Discuss the need and functions of different types of automatic transmission systems used in vehicles	**3**
CO5	Explain the features of hydrostatic drive & electric drive with merits and demerits	**3**

TEXT BOOKS:

1. Jack Erkavec, "Automotive Technology-A Systems Approach", Cengagelearning, Delmar,2010.
2. Newton K and Steeds W, "The Motor Vehicle",13th edition, ButterworthHeinemann, 2000.

REFERENCES:

1. Crouse, W.H, Anglin, D.L, "Automotive Transmission and Power Trains Construction", McGraw Hill, 1976.
2. Fischer. R, Kucukay F, Jurgens. G, Najork. R and Pollak B, "The Automotive Transmission Book", Springer International Publishers, 2015.
3. Heinz Heisler, "AdvancedVehicle Technology", Butterworth-Heinemann, Elsevier, India Edition, 2011.
4. Heldt P.M., "Torque Converters", Chilton Book Co., 1962.
5. JudgeA.W, "Modern Transmission System", Chapman and Hall Ltd, 2000.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	2	2	3	1	1	1	3	3	2	2	3	2
2.	3	3	2	2	3	1	1	1	3	3	2	2	3	2
3.	3	3	2	2	3	1	1	1	3	3	2	2	3	2
4.	3	3	2	2	3	1	1	1	3	3	2	2	3	2
5.	3	3	2	2	3	1	1	1	3	3	2	2	3	2
Average	**3**	**3**	**2**	**2**	**3**	**1**	**1**	**1**	**3**	**3**	**2**	**2**	**3**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22502	DESIGN OF MACHINE ELEMENTS AND TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

(Common to AE, AM)

OBJECTIVES:

- To familiarize the various steps involved in the design process.
- To know the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
- To gain knowledge on the principles and procedure for the design of gears, gear boxes and brakes.
- To learn to use standard practices and standard data.
- To learn to use catalogues and standard machine components.

(Use of Approved Design Data Book is permitted)

UNIT I STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 9

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams - Factor of safety - theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.

UNIT II SHAFTS AND COUPLINGS 9

Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways - Rigid and flexible couplings.

UNIT III MECHANICAL JOINTS AND BEARINGS 9

Threaded fasteners - Bolted joints – Welded joints, riveted joints for structures. Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, Selection of Rolling Contact bearings.

UNIT IV SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears.

UNIT V GEAR BOXES AND BRAKES 9

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi-speed gear box for machine tool applications -Constant mesh gear box, Speed reducer unit. Variable speed gear box, Design of disc brakes

TOTAL: 45 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to:		
CO1	Discuss the various types of stresses developing on machine elements.	**3**
CO2	Discuss and design the shaft as well as the various types of mechanical coupling.	**3**
CO3	Design and examine the various types of mechanical joints and bearings.	**3**
CO4	Design and justify the types of gear used in the various mechanical systems.	**3**
CO5	Discuss and design the various types of gear boxes and braking systems.	**3**

TEXT BOOKS:

1. Bhandari. V, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett, "Mechanical Engineering Design", 10th Edition, Tata McGraw-Hill, 2015.

REFERENCES:

1. Bernard Hamrock, Steven Schmid,Bo Jacobson, "Fundamentals of Machine Elements", 3rd Edition, Tata McGraw-Hill Book Co., 2013.
2. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill BookCo.(Schaum's Outline), 2010
3. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements", 8th Edition, Prentice Hall, 2003.
4. Sundararajamoorthy. T.V., Shanmugam.N, "Machine Design", Anuradha Publications, Chennai, 2003
5. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	2	2	3	1	1	1	3	3	2	2	2	2
2.	3	3	2	2	3	1	1	1	3	3	2	2	2	2
3.	3	3	3	2	3	2	2	2	3	3	2	2	1	1
4.	3	3	3	2	3	2	2	2	3	3	2	2	1	1
5.	3	3	3	2	3	2	2	2	3	3	2	2	1	1
Average	**3**	**3**	**2.6**	**2**	**3**	**1.6**	**1.6**	**1.6**	**3**	**3**	**2**	**2**	**1.4**	**1.4**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22503 HUMAN RELATIONS, VALUES AND ETHICS L T P C

(Common to AE, AM) **2 0 0 2**

OBJECTIVES:

- To learn the basics of value education.
- To learn the importance of human values.
- To know the basics of Engineering Ethics.
- To learn the safety, responsibility and rights.
- To study about Global issues.
-

UNIT I INTRODUCTION TO VALUE EDUCATION 6

Understanding Value Education - Self-exploration as the Process for Value Education Continuous Happiness and Prosperity – the Basic Human Aspirations - Right Understanding, Relationship and physical Facilities - Happiness and Prosperity – Current Scenario - Method to Fulfill the Basic Human Aspirations.

UNIT II HUMAN VALUES 6

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time– Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality.

UNIT III ENGINEERING ETHICS 6

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 6

Safety and Risk - Assessment of Safety and Risk - Risk Benefit Analysis and Reducing Risk - Respect for Authority - Collective Bargaining - Confidentiality - Conflicts of Interest - Occupational Crime - Professional Rights - Employee Rights - Intellectual Property Rights (IPR) - Discrimination.

UNIT V GLOBAL ISSUES 6

Multinational Corporations - Environmental Ethics - Global warming - Computer Ethics - Weapons Development - Engineers as Managers - Consulting Engineers - Engineers as Expert Witnesses and Advisors - Moral Leadership - Code of Conduct - Corporate Social Responsibility.

TOTAL: 30 PERIODS

Course Outcomes		RBT LEVEL
Students will be able to:		
CO1	Describe the importance of value education.	**2**
CO2	Briefly study the human values.	**2**
CO3	Understand the principles of Engineering Ethics.	**2**
CO4	Understand the importance of safety, responsibility and rights.	**2**
CO5	Aware about the global issues.	**2**

TEXT BOOKS:

1. R R Gaur, R,Sangal, G.P Bagaria, "A Foundation Course in Value Education", 2009.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCES:

1. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009.
2. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
3. Laura P.Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility", Mc Graw Hill education, India Pvt. Ltd., New Delhi, 2013.
4. TripathyA.N, "Human Values", New Age International Publishers, 2003.
5. World Community Service Centre, "Value Education", Vethathiri publications, Erode, 2011.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	1	1	1	1	0	3	2	3	2	1	1	2	1	1
2.	1	1	1	1	0	3	2	3	2	1	1	2	1	1
3.	2	2	2	2	0	3	2	3	2	2	2	2	2	2
4.	2	2	2	2	0	3	2	3	2	2	2	2	2	3
5.	1	1	1	1	0	3	3	3	2	2	2	3	2	2
Average	**1.4**	**1.4**	**1.4**	**1.4**	**0**	**3**	**2.2**	**3**	**2**	**1.6**	**1.6**	**2.2**	**1.6**	**1.8**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22504 **MECHANICS OF MACHINES** **L T P C**

(Common to AE, AM) **3 1 0 4**

OBJECTIVES:

- To understand the principles in the formation of mechanisms and their kinematics.
- To understand the importance of gears and gear trains.
- To understand the effect of friction in different machine elements.
- To analyze the forces and toques acting on simple mechanical systems.
- To understand the importance of balancing and free vibration.

UNIT I KINEMATICS OF MACHINERY (9+3)

Mechanisms - Terminology and definitions – kinematics inversions of four bar and slide crank chain mechanisms - kinematics analysis in simple mechanisms - velocity and acceleration polygons.

UNIT II GEARS AND GEAR TRAINS (9+3)

Spur gear - law of toothed gearing - Involute gearing - Interchangeable gears - Gear tooth action interference and undercutting - nonstandard teeth - gear trains - parallel axis gears trains [Basics only]-Epicyclic gear trains - automotive transmission gear train.

UNIT III FRICTION AND CAMS (9+3)

Friction Drives - Friction clutches - Single and Multi-plate, Brakes-Drum and Disc. Cams - classifications - displacement diagrams - layout of plate cam profiles - derivatives of followers motion.

UNIT IV DYNAMIC FORCE ANALYSIS (9+3)

Applied and Constrained Forces - Dynamic Force Analysis - Inertia Forces and Inertia Torque - D'Alembert's principle - superposition principle - Dynamic Force Analysis in simple machine members.

UNIT V BALANCING AND VIBRATION (9+3)

Static and Dynamic balancing - Balancing of revolving and reciprocating masses - Balancing machines. Vibration - free vibration of Longitudinal, Transverse, Torsional vibration - single degrees of freedom only.

TOTAL (L:45 + T:15): 60 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Explain the concepts of mechanisms and apply the basics to analyze various automotive and mechanical applications.	**2**
CO2	Examine different types of gears and gear trains.	**2**
CO3	Solve problems involving friction and cam.	**2**
CO4	Evaluate the motion and the dynamic forces acting on mechanical systems.	**2**
CO5	Apply and analyze the concept of balancing and vibrations on mechanical systems.	**2**

TEXT BOOKS:

1. Ambekar A.G., "Mechanism and Machine Theory", Prentice Hall of India, New Delhi, 2007.
2. Ballaney P. L., "Theory of Machines", Khanna Publishers, New Delhi, 2002.
3. Sadhu Singh, "Theory of Machines: Kinematics & Dynamics", 3rd Edition, 2016
4. Shigley J.E., Pennock G.R and Uicker J.J., "Theory of Machines and Mechanisms", Oxford University Press, 2015.
5 Singh V.P., "Theory of Machine", Dhanpat Rai & Co (P) Ltd., 2013.

REFERENCES:

1. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 2005.
2. Ghosh. A, and A.K. Mallick, "Theory and Machine", Affiliated East-West Pvt. Ltd., New Delhi, 1988.
3. Rao.J.S. and Dukkipatti R.V. "Mechanisms and Machines", Wiley-Eastern Ltd., New Delhi,1992.
4. Ramamurthi. V., "Mechanisms of Machine", Narosa Publishing House, 2002.
5. Robert L. Norton, "Design of Machinery", McGraw-Hill,2009.
6. Rao S. S., "Mechanical Vibrations", 5th Edition, Pearson Education, Inc., publishing as Prentice Hall, 2011.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	2	2	2	1	1	1	2	2	1	2	3	3
2.	3	2	3	2	3	1	1	1	2	2	1	2	3	3
3.	3	3	3	2	2	1	1	1	2	2	1	2	2	2
4.	3	3	3	3	3	1	1	1	2	2	1	2	3	3
5.	3	3	3	3	3	1	1	1	2	2	1	2	3	3
Average	**3**	**2.8**	**2.8**	**2.4**	**2.6**	**1**	**1**	**1**	**2**	**2**	**1**	**2**	**2.8**	**2.8**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22511	CAD/CAM LABORATORY	L	T	P	C
	(Common to AE, AM)	0	0	3	1.5

OBJECTIVES:

- To make the students to gain practical knowledge in handling 3D modeling software.
- To make the students to understand the Part programming in CNC Machining and Turning Centre.

LIST OF EXPERIMENTS

I 3D GEOMETRIC MODELING 24 PERIODS

1. Introduction of 3D Modeling software

Creation of 3D assembly model of following machine elements using 3D Modeling software

2. Flange Coupling
3. Screw Jack
4. Universal Joint
5. Piston
6. Connecting Rod
7. Crank Shaft
8. Cam Shaft
9. Clutch

II Manual Part Programming 21 PERIODS

1. Part Programming - CNC Machining Centre
   a) Linear Cutting
   b) Circular Cutting
   c) Cutter Radius Compensation
   d) Canned Cycle Operation
2. Part Programming - CNC Turning Centre
   a) Straight, Taper and Radius Turning
   b) Thread Cutting
   c) Rough and Finish Turning Cycle
   d) Drilling and Tapping Cycle

TOTAL: 45 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to:		
CO1	Interpret the bill of materials and develop 3D parts and assembly for mechanical components.	**3**
CO2	Interpret the bill of materials and develop 3D parts and assembly for automobile components.	**3**
CO3	Develop CNC programming and perform manufacturing using computer software.	**3**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	Description of Equipment	Quantity
1.	Computer nodes	30 Nos.
2.	Drafting and Modeling Softwares	30 Nos.
3.	A3 size plotter	1
4.	Laser Printer	1
5.	CNC Lathe	1
6.	CNC Milling	1
SOFTWARE		
7.	Any High end integrated modeling and manufacturing CAD / CAM software	15 licenses
8.	CAM Software for machining centre and turning centre (CNC Programming and tool path simulation for FANUC / Sinumeric and Heidenhain controller)	15 licenses
9.	Licensed operating system	Adequate

REFERENCES:

1. Creo Parametric 4.0 Tutorial by Roger Toogood, SDC Publications.
2. CAD / CAM Laboratory Manual Prepared by Department of Automobile Engineering, Sri Venkateswara College of Engineering.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	2	3	2	3	1	1	1	2	2	2	2	2	2
2.	3	2	3	2	3	1	1	1	2	2	2	2	3	3
3.	3	3	3	3	3	2	2	1	2	2	2	2	3	3
Average	**3**	**2.33**	**3**	**2.33**	**3**	**1.33**	**1.33**	**1**	**2**	**2**	**2**	**2**	**2.67**	**2.67**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22512 VEHICLE MAINTENANCE LABORATORY II

L	T	P	C
0	0	3	1.5

OBJECTIVES:

- Demonstrate and study of the various vehicle components for servicing them.
- To impart the technical knowledge for servicing the electrical component and the testing method of the vehicle on the maintenance aspects.

LIST OF EXPERIMENTS

1. Inspect and replacing of engine timing belt
2. Inspect and cleaning of throttle body, fuel injector and idle speed motor
3. Inspect, cleaning and servicing of braking system
4. Diagnosing of charging system and engine starting system
5. Obtain and study the waveform of ignition system of a multicylinder engine.
6. Identify and fault diagnosing of wiper motor and wiper motor control module.
7. Inspect and replacing of Macpherson suspension damper and spring
8. Replacing of flat tyre.
9. Measure the vehicle geometry using computerized wheel alignment equipment
10. Performance test of a four wheeler using chassis dynamometer and highlight the importance of the vehicle maintenance on the vehicle performance

TOTAL: 45 PERIODS

	COURSE OUTCOMES	**RBT LEVEL**
Students will be able to:		
CO1	Acquire the requisite skills to service the vehicle.	**3**
CO2	Diagnose the various vehicle components.	**3**

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	2	3	2	3	1	1	1	2	2	2	2	2	2
2.	3	2	3	2	3	1	1	1	2	2	2	2	3	3
Average	3	2	3	2	3	1	1	1	2	2	2	2	2.5	2.5

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22601	AUTOMOTIVE COMPONENTS DESIGN	L	T	P	C
	(Common to AE, AM)	3	1	0	4

(Use of Approved Design Data Book is permitted)

OBJECTIVES:

- To make the students understand the design concept and principles of various engine components.
- To familiarize the various steps involved in the automotive engine components.
- To impart the knowledge to the students about the various automotive chassis components.
- To impart a comprehensive knowledge of power train components.
- To know the various frames and Suspension systems, selection of frames and springs.

UNIT I DESIGN OF CYLINDER, PISTON AND CONNECTING ROD 9+3

Fundamental of engineering design, choice of material for cylinder and piston, design of cylinder, piston. material for connecting rod, determining minimum length of connecting rod, small end design, shank design, design of big end cap bolts.

UNIT II DESIGN OF CRANKSHAFT AND FLYWHEEL 9+3

Balancing of Internal Combustion engines, significance of firing order, material for crankshaft, design of crankshaft under bending and twisting, balancing weight calculations, development of short and long crank arms.

Determination of engine flywheel mass for a given co- efficient of speed fluctuation, stresses on flywheel rim. Design of hubs and flywheel arm, turning moment diagram, flywheel materials.

UNIT III DESIGN OF CLUTCH AND GEAR BOX 9+3

Design of single plate, multi-plate and cone clutch.

Layout of different types of gearbox, gear train calculation, bearing load calculation and selection of bearings, Design of three speed and four speed gearboxes.

UNIT IV DRIVE LINE AND REAR AXLE 9+3

Design of propeller shaft, final drive gearing, semi floating, three quarter floating, full floating and rear axle housings.

UNIT V VEHICLE FRAME AND SUSPENSION 9+3

Study of loads, moments and stresses on frame members. Design of frame for passenger and commercial vehicle, design of leaf springs, coil springs and torsion bar springs.

TOTAL (L : 45 + T : 15) : 60 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to:		
CO1	Discuss the design procedure for cylinder, piston and connecting rod of engines.	**3**
CO2	Design and examine the engine crankshaft and flywheel.	**4**
CO3	Design and analyze the clutch and gear box of automotive vehicles.	**4**
CO4	Design and compare the various drive line components.	**4**
CO5	Classify and design the various types of vehicle frame and suspension elements.	**4**

TEXT BOOKS:

1. Bhandari V, "Design of Machine Elements", 3rd Edition, Tata McGraw-Hill Book Co, 2016.
2. U.C. Jindal, "Machine Design", Pearson Education, 2013.

REFERENCES:

1. Dean Averns, "Automobile Chassis Design", Illife Book Co., 2001.
2. Giri N.K, "Automobile Mechanics, Khanna publishers", New Delhi, 2007.
3. HeldtP.M., "Automotive Chassis", Chilton Book Co., 1992.
4. Jain R.K, "Machine Design", Khanna Publishers", New Delhi, 2005.
5. Richard G Budynas Richard Gordon Budynas, J.Keith Nisbett., "Shigley's Mechanical Engineering Design", 10th edition, Tata McGraw-Hill, 2015.

C O U R S E ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	2	1	2		1	1	1	1	1	1		1	2	2
2.	2	1	2		1	1	1	1	1	1		1	2	2
3.	2	1	2		1	1	1	1	1	1		1	2	2
4.	2	1	2		1	1	1	1	1	1		1	2	2
5.	2	1	2		1	1	1	1	1	1		1	2	2
Average	**2**	**1**	**2**		**1**	**1**	**1**	**1**	**1**	**1**		**1**	**2**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22602	HYBRID AND ELECTRIC VEHICLES (Common to AE, AM, ME, MN)	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make the students to know and understand the constructional and working details about Hybrid and Electric Vehicles.
- To introduce various configuration of Hybrid and Electric Vehicles.
- To impart the knowledge about energy storage devices.
- To impart knowledge on electrical drives for automobiles.
- To introduce various electronic controllers for Hybrid and Electric Vehicles.

UNIT I INTRODUCTION TO NEED FOR ALTERNATIVE SYSTEM 9

History of electric and hybrid vehicles. Need of electric and hybrid vehicles – comparative study of diesel, petrol, electric and hybrid vehicles, Limitations of electric vehicles, Specification of different electric and hybrid vehicles. Opportunities and challenges in electric and hybrid vehicles.

UNIT II ENERGY STORAGE DEVICES 9

Electrochemical batteries, types of batteries – lead acid batteries, nickel based batteries, lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency and ultra-capacitors.

Recent developments in the Battery charging – Charging Methodologies - Charging stations - Battery swapping.

UNIT III ELECTRIC VEHICLES 9

Electric vehicle layout, performance of electric vehicles, traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, system components, electronic control system, advantage and limitations, safety and challenges, Case study of latest electric vehicles.

UNIT IV HYBRID VEHICLES 9

Concepts of hybrid electric drive train, types, architecture of series and parallel hybrid electric drive train, merits and demerits, hybrid electric drive train design, mild and full hybrids, Plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Case study of latest Hybrid vehicles.

UNIT V PROPULSION MOTORS AND CONTROLLERS 9

Types of electric motors – working principle of AC and DC motors, Characteristic of shunt, series and compound, types of DC motors - permanent magnet and separately exited DC motors, AC single phase and 3-phase motor, inverters, DC and AC motor speed controllers. selection of motors and controllers.

TOTAL: 45 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to:		
CO1	Outline the need and history of alternative systems for vehicle propulsion and compare their performance with conventional vehicles.	**3**
CO2	Discuss and compare the construction, working and performance of various energy storage devices and their construction methodologies.	**3**
CO3	Discuss and compare the architecture, performance of electric vehicles and their safety aspects.	**3**
CO4	Classify and discuss the different hybrid vehicle architecture and study their merits and demerits.	**3**
CO5	Describe the working, characteristics of propulsion motors and speed controllers.	**3**

TEXT BOOKS:

1. Iqbal Husain, "Electric and Hybrid Vehicles Design Fundamentals", CRC Press, 2005.
2. Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz Ebrahimi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", Third Edition, CRC Press, 2018.

REFERENCES:

1. Ottorino Veneri, "Technologies and Applications for Smart Charging of Electric and Plug-in Hybrid Vehicles", 1st edition, Springer Publishing, 2017.
2. Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication, 2005.
3. Ronald K. Jurgen, "Electric and Hybrid-Electric Vehicles: Engines and Powertrains", SAE International, 2015.
4. Tom Denton, "Electric and Hybrid Vehicles", 1st edition, Routledge Publishers, 2017.
5. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Softcover reprint of the original 1st ed., Springer, 2013.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	2	1	1			2	2	1	1	1		1	3	2
2.	2	1	1			1	2	1	1	1		1	3	2
3.	2	1	1			2	2	1	1	1		1	3	2
4.	2	1	1			2	2	1	1	1		1	3	2
5.	2	1	1			1	1	1	1	1		1	3	2
Average	**2**	**1**	**1**			**1.6**	**1.8**	**1**	**1**	**1**		**1**	**3**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22611	COMPREHENSION I	L	T	P	C
	(Common to AE, AM)	0	0	2	1

OBJECTIVES:

- To encourage the students to comprehend the technical knowledge in the field of Automobile Engineering acquired from the First Semester to Fourth Semester of B.E Degree Course through periodic exercise.

METHOD OF EVALUATION

The students will be assessed 100% internally through weekly test with objective type questions on all the subject related topics.

TOTAL: 30 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Recollect the concepts learnt from the courses studied from first semester to fourth semester.	**3**
CO2	Comprehend the technical knowledge to enhance their employability skills.	**3**

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	2	3	3	2	2	2	2	2	1	3	3	3
CO2	3	3	2	3	3	2	2	2	2	2	1	3	3	3
Average	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**3**	**3**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22612	ELECTRIC VEHICLE LABORATORY I	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To apply simulation-software on a electric vehicle subsystem to determine the response of the system for various inputs.

LIST OF EXPERIMENTS:

1. Simulation of nodal analysis for DC circuits.
2. Simulation of series RLC circuit.
3. Simulation of bipolar junction transistor.
4. Simulation of H bridge for DC Motor control.
5. Simulation of electronically operated valve.
6. Battery modeling for electric vehicle.
7. Hardware in-the-loop simulation for battery management.
8. Simulation of BMS-constant current charging of electric vehicle.
9. Simulation of electric vehicle driving range.
10. Design and simulation of thermal management system of electric vehicle.

TOTAL: 30 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Develop a mathematical modeling to simulate different electrical circuits.	**3**
CO2	Develop a mathematical modeling to simulate controls for electric motor.	**3**
CO3	Develop a mathematical modeling to simulate battery management system for electric vehicles.	**3**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
S.No.	**Description of Equipment**	**Quantity**
1.	Computer nodes	30 Nos.
2.	Drafting and Modeling Software	30 Nos.
3.	MATLAB SIMULINK software	30 Nos.

REFERENCES:

1. Shailendra Jain, "Modeling & Simulation using MATLAB - Simulink", Wiley, 2011.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	2	2	2	1	1	1	1	1	1	1		1	2	3
2.	2	2	2	1	1	1	1	1	1	1		1	2	3
3.	2	2	2	1	1	1	1	1	1	1		1	2	3
Average	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**		**1**	**2**	**3**

Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

HS22511 INTERVIEW AND CAREER SKILLS LABORATORY L T P C

(Common to all branches except CE) 0 0 3 2

OBJECTIVES:

- To enable learners to build confidence and enhance their language proficiency.
- To expose learners to the use of professional English.
- To equip them with employability skills.
- To expose learners to build entrepreneurship skills.

UNIT I LISTENING AND SPEAKING SKILLS 12

Conversation Skills – Types - Small Talk, Face-to-Face and Telephonic, Formal and Informal Conversations – Skills in presenting ideas and collating information during Conference Calls (one –to-one and technical group / team) – Academic and Workplace Situations – Conversing with Faculty/Visiting Faculty/Guests/Officials/Employers and Employees – Group Discussion – Etiquette and Dos and Don'ts, Turn-taking –Presentation Skills – Seminars and Projects using Digital Tools; Mock Interview – Etiquette and Dos and Don'ts – Audio-Visual interface for enhancement of Listening and Speaking Skills.

UNIT II READING / SPEED READING,CRITICAL THINKING AND 12

Reading Comprehension – General and Scientific Texts/Articles/Case Studies from different or relevant fields of study for analysis and critical thinking; Employability Skills – Writing Job Applications – Cover Letter accompanying Résumé – Types of Business Letters and Email Writing and Etiquette; Writing Reports – Statement of Purpose – Writing Articles for Publication Style and Format – Creating Blogs or Company Profiles – Speed Reading of Voluminous Reports / Documents and Exacting Necessary Information and Abstract Preparation including Dissemination.

UNIT III ENGLISH FOR PROFESSIONAL EXAMINATIONS 12

Sentences, Paragraphs and Reading Comprehension – Vocabulary Building – General and Technical Terms – Contextual Meaning – Spelling – Subject-Specific Words – Usage and User-Specific Terminology.

UNIT IV ENTREPRENEURSHIP SKILLS 9

Introduction to Entrepreneurship; Developing Leadership Qualities and Team Work; Goal Setting and Real-Life Scenarios; Fundamentals of Entrepreneurial Skills – Marketing Strategies - Microcosmic and Macrocosmic Levels of Product Sales and Survey – Sector / Industry Appraisal and Appreciation (Review and Understanding State of the Nation / Economy / Environment / Sector Reports Published) - Interaction & Understanding Role of Multi-Lateral Financial / Institutional / Industrial Agencies such as World Bank, ADB, UNDP, CII etc.

TOTAL (P:45): 45 PERIODS

TEACHING METHODS:

1. To be totally learner-centric with minimum teacher intervention as the course revolves around practice.
2. Suitable audio/video samples from Podcast/YouTube to be used for illustrative purposes.
3. Portfolio approach for writing to be followed. Learners are to be encouraged to blog, tweet, text and email employing appropriate language.
4. GD/Interview/Role Play/Debate could be conducted off the laboratory (in a regular classroom) but learners are to be exposed to telephonic interview and video conferencing.
5. Learners are to be assigned to read/write/listen/view materials outside the classroom as well for gaining proficiency and better participation in the class.
6. Learners to form team(s), select a module of external Industrial / Institutional interaction and prepare a short thesis/project proposal.

COs	COURSE OUTCOMES	RBT LEVEL
At the end of the course, learners should be able to		
CO1	Take international examination such as IELTS and TOEFL.	**3**
CO2	Make presentations and Participate in Group Discussions.	**3**
CO3	Successfully answer questions in interviews.	**2**

REFERENCES:

1. Business English Certificate Materials, Cambridge UniversityPress.
2. Graded Examinations in Spoken English and Spoken English for Work downloadable materials from Trinity College,London.
3. International English Language Testing System Practice Tests, Cambridge University Press.
4. Interactive Multimedia Programs on Managing Time and Stress.
5. Personality Development (CD-ROM), Times Multimedia,Mumbai.

WEB SOURCES:

1. http://www.slideshare.net/rohitjsh/presentation-on-groupdiscussion
2. http://www.washington.edu/doit/TeamN/present_tips.html
3. http://www.oxforddictionaries.com/words/writing-jobapplications
4. http://www.kent.ac.uk/careers/cv/coveringletters.htm
5. http://www.mindtools.com/pages/article/newCDV_34.html

COURSE ARTICULATION MATRIX

1:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.										3				
2.										3				
3.										3				
Average										**3**				

Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22613	SIMULATION OF ENGINE AND CHASSIS COMPONENETS LABORATORY	L	T	P	C
		0	0	2	1

(Common to AE, AM)

OBJECTIVES:

- To expose the students to different applications of simulation and analysis tools.
- To familiarize the students to use modeling software to model engine components and chassis design.

LIST OF EXPERIMENTS

1. Mathematical modeling and simulation of a simple vehicle system considering tractive effort and inertia force only.
2. Mathematical modeling and simulation of a vehicle considering various forces such as rolling resistance, air resistance, gradient resistance, acting on the vehicle during acceleration.
3. Mathematical modeling and simulation of simple transmission system by using newton's second law.
4. Modeling and analysis of piston with different loads in the top end.
5. Modeling and analysis of connecting rod with different loads in the bigger and smaller ends.
6. Modeling and analysis of crank shaft with different loads in the both the ends.
7. Modeling and analysis of Engine cylinder head with different temperature in inner side of the cylinder.
8. Modeling and analysis of clutch plate with different loads in the contact surface.
9. Modeling and analysis of gear box with different loads in the contact surface.
10. Modeling and analysis of chassis frame with different loads on the surface and fixed points.

TOTAL: 45 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
At the end of the course, learners should be able to		
CO1	Simulate vehicle system using MATLAB simulation software.	**4**
CO2	Demonstrate structural and thermal analysis for various engine components using analysis software.	**4**
CO3	Demonstrate structural analysis for various chassis components using analysis software.	**4**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	Description of Equipment	Quantity
1.	Computer nodes	30 Nos.
2.	Drafting and Modeling Softwares	30 Nos.
3.	Ansys Software	30 Nos.
4.	MATLAB SIMULINK software	30 Nos.

REFERENCES:

1. Dean Averns, “Automobile Chassis Design”, Illife Book Co., 2001.
2. Kent Lawrence, “ANSYS Workbench Tutorial Release 13” SDC Publications, 2011.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	2	2	2	3				1		2	2	3	3
2.	3	2	2	2	3				1		2	2	3	
3.	3	2	2	2	3				1		2	2		
Average	**3**	**2**	**2**	**2**	**3**				**1**		**2**	**2**	**3**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22701	ARTIFICIAL INTELLIGENCE FOR AUTOMOTIVE APPLICATIONS	L	T	P	C
		3	0	0	3

(Common to AE, AM)

OBJECTIVES:

The student should be made to:

- Understand the technologies used in autonomous systems.
- Understand the challenges involved in building an autonomous system.
- Understand the open source initiative for self-driving cars systems as a tool to teach how to understand, operate, maintain, and enhance this newly emerging technology.
- Know how to operate, maintain, and modify the important modules in the autonomous systems.

UNIT I AUTONOMOUS DRIVING TECHNOLOGIES 9

Autonomous Driving Technologies overview – Autonomous Driving algorithms – Autonomous Driving Client System – Autonomous Driving cloud platform.

UNIT II PERCEPTION 9

Perception in Autonomous Driving – Detection – Segmentation – Stereo, optical flow and scene flow – Tracking.

UNIT III MODELING AUTONOMOUS DRIVING 9

Machine and Deep Learning in Autonomous driving perception – Convolutional Neural Networks – Detection – Semantic Segmentation – Stereo and optical flow.

UNIT IV PREDICTION AND ROUTING 9

Prediction and Routing – Planning and control – Traffic Prediction- Lane level Routing.

UNIT V DECISION AND PLANNING 9

Decision, planning and control – Behavioral Decisions – Motion Planning – Feedback control.

TOTAL: 45 PERIODS

OUTCOMES:

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Understand about the Autonomous Driving Technologies.	**2**
CO2	Develop motion plan for the vehicle based on the environment, behaviour and interaction of objects.	**3**
CO3	Apply the Machine and Deep Learning techniques in the Autonomous driving system.	**3**
CO4	Understand the Prediction and Routing techniques in an Autonomous driving system.	**2**
CO5	Analyze the planning and control using decision making techniques.	**3**

TEXTBOOKS:

1. Shaoshan Liu et al., “Creating Autonomous Vehicle Systems”, M & C Publishers, 2018.

REFERENCES:

1. Shaoshan Liu; Liyun Li; Jie Tang; Shuang Wu; Jean-Luc Gaudiot, “Creating Autonomous Vehicle Systems”, in Creating Autonomous Vehicle Systems, Morgan & Claypool, 2017.
2. Danil Prokhorov, “Computational Intelligence in Automotive Applications”, Studies in Computational Intelligence book series, Springer, 2008.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	2	3	3	3	3	2	2	2	3	2	2	3	1	2
CO2	2	3	3	3	3	2	2	2	3	2	2	3	1	3
CO3	3	3	3	3	3	2	1	2	3	2	2	3		1
CO4	2	3	3	3	3	2	1	2	3	2	2	3		1
CO5	2	3	3	3	3	2	1	2	3	2	2	3		2
Average	**2.2**	**3**	**3**	**3**	**3**	**2**	**1.4**	**2**	**3**	**2**	**2**	**3**	**1**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22702 MOBILITY ENGINEERING MANAGEMENT L T P C
(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- To understand the different functions of personnel management.
- To make the students understand the importance of managing different transport systems.
- To practice the procedure for preparing bus schedule and fare structure.
- To gain knowledge about motor vehicle act.
- To understand the importance of maintenance involved in transport industry.

UNIT I INTRODUCTION 9

Personnel management; objectives and functions of personnel management, industrial and organizational psychology, industrial sociology, application of sociology, industrial relations, introduction to personality disorders. Selection process - stages of selection, employment tests, interviewing, training objectives, advantages, methods of training, training methods, psychological tests.

UNIT II TRANSPORT SYSTEMS 9

Introduction to various transport systems, selection of transport mode, Types of motor vehicles, advantages of motor transport, recent developments in transport sector, Road transport and highways - administrative units, powers and duties of employees, organizational setup, Structure of fleet management, optimum utilization of fleet.

UNIT III SCHEDULING AND FARE STRUCTURE 9

Principal features of operating costs for transport vehicles with examples of estimating the costs, Fare structure and method of drawing up of a fare table, Various types of fare collecting methods, Basic factors of bus scheduling. Problems on bus scheduling.

UNIT IV MOTOR VEHICLE ACT 9

Registration of motor vehicles, traffic signs, fitness certificate, permit, motor vehicle insurance policies, Transfer of ownership, transfer of vehicles from state to state, Principles of driving, driving procedure, types of driving licenses, Licensing of conductors, Description of vehicles and Constructional regulations - tanker, tipper, delivery van, power wagons, recovery van and fire fighting vehicles, spread over, running time, test for competence to drive.

UNIT V MAINTENANCE 9

Preventive maintenance system in transport industry, general layout of modern service station, tyre maintenance procedures, causes for uneven tyre wear, remedies, maintenance procedure for better fuel economy, Design of bus depot layout.

TOTAL: 45 PERIODS

OUTCOMES:		
COs	**COURSEOUTCOMES**	**RBTLEVEL**
Students will be able to		
CO1	Explain the different aspects of personnel management related to organization.	**3**

CO2	Compare various modes of transport system.	**3**
CO3	Analyze and select the suitable method for preparing a bus schedule and fixing the fare.	**3**
CO4	Outline on the motor vehicle act and maintenance aspects of transport.	**3**
CO5	Discuss the maintenance aspects to be followed in transport industry.	**3**

TEXT BOOKS:

1. John Duke, "Fleet Management", McGraw-Hill Co, USA, 1984.
2. Khilery. V.S. and Dr. Satpal Sharma, "Motor Vehicle Act and Transport Management", 1st edition, Ishan Publications, India, 2016.

REFERENCES:

1. Edmund J Gubbins, "Managing Transport Operations", 3rd Edition, Kogan Page, 2009.
2. Joel Levitt, "Basics of Fleet Maintenance", Paperback, 2010.
3. Kitchin. L.D., "Bus Operation", III edition, Illiffee and Sons Co., London, 1992.
4. NagabhushanaRao S, "Transport Management", Hardcover, 2017.
5. Taxmann, "Guide to Motor Vehicle Act 1988", Paperback, 2019.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1								2	2		2			
CO2	2	1	1	1	1	2	2	1	1	1	1	2	3	3
CO3	1	1	1	1		2	1	1	1	1	1	1		
CO4	1	1	1	1		2	1	1	1	1	1	1		1
CO5	2	2	1	2	1	2	1	2	2	2	1	2	1	3
Average	**1.5**	**1.25**	**1**	**1.25**	**1**	**2**	**1.25**	**1.**	**1.4**	**1.25**	**1.2**	**1.5**	**2**	**2.33**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22711	COMPREHENSION II (Common to AE, AM)	L 0	T 0	P 2	C 1

OBJECTIVES:

- To encourage the students to comprehend the technical knowledge in the field of Automobile Engineering acquired from the Fifth Semester to Sixth Semester of B.E Degree Course through periodic exercise.

METHOD OF EVALUATION

The students will be assessed 100% internally through weekly test with objective type questions on all the subject related topics.

TOTAL: 30 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Recollect the concepts learnt from the courses studied from fifth semester to sixth semester.	**3**
CO2	Comprehend the technical knowledge to enhance their employability skills.	**3**

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	2	3	3	2	2	2	2	2	1	3	3	3
CO2	3	3	2	3	3	2	2	2	2	2	1	3	3	3
Average	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**3**	**3**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22703 VEHICLE DYNAMICS:THEORY AND PRACTICES L T P C

(Common to AE, AM) **3 0 2 4**

OBJECTIVES:

- To familiarize the procedure to find the stability and performance of the vehicle.
- To enhancing the knowledge about the fundamentals of vehicle vibrations.
- To introduce the concepts of mathematical modeling and design of vehicle suspension system and its control methods.
- To make the students to understand the effect of tyre dynamics.
- To analyze the vehicle handling characteristics and its effects of the vehicle.

UNITI LONGITUDINAL DYNAMICS AND CONTROL 9+9

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Aerodynamic forces and moments, Equation of motion, Load distribution for three wheeler and four wheeler, Calculation of Maximum acceleration, Reaction forces for Different drives, Braking and Driving torque, Prediction of Vehicle performance, Anti-lock Braking System (ABS), Stability control, Traction control.

Practical-Modeling and simulation of simple longitudinal dynamics model of a vehicle which is subjected to various forces, load transfer effect during braking and acceleration, automotive braking system.

UNITII CONCEPT OF VIBRATION 9+6

Free, Forced, Undamped and Damped Vibration, Response Analysis of Single Degrees of Freedom (DOF), Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed.

Practical- Modeling and simulation of single and two degree of freedom systems of a vehicle.

UNITIII VERTICAL DYNAMICS 9+6

Human response to vibration, Sources of Vibration, Design and analysis of Passive, Semi-active and Active suspension using Quarter car, Half car and Full car model, Influence of suspension stiffness, suspension damping, and tire stiffness, Control law for Linear Quadratic Regulator (LQR), H-Infinite, Skyhook damping, Air suspension system and their properties.

Practical – Modeling and simulation of multi degrees of freedom of a Quarter car and half car model.

UNITIV TIRES 9+3

Tire forces and moments, Tire structure, Longitudinal and Lateral force at various slip angles, rolling resistance, Tractive and cornering property of tire, Performance of tire on wet surface, Ride property of tires, Magic formulae of tire model, Estimation of tire road friction, Test on Various road surfaces, Tire vibration.

Practical-Determination of vehicle velocity dependent resistive force coefficients using Magic formulae of tire model.

UNITV LATERAL DYNAMICS 9+6

Steady state handling characteristics, Steady state response to steering input, Testing of handling characteristics, Transient response characteristics, Direction control of vehicles, Roll center, Roll axis, Vehicle under side forces, Stability of vehicle on banked road and during turn, Effect of suspension on cornering.

Practical -Modeling and simulation of a bicycle model vehicle steady state handlingcharacteristics, transient handling characteristics of a vehicle.

TOTAL(L:45+P:30):75PERIODS

COs	COURSEOUTCOMES	RBT Level
Students will be able to		
CO1	Discuss and examine the stability of vehicles, tractive efforts, prediction of vehicle performance and effects on braking and driving torque.	4
CO2	Apply suitable methods to determine the frequency and mode shapes of free, forced and damped vehicle vibrations.	3
CO3	Design vehicle suspension system and its control methods.	4
CO4	Explore the effects of tyre dynamics on the vehicle performance.	3
CO5	Discuss and examine the vehicle handling characteristics and its effects.	3

TEXTBOOKS:

1 Rajesh Rajamani, "Vehicle Dynamics and Control", 1st edition, Springer,2005.

2 Wong J. Y, "Theory of Ground Vehicles", 3rd Edition, Wiley-Interscience, 2001.

REFERENCES:

1 Dean Karnopp, "Vehicle Stability", 1st edition, Marcel Dekker, 2004.

2 Hans B Pacejka, "Tire and Vehicle Dynamics", 2nd edition, SAE International,2005.

3 Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", Elsevier, 2004.

4 NakhaieJazar. G., "Vehicle Dynamics: Theory and Application", 1st edition, Springer,1982.

5 Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", Society of Automotive Engineers Inc, 1992.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	2	2	2	1	1	1	1	1	1	2	3	3
CO2	3	3	2	2	2	1	1	1	1	1	1	2	3	3
CO3	3	3	3	2	2	2	1	1	2	1	1	3	2	3
CO4	3	3	3	2	2	2	1	1	2	1	1	3	2	3
CO5	3	3	3	2	2	2	1	1	2	1	1	3	2	3
Average	**3**	**3**	**2.6**	**2**	**2**	**1.6**	**1**	**1**	**1.6**	**1**	**1**	**2.6**	**2.6**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22712 ELECTRIC VEHICLE LABORATORY II

L	T	P	C
0	0	3	1.5

OBJECTIVES:

- To impart the knowledge on dismantling and assembling of electrical vehicle motor.
- To teach the testing method of electrical vehicle motor and electrical vehicle.

LIST OF EXPERIMENTS

1. Identify the location of various major electrical vehicle components on an electric vehicle and study the electric vehicle powertrain in a vehicle.
2. Dismantling, study and assembling of BLDC motor.
3. Dismantling, study and assembling of PMSM motor.
4. Dismantling, study and assembling of induction motor.
5. Performance test on BLDC motor.
6. Performance test on PMSM motor.
7. Performance test on Induction motor.
8. Measure the current consumption and voltage drop at various electric components of an electric vehicle.
9. Performance test on an electric vehicle at steady state condition.
10. Performance test on an electric vehicle for the Indian driving cycle.

TOTAL: 45 PERIODS

COs	COURSEOUTCOMES	RBT LEVEL
Studentswill beable to:		
CO1	Study the construction details of various motor.	**3**
CO2	Conduct the performance test on an electric vehicle motor.	**3**
CO3	Measure the various electrical parameter of the electric vehicle while testing it.	**3**

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	2	3	2	2	1	2	1	2	1	1	3	3	2
2.	3	2	3	2	3	1	2	1	2	2	1	3	3	2
3.	3	2	3	2	3	1	2	1	2	2	1	3	3	3
Average	**3**	**2**	**3**	**2**	**2.67**	**1**	**2**	**1**	**2**	**1.67**	**1**	**3**	**3**	**2.33**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22811	PROJECT WORK (Common to AE, AM)	L 0	T 0	P 20	C 10

OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

GUIDELINE FOR REVIEW AND EVALUATION

The students in a group of 2 to 3 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 300 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Design/Develop viable solutions for societal issues with environmental considerations applying the basic automobile engineering knowledge.	**4**
CO2	Study and analyze research literature to create research methods.	**4**
CO3	Utilize the new automobile computer software tools, algorithms, techniques to provide valid conclusion following the norms of engineering practice.	**3**
CO4	Apply management principles to function effectively in the project team for project execution.	**3**
CO5	Engage in learning for effective project implementation in the broadest context of technological change with consideration for public health, safety, cultural and societal needs.	**3**
CO6	Write reports on new findings in the field of Automobile Engineering and make presentation to the engineering community and society.	**3**

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22021 AUTOMOTIVE SAFETY AND ERGONOMICS L T P C
(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- To know the basic design of the body for safety concepts.
- To understand the working of various safety system followed in vehicle.
- Students will be familiarized in different collision warning systems utilized in vehicle for smooth operation.
- To gain the knowledge in the field of comfort and convenience system of a vehicle.
- Students will design a vehicle under ergonomics concepts.

UNIT I INTRODUCTION 9

Design of the body for safety, Energy equation, Engine location, Deceleration of vehicle inside passenger compartment, Deceleration on impact with stationary and movable obstacle, Concept of crumble zone, Safety sandwich construction.

UNIT II SAFETY CONCEPTS AND EQUIPMENTS 9

Active safety, classification of active safety, Passive safety, Classification of passive safety, Seat belt, Automatic seat belt tightener system, Collapsible steering column, Tiltable steering wheel, Air bags, Electronic system for activating air bags.

UNIT III COLLISION WARNING AND AVOIDANCE SYSTEMS 9

Collision warning system, Causes of rear end collision, Frontal object detection, Rear vehicle object detection system, Object detection system with braking system interactions.

UNIT IV COMFORT AND CONVENIENCE SYSTEM 9

Steering and mirror adjustment, Central locking system, Garage door opening system, Tyre pressure control system, Rain sensor system, Environment information system.

UNIT V ERGONOMICS IN AUTOMOTIVE SAFETY 9

Ergonomics aspects in Automobile Design, Occupant packing, Computer aided ergonomics design, Automotive seat design, Design of symbols for automobile control and displays.

TOTAL: 45 PERIODS

OUTCOMES:

COs	Course Outcomes	RBT Level
Students will be able to		
CO1	Describe the body design for safety with respect to engine location, deceleration impact, crumple zone and sandwich construction.	**3**
CO2	Classify and discuss active and passive safety system equipped in vehicles.	**3**
CO3	Compare the modern collision warning systems employed in vehicles to prevent accidents.	**3**
CO4	Categorize and discuss the various comfort and convenience systems utilized in the vehicle.	**3**
CO5	Outline the application of ergonomic principles in the design of various components of automobile.	**3**

TEXT BOOKS:

1. Bosch, "Automotive Handbook", 10th Edition, SAE publication, 2018.
2. Vivek D. Bhise, "Ergonomics in the Automotive Design Process", 1st Edition CRC Press Published, 2011.
3. Powloski. J, "Vehicle Body Engineering", Business books limited, London, 1969.

REFERENCES:

1. Bosch, "Safety, Comfort and Convenience Systems", John Wiley, 2011.
2. Daniel J. Holt, "Recent Developments in Automotive Safety Technology" SAE International, 2004.
3. Nikolaos Gkikas, "Automotive Ergonomics: Driver-Vehicle Interaction", CRC Press, 2012.
4. Ronald.K.Jurgen, "Automotive Electronics Handbook", Second Edition, McGraw-Hill, 1999.
5. Stuart Macey, "H-Point: The Fundamentals of Car Design & Packaging" Design studio press, 2017

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	2	3	2	2	3	1	2	1	1	1	2	1	2
2.	3	2	2	2	1	3	1	2	1	2	1	2	1	3
3.	3	3	2	2	2	3	1	2	1	2	1	2	1	3
4.	3	2	2	1	1	2	1	1	1	2	1	2	1	2
5.	3	2	3	2	2	2	1	2	1	2	1	2	1	2
Average	**3**	**2.2**	**2.4**	**1.8**	**1.6**	**2.6**	**1**	**1.8**	**1**	**1.8**	**1**	**1**	**1**	**2.4**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22022 AUTOMOTIVE SENSORS AND ACTUATORS L T P C
(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- To make the students to list common types of sensor and actuators used in automotive vehicles.

UNIT I INTRODUCTION TO MEASUREMENTS AND SENSORS 9

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards- Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error- Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers- Dynamic characteristics of first and second order transducers for standard test inputs.

UNIT II VARIABLE RESISTANCE AND INDUTANCE SENSORS 9

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT.

UNIT III VARIABLE AND OTHER SPECIAL SENSORS 9

Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

UNIT IV AUTOMOTIVE ACTUATORS 9

Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

UNIT V AUTOMATIC TEMPERATURE CONTROL ACTUATORS 9

Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

TOTAL: 45 PERIODS

OUTCOMES:

COs	Course Outcomes	RBT Level
Students will be able to		
CO1	Classify sensors, perform analysis and explain the static and dynamic characteristics of transducers.	**3**
CO2	Design measuring equipment's for the measurement of pressure force, temperature and flow.	**3**
CO3	Generate new ideas in designing the sensors and actuators for automotive application.	**3**

CO4	Understand the operation of the sensors, actuators and electronic control.	**3**
CO5	Design temperature control actuators for vehicles.	**3**

TEXT BOOKS:

1. Ernest O. Doebelin Dhanesh N.Manik , "Doebelin's Measurement Systems", 7th Edition (SIE), McGraw Hill Publishers, 2019.
2. Robert Brandy, "Automotive Electronics and Computer System", Prentice Hall, 2001.

REFERENCES:

1. James D Halderman, "Automotive Electrical and Electronics", Prentice Hall, USA, 2013.
2. Patranabis D, "Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd, 2003.
3. Tom Denton, "Automotive Electrical and Electronics Systems", Third Edition, SAE International, 2004.
4. William Kimberley, "Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
5. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective", 8th Edition, Elsevier Butterworth-Heinemann Publishers, 2017.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	2	3	2	2	1	1	1	2	1	2	2	3
2.	3	3	3	2	3	2	2	1	2	2	2	2	2	3
3.	3	3	3	3	2	2	2	1	2	2	2	2	3	3
4.	3	3	3	3	2	2	2	1	2	2	2	2	3	3
5.	3	3	3	2	3	2	2	1	2	2	2	2	3	**3**
Average	**3**	**3**	**2.8**	**2.6**	**2.4**	**2**	**1.8**	**1**	**1.8**	**2**	**1.8**	**2**	**2.6**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22023	AUTONOMOUS AND CONNECTED VEHICLES (Common to AE, AM)	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make the students to enumerate the requirements, levels, hardware and software in autonomous vehicles.

UNITI INTRODUCTION TO AUTONOMOUS VEHICLE TECHNOLOGY 9

Introduction - SAE autonomous Level Classification-Examples-Application of Autonomous Vehicle - Advantages and Disadvantages of Autonomous Vehicles.

UNITII PATH PLANNING AND DECISION MAKING 9

Principles of decision making and path planning for autonomous vehicles-Decision making approaches-Approximation-Heuristic-Graph based-Point guidance. Verification and validation of decision making and path planning- Application examples of task allocation and path planning algorithms.

UNITIII SENSORS, PERCEPTION AND VISUALISATION 9

Introduction to sensors, perception and visualisation for autonomous vehicles-Sensor integration architectures and multiple sensor fusion-AI algorithms for sensing and imaging-neural networks.

UNITIV NETWORKING AND CONNECTED VEHICLES 9

Current and future vehicle networking technologies- CAN, LIN, MOST and Flex-ray. The use of modern validation and verification methods- software-in-the-loop, and hardware-in-the-loop techniques. The role of Functional Safety and ISO26262 within the overall control system. Interdependency between software engineering and control system-advanced test methods for the validation of safety-critical systems. Connected vehicle control (CACC). vehicle-to-vehicle[V2V],vehicle-to-infrastructure [V2I], and Vehicle to "Cloud" [V2C]. Applications such as intelligent traffic signals, collaborative adaptive cruise and vehicle platooning.

UNITV HUMAN FACTORS AND ETHICAL DECISION MAKING 9

Introduction to Human Factors-Human Performance: Perception and Attention-Situation Awareness and Error-Human Reliability: Driver Workload and Fatigue-Emotion and Motivation in Design-Trust in Autonomous Vehicles and Assistive Technology-Designing ADAS Systems-Driverless Vehicles and Ethical Dilemmas: Human Factors and Decision Making Software-Application of Human Factors in Autonomous Vehicles. International and national regulatory frameworks for CAV and their safe operation.

TOTAL:45PERIODS

OUTCOMES:		
COs	**COURSE OUTCOMES**	**RBT Level**
Students will be able to		
CO1	Classify and explain the application of autonomous vehicle.	3

CO2	Develop motion plan for the vehicle based on the environment, behaviour and interaction of objects.	3
CO3	Describe various computer vision features and techniques.	3
CO4	Describe the current and future vehicle networking technologies.	3
CO5	Develop a foundational understanding of Human Factors and ethical decision making in autonomous vehicles.	3

TEXT BOOKS:

1 Autonomous Driving: How the Driverless Revolution will Change the World, by AndreasHerrmann, Walter Brenner, Rupert Stadler, ISBN-10 1787148343, ISBN-13 978-1787148345,Emerald Publishing Limited, 26 March 2018.

2 Autonomous Vehicles: Technologies, Regulations, and Societal Impacts, GeorgeDimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos, Paperback ISBN:9780323901376, eBook ISBN: 9780323901383, 1st Edition - April 14, 2021, Elsevier.

REFERENCES:

1 Driverless: Intelligent Cars and the Road Ahead (MIT Press) 1St Edition, by Hod Lipson , Melba Kurmanr), ISBN-13: 978-0262035224, ISBN-10: 0262035227, September 23, 2016.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	3	3	3	2	2	2	2	2	2	2	1	2
2.	3	3	3	3	3	2	2	2	2	2	2	2	1	2
3.	3	3	3	3	3	2	1	2	2	2	2	3	1	1
4.	3	3	3	3	3	2	1	2	2	2	2	3	1	1
5.	3	3	3	3	2	3	2	3	2	2	2	3	1	**1**
Average	**3**	**3**	**3**	**3**	**3**	**2.2**	**1.6**	**2.2**	**2**	**2**	**2**	**2.6**	**1**	**1.4**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22024 BATTERY AND FUEL CELL TECHNOLOGY FOR ELECTRIC VEHICLES

L	T	P	C
3	0	0	3

(Common to AE, AM)

OBJECTIVES:

- To understand the working principle of different types of automotive batteries.
- To gain knowledge in energy storage systems available for electric vehicles.
- To know the history and basic types of fuel cells.
- To acquire knowledge in fuel cell components.
- To know the applications of fuel cell in automobiles.
-

UNIT I INTRODUCTION TOBATTERIES 9

Classification of batteries, Automotive Batteries - Principle, construction and working of lead acid battery, advanced lead-acid batteries horizontal plate Pb-acid batteries for transportation, cylindrical Pb-acid battery vs. flat plate system, maintenance free batteries, Battery – characteristics, rating, efficiency, testing and charging, Maintenance of batteries.

UNIT II ENERGY STORAGE SYSTEMS 9

Advanced Li-ion batteries - principle of operation, battery components and design, electrode, cell and battery fabrications, L-polymer batteries and applications, Li-S battery, Li-Air battery, Sodium battery, Magnesium battery, Aluminum battery, Advance Ni-MH batteries for transportation, future prospects of Ni-MH batteries, lithium ion batteries, Battery Management System, Super capacitors.

UNIT III INTRODUCTION TO FUEL CELLS 9

Fuel cells - History, working principle of fuel cell, components of fuel cell, compare battery and fuel cell, Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC, relative merits and demerits.

UNIT IV FUEL CELL COMPONENTS AND THEIR IMPACT ON PERFORMANCE 9

Fuel cell performance characteristics, current, voltage, voltage efficiency and power density, ohmic resistance, kinetic, sizing of a fuel cell stack, stack configuration, stack clamping, bi-polar plate, humidifiers and cooling plates.

UNIT V FUEL CELLS FOR AUTOMOTIVE APPLICATIONS 9

Fuel cells for automotive applications, technology advances in fuel cell vehicle systems, on-board hydrogen storage, liquid hydrogen and compressed hydrogen, metal hydrides, fuel cell control system, alkaline fuel cell, road map to market.

TOTAL: 45 PERIODS

OUTCOMES:

COs	COURSE OUTCOMES	RBT Level
CO1	Describe the construction, working, performance characteristics and maintenance of conventional automotive batteries.	3
CO2	Compare the construction and working of different storage systems and discuss battery management system used in electric vehicles.	3

CO3	Outline the working principle of different fuel cells used in electric vehicles.	**3**
CO4	Discuss the fuel cell performance and stack configuration for automotive application.	**3**
CO5	Compare the hydrogen storage techniques for fuel cell and its automotive applications.	**3**

TEXT BOOKS:

1. David Linden, Thomas Reddy, "Handbook of Batteries", McGraw Hill Professional, Third Edition, 2002.
2. Gregor Hoogers, "Fuel Cell Technology Handbook", Society of Automotive Engineers, 2002.

REFERENCES:

1. Albert N. Link, Alan C. O'Connor and Troy J. Scot, "Battery Technology For Electric Vehicles", Routledge, 2015.
2. James Larminie, John Lowry, "Electric Vehicle Technology", Second Edition, Wiley-Blackwell, 2012.
3. Mehrad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRC Press, 2004.
4. Ryan O'Hayre, Suk-Won Cha, Whitney G. Colella, Fritz B. Prinz, "Fuel Cell Fundamentals", Third Edition, Wiley, 2016.
5. Shripad T. Revankar and Pradip Majumdar, "Fuel Cells - Principles, Design and Analysis", CRC Press, 2014.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	3	3	2	2	2	1	2	2	2	3	1	2
2.	3	3	3	3	2	3	3	2	2	2	2	3	1	2
3.	3	3	3	3	2	3	3	2	2	2	2	3	1	2
4.	3	3	3	3	2	3	3	2	2	2	2	3	1	2
5.	3	3	3	3	2	3	3	2	2	2	2	3	1	2
Average	**3**	**3**	**3**	**3**	**2**	**2.8**	**2.8**	**1.8**	**2**	**2**	**2**	**3**	**1**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22025	ELECTRIC TWO AND THREE WHEELERS	L	T	P	C
	(Common to AE, AM)	3	0	0	3

OBJECTIVES:

- To educate the various laws applied in working of motors.
- To teach the fundamentals of battery and its characteristics.
- To educate the electric vehicle charging and controllers.
- To impart knowledge on various chassis components and subsystems in two and three wheelers.
- To impart knowledge on vehicle servicing and maintenance through various case study.

UNIT I MOTORS **9**

Introduction, The Lorentz Force Law, Coulomb's Law, Biot-Savart's Law, Brushed DC Motors, Brushless Motors, Reluctance Motors, Faraday's Law, AC Induction Motors, Motor Efficiency, Maximum Acceleration.

UNIT II BATTERY **9**

Introduction, Battery Fundamentals, Cathode, Anode, Electrolyte, Circuit, Separator, Charging, Discharging, Cost, Energy Storage/Charge Capacity, Battery Life, Energy Density, Specific Power, State of Charge and Depth of Discharge, Lithium-Ion Batteries, Battery Characteristics, Electric Vehicle Charging, Cell and Battery Voltages, Charge and Energy Efficiency, Battery Temperature, Battery Geometry.

UNIT III ELECTRIC VEHICLE CHARGING AND CONTROLLERS **11**

Electric Vehicle Charging, Level 1 Charging, Level 2 Charging, DC Fast Charging (Level 3), Charging Connectors, SAE J1772, Combined Charging System (CCS), IEC 62196 Type 2 (Mennekes), Mennekes CCS, CHAdeMO, Tesla, Charging Process, Energy Efficiency, Vehicle Efficiency, Charging Efficiency, Transmission and Distribution Efficiency, Generation Efficiency, Introduction of controller,Circuit Elements, Mathematical approach on Resistors, Inductors, Capacitors, Diodes, Transistors, Controllers, Step-Down DC Controllers, Step-Up/Down DC Controllers, AC Controllers.

UNIT IV CHASSIS AND SUBSYSTEMS **10**

Main frame for two and three wheelers - its types, Chassis components, different drive systemsfor two wheelers, front and rear suspension systems, shock absorbers, panel meters andcontrols on handle bar, Drum brakes and Disc brakes - construction, working and its types, front and rear brake links layouts, brake actuation mechanism, Combined Brake System in two wheelers, Antilock BrakeSystem for two wheelers, Wheels, wheels types - spoke, cast, disc , its merits and demerits, tyreand tubes construction and its types, Steering geometry.

UNIT V ELECTRIC TWO AND THREE WHEELERS – CASE STUDY **6**

Case study of Sports bike, Motor cycles, Scooters and Mopeds, Auto rickshaws, Pick up van, Delivery van and Trailer, Servicing and maintenance, recent developments.

TOTAL:45PERIODS

OUTCOMES:		
COs	**COURSE OUTCOMES**	**RBT Level**
CO1	Apply the various laws and how those laws are applied in the working principle of the various motor.	3
CO2	Apply the learning battery concept on a vehicle.	3
CO3	Apply the knowledge acquired on the learning of electric vehicle charging and controllers.	3
CO4	Apply the basic concept of chassis and subsystems.	3
CO5	Apply the acquired knowledge on two and three wheeler- case study and its servicing on a vehicle the electric two and three wheeler.	3

TEXT BOOKS

1 Per Enge, Nick Enge, Stephen Zoepf, "Electric Vehicle Engineering", 1st Edition, McGraw Hill Publication, 2021.

2 Dhruv U. Panchal, "Two and Three Wheeler Technology", PHI Learning Pvt. Ltd., 2015.

REFERENCES

1 Irving, P.E., "Motor Cycle Engineering", Temple Press Book, London, 1992.

2 Elvis Payne , "The A-Z of Three-wheelers", Crecy Publishing, 2014.

3 Marshall Cavendish, "Encyclopedia of Motor Cycling", 20 volumes, New York and London, 1989.

4 Ramalingam K. K, "Two Wheelers", Scitech publications, Chennai, 2009.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	3	3	2	2	2	2	2	2	2	3	1	2
2.	3	3	3	3	2	3	2	2	2	2	2	3	2	2
3.	3	3	3	3	2	3	3	2	2	2	2	3	2	2
4.	3	3	3	3	2	2	2	2	2	2	2	3	2	3
5.	3	3	3	3	2	2	2	2	2	2	2	3	2	2
Average	**3**	**3**	**3**	**3**	**2**	**2.4**	**2.2**	**2**	**2**	**2**	**2**	**3**	**1.8**	**2.2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22026	ELECTRIC VEHICLE MANAGEMENT SYSTEMS (Common to AE, AM)	L T P C 3 0 0 3

OBJECTIVES:

- To understand the fundamentals of electric vehicles and their importance in sustainable transportation.
- To explore the components and functionalities of Electric Vehicle Management Systems (EVMS).
- To learn about the role of EVMS in optimizing fleet operations, energy management, and sustainability.
- To gain insights into the challenges and considerations involved in implementing and operating EVMS.
- To analyze case studies and real-world examples of successful EVMS deployments.

UNIT I INTRODUCTION TO ELECTRIC VEHICLE MANAGEMENT SYSTEMS (EVMS) 9

Overview of Electric Vehicles (EVs), Electric Vehicle Components and Systems, Charging Infrastructure, Fleet Management Principles, Energy Management Systems (EMS), Vehicle-to-Grid (V2G) Integration, Smart Charging Solutions, Regulatory Landscape and Standards, Emerging Trends and Future Outlook, Case Studies and Industry Applications.

UNIT II CHARGING INFRASTRUCTURE MANAGEMENT 9

Types of Charging Infrastructure , Charging Station Components, Charging Infrastructure Deployment, Charging Station Management Software, Charging Session Management, Charging Infrastructure Optimization, Charging Infrastructure Standards and Regulations, Future Trends in Charging Infrastructure, Case Studies and Real-world Examples.

UNIT III BATTERY HEALTH MONITORING 9

Battery Basics, Battery Management System (BMS), State of Health (SoH) Estimation, Battery Aging Mechanisms, Diagnostic Techniques, Fault Detection and Diagnosis, Battery Management Strategies, Real-time Monitoring and Data Analysis, Battery Testing and Validation. Thermal Management, Integration with Electric Vehicle Systems.

UNIT IV ELECTRIC VEHICLE PERFORMANCE AND ANALYSIS 9

Introduction to Electric Vehicle Performance and Analysis, Key Performance Indicators (KPIs) for Vehicle Management, Data Collection and Management, Data Visualization and Reporting, Vehicle Health Monitoring, Energy Efficiency and Consumption Analysis, Route Analysis and Optimization, Methods for evaluating driver performance, Case Studies and Practical Applications.

UNIT V ELECTRIC VEHICLE DIAGNOSTICS AND MAINTENANCE 9

Introduction to Remote Diagnostics and Maintenance (RDM), Telemetry and Sensor Systems, Data Acquisition and Signal Processing, Condition Monitoring and Fault Detection, Remote Troubleshooting and Diagnostics, Predictive Maintenance Strategies, Cyber security and Data Privacy, Remote Firmware Updates and Software Maintenance, Integration with Internet of Things (IoT) and Cloud Platforms

TOTAL:45 PERIODS

OUTCOMES		
COs	**COURSE OUTCOMES**	**RBT Level**
CO1	Identify and describe the key components and functionalities of Electric Vehicle Management Systems.	3
CO2	Implement charging infrastructure management strategies to optimize charging schedules and minimize energy costs.	3
CO3	Evaluate battery health metrics and devise maintenance strategies to prolong battery life and enhance performance.	3
CO4	Analyze real-time vehicle data and apply monitoring techniques to track battery status and performance effectively.	3
CO5	Integrate EVMS with external systems such as enterprise software and telematics platforms to streamline operations and data exchange.	3

TEXT BOOKS:

1 Nicolae Tudoroiu, Mdpi AG, "Battery Management Systems of Electric and Hybrid Electric Vehicles", 2021, ISBN-13 : 978-3036510606.

2 Vahid Vahidinasab, Behnam Mohammadi-Ivatloo, "Electric Vehicle Integration via Smart Charging: Technology, Standards, Implementation, and Applications (Green Energy and Technology) ", Springer International Publishing AG, 2022, ISBN-13 : 978-3031059087.

REFERENCES

1 Gerardus Blokdyk, "Electrical Vehicle Charging Infrastructure", 5STARCooks,2017, ASIN : B081MX3YSL

2 Iqbal Husain, "Electric and Hybrid Vehicles, Design Fundamentals", CRC Press, 2021, ISBN : 9780429956362.

3 James H. "Banks Introduction to Transportation Engineering", By, McGraw-Hill, 2002, ISBN 0072431881.

4 James Larminie, John Lowry, "Electric Vehicle Technology Explained", 2nd Edition, , ISBN: 978-1-119-94273-3.

5 João A. Peças Lopes, Rodrigo Garcia-Valle, "Electric Vehicle Integration Into Modern Power Networks", Springer New York, 2012, ISBN : 1461401348

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	3	3	2	2	2	2	2	2	2	3	2	2
2.	3	3	3	3	2	2	2	2	2	2	2	3	2	2
3.	3	3	3	3	2	2	2	2	2	2	2	3	2	2
4.	3	3	3	3	2	2	2	2	2	2	2	3	2	2
5.	3	3	3	3	2	2	2	2	2	2	2	3	2	2
Average	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22027	MOTORS AND CONTROLS FOR HYBRID AND ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

(Common to AE, AM)

OBJECTIVES

- To understand Modern Electrical drive system and drive dynamics.
- To understand the Construction, control and Braking of DC and BLDC Motor.
- To understand the Construction, control and Braking of Induction Motor drive.
- To understand the Construction, control and Braking of Synchronous Reluctance Motor.
- To study Constructional feature, importance of control and Braking of special electric machines.

UNIT I Modern Electrical Drives and Principles **9**

Choice of electric propulsion system, block diagram of EV propulsion system, Electromagnetic Torque Control Principles, single motor and multi-motor configurations, fixed & variable geared transmission, In-wheel motor configuration, classification of EV motors, Sizing and Comparison of Electric Motors for EV applications.

UNIT II DC and BLDC Motor **9**

DC Series, Speed Control and Braking, traction application, DC motors with Permanent Magnets, Out-runner type BLDC Motor In-runner type BLDC Motor and its transmission system. Torque Equation, Speed-Torque Characteristics, Speed Control and Braking, Simulation of BLDC motor for two wheeler tractive effort.

UNIT III Induction Motor Drive **9**

Three Phase Inverter Based Induction Motor Drive, Speed Control of Induction Motor, Field oriented control, Adaptive Control, Model Reference Adaptive Control (MARS), Sliding mode Control, Configuration of HEV (Series, Parallel, Series-parallel &Complex), Power Flow control, Examples. Power flow control in all HEV configurations, Examples of HEV system performance.

UNIT IV PMSM and Synchronous Reluctance Motor **9**

PMSM -Constructional features – Principle of operation, Torque equation-Drive circuits of Synchronous Reluctance Motor, Speed- torque Characteristics, Speed Control and Braking.

Introduction - Constructional features of Synchronous Reluctance Motor– Principle of operation –Reluctance torque, Torque equation-Drive circuits of Synchronous Reluctance Motor, Speed-torque Characteristics, Speed Control and Braking. Comparison of PMSM, and SyRM for electric tractive effort.

UNIT V Auxiliary Electrical Machines in EVs **9**

Power Windows, Sun roof, Wiper-Motors and its control. Cooling system, Air-conditioner system and its control. Control view mirrors.

TOTAL: 45 PERIODS

OUTCOMES:		
COs	**COURSE OUTCOMES**	**RBT LEVEL**
CO1	Critically examine the rudimentary concepts of electric drives especially applicable to electric propulsion system.	**3**

CO2	Explore the modeling of DC motor and PMBLDC motor along with its characteristics.	**3**
CO3	Investigate the applicability of induction motor in hybrid electric vehicles through its modeling and control aspects.	**3**
CO4	Comprehend the construction, principle operation and to examine the control and braking operation of PMSM and SynRM for electric traction application.	**3**
CO5	Appreciate the constructional features and to explore the various aspects control and braking of auxiliary machines for EV applications.	**3**

TEXT BOOKS:

1. P.C. Krause, O. Wasynczuk, and S. D. Sudhoff, "Analysis of Electric Machinery", McGraw-Hill Book Company, 1986.
2. Ned Mohan, "Advanced Electric Drives-Analysis, Control, and Modeling Using MATLAB/Simulink", Wiley 2014
3. Rik De Doncker, Duco W.J. Pulle, André Veltman, "Advanced Electrical Drives - Analysis, Modeling, Control", Springer 2011.

REFERENCES:

1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, 2011.
2. P. S. Bhimbra, "Generalized Theory of Electric Machines", Khanna Publication.2006

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	3	3	2	2	2	2	2	2	2	3	2	2
2.	3	3	3	3	2	2	2	2	2	2	2	3	2	2
3.	3	3	3	3	2	2	2	2	2	2	2	3	2	2
4.	3	3	3	3	2	2	2	2	2	2	2	3	2	2
5.	3	3	3	3	2	2	2	2	2	2	2	3	2	2
Average	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22028 **SOLAR ENERGY TECHNOLOGY** **L T P C**

(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- Describing the solar radiation and various solar collectors.
- Explaining the various solar thermal energy technologies and their application
- Analyzing the various solar PV cell materials and conversion techniques.
- Discussing various Solar SPV systems designs and their applications.
- Applying solar passive building techniques for cooling and heating applications

UNIT I SOLAR RADIATION AND COLLECTORS 9

Solar angles – Sun path diagrams – Radiation - extraterrestrial characteristics - measurement and estimation on horizontal and tilted surfaces - flat plate collector thermal analysis - testing methods-evacuated tubular collectors - concentrator collectors – classification - design and performance parameters - tracking systems - compound parabolic concentrators - parabolic trough concentrators - concentrators with point focus - Heliostats – performance of the collectors.

UNIT II SOLAR THERMAL TECHNOLOGIES 9

Principle of working, types, design and operation of - Solar heating and cooling systems - Thermal Energy storage systems – Solar Desalination – Solar cooker : domestic, community – Solar pond – Solar drying-solar chimney-solar thermal electricity conversion.

UNIT III SOLAR PV FUNDAMENTALS 9

Semiconductor – properties - energy levels - basic equations of semiconductor devices physics. Solar cells - p-n junction: homo and hetero junctions - metal-semiconductor interface - dark and illumination characteristics - figure of merits of solar cell - efficiency limits - variation of efficiency with band-gap and temperature - efficiency measurements - high efficiency cells – Solar thermo-photovoltaics.

UNIT IV SPV SYSTEM DESIGN AND APPLICATIONS 9

Solar cell array system analysis and performance prediction- Shadow analysis: reliability - solar cell array design concepts - PV system design - design process and optimization - detailed array design - storage autonomy - voltage regulation - maximum tracking - centralized and decentralized SPV systems - standalone - hybrid and grid connected system - System installation - operation and maintenances - field experience - PV market analysis and economics of SPV systems.

UNIT V SOLAR PASSIVE ARCHITECTURE 9

Thermal comfort - bioclimatic classification – passive heating concepts: direct heat gain - indirect heat gain - isolated gain and sunspaces - passive cooling concepts: evaporative cooling - Radiative cooling- application of wind, water and earth for cooling; shading - paints and cavity walls for cooling roof radiation traps - earth air-tunnel – energy efficient landscape design - thermal comfort.

TOTAL: 45 PERIODS

OUTCOMES:		
COs	**Course Outcomes**	**RBT LEVEL**
Upon successful completion of the course, the students should be able to:		
CO1	Describe the solar radiation and various solar collectors.	**3**
CO2	Explain the various solar thermal energy technologies and their applications.	**3**
CO3	Analyze the various solar PV cell materials and conversion techniques.	**3**
CO4	Discuss various Solar SPV systems designs and their applications.	**3**
CO5	Apply solar passive building techniques for cooling and heating applications.	**3**

TEXTBOOKS:

1. G.D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.
2. Twidell, J.W. & Weir, A., "Renewable Energy Resources", EFN Spon Ltd., UK, 2015.

REFERENCES:

1. Chetan Singh Solanki, Solar Photovoltatics – Fundamentals, Technologies and Applications, PHI Learning Private limited, 2011.
2. John A. Duffie, William A. Beckman, Solar Engineering of Thermal Processes, John Wiley & Sons, 2013.
3. Lovegrove K., Stein W., Concentrating Solar Power Technology, Woodhead Publishing Series in Energy, Elsevier, 1st Edition, 2012.
4. Solar Energy International, Photovoltaic – Design and Installation Manual, New Society Publishers, 2006.
5. Sukhatme S P, Nayak J K, Solar Energy – Principle of Thermal Storage and collection, Tata McGraw Hill, 2008.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1.	3	3	3	3	2	2	3	2	2	2	2	3	3	3
2.	3	3	3	3	2	2	3	2	2	2	2	3	3	3
3.	3	3	3	3	2	2	3	2	2	2	2	3	3	3
4.	3	3	3	3	2	2	3	2	2	2	2	3	3	3
5.	3	3	3	3	2	2	3	2	2	2	2	3	3	3
Average	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22031 ADVANCED THEORY OF IC ENGINES L T P C
(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- Acquiring knowledge in stoichiometry calculations.
- Acquiring knowledge in Ideal and actual fuel air cycles.
- Knowledge in usage of software for simulating the performance of IC engines.
- Acquiring ability to simulate the various types of combustion processes of IC engines.
- Acquiring knowledge in photographic studies of combustion processes.

UNIT I COMBUSTION OF FUELS 9

Chemical composition and molecular structure of hydrocarbon fuels, combustion stoichiometry of hydrocarbon fuels - chemical energy and heat of reaction calculations - chemical equilibrium and adiabatic flame temperature calculation, Theory of SI and CI engine combustion – Flame velocity and area of flame front, Fuel spray characteristics - droplet size, depth of penetration and atomization.

UNIT II ENGINE CYCLE ANALYSIS 8

Ideal air, fuel air cycle and actual cycle analysis, Progressive combustion analysis in SI engines, Parametric studies on work output, efficiency and other engine performance.

UNIT III COMBUSTION MODELLING 10

Basic concepts of engine simulation - Governing equations, Classification of engine models- Thermodynamic models for Intake and exhaust flow process - Quasi steady flow - Filling and emptying - Gas dynamic Models, Thermodynamic based in cylinder models for SI engine and CI engines.

UNIT IV NON-CONVENTIONAL IC ENGINES 9

Concept of L.H.R. engine and its recent developments, Variable compression ratio engine and its use in engine research, Wankel rotary combustion engine, Dual fuel engine concept for multi fuel usage in CI engines - performance studies on dual fuel engine, Free piston engine, Stratified charge and lean burn engines. Locomotive and marine engines.

UNIT V COMBUSTION ANALYSIS IN IC ENGINES 9

Photographic studies of combustion processes - Analysis of Pressure crank angle diagrams in SI and CI engines. Knock study for Pressure crank angle histories, Apparent heat release rate and Wiebe's law analysis for combustion, Calculation of Ignition delay and combustion duration, Hot wire and laser Doppler anemometry and velocimetry for flow and combustion analysis in IC engines.

TOTAL: 45 PERIODS

OUTCOMES:

COs	COURSE OUTCOMES	RBT LEVEL
At the end of the course, the student will be able to		
CO1	Analyze the products of combustion and develop mathematical model of combustion.	**3**
CO2	Compare various aspects of engine cycle analysis.	**3**
CO3	Outline the modeling and thermodynamic simulation of SI and CI engine cycles.	**3**
CO4	Outline the recent developments in IC engines.	**3**
CO5	Discuss various technologies and instruments for combustion analysis.	**3**

TEXT BOOKS:

1. Ganesan.V,"Computer Simulation of Spark Ignition Engine Processes", Universities Press (I) Ltd, Hyderabad, 2001.
2. HeywoodJ.B, "Internal Combustion Engine Fundamentals", 2nd edition, McGraw Hill Book Co., 2018.

REFERENCES:

1. BensonR.S, Whitehouse, N.D, "Internal Combustion Engines", Pergamon Press, Oxford, 1979.
2. Ganesan,V. "Computer Simulation of Compression - Ignition Engine Processes", Universities Press (India) Ltd., Hyderabad, 2000.
3. Ganesan.V,"Internal Combustion Engines", 4th edition, Tata McGraw Hill Publishing Co., 2012.
4. Mathur R.B and Sharma R.P., "Internal Combustion Engines", DhanpatRai& Sons 2007.
5. Ramalingam K.K, "Internal Combustion Engine", 3rd edition, Scitech publications, Chennai, 2016.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	3	3	2	2	3	2	2	2	2	3	3	3
CO2	3	3	3	3	2	2	3	2	2	2	2	3	3	3
CO3	3	3	3	3	3	2	3	2	2	2	2	3	3	3
CO4	3	3	3	3	3	2	3	2	2	2	2	3	3	3
CO5	3	3	3	3	3	2	3	2	2	2	2	3	3	3
Average	**3**	**3**	**3**	**3**	**2.6**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

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AE22032	ALTERNATIVE FUELS	L	T	P	C
	(Common to AE, AM)	3	0	0	3

OBJECTIVES:

- To know about the production methods and characteristics of alcohol as an automotive fuel.
- To study the importance of using vegetable oil as a fuel for automotive applications.
- To know the properties, production methods usage of hydrogen in automotive engines.
- To understand the usage of gaseous fuel in internal combustion engines.
- To study the the recent advancements available in the alternative energy systems.

UNIT I ALCOHOLS AS FUELS 9

Alternative fuels – Introduction, need and availability, Alcohols as fuel - production methods - properties - methods of using alcohols in CI and SI engines, blending, dual fuel operation, surface ignition and oxygenated additives, Performance, emission and combustion characteristics in CI and SI engines.

UNIT II VEGETABLE OILS AS FUELS 9

Vegetable oils – types and properties, different methods of using vegetable oils in engines – blending, preheating, transesterification and emulsification, Performance, emission and combustion characteristics in diesel engines.

UNIT III HYDROGEN AS ENGINE FUEL 9

Hydrogen - combustive properties, production methods, problems associated with hydrogen as fuel and solutions, different methods of using hydrogen in SI and CI engines, Performance, emission and combustion analysis in engines. Hydrogen storage, safety aspects of hydrogen.

UNIT IV BIOGAS, NATURAL GAS AND LPG AS FUELS 9

Production methods of Biogas, Natural gas and LPG, Properties, CO_2 and H_2S scrubbing in Biogas., modification required to use in SI and CI Engines, Performance, emission and combustion characteristics of Biogas, NG and LPG in SI and CI engines.

UNIT V ELECTRIC, HYBRID AND FUEL CELL VEHICLES 9

Electric and Hybrid vehicles – layout, different configurations, advantages and disadvantages. electronic control system, power split device. high energy and power density batteries, Basics of fuel cell vehicles and solar powered vehicles.

TOTAL: 45 PERIODS

OUTCOMES:

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Describe the need, availability of different alternative fuels and also to justify the suitability of alcohol as an alternative fuel for IC engines.	**3**
CO2	Classify and discuss the different methods of using vegetable oils as a fuel and analyze theirperformance, combustion and emission characteristics in diesel engines.	**3**
CO3	Illustrate different methods of hydrogen production and discuss the usage of hydrogen as analternative fuel in engines.	**3**
CO4	Compare the performance of different gaseous fuels used as the alternatives in IC engines.	**3**
CO5	Discuss the recent advancements in the alternative energy systems.	**3**

TEXT BOOKS:

1. Richard L Bechtold P.E., “Alternative Fuels Guide Book”, Society of Automotive Engineers,2014 ISBN 0-76-80-0052-1.
2. Thipse S.S, “Alternative Fuels - Concepts, Technologies and Developments”, Jaico Publisher, 2010.

REFERENCES:

1. Arumugam S. Ramadhas, “Alternative Fuels For Transportation”, CRC Press, 2011.
2. AyhanDemirbas, “Biodiesel A Realistic Fuel Alternative for Diesel Engines”, Springer-Verlag London Limited 2008,ISBN-13: 978184628994.
3. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, “The Biodiesel Handbook”, AOCS PressChampaign, Illinois 2005.
4. Richard Folkson, “Alternative Fuels and Advanced Vehicle Technologies for Improved Environmental Performance”, Woodhead Publishing, 2014.
5. Transactions of SAE on Biofuels (Alcohols, Vegetable oils, CNG, LPG, Hydrogen, Biogas etc.).

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	3	3	2	3	3	2	2	2	2	3	3	3
CO2	3	3	3	3	2	3	3	2	2	2	2	3	3	3
CO3	3	3	3	3	2	3	3	2	2	2	2	3	3	3
CO4	3	3	3	3	2	3	3	2	2	2	2	3	3	3
CO5	3	3	3	3	2	3	3	2	2	2	2	3	3	3
Average	3	3	3	3	2	3	3	2	2	2	2	3	3	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22033 AUTOMOTIVE CONTROL SYSTEMS FOR DRIVELINE **L T P C**
(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- To make the students to use the transfer function models for analysis physical systems and introduce the control system components.
- To provide adequate knowledge in time response of systems and steady state error analysis.
- To accord basic knowledge in obtaining the open loop and closed loop frequency responses of systems.
- To introduce stability analysis and design of compensators.
- To introduce vehicle driveline control system.

UNIT I INTRODUCTION AND SYSTEM REPRESENTATION 11

Open loop and closed loop systems - Examples, Control system components, Transfer function of physical systems - Mechanical systems, Translational and Rotational systems, Electrical network, Thermal and hydraulic systems, Transfer function of DC Generator, DC servomotor, AC servomotor, Transfer function of overall systems, Block diagram - reduction techniques. Signal flow graphs – Mason gain formula.

UNIT II TIME RESPONSE ANALYSIS 9

Standard Test signals - Time response of zero, first and second order systems, Performance criteria, Type of systems, Steady-state error constants – position, velocity and acceleration error constants, Generalized error series – Feedback characteristics of control systems, Controllers – P, PI and PID control modes.

UNIT III FREQUENCY RESPONSE ANALYSIS 6

Frequency domain specifications – peak resonance, resonant frequency, bandwidth and cut-off rate, correlation between time and frequency responses for second order systems, Polar plot, Bode plot – Gain Margin and Phase Margin.

UNIT IV STABILITY OF SYSTEMS 9

Characteristic equation – Location of roots of characteristic equation – Absolute stability and Relative stability, Routh-Hurwitz criterion of stability – Necessary and sufficient conditions, Nyquist Stability - Principle of argument – Nyquist path – Nyquist stability criterion – Determination of Nyquist stability – Assessment of relative stability, Bode Plot – Assessment of stability, Nichols Chart.

UNIT V ROOT LOCUS AND COMPENSATORS AND AUTOMOTIVE DRIVELINE CONTROL 10

ROOT LOCUS AND COMPENSATORS: Root locus concept, Rules for construction of root loci, problems, stability analysis, Lag, Lead and Lag-Lead Compensators – Transfer function and Characteristics

AUTOMOTIVE DRIVELINE CONTROL Driveline modeling, Basic driveline equations, An illustrative Modeling example - Engine, delimiters, sensor system, Experiments for driveline modeling, Engine friction modeling, Obtaining set of models, Model with drive-shaft flexibility, Drive shaft model, Parameter estimation of the drive shaft model, Results of parameter estimation.

TOTAL: 45 PERIODS

OUTCOMES:

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Derive transfer functions for electrical and mechanical systems.	**3**
CO2	Perform time response analysis.	**3**
CO3	Sketch Bode and Polar plots for a transfer function.	**3**

CO4	Verify the stability of a system by Routh-Hurwitz and Nyquist criteria.	**3**
CO5	Design a compensator using Root locus / Bode plots for a power electronic converter and model a physical system of a vehicle driveline.	**3**

TEXTBOOKS:

1. Gopal M, "Control Systems – Principles and Design" Tata McGraw-Hill, New Delhi, 2012.
2. Norman S Nise, "Control System Engineering", John Wiley & Sons, New Delhi, 2012.

REFERENCES:

1. Benjamin Kuo, "Automatic Control Systems", Prentice Hall of India, New Delhi, 2010.
2. Kiencke U, Nielsen L, "Automotive control systems for engine, driveline and vehicle', Springer, SAE International,USA, 2000.
3. Nagrath I J and Gopal M, "Control System Engineering", New Age International, New Delhi, 2011.
4. Ogata K, "Modern Control Engineering", Prentice Hall of India, New Delhi, 2010.
5. William S Levine, "Control System Fundamentals," The Control Handbook, CRC Press, Taylor and Francis Group, 2011.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	3	3	2	3	2	1	2	2	2	3	3	3
CO2	3	3	3	3	2	2	1	1	2	2	2	3	3	3
CO3	3	3	3	3	3	2	1	1	2	2	2	3	3	3
CO4	3	3	3	3	3	2	1	1	2	2	2	3	3	3
CO5	3	3	3	3	3	2	2	1	2	2	2	3	3	3
Average	**3**	**3**	**3**	**3**	**2.6**	**2.2**	**1.4**	**1**	**2**	**2**	**2**	**3**	**3**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22034 AUTOMOTIVE NOISE, VIBRATION AND HARSHNESS L T P C
(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- To know about the sources of Noise, Vibration and Harshness in vehicles.
- To study the measurement techniques of noise, vibration and Harshness pertaining to an automobile and its control methods.
- To study theeffects of transportation noise and its control techniques.
- To study the effects of interior transportation noise and its control techniques related to automobile.
- To study the measurement techniques of noise, vibration and harshness pertaining to an automobile.

UNIT I FUNDAMENTALS OF NOISE AND VIBRATION 9

Theory of sound - Predictions and measurement, Sound sources, Sound propagation in the Atmosphere, Sound radiation from structures and their response to sound, Introduction to vibration, free and forced vibration, undamped and damped vibration, Vibration of simple discrete and continuous systems, Torsional vibration, Determination of natural frequencies.

UNIT II VIBRATIONS MEASUREMENT TECHNICS AND CONTROL 9

Vibration measuring Instruments: Vibration pick-up, Types of transducers, Vibrometer for measurement of Frequency of vibrations, Period, Amplitude, Velocity and Acceleration parameters, Vibrations isolation, Different types of vibration absorber.

UNIT III TRANSPORTATION NOISE AND VIBRATION - SOURCES, PREDICTION, AND CONTROL 9

Introduction to Transportation noise and vibration sources, Internal combustion engine noise prediction and control - Diesel, Exhaust and Intake noise and Acoustical design of mufflers, Tire/Road Noise - Generation, Measurement, and Abatement, Aerodynamic sound sources in vehicles - Prediction and Control, Transmission and Gearbox noise and vibration prediction and control, Brake noise prediction and control, Definition of Harshness, Its effect and acceptable degree of Harshness, Perception of Ride comfort.

UNIT IV INTERIOR TRANSPORTATION NOISE AND VIBRATION SOURCES - PREDICTION AND CONTROL 9

Introduction to Interior transportation noise and vibration sources, Automobile, Bus and Truck Interior noise and vibration prediction and control, Noise and Vibration in Off-Road vehicle Interiors - Prediction and control.

UNIT V NOISE AND VIBRATION ANALYSIS EQUIPMENT, SIGNAL PROCESSING, AND MEASURING TECHNIQUES 9

General Introduction to noise and vibration measuring equipment, Signal acquisition and processing, Acoustical transducer principles and Types of microphones, Sound level meters, Noise Dosimeters, Analyzers and signal generators, Equipment for data acquisition, Determination of sound power level and emission sound pressure level, Sound intensity measurements, Noise and vibration data analysis, Calibration of measurement microphones, Calibration of shock and vibration transducers, Metrology and traceability of vibration and shock measurements.

TOTAL: 45 PERIODS

OUTCOMES:		
COs	**COURSE OUTCOMES**	**RBT LEVEL**
Students will be able to		
CO1	Discuss the basic fundamentals of noise and vibrations.	3
CO2	Classify and discuss the various techniques to measure and control the automotivevibrations.	3

CO3	Describe the effects of transportation noise and its control techniques.	3
CO4	Outline the effects of interior transportation noise and its control techniques related to automobile.	3
CO5	Describe the measurement techniques of noise, vibration pertaining to an automobile.	3

TEXTBOOKS:

1. David A.Bies and Colin H.Hansen, "Engineering Noise Control: Theory and Practice", SponPress, London, 2009.
2. Mathew Harrison, "Vehicle refinement Controlling Noise and vibration in road vehicles" , SAE International, Elsevier Butterworth-Heinemann, 2008.
3. Xu Wang, "Vehicle Noise and Vibration Refinement",Woodhead Publishing Limited, 2010.

REFERENCES:

1. Allan G. Piersol,Thomas L. Paez, Harris,"Shock and Vibration Handbook", McGraw-Hill, New Delhi, 2010.
2. Clarence W. de Silva, "Vibration Monitoring, Testing, and Instrumentation", CRC Press, 2007.
3. Colin H Hansen, "Understanding Active Noise Cancellation", Spon Press, London 2003.
4. KewalPujara,"Vibrations and Noise for Engineer"s, DhanpatRai& Sons, 1992.
5. Matthew Harrison, "Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles", Elsevier Butterworth-Heinemann, Burlington, 2004.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	3	2	2	2	1	1	2	2	1	2	2	3
CO2	3	3	3	2	2	2	1	1	2	2	1	2	2	3
CO3	3	3	3	2	2	2	2	1	2	2	1	2	2	3
CO4	3	3	3	2	2	2	2	1	2	2	1	2	2	3
CO5	3	3	3	3	3	2	2	1	2	2	2	2	2	3
Average	**3**	**3**	**3**	**2.2**	**2**	**2**	**1.6**	**1**	**2**	**2**	**1.2**	**2**	**2**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22035 AUTOMOTIVE POLLUTION AND CONTROL L T P C

(Common to AE, AM) **3 0 0 3**

COURSEOBJECTIVES

- To impart knowledge in sources and effects of automotive pollution and emission standards
- To understand the formation of major pollutants in spark ignition engines.
- To understand the formation of major pollutants in compression ignition engines.
- To introduce different control techniques for emission reduction.
- To impart knowledge in the working principle of emission measuring instruments and test procedures.

UNITI INTRODUCTION 9

Pollutants – sources – formation – effects of pollution on environment and human, transient operational effects on pollution, regulated and unregulated emissions, emission standards.

UNITII EMISSIONS IN SI ENGINE 9

Chemistry of SI engine combustion, HC, CO and NOx formation in SI engines, smoke emissions from SI engines, effect of operating variables on emission formation.

UNITIII EMISSIONS IN CI ENGINE 9

Basics of diesel combustion, HC, CO, NOx, soot, smoke and particulate matter formation in CI engines, sulfur, aldehyde and odor emissions from CI engines, effect of operating variables on emission formation.

UNITIV CONTROL TECHNIQUES FOR REDUCTION OF EMISSION 9

Design modifications, optimization of operating factors, fuel modification, evaporative emission control, exhaust gas recirculation, selective catalytic reduction, secondary air injection, positive crankcase ventilation system, diesel oxidation catalyst, NOxadsorber catalysts, particulate trap, carbon capture and storage, exhaust treatment in SI engines, thermal reactors, catalytic converters, gasoline particulate filters.

UNITV INSTRUMENTATION, EMISSION MEASUREMENT AND TEST PROCEDURES 9

Non Dispersive Infra Red Analyzer, Flame Ionization Detector, Chemiluminescent Analyzer, Dilution Tunnel, Gas Chromatograph, Smoke meters and modern methods for emission measurement. Test procedures, Constant Volume Sampling methods, Test cycles – Indian Driving Cycle – New European Driving Cycle – Federal Test Procedure – Sealed Housing Evaporation Determination tests.

TOTAL: 45 PERIODS

COs	COURSEOUTCOMES Students will be able to	RBT Level
CO1	Outline the important sources of pollutant, effects of emission and their standards.	3
CO2	Discuss and compare the emission formation and the effects of operating variables on emission in spark ignition engines.	3
CO3	Discuss and compare the emission formation and the effects of operating variables on emission in compression ignition engines.	3
CO4	Explain the suitable control techniques for the reduction of engine emission.	3
CO5	Select the suitable instrument for the measurement of emission and outlining the different test cycles adopted in emission measurement.	3

TEXTBOOKS

1 Heywood, J.B., "Internal Combustion Engine Fundamentals", Indian edition, McGraw Hill Book Co., 2017.

2 Pundir. B.P, "IC Engines Combustion and Emissions" Narosa Publishers, 2014.

REFERENCES

1 Ganesan V, "Internal Combustion Engines", 4th edition, Tata McGraw Hill Co., 2017.

2 Ramalingam K.K, "Internal Combustion Engines", 3rd edition, Scitech Publications, 2016.

3 Obert E.F, “Internal Combustion Engines and Air Pollution” 3rd edition, Intex Educational Pub, 1982.
4 SAE Transactions, “Automobiles and Pollution”, 1995.
5 Springer and Patterson, “Engine Emission”, Plenum Press, 1990.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	3	3	2	3	3	2	2	2	2	2	3	2
CO2	3	3	3	3	2	3	3	2	2	2	2	2	3	2
CO3	3	3	3	3	2	3	3	2	2	2	2	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2	2	2	3	2
CO5	3	3	3	3	2	3	3	2	2	2	2	2	3	2
Average	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22036 **DESIGN OF EXPERIMENTS** **L T P C**

(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- To acquire knowledge about Design of experiments.
- Understand various aspects of DoE.
- Design experiments based on problem description.
- Offer optimized solution for a given problem.

UNIT I FUNDAMENTALS OF EXPERIMENTATION 7

Role of experimentation in rapid scientific progress, Historical perspective of experimental approaches, Steps in experimentation, Principles of experimentation.

UNIT II COMPARATIVE EXPERIMENTS 9

Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means & ANOVA

UNIT III EXPERIMENTAL DESIGN 11

Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data

UNIT IV RESPONSE SURFACE METHODOLOGY 9

Concept, linear model, steepest ascent, second order model, regression, optimization

UNIT V TAGUCHI TECHNIQUE 9

Taguchi's Parameter Design: Concept of robustness, noise factors, objective function & S/N ratios, inner-array and outer-array design, data analysis

TOTAL: 45 PERIODS

OUTCOMES:		
COs	**COURSE OUTCOMES**	**RBT LEVEL**
Students shall be able to		
CO1	Formulate objective(s) and identify key factors in designing experiments for a given problem.	**3**
CO2	Develop appropriate experimental design to conduct experiments for a given problem.	**3**
CO3	Analyze experimental data to derive valid conclusions.	**3**
CO4	Optimize process conditions by developing empirical models using experimental data.	**3**
CO5	Design robust products and processes using parameter design approach.	**3**

TEXTBOOKS:

1. Krishnaiah K, Shahabudeen P, "Applied Design of Experiments and Taguchi Method", Second edition, PHI, 2012.
2. Montgomery DC, "Design and Analysis of Experiments", 7th Edition, John Wiley & Sons, NY, 2008.

REFERENCES :

1. Daniel Coleman, Belt Gunter , "A DOE Handbook", Createsapce publisher, 2013
2. Ross PJ, "Taguchi Techniques for Quality Engineering", McGraw-Hill Book Company, NY, 2008.

WEB RESOURCES :

https://nptel.ac.in/courses/110105087/

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	3	3	2	3	3	2	2	2	2	2	3	2
CO2	3	3	3	3	2	3	3	2	2	2	2	2	3	2
CO3	3	3	3	3	2	2	2	2	2	2	2	2	3	2
CO4	3	3	3	3	2	2	2	2	2	2	2	2	3	3
CO5	3	3	3	3	3	2	2	2	2	2	2	2	3	3
Average	**3**	**3**	**3**	**3**	**2.2**	**2.4**	**2.4**	**2**	**2**	**2**	**2**	**2**	**3**	**2.4**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22037 ENGINE AND VEHICLE MANAGEMENT SYSTEMS **L T P C**
(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- To accord basic knowledge of microprocessor, their architecture and programming techniques.
- To enhancing the knowledge of sensors used in automotive applications.
- To make the students to understand the ignition and injection methods used in Spark Ignition management systems.
- To make the students to understand the fuel injection methods used in diesel engine management systems.
- To understand the working of various safety system followed in vehicle.

UNIT I FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS 9

Microprocessor architecture, Open and closed loop control strategies, Proportional Integral Derivative controller, Look up tables, introduction to modern control strategies - Fuzzy logic and adaptive control, Parameters to be controlled in Spark Ignition (SI) and Compression Ignition (CI) engines and in the other parts of the automobile.

UNIT II SENSORS 9

Inductive, Hall effect, Hot wire, Thermistor, Piezo electric, Piezoresistive, Throttle position, Mass air flow, Crank shaft position, Cam position, Engine speed, Wheel speed, Steering position, Tire pressure, Steering torque, Fuel level, Crash, Exhaust gas oxygen level, Knock, Engine temperature, Manifold Temperature and Pressure sensors.

UNIT III SI ENGINE MANAGEMENT 9

Three way catalytic converter, conversion efficiency versus lambda, Layout and working of SI engine management systems like Bosch L-Jetronic and LH-Jetronic, Group and sequential injection techniques, Working of the fuel system components, Cold start and warm up phases, idle speed control, acceleration and full load enrichment, deceleration fuel cutoff. Fuel control maps, open loop control of fuel injection and closed loop lambda control. Electronic ignition systems and spark timing control, Closed loop control of knock.

UNIT IV CI ENGINE MANAGEMENT 9

Fuel injection system parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced post injection and retarded post injection. Electronically controlled Unit Injection system. Layout of the common rail fuel injection system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, Exhaust gas recirculation (EGR) valves.

UNIT V VEHICLE MANAGEMENT SYSTEMS 9

Anti-lock Braking system (ABS) its need, layout and working, Electronic control of suspension, Electric power steering, Supplementary Restraint System of air bag system - crash sensor, seat belt tightening, Cruise control, Vehicle security systems - alarms, vehicle tracking system, On board diagnostics, Collision avoidance Radar warning system.

TOTAL: 45 PERIODS

OUTCOMES:		
COs	**COURSE OUTCOMES**	**RBT LEVEL**
Students will be able to		
CO1	Discuss the fundamentals of control strategies applied in engines and automotive components.	**3**
CO2	Explore the construction and working principle of automotive sensors.	**3**
CO3	Discuss and compare the fuel control techniques featured in spark ignition engines.	**3**

CO4	Discuss and compare the fuel control techniques featured in compression ignition engines.	**3**
CO5	Explore the control system employed in comfort, security and safety of vehicle.	**3**

TEXTBOOKS:

1. Eric Chowanietz, "Automobile Electronics", SAE Publications,1995.
2. William B Ribbens, "Understanding Automotive Electronics", 8thedition, Butterworth-Heinemann, 2017.

REFERENCES:

1. Holt, Daniel J,"Recent Developments in Automotive safety technology" SAE International, 2004.
2. Robert Bosch, "Diesel Engine Management", Wiley-Blackwell, 4th edition, 2006.
3. Robert Bosch, "Gasoline Engine Management", Wiley, 3rd edition, 2006.
4. Robert Bosch Gmbh, "Automotive Electricals Electronics System and Components", 4th Edition, 2004.
5. Tom Denton, "Automotive Electrical and Electronics Systems" 5 edition, Routledge, 2017.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	3	3	2	2	3	2	2	2	2	3	3	2
CO2	3	3	3	3	2	2	2	2	2	2	2	3	2	3
CO3	3	3	3	3	2	2	3	2	2	2	2	3	3	2
CO4	3	3	3	3	2	2	3	2	2	2	2	3	3	2
CO5	3	3	3	3	2	2	2	2	2	2	2	3	3	2
Average	**3**	**3**	**3**	**3**	**2**	**2**	**2.6**	**2**	**2**	**2**	**2**	**3**	**2.8**	**2.2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22038 **VEHICLE BODY ENGINEERING** **L T P C**

(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- Tounderstandthetypes ofcarbodyanditsconstructional details, driver' visibility,carseat design, trim items, mechanisms and painting process.
- Tounderstandthetypesofbus/commercialvehiclebodyanditsconstructionaldetails,driver seat design and painting process.
- Tostudyaboutthemethodsandproceduresinvolvedincarryingoutthevehiclebody analysis.
- To understand the basic principles of vehicle aerodynamics and various body optimizationtechniques.
- Tostudyaboutthedesign, safetyandfatigueaspectsof avehicle body.

UNITI CARBODYDETAILS 9

Types of Car body - Saloon, convertibles, Limousine, Estate Van, Racing and Sports car. Visibility - Regulations, driver's visibility, tests for visibility, methods of improving visibility andspaceincars,Driverseatdesign,Carbodyconstruction-Variouspanelsincarbodies-
Design criteria and initial tests, Body trim items, body mechanisms. Modern painting process ofa passenger car body, Anti-corrosion methods.

UNITII BUS,TRUCKANDSPECIALITY PASSENGER VEHICLES 9

Types of bus body: based on capacity, distance travelled and based on construction, Bus body layout for various types.
Regulations – Constructional details: Conventional and integral, Driver seat design, Drivers cab design – Regulations, Modern painting process of a passenger bus body.
Commercial vehicle body technology, trends, Tipper body and Tanker body, special goods vehicle, special haulage vehicles. Buses and coaches, Passenger Specialty Vehicle (PSV) structural design, low floor and articulated buses, three wheelers and light weight trailers.

UNITIII VEHICLE BODY ANALYSIS 9

Introduction, criteria for vehiclebodydesign, sheet metal representation, curved panels, equation forflexure, torsion, twistand differential bending, beam idealization and flexural axis, instability ofthinwalledstructures.Unitloadmethodandstructuraldeflection,torsionalstiffness,carbody
idealization, symmetric bending and torsional loading, closed integral car structure, bus body idealization for analysis, bus body in torsion.

UNITIV VEHICLE AERODYNAMICS 9

Objectives, Vehicle drag and types., Various types of forces and moments influencing drag, Effects of forces and moments, Side wind effects on forces and moments, Various body optimization techniques for minimum drag, Wind tunnels – Principle of operation, Types, Wind tunnel testing - Flow visualization techniques, Air flow management test–measurement of various forces and moments by using wind tunnel.

UNITV DESIGN,SAFETYANDFATIGUE ASPECTS 9

Types of materials used in body construction-Steel sheet, timber, plastics, Glass fiber reinforced plastics(GRP), properties of materials,Design for press working, design for spot welding, adhesivesandsealants,goodsvehiclestructuredesign,chassisframeconfiguration,structural
properties of chassis frame members, Safety aspects of car and body. Crash tests, forces in roll over, head on impact, plastic collapse and analysis, fatigue and vibration, structural vibration.

TOTAL: 45 PERIODS

OUTCOMES:		
COs	**COURSE OUTCOMES**	**RBT LEVEL**
Students will be able to		
CO1	Discuss the different types of car bodies, their safety aspects and regulations.	**3**

CO2	Describe the construction, operation of different types of bus body and commercial vehiclebody and its regulations.	**3**
CO3	Examine and analyze the forces acting on the vehicle body.	**3**
CO4	Explain the various drag and moments acting on the vehicle body.	**3**
CO5	Discuss the concepts of the vehicle body with respect to design, safety and comfort.	**3**

TEXTBOOKS:

1. JohnFenton,"HandbookofAutomotiveBodyandSystemsDesign",JohnWiley&Sons, 2013.
2. Powloski,J,"Vehicle BodyEngineering",BusinessBooksLtd.,1998.

REFERENCES:

1. JohnFenton,"HandbookofAutomotiveConstructionand DesignAnalysis", JohnWiley&Sons, 2014.
2. JamesEDuffy,"ModernAutomotiveTechnology",Goodheart-Willcox;SeventhEdition, 2011.
3. Dieler Anselm, "ThePassengerCarBody",SAEInternational,2000.
4. Braithwaite,J.B., "VehicleBodybuildinganddrawing",HeinemannEducationalBooks Ltd.,London, 1997.
5. Giles,G.J., "BodyConstructionandDesign",IlliffeBooksButterworth&Co.,1991.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	3	3	2	2	2	2	2	2	2	3	2	3
CO2	3	3	3	3	2	2	2	2	2	2	2	3	2	3
CO3	3	3	3	3	2	2	2	2	2	2	2	3	2	3
CO4	3	3	3	3	2	2	2	2	2	2	2	3	2	3
CO5	3	3	3	3	2	2	2	2	2	2	2	3	2	3
Average	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22041	ADDITIVE MANUFACTURING	L	T	P	C
	(Common to AE, AM)	3	0	0	3

OBJECTIVES

- To study the principles involved in Additive Manufacturing.
- To study the design concepts adopted in Additive Manufacturing technologies.
- To know the methods, possibilities and limitations of Additive Manufacturing technologies.
- To be familiar with the characteristics of the different materials used in Additive Manufacturing technologies.
- To know the applications as well as environmental effects of Additive Manufacturing technologies.

UNIT I INTRODUCTION 9

Overview – Need – Evolution- Development of Additive Manufacturing Technology - Principle – AM Process Chain- Classification –Rapid Prototyping- Rapid Tooling – Rapid Manufacturing - Benefits.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

Design tools: Data processing - CAD model preparation – Part orientation and support structure generation – Model slicing –Tool path generation- Design for Additive Manufacturing: Concepts and objectives- AM unique capabilities – Design for Additive manufacturing**(**DFAM) for part quality improvement- Software for Additive Manufacturing Technology: MIMICS, MAGICS.

UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 9

Classification - Liquid based system -Stereo lithography Apparatus (SLA) -Principle, process,advantages and applications -Solid based system-Fused Deposition Modeling-Principle, process, advantages and applications, Laminated Object Manufacturing.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 9

Selective Laser Sintering – Principles of SLS process –Process, advantages and applications,Three Dimensional Printing - Principle, process, advantages and applications-Laser Engineered Net Shaping (LENS), Electron Beam Melting.

UNIT V ADDITIVE MANUFACTURING APPLICATIONS 9

Functional models, Patterns for casting, Medical models, Art models, Engineering analysis models, new materials development, Bi-metallic parts, Re-manufacturing, Application with examples for Aerospace, Defence, Automobile, Bio-medical and general engineering industries, Typical case studies relevant to automotive applications.

TOTAL: 45 PERIODS

OUTCOMES:		
COs	**COURSEOUTCOMES**	**RBT Level**
Students will be able to		
CO1	Discuss the concepts of Additive Manufacturing technologies, their potential to support designand manufacturing	**3**
CO2	Identify the digitizing techniques and slicing concepts for preparing a CAD model for additivemanufacturing	**3**
CO3	Outline the working principle, process parameters and applications of liquid and solid based additive manufacturing systems	**3**
CO4	Outline the working principle, process parameters and applications of powder based additive manufacturing systems	**3**
CO5	Apply the concepts of additive manufacturing to diverse industrial applications.	**3**

TEXTBOOKS:

1. Chua C.K., Leong K.F., and Lim C.S., **"**Rapid prototyping: Principles and applications**"**, Third edition, World Scientific Publishers, 2010
2. Ian Gibson, David W.Rosen, Brent Stucker**"**Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing**",** Springer, 2010.

REFERENCES:

1. Gebhardt A, "Rapid Prototyping", Hanser Gardener Publications,2003.
2. Hilton P.D and Jacobs P.F,"Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.
3. Kamrani A.Kand Nasr E.A,"Rapid Prototyping: Theory and Practice", Springer,2006.
4. Liou L.W and Liou F.W, **"**Rapid Prototyping and Engineering applications:A tool box for prototype development**"**, CRC Press, 2007.
5. Tom Page,**"**Design for Additive Manufacturing**",**LAP Lambert Academic Publishing, 2012.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	2	2	2	3	2	2	2	2	2	2	3	2	2
CO2	3	2	2	3	3	2	2	2	2	2	2	3	2	2
CO3	3	2	2	3	3	2	2	2	2	2	2	3	2	2
CO4	3	2	2	3	3	2	2	2	2	2	2	3	2	2
CO5	3	3	3	3	3	2	2	2	2	3	2	3	3	3
Average	**3**	**2.2**	**2.2**	**2.8**	**3**	**2**	**2**	**2**	**2**	**2.2**	**2**	**3**	**2.2**	**2.2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

ME22031 DIGITAL MANUFACTURING AND INTERNET OF THINGS **L T P C**
(Common to ME, AE, AM, MN) **3 0 0 3**

OBJECTIVES:

- Acquire knowledge about the fundamentals of digital manufacturing.
- Understand the integration of IoT technologies with digital manufacturing processes.
- Apply data analytics techniques to interpret manufacturing data collected through IoT.

UNIT I INTRODUCTION TO DIGITAL MANUFACTURING 9

Historical context and evolution of Digital Manufacturing - Key Components and Technologies - DNC and CNC - Additive Manufacturing - Adaptive control - types, application and benefits - general configuration of adaptive control and function – reasons for process change -practical problems with adaptive control - example for feedback and adaptive control.

UNIT II MECHATRONIC ELEMENTS IN CNC MACHINE TOOLS 9

CNC systems - configuration of the CNC system – interfacing – monitoring – diagnostics machine data - compensations for machine accuracies - PLC in CNC – PLC programming for CNC, steps in programming and case studies - machine structure -types of loads on CNC machine - guide ways and types - mechanical transmission elements - elements for rotary motion to linear motion - ball screw and types -roller screw and types -rack and pinion - various torque transmission elements -requirements of feed drives and spindle drive.

UNIT III INTERNET OF THINGS (IoT) 9

IoT Fundamentals and Architecture - Architecture and Layer - Types - IoT Systems - IoT devices - Sensors and Data Acquisition - Techniques - Challenges in industrial environments - Data Management and Security - Design and Methodology.

UNIT IV COMMUNICATION PROTOCOLS 9

IoT Communication Protocols - Principles of Wired and Wireless Connectivity – Efficiency – Security – Range - Power consumption - Data rate - Scalability - Data Exchange in IoT systems - IoT Gateway - IoT Hardware - Cloud Computing - Fog and Edge Computing.

UNIT V CHALLENGES AND CASE STUDIES 9

Security Threats and Vulnerabilities - Cyber threats in IoT-enabled manufacturing systems - Strategies for securing infrastructure, devices and data - Predictive Maintenance and Quality Control. Case studies -Connected Vehicles - Smart Grid - Industrial IoT - Agriculture, Healthcare, Activity Monitoring.

TOTAL: 45 PERIODS

OUTCOMES:

COs	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Apply procedural knowledge and technical skills to execute digital manufacturing processes.	3
CO2	Able to design and implement end-to-end IoT solutions.	3
CO3	Develop proficiency in collecting, processing, analyzing, and visualizing IoT data.	3
CO4	Gain an understanding of the security and privacy challenges inherent in IoT systems.	3
CO5	Apply IoT principles and technologies to real-world scenarios across different domains.	4

TEXT BOOKS:

1. Groover, M.P., "Automation, Production System and CIM", Prentice Hall of India Pvt. Ltd, 2003.
2. S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IoT. Cambridge University Press.

REFERENCES:

1. Kaushik Kumar, DivyaZindani , J. Paulo Davim, 2019. Digital Manufacturing and Assembly Systems in Industry 4.0 (Science, Technology, and Management), CRC Press.
2. S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.
3. Internet of Things - A Hands on Approach -ArshdeepBahga and Vijay Madisetti. Universities Press, ISBN: 9788173719547.
4. Designing the Internet of Things - Adrian McEwen & Hakim Cassimality. Wiley India, ISBN: 9788126556861.

E-RESOURCES: (including NPTEL course)

1. https://onlinecourses.nptel.ac.in/noc22_cs53/preview

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	2									1	1	1
CO2	3	3	2		2							1	1	1
CO3	3	3	2		2							1	1	1
CO4	3	3	2		2							1	1	1
CO5	3	3	3	3		2	1	1				1	1	1
Average	**3**	**3**	**2.2**	**3**	**2**	**2**	**1**	**1**				**1**	**1**	**1**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22042 FAILURE ANALYSIS AND NDT TECHNIQUES L T P C

(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- To introduce need and scope of failure analysis and fundamental sources of failures.
- To learn about non-destructive testing and basic principles of visual inspection.
- To study about magnetic testing and principles, techniques.
- To learn the principle of radiography testing and its inspection techniques and methods.
- To study the acoustic testing principle and technique and instrumentation.

UNITI INTRODUCTION 9

Introduction and need and scope of failure analysis. Engineering Disasters and understanding failureanalysis. Fundamental sources of failures. Deficient design. Improper Manufacturing &Assembly. Tree diagram and FMEA.

UNITII VISUAL INSPECTION 9

Introduction to Non-Destructive Testing: An Introduction, Visual examination, Basic Principle, TheEye, Optical aids used for visual inspection, Applications. Liquid Penetrant Testing: Physicalprinciples, Procedure for penetrant testing, Penetrant testing materials, Penetrant testing methods,Sensitivity, Applications, Limitations and Standards.

UNITIII MAGNETIC TESTING 9

Magnetic Particle Testing, Eddy Current Testing: Magnetism-basic definitions and principle of magnetic particle testing, Magnetizing techniques, induced current flow, Procedure used for testinga component, Equipment Used for magnetic particle testing, Sensitivity, Limitations. Eddy CurrentTesting: Principles, Instrumentation for eddy current testing Techniques. Sensitivity Advanced EddyCurrent Test Methods, Applications, Limitations.

UNITIV RADIOGRAPHY TESTING 9

Radiography, Ultrasonic Testing: Basic principle, Electromagnetic radiation, Sources, Radiationattenuation in the specimen. Effect of radiation in film, Radiographic imaging, Inspection techniques,Applications of radiographic inspection, Limitations, Safety in Industrial Radiography, Standards,Neutron radiography. Ultrasonic Testing: Basic properties of sound beam, Ultrasonic transducers,Inspection methods, Techniques for Normal Beam Inspection, Techniques for Angle BeamInspection, Flaw characterization techniques, Ultrasonic flaw detection equipment, Modes ofDisplay, Immersion Testing, Applications of Ultrasonic Testing, Advantages, Limitations.

UNITV ACOUSTIC TESTING 9

Acoustic Emission Testing: Principle of Acoustic Emission Testing, Technique, Instrumentation,Sensitivity, Applications, Standards. Thermograph: Basic Principles, Detectors and Equipment,Techniques, Applications, Codes and Standards. In Situ Metallographic Examination: Approach tothe Selection of Site for Metallographic examination, Replication process, Significance ofMicrostructure observation, Decision making, Applications, Codes and Standards.(digital signalprocess).

TOTAL:45PERIODS

OUTCOMES:

COs	COURSEOUTCOMES	RBT Level
CO1	Discuss the need and scope of failure analysis and fundamental sources of failures.	3
CO2	Describe about non-destructive testing and basic principles of visual inspection.	3
CO3	Explain about magnetic testing and principles, techniques.	3
CO4	Explain the principle of radiography testing and its inspection techniques and methods.	3

CO5	Describe the acoustic testing principle and technique and instrumentation.	3

TEXTBOOKS:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu Practical Non-Destructive Testing, Narosa Publishing House, 2014.
2. Ravi Prakash, Non-Destructive Testing Techniques, 1st revised edition, New Age InternationalPublishers, 2010

REFERENCES:

1. ASM Metals Handbook,Non-Destructive Evaluation and Quality Control, American Societyof Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,
   Vol. 1,Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal TestingVol. 4,Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic EmissionTesting, Vol. 7,Ultrasonic Testing
3. Charles, J. Hellier, Handbook of Non destructive evaluation, McGraw Hill, New York 2001.
4. Paul E Mix, Introduction to Non-destructive testing: a training guide, Wiley, 2nd Edition NewJersey, 2005
5. J.Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-HillEducation, 2nd edition (2011).

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	2	2	1	2	2				1			1	2	1
CO2	2	2	1	2	2				1			1	2	1
CO3	2	2	1	2	2				1			1	2	1
CO4	2	2	1	2	2				1			1	2	1
CO5	2	2	1	2	2				1			1	2	1
Average	**2**	**2**	**1**	**2**	**2**				**1**			**1**	**2**	**1**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22043 FINITE ELEMENT ANALYSIS FOR AUTOMOBILE ENGINEERS

L	T	P	C
3	0	0	3

(Common to AE, AM)

OBJECTIVES:

- To introduce the concepts of mathematical modeling of engineering problems.
- To understand the mathematical formulation and physical principles underlying the Finite Element analysis as applied to solid mechanics and thermal analysis.
- To derive finite element equations for simple and complex elements.
- To formulate the axisymmetric element by using the finite element equation.
- To analyze the isoparametric elements using simple finite element equations.

UNIT I INTRODUCTION 9

Historical background, Mathematical modeling of field problems in engineering - Governing equations, discrete and continuous models - Boundary, Initial and Eigen Value problems, Weighted residual method, Equivalence weighted residual method and Variational formulation, Ritz technique, Basic concepts of Finite Element Method.

UNIT II ONE DIMENSIONAL PROBLEMS 9

One dimensional second order equation - Discretization, Element types - Linear and Higher order elements, Derivation of Shape functions, Stiffness matrices and Force vectors, Assembly of matrices, problems from solid mechanics and heat transfer, simple analysis of automotive components like push rod, brake rod, wheel axle subjected to axial load only using computer software.

Longitudinal vibration frequencies and mode shapes, Fourth order beam equation - Transverse deflections and natural frequencies of beams.

UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

Second order 2D equations involving scalar variable functions - Variational formulation, Finite element formulation, Triangular elements - Shape functions and Stiffness matrices and Force vectors.

Application to Field Problems - Thermal problems, Quadrilateral elements, Higher order elements, Heat transfer analysis through engine cylinder wall and liner, wheel axle.

UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS 9

Equations of elasticity - plane stress, plane strain and axisymmetric problems, Body forces and temperature effects, Stress calculations - plate and shell elements.

Structural analysis of fuel and brake fluid through hoses using modern computer software.

UNIT V ISOPARAMETRIC FORMULATION 9

Natural co-ordinate systems - Isoparametric elements - Shape functions for isoparametric elements - one and two dimensions, serendipity elements, numerical integration and application to plane stress problems, Matrix solution techniques - Solution techniques to dynamic problems.

Introduction to analysis software, analysis of simple automotive components using computer software.

TOTAL: 45 PERIODS

OUTCOMES:

COs	COURSEOUTCOMES	RBT Level
Students will be able to		
CO1	Examine the different mathematical techniques used in FEM analysis.	**3**
CO2	Explain the role and significance of shape functions in finite element formulations and use linear, quadratic, and cubic shape functions for interpolation	**3**
CO3	Explain the formulation of two-dimensional elements (triangle and	**3**

	quadrilateral continuum) and its application	
CO4	Select appropriate space (planar (plane stress or strain), axisymmetric, or spatial), idealization (type of element), and modeling techniques	**3**
CO5	Apply professional-level finite element software to solve engineering problems in solid mechanics, fluid mechanics and heat transfer	**3**

TEXTBOOKS:

1. Reddy J.N, "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2005.
2. Seshu P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

REFERENCES:

1. BatheK.J, "Finite Element Procedures", PrenticeHall, 1996.
2. BhattiAsghar M, "Fundamental Finite Element Analysis and Applications", JohnWiley & Sons, 2013.
3. Chandrupatla&Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice HallCollege Div,1990.
4. Logan D.L, "A first course in Finite Element Method", Thomson Asia Pvt. Ltd.,2002.
5. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition,2002.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	2	1	2	2	2	2	2	2	2	2	3	2	2
CO2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	3	2	2	2	2	2	2	2	2	2	2
CO5	2	2	2	2	3	2	2	2	2	2	2	2	2	2
Average	**2.2**	**2**	**1.8**	**2.2**	**2.2**	**2**	**2**	**2**	**2**	**2**	**2**	**2.2**	**2**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22044	FUNDAMENTALS OF NANO SCIENCE AND TECHNOLOGY	L	T	P	C
		3	0	0	3

(Common to AE, AM)

OBJECTIVES:

- To make the students to understand the fundamentals of nano science and technology.

UNIT I INTRODUCTION 9

Nanoscale Science and Technology - Implications for Physics, Chemistry, Biology and Engineering - Classifications of nanostructured materials - nano particles - quantum dots, Nanowires – ultra – thinfilms - multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II PREPARATION METHODS 9

Bottom-up Synthesis -Top-down Approach: Precipitation, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III PATTERNING AND LITHOGRAPHY FOR NANOSCALE DEVICES 9

Introduction to optical/UV electron beam and X-ray Lithography systems and processes, Wet etching, dry (Plasma /reactive ion) etching, Etch resists-dip pen lithography.

UNIT IV PREPARATION ENVIRONMENTS 9

Clean rooms: specifications and design, air and water purity, requirements for particular processes, Vibration free environments: Services and facilities required. Working practices, sample cleaning, Chemical purification, chemical and biological contamination, Safety issues, flammable and toxic hazards, biohazards.

UNIT V CHARACTERISATION TECHNIQUES 9

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques - AFM, SPM, STM, SNOM, ESCA, SIMS - Nanoindentation.

TOTAL: 45 PERIODS

OUTCOMES

COs	COURSEOUTCOMES	RBT Level
Students will be able to		
CO1	Discuss the fundamentals of nanoscience.	3
CO2	Describe the various preparation methods.	3
CO3	Apply the concept of patterning and lithography for nanoscale devices.	3
CO4	Discuss the effect of environments on nanomaterial preparation.	3
CO5	Outline the characterization techniques of nanoscience.	3

TEXTBOOKS:

1. John Dinardo N, “Nanoscale Characterization of Surfaces & Interfaces”, Second edition, Weinheim Cambridge, Wiley-VCH, 2000.
2. Edelstein A S and Cammearata R C, “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Publishing, Bristol and Philadelphia, 1996.

REFERENCES:

1. AkhleshLakhtakia (Editor) The Hand Book of Nano Technology, “Nanometer Structure”, Theory, Modeling and Simulations. Prentice-Hall of India (P) Ltd, New Delhi, 2007.
2. G Timp (Editor), Nanotechnology, AIP press/Springer, 1999.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	2	1	1	1	2	2	2	2	2	2	2	3	1	1
CO2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	1	1	2	1	2	2	2	2	1	2	1	1	1	1
CO4	1	1	1	2	1	1	2	2	1	1	1	1	1	1
CO5	2	1	1	1	2	2	2	2	2	2	2	2	1	1
Average	**1.6**	**1.2**	**1.4**	**1.4**	**1.8**	**1.8**	**2**	**2**	**1.6**	**1.8**	**1.6**	**1.8**	**1.2**	**1.2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22045 MANUFACTURING OF AUTOMOTIVE COMPONENTS L T P C
(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- To understand the requirements of each automotive component.
- To select the materials required for each automotive component.
- To know the step by step procedure involved in the manufacture of vehicle components.
- To know the various heat treatment and surface treatment processes involved in the production of automotive parts.
- To study about the various advanced materials and manufacturing techniques.

UNIT I ENGINE COMPONENTS 9

Overview - Material selection and Manufacturing methods for the Engine Component, Engine block – Casting – Conventional and expendable pattern, Cylinder head – Casting, machining and thermal barrier coating, Crank shaft, Connecting rod, Camshaft – Forging, machining and heat treatment. Piston - Gravity, squeeze, die casting, machining and finishing, Gudgeon Pin - Machining and Finishing, Valve forging, friction welding, machining, thermal barrier coating, heat treatment and surface improvement, Cylinder Liners, Piston ring - Centrifugal, High pressure die casting(HPDC), Low pressure die casting(LPDC), machining and finishing, Castings Processes for Oil pan and Carburetors, Push Rods, Rocker Arm, Tappets, Spark Plug – Forging, Machining, Finishing and Heat treatment.

UNIT II TRANSMISSION COMPONENTS 9

Overview - Material selection and Manufacturing methods for transmission system, Flywheel - Casting and Machining, Clutch - Friction plate, clutch housing, pressure plate-conventional and fine blanking, composite friction lining. Methods of Gear manufacture – Gear hobbing and gear shaping machines - gear generation - gear finishing and shaving – Grinding and lapping of hobs and shaping cutters – gear honing – gear broaching. Gearbox - Casting, precision forging, powder metallurgy, heat treatment and finishing. Propeller shaft - Continuous casting, extrusion, heat treatment and surface hardening, Axle-Differential – Axle Shaft – Bearing – fasteners-Forging, casting and machining, Leaf and coil spring - Forging and machining, composite leaf spring and wrap forming of coil spring.

UNIT III BODY COMPONENTS 9

Surface treatment – Plastics – Plastics in Automobile vehicles – Processing of plastics - Body Panel - Thermoforming and hydro forming, press forming, stretch forming, Emission control system – catalytic converter – Hydro forming of exhaust manifold and lamp housing. Welding – Resistance welding and other welding processes with the use of Robots in body weldment. Instrument Panel - Principle of injection molding, injection molding of instrument panel, Bumpers - Molding of bumpers, reinforced reaction injection molding, tooling and tooling. Manufacture of polymer panels.

UNIT IV CHASSIS COMPONENTS 9

Material selection and manufacturing methods for Vehicle Frame Manufacturing, Wheel drum, Brake drum, Brake shoes, wheel rim and wheel housing manufacturing, Steering systems, shock absorbers, dead axle – casting, forging, machining and finishing operation. Heat treatment procedures for chassis components.

UNIT V TYRES AND ADVANCED MATERIALS MANUFACTURING 9

Tyre and tube manufacturing, spray painting, powder coating, Prototype Manufacturing - Rapid Prototyping(RPT), 3D Printing, chemical vapour deposition, physical vapour deposition, cryogenic grinding of powders, sealants, sound proof materials, structural adhesives, Metal matrix composite(MMC) liners –Selection of materials for automotive components.

TOTAL: 45 PERIODS

OUTCOMES:		
COs	**COURSE OUTCOMES**	**RBT Level**
	Students will be able to	
CO1	Select the suitable materials and methods to manufacture engine components.	**3**
CO2	Identify the suitable materials and methods to manufacture transmission components.	**3**
CO3	Discuss the suitable materials and methods to manufacture body components.	**3**
CO4	Select the suitable materials and methods to manufacture chassis components.	**3**
CO5	Explore the recent developments in material selection and manufacturing processes ofautomotive components.	**3**

TEXTBOOKS:

1. Kalpakjian, "Manufacturing Engineering and Technology", Pearson Education, 2005.
2. Heldt P M, "High Speed Combustion Engines", Oxford IBH publishing Co., Calcutta, 1996.

REFERENCES:

1. B.P. Bhardwaj, "The Complete Book on Production of Automobile Components & Allied Products", NIIR Project Consultancy Services, 2014.
2. John A S, "Introduction to Manufacturing Processes", Tata McGraw-Hill, 2012.
3. Kalpakjian, "Manufacturing Processes For Engineering Materials", Pearson Education, 2009.
4. Philip F O and JairoMunuz, "Manufacturing Processes and Systems", John Wiley & Sons, New York, 1998.
5. Degarmo E P, "Materials and process in Manufacturing", Macmillan Publishing Co, 1997.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	2	2	2	2	2	2	2	2	2	2	3	3	2
CO2	3	2	2	2	2	2	2	2	2	2	2	3	3	2
CO3	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Average	**2.4**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2.4**	**2.4**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22046 **NEW PRODUCT DEVELOPMENT** **L T P C**

(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- To introduce the fundamental concepts of the new product development.
- To develop material specifications, analysis and process.
- To Learn the Feasibility Studies & reporting of new product development.
- To study the New product qualification and Market Survey on similar products of new product development.
- To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model.

UNIT I FUNDAMENTALS OF NPD **9**

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.

UNIT II MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS **9**

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

UNIT III ESSENTIALS OF NPD **9**

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

UNIT IV CRITERIONS OF NPD **9**

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.

UNIT V REPORTING & FORWARD-THINKING OF NPD **9**

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost).

TOTAL: 45 PERIODS

OUTCOMES		
COs	**CourseOutcomes**	**RBTLEVEL**
Uponsuccessfulcompletionofthecourse,thestudentsshouldbeableto:		
CO1	Discuss fundamental concepts and customer specific requirements of the New Product development.	**3**
CO2	Discuss the Material specification standards, analysis and fabrication, manufacturing process.	**3**
CO3	Develop Feasibility Studies & reporting of New Product development.	**3**
CO4	Analyzing the New product qualification and Market Survey on similar products of new product development.	**3**
CO5	Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model.	**3**

TEXTBOOKS:

1. Product Development – StenJonsson.
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger.

REFERENCES:

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark.
2. Change by Design - Tim Brown, HarperCollins e-books, 2009.
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker.
4. Winning at New Products – Robert Brands 3rd Edition.
5. Product Design & Value Engineering – Dr. M.A. Bulsara&Dr. H.R. Thakkar.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	1	1	3	1				1	1			1	2	2
CO2	1	1	3	1				1	1			1	2	2
CO3	1	1	3	1				1	1			1	2	2
CO4	1	1	3	1				1	1			1	2	2
CO5	1	1	3	1				1	1			1	2	2
Average	**1**	**1**	**3**	**1**				**1**	**1**			**1**	**2**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22047 **NOVEL AUTOMOTIVE MATERIALS** **L T P C**

(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- Study about the failure and strengthening mechanisms.
- Understand the concepts of heat treatment and surface modification techniques.
- Gain knowledge on metallic and non- metallic materials and their applications in automobiles.
- Analyze the properties of different materials used for automotive structures, engine and transmission systems.
- Explore about light weight materials and new materials.

UNITI STRENGTHENING MECHANISMS AND METALLIC MATERIALS 10

Failure mechanism - Strengthening mechanisms and their need in automotive environment- Strengthening material - Strain hardening, alloying, polyphase mixture, martensitic precipitation, dispersion, fiber and texture strengthening.

Cast irons - types, properties, structures, compositions and applications, plain carbon steels, low alloy steels and effects of alloying elements, high alloy steels, stainless steel types, castability, formability, machinability, hardenability and weldability of the material, high temperature steels and super alloys. Decorative and functional coating materials for automotive parts - Electro less Nickel, Hard Chrome, and, Zirconium Phosphate, Zinc flake, Metal oxides.

UNITII COMPOSITES 9

Mechanics, Manufacturing and Design. Types of composites. Fiber reinforced plastics (FRP), engineering ceramics, metal matrix composites, silicon carbide, graphite, fibres of zirconia, alumina and boron nitride - metal filaments - boron filaments - glass fibres applications, nanocomposites.Piezoelectric composites - Applications in automobiles.

UNITIII ELECTRICAL AND MAGNETIC MATERIALS 8

Semiconductors materials, single crystals, soft and hard magnets, superconductors, MEMS and NEMS materials, smart materials, shape memory alloys. Piezoelectric materials. Piezoceramic materials, polyvinyldenefluoride, Magnetostrictive Materials. Metglasmaterials.

UNITIV RUBBER AND PLASTICS MATERIALS 8

Plastics / rubber components in automobiles – function – selection criteria. Structure – property relationship of rubber. Rubber mounts – spring design – comparison with metallic springs – shape factor and its effect. Typical mounts, compounding and manufacture. Seals for static and dynamic applications. Brake fluid / hydraulic hoses, materials and manufacture.

UNITV LIGHT WEIGHT MATERIALS AND ADVANCED MATERIALS 10

Background and motivation of introducing light weight materials in automotive applications. Value Vs. Weight. Crash safety laws.Light weight automotive materials: Magnesium alloys, Aluminum alloys, advance high strength steels, carbon fiber composites. Efficient material utilization. Improving crashworthiness. Design strategies to get light weight design.

Nanostructured materials, high temperature electronic materials, Materials for Intelligent systems and other safety systems.

TOTAL:45PERIODS

OUTCOMES:

COs	COURSEOUTCOMES	RBT Level
CO1	Discuss failure and strengthening mechanisms, identify the application of metallic materials to automobile parts.	3
CO2	Investigate the different types of composites and their automotive applications based on its cost and use.	3
CO3	Discuss the electrical and magnetic properties and its specific application to various automotive components based on its use.	3

CO4	Select rubber and plastic materials and their suitability to automotive applications.	3
CO5	Select the suitable light weight material and new materials based on its strength, cost and use.	3

TEXTBOOKS:

1. Ahmed Elmarakbi,"Advanced Composite Materials for Automotive Applications - Structural Integrity and Crashworthiness", John Wiley & Sons Ltd, 2014.
2. Brian Cantor, Patrick Grant, Colin Johnston, "Automotive Engineering: Lightweight, Functional, and Novel Materials", CRC Press, Taylor & Francis Group, 2006.

REFERENCES:

1. ASM Handbook. "Materials Selection and Design", Vol. 20- ASM Metals Park Ohio.USA, 1997.
2. C. Brian, G. Patrick and J. Colin., Automotive Engineering: Light Weight, Functional and Novel Materials, Taylor & Francis, 2007.
3. Hiroshi Yamagata," The Science and Technology of Materials in Automotive Engines", Woodhead Publishing, 2005.
4. James A. Jacobs, Thomas F. Kilduff., "Engineering Materials Technology: Structure, Processing, Properties & Selection", Prentice Hall, USA, 1996.
5. Polmear I.J,Light Alloys, Arnold Publishers, 1995.
6. Smallman R. E, Bishop R. J," Modern Physical Metallurgy and Materials Engineering-Science, process, applications", Sixth Edition, Butterworth-Heinemann, 1999.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	2	2	2	2	2	2	2	2	2	3	3	2	2
CO2	3	3	2	2	2	2	2	2	2	2	3	3	2	2
CO3	2	2	3	2	2	2	2	2	2	2	3	3	2	2
CO4	2	2	2	3	2	2	2	2	2	2	3	3	2	2
CO5	2	2	2	2	3	2	2	2	2	2	3	3	2	2
Average	**2.4**	**2.2**	**2.2**	**2.2**	**2.2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22051 **AUTOMOTIVE AERODYNAMICS** **L T P C**

(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- Students get an exposure to the evolution of vehicle aerodynamics, flow related problems & requirements in and around a vehicle.
- Students learn about the flow around a car, facilities and strategies available to develop low drag profiles and the ways available to optimize the shape of cars.
- Students learn about the aerodynamic forces and moments & its related problems, dirt accumulation, wind noise.
- Students learn about the methods of reducing the drag in commercial vehicles.
- Students get exposure to different types of wind tunnels & its configuration, measurements of forces and various parameters of a vehicle using it.

UNIT I INTRODUCTION **9**

Scope, overview of historical developments, fundamental of fluid mechanics, flow phenomenon related to vehicles, various resistance to vehicle motion-performance, fuel consumption and traction force diagram of a passenger car, Engine cooling requirements, cooling of engines, airflow through the passenger compartment.

UNIT II AERODYNAMIC DRAG AND SHAPE OPTIMIZATION OF CARS **9**

Cars as a bluff body, flow field around car, drag force, types of drag force, analysis of aerodynamic drag, strategies for aerodynamic development - shape and detail optimization techniques with case studies, Modification – parameters - front end, wind shield, rear end, roof, underbody, side panels, wheels, spoilers.

UNIT III VEHICLE HANDLING **9**

Origin of forces and moments on a vehicle - lateral stability problems - methods to calculate forces and moments – vehicle dynamics under side winds - the effects of forces and moments, tests for directional stability, dirt accumulation on the vehicle, wind noise, Add-ons to improve stability of road vehicles.

UNIT IV AERODYNAMICS OF COMMERCIAL VEHICLES **9**

Tractive resistance and fuel consumption – Drag coefficients of various commercial Vehicles – Scope for reducing drag on commercial vehicles -Trucks with trailers and buses, Advantages of commercial vehicles aerodynamics and its effects – Vehicle soiling & its effects on driving.

UNIT V WIND TUNNELS FOR VEHICLES AERODYNAMICS **9**

Need of a wind tunnel, principle of wind tunnel technology, problems with reduced scale models, full scale wind tunnels examples and case studies, instrumentation and measurement techniques, Introduction to numerical analysis- Computational fluid dynamics(CFD) analysis.

TOTAL: 45 PERIODS

OUTCOMES:

COs	Course Outcomes	RBT LEVEL
Students will be able to		
CO1	Discuss the background on the vehicle aerodynamic concepts, optimization of the flow characteristics and improvement of vehicle performance with respect to fuel economy.	**3**
CO2	Apply the basic concepts to reduce the drag of cars by employing the strategies leading to low drag profile as well as to optimize shapes of cars leading to aesthetic and stylish look.	**3**
CO3	Analyze the effect of various aerodynamic forces and moments to maintain the vehicle stability and also, to reduce the effect of wind noise and to prevent the water & dirt accumulation on vehicles.	**3**
CO4	Identify the vehicle aerodynamic concepts to improve the performance of a commercial vehicle with respect to fuel economy.	**3**
CO5	Select a wind tunnel for the vehicle to be tested and deduce the measurement of parameters.	**3**

TEXTBOOKS:

1. Barnard R H, “Road Vehicle Aerodynamic Design”, 3rd edition, Mech Aero Publishing, 2010.
2. Hucho W.H., “Aerodynamic of Road Vehicles”, Fourth edition, Society of Automotive Engineers, U.S, , 1997.

REFERENCES:

1. Alan Pope, Jewel B. Barlow, William H. Rae, “Low speed wind tunnel testing”, Third edition, John Wiley & Sons, 1984.
2. Joseph Katz, “Race Car Aerodynamics: Designing for Speed”, 2nd Edition, Robert Bentley Incorporated, 1996.
3. YomiObidi T, “Theory and Applications of Aerodynamics for Ground Vehicles”, SAE International, October 2014.
4. The International Vehicle Aerodynamics Conference, 1st Edition, Woodhead Publishing, October 2014.
5. “Automotive Aerodynamics”, Update SP-706, Society of Automotive Engineers Inc, 1987.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	2	2	2	2	1	3	1	1	2	1	2	2	2
CO2	3	3	3	2	2	1	3	1	1	2	1	2	2	2
CO3	3	3	2	3	2	1	3	1	1	2	1	2	2	2
CO4	3	2	2	2	2	1	3	1	1	2	1	2	2	2
CO5	3	2	3	3	3	1	3	1	1	2	1	2	2	2
Average	**3**	**2.4**	**2.4**	**2.4**	**2.2**	**1**	**3**	**1**	**1**	**2**	**1**	**2**	**2**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22052 **AUTOMOTIVE AUTOMATION** **L T P C**

(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- To know about the basic concepts in automation.
- To know about transfer lines and automated assembly.
- To know about automation controller.
- To design the automated systems.
- To study the automotive applications.

UNIT I FUNDAMENTAL CONCEPTS OF AUTOMATION 9

Fundamental concepts in manufacturing and automation, definition of automation, reasons for automating, Types of production and types of automation, automation strategies, levels of automation.

UNIT II TRANSFER LINES AND AUTOMATED ASSEMBLY 9

General terminology and analysis, analysis of transfer lines without storage, partial automation, Automated flow lines with storage buffers, Automated assembly-design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines, AS/RS, RFID system, AGVs, modular fixturing. Flow line balancing.

UNIT III PROGRAMMABLE AUTOMATION 9

Special design features of CNC systems and features for lathes and machining centers, Drive system for CNC machine tools, Introduction to CIM; condition monitoring of manufacturing systems.

UNIT IV DESIGN FOR HIGH SPEED AUTOMATIC ASSEMBLY 9

Introduction, Design of parts for high speed feeding and orienting, high speed automatic insertion. Analysis of an assembly. General rules for product design for automation.

UNIT V APPLICATIONS OF AUTOMOTIVE AUTOMATION 9

Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications. Case studies-pick and place robot.

TOTAL : 45 PERIODS

OUTCOMES:

COs	Course Outcomes	RBT LEVEL
Students will be able to		
CO1	Describe the basic concepts of automation.	**3**
CO2	Analyze the transfer lines and discuss the types of automated assembly systems.	**3**
CO3	Outline the application of CNC system in manufacturing industry.	**3**
CO4	Design and analyze high speed assembly.	**3**
CO5	Outline the various applications of robots in manufacturing industry.	**3**

TEXTBOOKS:

1. Mikell P Groover, "Automation Production Systems and Computer- Integrated Manufacturing", Pearson Education, New Delhi, 2001.
2. Richaerd D Klafter, Thomas Achmielewski and MickaelNegin, "Robotic Engineering – An integrated Approach", Prentice HallIndia, New Delhi, 2001.

REFERENCES:

1. Bolton W, "Mechatronics", Pearson Education, 1999.
2. James A Rehg, "Introduction to Robotics in CIM Systems", Prentice Hall of India, 2002.
3. JoffreyBoothroyd, Peter Dewhurst and Winston A. Knight, "Product Design for manufacture and Assembly", CRC Press, 2011.
4. Mikell P Groover, "Industrial Robots – Technology Programmes and Applications", McGraw Hill, New York, USA. 2000.
5. Steve F Krar, "Computer Numerical Control Simplified", Industrial Press, 2001.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	1	1	1	2	1	2	1	1	2	1	2	2	2
CO2	3	3	2	2	2	1	2	1	1	2	1	2	2	2
CO3	3	2	2	2	3	1	2	1	1	2	1	2	2	2
CO4	3	3	3	3	3	1	2	1	1	2	2	2	2	2
CO5	3	2	2	2	3	1	2	1	1	2	1	2	2	2
Average	**3**	**2.2**	**2**	**2**	**2.6**	**1**	**2**	**1**	**1**	**2**	**1.2**	**2**	**2**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

CH22053 DISASTER MITIGATION MANAGEMENT L T P C
(Common to CH, AE, AM, CE) **3 0 0 3**

OBJECTIVES:

- Provide students an exposure to disasters, their significance and types.
- Ensure that students begin to understand the relationship between Vulnerability, Disasters, Disaster prevention and risk reduction
- Study a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- Enhance awareness of institutional processes in the country and
- Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity

UNIT I INTRODUCTION TO DISASTERS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, Class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, Complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) 9

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority (SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmers And legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmers And legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

TOTAL: 45 PERIODS

OUTCOMES:		
COs	**CourseOutcomes**	**RBTLEVEL**
Uponsuccessfulcompletionofthecourse,thestudentsshouldbeableto:		
CO1	Differentiate the types of disasters, causes and their impact on environment and Society.	**3**

CO2	Assess vulnerability and various methods of risk reduction measures as well as Mitigation.	**3**
CO3	Draw the hazard and vulnerability profile of India, Scenarios in the Indian context. Know the Disaster damage assessment and management.	**3**
CO4	Awareness of institutional processes in the country and to develop rudimentary	**3**
CO5	Ability to respond to their surroundings with potential disaster response in areas where they live.Complete preparedness, response and recovery in order to reduce the impactof Disasters .	**3**

TEXT BOOKS:

1. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011.
2. KapurAnu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage, Publishers, New Delhi, 2010.

REFERENCES:

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2002.
2. Government of India, National Disaster Management Policy, 2009.
3. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423.
4. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361.

AE22053	EMBEDDED SYSTEMS FOR AUTOMOTIVE APPLICATIONS	L	T	P	C
		3	0	0	3

(Common to AE, AM)

OBJECTIVES:

The student should be made to

- Learn the potential of automotive systems in industries.
- Understand Automotive Sensory Systems.
- Learn the microcontroller, their architecture and programming techniques.
- Learn the different automotive protocols for internal communication.
- Learn the working of automobile safety systems.

UNIT I AUTOMOTIVE EMBEDDED SYSTEMS 9

Introduction to Automotive Embedded Systems - Overview of present-day embedded products - Basic building blocks of embedded systems - Automotive Systems Overview - Embedded Technology in Automotive Industry. Embedded System Development Process - Tool Chain and Cross Compilation. Future Trends in Automotive Embedded Systems: Hybrid Vehicles, Electric Vehicles.

UNIT II AUTOMOTIVE SENSORS 9

Basics and overview-Automotive applications-Sensor classification. Sensor measuring principles-Position sensor-speed and rpm sensors-Acceleration sensors-Pressure sensors-Force and Torque sensors. Sensor types-Engine speed sensor-wheel speed sensor-Accelerator pedal sensor-torque sensor-steering angle sensor-rain/light sensor.

UNIT III PIC MICROCONTROLLER 9

Architecture and instruction set – Program and Data memory – CPU registers – I/O port expansion – Interrupts - Programming concepts Assembly and Embedded C. PIC Microcontroller Peripherals: Timer0 – Timer 1 - Compare and Capture mode — Timer 2 - PWM outputs.

UNIT IV COMMUNICATION PROTOCOLS 9

Introduction to control networking – Communication protocols in embedded systems – SPI, I2C, and USB. Vehicle communication protocols – Introduction to CAN, LIN, FLEXRAY, MOST, AUTO SAR.

UNIT V SAFETY SYSTEMS 9

Antilock braking system, Air bag restraint system, Voice warning system, Seat belt system, Road navigation system, Anti-theft system.

TOTAL: 45 PERIODS

OUTCOMES:

COs	COURSE OUTCOMES	RBT Level
CO1	Explain the fundamental building blocks of embedded systems, and evaluate the impact of embedded technology on the automotive industry.	3
CO2	Provide a comprehensive overview of automotive sensorsand the operational principles of different automotive sensors.	3
CO3	Explainthe PIC microcontroller architecture, instruction sets, and programming concepts.	3
CO4	Describe the characteristics and applications of communication protocols in automotive embedded systems and vehicle communication systems.	3
CO5	Explain the operation and significance of safety systems in vehicles.	3

TEXT BOOKS:

1. John B. Peatman, “Design with PIC Microcontrollers”, Pearson Education, Singapore - 1998.
2. William Ribbens, “Understanding Automotive Electronics an Engineering Perspective”, 7th Edition, Butterworth-Heinemann (an imprint of Elsevier Publications), 2012.

REFERENCES:

1. Jurgen, R., "Automotive Electronics Hand Book", 2nd edition, McGraw-Hill Professional, 1999.
2. Robert Bosch Gmbh, "Automotive Electricals Electronics System and Components", 4thEdition, 2004.
3. RobertBoschGmbh, "Automotive Electronics Handbook". 2018.
4. Tim Wilmshurst, "Designing Embedded Systems with PIC Microcontrollers: Principles and Applications", Newness Publisher, 2007.
5. Tom Denton, "Automobile Electrical and Electronic Systems", fifth edition, Taylor & Francis Ltd., 2017.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	3	3	2	2	2	2	2	2	2	3	3	3
CO2	3	3	3	3	2	2	2	2	2	2	2	3	3	3
CO3	3	3	3	3	2	2	2	2	2	2	2	3	3	3
CO4	3	3	3	3	2	2	2	2	2	2	2	3	3	3
CO5	3	3	3	3	2	2	2	2	2	2	2	3	3	3
Average	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22054 HYDRAULICS AND PNEUMATICS SYSTEMS L T P C
(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- This course will give an appreciation of the fundamental principles, design and operation of hydraulic and pneumatic machines, components and systems and their application in recent automation revolution.

UNIT I FLUID POWER PRINCIPLES AND FUNDAMENTALS 7

Introduction, Advantages and Applications of Fluid power system. Types of fluid power systems -Basics of Hydraulics and Pneumatics. Hydraulic fluids- types and properties of hydraulic fluids. Properties of air– Perfect Gas Laws, Pascal's Law, Darcy's equation, Valves and fittings. Losses in pipes and fittings-K factor. Hydraulic and Pneumatic power packs.

UNIT II HYDRAULIC SYSTEM AND COMPONENTS 11

Sources of Hydraulic power- Pumping Theory – Pump Classification- Construction, Working, Advantages, Disadvantages, Performance and Selection criterion of Linear& Rotary pumps. Hydraulic Actuators - Cylinders & Motors - Types and construction. Control Components - Directional control, Flow control and Pressure control valves- Types, Construction, Operation and Applications. Fluid Power ANSI Symbol.

UNIT III DESIGN OF HYDRAULIC CIRCUITS 9

Accessories - Pressure Switches, Electrical switches, Limit switches, Relays – Applications. Types of Accumulators and its Applications.

Design of Hydraulic circuits- Reciprocation, Speed control- meter-in & meter-out circuits, Sequence, Synchronization, Regenerative, Pump Unloading-Double pump circuits. Pressure Intensifier, Air-over oil system, Hydrostatic transmission, Electro hydraulic circuits and Mechanical Hydraulic servo systems

UNIT IV PNEUMATIC SYSTEM AND COPONENTS 7

Compressors- types and working principle. Filter, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust valves, Pneumatic actuators, Servo systems. Introduction to Fluidics, Pneumatic logic circuits.

UNIT V DESIGN OF INDUSTRIAL HYDRAULIC AND PNEUMATIC CIRCUITS 11

Design of circuits using the components of hydraulic system for Drilling, Planning, Shaping, Punching, Pressing operations. Sequential circuit design for simple application using cascade method, Electro pneumatic circuits.

Selection of Hydraulic and Pneumatic components, Installation, fault finding and maintenance of hydraulic and pneumatic components. Microprocessor and PLC- Applications in Hydraulic and Pneumatics, Low cost Automation

TOTAL: 45 PERIODS

OUTCOMES:

COs	Course Outcomes	RBT LEVEL
CO1	Students will have the ability to illustrate the principles, basic laws, applications, advantages and disadvantages of fluid power systems.	**3**
CO2	Students will be able to illustrate the construction, working and selection of different 73 hydraulic components.	**3**
CO3	Students will have the ability to design the basic hydraulic circuits for different industrial applications.	**3**
CO4	Students will be able to distinguish the construction, working and selection of different pneumatic components & fluidic elements and apply them for designing the basic industrial pneumatic circuits.	**3**

CO5	Students will describe the concepts of Electrohydraulic, microprocessor, PLC, and able to design the hydraulic & pneumatic circuits for the automation of different industrial processes.	**3**

TEXT BOOKS:

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education, 7th edition, 2009.
2. James L. Jhonson, "Introduction to Fluid Power", Delmar Thomson Learning, 2002.

REFERENCES:

1. Dudelyt A Pease and John J.Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
2. Majumdar S.R, "Oil Hydraulics Systems-Principles and Maintenance", Tata McGraw-Hill, 2001.
3. Majumdar S.R, "Pneumatic Systems-Principles and Maintenance", Tata McGraw-Hill, 2007.
4. Micheal J, Pinches and Ashby J.G, "Power Hydraulics", Prentice Hall, 1989.
5. ShanmugaSundaram K, "Hydraulic and Pneumatic Controls", S. Chand limited, 2006.
6. Srinivasan R, "Hydraulic and Pneumatic Control", Tata McGraw-Hill Education, 2012.

WEB RESOURCES:

1. NPTEL Course - https://nptel.ac.in/courses/112105046/

AE22055 METROLOGY AND MEASUREMENT SYSTEM L T P C

3 0 0 3

OBJECTIVES:

- To provide knowledge on various metrological equipment available to measure the dimension of the components.
- To provide knowledge on the correct procedure to be adopted to measure the dimension of
- the components.
- To describe the principles of linear and angular measurement tools used for industrial applications
- To demonstrate the techniques of form measurement and advancements used for industrial components.
- To discuss various measurement of process parametersrequiredfor industrial applications.

UNITI BASICS OF METROLOGY 9

Introduction to Metrology – Need – Elements – Work piece, Instruments – Persons – Environment –their effect on Precision and Accuracy – Errors – Errors in Measurements – Types – Control – Types of standards. Sensitivity and readability of measuring instruments. Abbe's principle of measurement.

UNITII LINEARMEASUREMENT 9

Linear Measuring Instruments – Evolution – Types – Classification – Vernier calipers – Vernier height gauge-Vernier depth gauge - micrometers-slip gauges and its accessories-Limit gauges – Taylor's principle of gauge design –terminology – procedure – concepts of interchangeability and selective assembly. Comparators – types- principle of working and applications.

UNITIII ANGULAR MEASUREMENT 8

Angular measuring instruments – Types – Bevel protractor-spirit levels - clinometers - angle gauges, sine bar and sine table–Angle alignment telescope – Autocollimator – Angle dekker, Applications.

UNIT IV FORM MEASUREMENT AND ADVANCES IN METROLOGY 10

Principles and Methods of straightness – Flatness measurement, surface finish measurement, Roundness measurement – Applications. Profile projector.

Basic concept of lasers - Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment.

Automatic inspection system, Machine vision for online-offline inspection.

UNITV MEASUREMENT OF PROCESS PARAMETERS 9

Measurement of Force – Load cells – Hydraulic & Pneumatic load cells – LVDT. Basics of Torque & Power measurement. Flow measurement – Differential pressure flow meter, Magnetic flow meter – Ultrasonic flow meter. Temperature measurement - Thermocouples – Radiation pyrometer – Infrared temperature sensor.

TOTAL: 45PERIODS

COs	COURSE OUTCOMES	RBT Level
CO1	Describe the concepts ofstandards and measurements applied to metrological instruments	2
CO2	Select the suitable measuring instrumentfor linear measurements and calibrate them to improve the accuracy.	3
CO3	Select the suitable measuring instrument for angular measurements and calibrate them to improve the accuracy.	3
CO4	Acquire the knowledge on advanced measuring devices and theirapplications for dimensional and form measurements.	3
CO5	Ability to select the suitable instruments to measure the differentprocess parameters like pressure, temperature and force.	3

TEXTBOOKS

1 Jain R.K. "Engineering Metrology", Khanna Publishers, 2009.

2 Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2005.

REFERENCES

1 Alan S. Morris, "The essence of Measurement", Prentice Hall of India 1996.

2 Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education, 2014.

3 Charles Reginald Shotbolt, "Metrology for Engineers", 5th edition, Cengage Learning EMEA,1990.

4 Donald Peckman, "Industrial Instrumentation", Wiley Eastern, 2004.

5 ASTME Handbook of Industrial Metrology, Prentice Hall, 1997.

6 Raghavendra Krishnamurthy, "Engineering Metrology & Measurements", Oxford Univ. Press, 2013.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	2	1	2	2	2	2	2	1	2	1	3	2	2
CO2	3	3	2	3	3	2	2	2	1	2	1	3	2	2
CO3	3	3	2	3	3	2	2	2	1	2	1	3	2	2
CO4	3	2	2	3	3	2	2	2	1	2	1	3	3	3
CO5	3	2	2	3	3	2	2	2	1	2	1	3	3	3
Average	**3**	**2.4**	**1.8**	**2.8**	**2.8**	**2**	**2**	**2**	**1**	**2**	**1**	**3**	**2.4**	**2.4**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22056	OPERATIONS RESEARCH	L	T	P	C
	(Common to AE, AM)	3	0	0	3

OBJECTIVES:

- To provide knowledge and training in using optimization techniques under limited resources for the engineering and business problems
- To understand concept of inventory and project management
- To learn about decision models and queuing theory

UNIT I LINEAR MODELS 10

Phases of OR – Linear programming Formulation- Graphical Solution and Simplex Method – IPPs - Definition – Types Formulation – Branch and Bound Technique (2 – Variable problems only)

UNIT II TRANSPORTATION AND SEQUENCING MODELS 9

Transportation model – Initial solution by North West corner method – Least Cost method – VAM. Optimality test – MODI method. Assignment model – formulation – Balanced and unbalanced assignment problems. Sequencing – Problem with N jobs and 2 machines - 3 machines and 'M' machines.

UNIT III PROJECT MANAGEMENT AND INVENTORY 8

CPM and PERT networks – Critical path scheduling – Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

UNIT IV QUEUING THEORY AND NON-LINEAR MODEL 9

Queuing models - Queuing systems and structures – Notation parameter – Single server and multi-server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation Introduction - Lagrangian Method - Kuhn-Tucker conditions.

UNIT V DECISION MODELS 9

Decision models – Game theory – Two-person zero sum games – Graphical solution- Algebraic solution– Linear Programming solution. Replacement models – Items that deteriorate with time - When money value changes – Items that fail completely – Individual replacement and Group replacement.

TOTAL: 45 PERIODS

OUTCOMES:

COs	Course Outcomes	RBT LEVEL
Students will be able to		
CO1	The students will identify, develop and evaluate LP models to achieve the best solution	**3**
CO2	The students will select suitable methodology for analyzing the network problems.	**3**
CO3	The students will select the suitable methodology for real time problems in inventory and sequencing.	**3**
CO4	The students will apply suitable technique for queuing problem.	**3**
CO5	The students will evaluate a situation and suggest suitable decisions.	**3**

TEXTBOOKS:

1. Panneerselvan. R., "Operation Research", Prentice Hall of India Pvt Ltd, 2016.
2. Taha H.A., "Operations Research", Tenth Edition, Prentice Hall of India, 2016.

REFERENCES:

1. Rama Murthy R, “Operations Research”, Second edition, New Age International Publisher, 2007.
2. Hira and Gupta “Problems in Operations Research”, S.Chand and Co.2008.
3. Wagner, “Operations Research”, Prentice Hall of India, 2000.

WEB RESOURCES:

1. https://nptel.ac.in/courses/110/106/110106062/
2. https://nptel.ac.in/courses/112/106/112106134/

ME22046 **TOTAL QUALITY MANAGEMENT** **L T P C**
(Common to ME, AE, AM, MN) **3 0 0 3**

OBJECTIVES:

- To facilitate the understanding of Quality Management principles and processes.
- To learn TQM & process monitoring techniques.
- To know about various quality management system implemented in industries.

UNIT I INTRODUCTION **8**

Fundamentals of TQM – Historical developments – important philosophies- (Deming, Juran, Crossby, Ishikawa) and their impact of quality – Quality planning, Quality statement – Quality policy.

UNIT II TQM PRINCIPLES **9**

Customer focus - Customer satisfaction – customer perception of quality, customer complaints, Employee involvement – Empowerment and Team work- Recognition and Reward – Performance appraisal - Supplier Quality Management – Supplier Rating – Supplier rating by Analytical Hierarchical Process (AHP)

UNIT III PROCESS MONITORING **9**

Seven tools of quality, New Seven management tools, Statistical fundamentals – Normal curve charts for variables and attributes, TPM – Concepts, Process Capability analysis ,PDSA cycle, 5S, Kaizen.

UNIT IV TQM TECHNIQUES **10**

Quality Functions Deployment (QFD) – house of Quality, QFD process and benefits, Benchmarking process, Taguchi Quality Loss function, FMEA – concept, Industrial case studies on DFMEA and PFMEA – Six Sigma –concepts- Methodologies

UNIT V QUALITY MANAGEMENT SYSTEMS **9**

Need for ISO – ISO 9001: 2015 – Elements, Implementation, Documentation and Auditing, QS 9000 / TS 16949 - ISO14000 and OSHAS 18000 – Concept requirements and benefits – Case studies.

TOTAL: 45 PERIODS

OUTCOMES:

COs	**CourseOutcomes**	**RBTLEVEL**
Students will be able to		
CO1	Explain the evolution and concepts of TQM (Total Quality Management), quality and its need.	**3**
CO2	Understand the principles of TQM and explain the concept of statistical process control.	**3**
CO3	Illustrate process monitoring tools and relate with industrial examples.	**3**
CO4	Apply the various techniqueS of TQM in industries	**3**
CO5	Explain the need for quality systems of International standards	**3**

TEXTBOOKS:

1. Dale H. Besterfiled, et at., "Total quality Management", Third Edition, Pearson Education Asia, Indian Reprint, 2006.
2. Poornima M. Charantimath, Total Quality Management, Pearson education, 3rd edition, 2017.

REFERENCES:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.

2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
3. ShridharaBhat, “TQM Text and Cases”, Himalaya Publishing House, 2002.
4. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.

WEB RESOURCES:

1. https://nptel.ac.in/courses/110/104/110104080/
2. https://nptel.ac.in/courses/110/104/110104085/

AE22061 AUTOMOTIVE AIR CONDITIONING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To acquire the basic knowledge in air conditioning systems and its components.
- To understand the concept of automotive cooling and heating systems.
- To know the various refrigerants and its handling.
- To understand and basic concepts of air routing and temperature control.
- To underline the importance of maintenance and service of air conditioning systems.

UNIT I AUTOMOTIVE AIRCONDITIONING FUNDAMENTALS 9

Purposes of Heating, Ventilation and Air Conditioning, Environmental Concerns, Ozone layer depletion, Location of air conditioning components in a car, Schematic layout of a vehicle refrigeration system. Psychrometry - Basic terminology, Psychrometric mixtures, Psychrometric Chart, Related problems.

UNIT II AUTOMOTIVE COOLING AND HEATING SYSTEM 9

Vehicle Refrigeration System and related problems, Fixed thermostatic and Orifice tube system, Variable displacement thermostatic and Orifice tube system, Vehicle air conditioning operation Types of compressor, compressor clutches, compressor clutch electrical circuit, compressor lubrication, condensers, evaporators, expansion devices, evaporator temperature and pressure controls, receiver, drier, accumulators, refrigerant hoses, connections and other assemblies, Heating system.

UNIT III AIR-CONDITIOING CONTROLS, DELIVERY SYSTEM AND REFRIGERANTS 9

Types of control devices, preventing compressor damage, preventing damage to other systems - maintaining driveability, preventing overheating, ram air ventilation, air delivery components, control devices, vacuum controls containers, handling refrigerants, discharging, charging &leak detection, refrigeration system diagnosis, diagnostic procedure, ambient conditions affecting system pressures.

UNIT IV AUTOMATIC TEMPERATURE CONTROL 9

Different types of sensors and actuators used in automatic temperature control, fixed and variable displacement temperature control, semi-automatic, controller design for fixed and variable displacement type air conditioning system.

UNIT V SYSTEM SERVICING AND TESTING 9

Special tools for servicing vehicle air conditioning, diagnosing components and air conditioning systems, diagnosing cooling system, air delivery system, automatic temperature control system diagnosis and service.

TOTAL: 45 PERIODS

OUTCOMES:

COs	Course Outcomes	RBT LEVEL
Students will be able to		
CO1	Discuss the fundamentals of automotive air conditioning.	**3**
CO2	Describe the constructional details and working of automotive cooling and heating system.	**3**
CO3	Outline the air condition controls, delivery system and refrigerants.	**3**
CO4	Explain the functions of automatic temperature control employed in automotive airconditioning.	**3**
CO5	Discuss servicing and testing of air conditioning components.	**3**

TEXT BOOKS:

1. Warren Farnell and James D.Halderman, "Automotive Heating, Ventilation, and AirConditioning systems", Classroom Manual, Pearson Prentice Hall, 2004.
2. Warren Farnell and James D.Halderman, "Automotive Heating, Ventilation, and Air Conditioning systems", Shop Manual, Pearson Prentice Hall, 2004.

REFERENCES:

1. GoingsL.F., "Automotive Air Conditioning", American Technical services, 1974.
2. McDonald, K.L., "Automotive Air Conditioning", Theodore Audel series,1978
3. Mitchell Information Services, Inc., "Mitchell Automatic Heating and Air Conditioning Systems", Prentice Hall Inc., 1989.
4. Paul Weisler, "Automotive Air Conditioning", Reston Publishing Co. Inc., 1990.
5. William H Crouse and Donald L Anglin, "Automotive Air conditioning", McGraw Hill Inc., 1990.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	2	1	2	1	2	1	3	1	1	1	1	2	1	2
CO2	3	2	2	1	2	2	3	1	2	2	1	2	2	3
CO3	3	2	2	1	2	2	3	1	2	2	1	2	2	3
CO4	3	2	2	1	2	2	3	1	2	2	1	2	2	3
CO5	3	2	2	1	2	2	3	1	2	2	1	2	2	3
Average	**2.8**	**1.8**	**2**	**1**	**2**	**1.8**	**3**	**1**	**1.8**	**1.8**	**1**	**2**	**1.8**	**2.8**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

MN22071 COMPUTATIONAL FLUID DYNAMICS: THEORY AND PRACTICES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To expose the students to the basics of CFD and the procedures.
- To acquire knowledge of finite difference and finite volume methods.
- To acquire the ability to solve the problems using finite volume method.

UNIT I INTRODUCTION AND GOVERNING EQUATIONS 9

Introduction - Impact and applications of CFD in diverse fields - Governing equations of fluid dynamics – Continuity - Momentum and energy - Generic integral form for governing equations - Initial and Boundary conditions - Governing equations for boundry layers - Classification of partial differential equations – Hyperbolic - Parabolic - Elliptic and Mixed types - Applications and relevance.

UNIT II FINITE DIFFERENCE METHOD 9

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – solution methods for finite difference equations – Elliptic equations – Iterative solution Methods – Parabolic equations – Explicit and Implicit schemes.

UNIT III FINITE VOLUME METHOD (FVM) FOR CONDUCTION 9

Finite volume formulation for steady state one and two -dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank – Nicolson and fully implicit schemes.

UNIT IV FINITE VOLUME METHOD FOR CONVECTION 9

Steady one-dimensional convection– Central, upwind differencing schemes-properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

UNIT V CALCULATION FLOW FIELD BY FVM 9

Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, two equation (k-Є) models.

TOTAL: 45 PERIODS

OUTCOMES:

COs	Course Outcomes	RBT LEVEL
CO1	The students will establish the mathematical representation of the governing equations of fluid flow and heat transfer.	**3**
CO2	The students will choose and apply explicit, implicit and semi-implicit methods of finite differencing based on applications.	**3**
CO3	The students will deduce the suitable governing equations to formulate numerical solutions for conduction problems using finite volume method.	**3**
CO4	The students will prioritize different schemes used for convection problems using finite volume methods.	**3**
CO5	The student will appraise the knowledge of CFD techniques, basic aspects of discretization and grid generation.	**3**

TEXT BOOKS:

1. Jiyan Tu, Guan Heng Yeoh, Chaoqun Liu, "Computational Fluid Dynamics : A Practical Approach", Second edition, Elsevier Ltd, 2018
2. MuralidharK and Sundararajan T, "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2014.
3. Versteeg H.K, "An Introduction to Computational Fluid Dynamics, The Finite Volume Method", Pearson Publication, Second edition, 2008.

REFERENCES:

1. Anderson. J.D, "Computational Fluid Dynamics- The Basic with Applications", Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi,2004
2. Hoffman K.A, "Computational Fluid Dynamics for Engineering", Engineering Education System, Austin, Texas 1989.
3. Chung T.J, "Computational Fluid Dynamics", Cambridge University Press,2003.
4. Sreenivas Jeyanthi, "Computational Fluid Dynamics for Engineers and Scientists", Springer, 2018.

WEB RESOURCES:

- https://www.mie.utoronto.ca/
- https://nptel.ac.in/courses/112/107/112107079/
- https://nptel.ac.in/courses/101/106/101106045/

AE22062 **INDUSTRIAL ROBOTICS** **L T P C**
3 0 0 3

OBJECTIVES:

- Provide students with a comprehensive understanding of the fundamentals of robotics.
- Familiarize students with the Robot Motion Analysis and arm dynamics.
- Enable students to analyze the motion and behavior of robotic systems through the study of kinematics and dynamics
- Equip students with the skills necessary to program industrial robots for a variety of tasks
- Introduce students to the various sensors used in industrial robotics for perception and environment sensing

UNIT I FUNDAMENTALS OF ROBOT & STRUCTURE OF ROBOTICS 9

Occurance of Events in the History of Robots, Management and robotics, The Characteristic and application of the present robot(Industrial), Anatomy of robot, classification of robot, Robot links, Joints in robots, Performance parameter, Hydraulic and Pneumatic actuators, Electric drives, Stepper Motors, Wrist and Motions. Design of Gripper Fingers.

UNIT II ROBOT MOTION ANALYSIS AND ARM DYNAMICS 9

Introduction, Transformations rotation matrix, Inverse transformation, Composite rotation matrix, Homogeneous transformation- Geomentric interpolation, inverse homogeneous, Composite homogeneous, Manipulator parameters, D-H representative, Arm matrix- Kinematics equations, Joint velocity, The lagrangian equation of motions, dynamic equation for general manipulator.

UNIT III ROBOT CONTROL SYSYTEM 9

Introduction to control concepts, Block diagram of robot control system, spring mass damper system, Transient response of second order system, controller design parameters, Control of single llink manipulator, Modeling of the transfer function for a single joint, Controller- The proportional derivative controller.Trajectory Planning -Trajectory planning wiyh 3^{rd} order and 5^{th} order planning.

UNIT IV INDUSTRIAL ROBOT PROGRAMME 9

Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effectors Commands, and simple programs. Programming to Palletise the object, Programming operating and storage, AL program for Bolt task Insertion Task.

UNIT V SENSORS IN ROBOTICS 9

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.

TOTAL :45 PERIODS

CO	COURSE OUTCOMES	RBT Level
Students will be able to		
CO1	Discuss the fundamentals of robot & structure of robots.	3
CO2	Analyze the robot motion and arm dynamics.	3
CO3	Design a robot control system.	3

CO4	Create program for various motion of robots.	3
CO5	Outline the working of sensors used in the robot.	3

TEXTBOOKS

1 Ganesh.S.Hedge,"A textbook of Industrial Robotics", Lakshmi Publications, 2006.

2 Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2ND edition 2012. .

REFERENCES

1 Fu K.S. Gonalz R.C. and ice C.S.G."Robotics Control, Sensing, Vision and Intelligence", McGraw Hill book co. 2007.

2 Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005

3 Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.

4 John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.

5 YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	3	3	3	1	2	0	1	1	0	3	2	2
CO2	3	3	3	3	3	1	2	0	1	1	0	3	2	2
CO3	3	3	3	3	3	2	1	1	2	2	2	3	1	2
CO4	2	2	3	2	3	1	1	1	1	1	1	2	1	2
CO5	2	2	2	2	3	1	1	1	1	1	1	2	1	2
Average	**2.6**	**2.6**	**2.8**	**2.6**	**3**	**1.2**	**1.4**	**1**	**1.2**	**1.2**	**1.33**	**2.6**	**1.4**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22063 OFF HIGHWAY VEHICLES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To make the students to know and understand the various Off road vehicle and their systems and its features.
- To understand the working principle of various earth - moving machines.
- To impart knowledge about Scrappers, Graders, Shovels and Ditchers.
- To introduce the various farm equipment and combat vehicles.
- To impart knowledge on various systems present in off-road vehicles.

UNIT I CLASSIFICATION AND REQUIREMENTS OF OFF ROAD 6

Construction layout, capacity and applications. Power Plants, Chassis and Transmission, Multi-axle vehicles, Multi-axle steering and four wheel steering.

UNIT II EARTH MOVING MACHINES 10

Earthmovers like dumpers, loaders-single bucket, Multi bucket and rotary types - bulldozers, excavators, backhoe loaders, scrappers, drag and self powered types, Bush cutters, stumpers, tree dozer, rippers, Power and capacity of earth moving machines.

UNIT III SCRAPPERS, GRADERS, SHOVELS AND DITCHERS 10

Scrappers, elevating graders, motor graders, self powered scrappers and graders, Power shovel, revolving and stripper shovels - drag lines – ditchers - capacity of shovels.

UNIT IV FARM EQUIPMENTS, MILITARY AND COMBAT VEHICLES 8

Tractors Constructional Details, Tractors in Earth moving applications, Harvesting machine - wheel and chain type, Recent trends in tractor design, Power take off, special implements. Special features and constructional details of tankers, gun carriers and transport vehicles.

UNIT V VEHICLE SYSTEMS, FEATURES 11

Brake system and actuation - Oil Cooled Disc Brakes and dry disc caliper brakes, body hoist and bucket operational hydraulics, Hydro - pneumatic suspension cylinders, Power steering system, Kinematics for loader and bulldozer operational linkages, Safety features, safe warning system for dumper, Design aspects on dumper body, loader bucket and water tank of sprinkler.

TOTAL: 45 PERIODS

OUTCOMES:

COs	Course Outcomes	RBT LEVEL
Students will be able to		
CO1	Classify and discuss the layout and requirements of off road vehicles.	**3**
CO2	Classify and compare the salient features of different off road vehicles.	**3**
CO3	Describe the working principle of various earth moving machines.	**3**
CO4	Discuss the constructional details of farm equipment, military and combat vehicles.	**3**
CO5	Describe the suspension, steering, braking systems and safety features of off-road vehicles.	**3**

TEXTBOOKS:

1. Nakra C.P, “Farm Machines and Equipments”, Dhanpatrai Publishing Company Pvt. Ltd., 2003.
2. Robert L Peurifoy, “Construction, Planning, Equipment and Methods”, Tata McGraw HillPublishing Company Ltd, 2013.

REFERENCES:	
1.	Bart H Vanderveen, "Tanks and Transport Vehicles", 1st edition, Frederic Warne and Co Ltd., London, 1974.
2.	Hamid Taghavifar, Aref Mardani, "Off-road Vehicle Dynamics: Analysis, Modelling and Optimization",Springer; 1st ed, 2017.
3.	La S. Ageikin, "Off the Road Wheeled and Combined Traction Devices: Theory and Calculation", Ashgate Publishing Co. Ltd. 1998.
4.	Satyanarayana. B., "Construction Planning and Equipment", Standard publishers anddistributors, New Delhi, 1985.
5.	Schulz Erich J, "Diesel equipment I & II", McGraw Hill company, London, 1982.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO1	2	2	3	1	2	2	2	1	1	2	1	2	2	3
CO2	2	2	2	2	2	1	2	1	1	2	1	2	2	3
CO3	3	2	2	1	2	1	1	1	1	2	1	2	2	3
CO4	3	2	3	1	2	2	1	1	1	2	1	2	2	3
CO5	3	2	3	2	2	2	1	1	1	2	1	2	1	3
Average	**2.6**	**2**	**2.6**	**1.4**	**2**	**1.6**	**1.4**	**1**	**1**	**2**	**1**	**2**	**1.8**	**3**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

ME22087 PRINCIPLES OF MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

- To enable the students to study the evolution of management, functions and principles of management and to learn the application of management principles in an organization.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management –Nature of Management-Management as Science or Art-Management and Administration-Evolution of Management-Contribution of Taylor and Fayol– types of managers - managerial roles and skills - Organization Culture – Dimensions, strong and weak culture –External Environment -.specific and general environment – Understanding the global environment.

UNIT II PLANNING 9

Nature and purpose of planning – Steps Involved in planning process – Types of plans – management by objectives – Strategic management process– types of corporate strategies - Planning Tools and Techniques-Forecasting – Benchmarking - Decision making steps and process

UNIT III ORGANISING 9

Nature and purpose – Formal and informal organization — Line and staff authority – delegation of authority – departmentalization by different strategies - centralization and decentralization –span of control- Human Resource Management – External factors - HR Planning - Recruitment and Decruitment - selection – selection tools – Orientation – Employee training - Employee Performance Management – Appraisal methods - Compensation and benefits.

UNIT IV DIRECTING 9

Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership – communication – process of communication – barrier in communication – effective communication.

UNIT V CONTROLLING 9

Types of control systems: Market, Bureaucratic, Clan- Importance of control - process of controlling – Types of control: Feed forward, Concurrent, Feedback -Qualities of effective control system – Factors affecting control – controlling for organizational performance – control techniques -budget - Program evaluation and review technique – Information technology in controlling: opportunities and challenges.

TOTAL: 45 PERIODS

OUTCOMES		
COs	**Course Outcomes**	**RBT LEVEL**
Students will able to		
CO1	Practice various managerial roles in the enterprise, apply various managerial approaches to handle complex situations and design planning process to reach the decided organizational objectives.	**3**
CO2	Formulate strategies for the betterment of the organization as demanded by the environment and the current scenario existing in the organization.	**3**

CO3	Group activities for the efficient attainment of organizational objectives, and able to effectively execute various human resource planning activities as required by the organization.	**3**
CO4	Execute the appropriate motivational and leadership techniques as demanded by the situation in the organization and effectively utilize various communication methods in the organization.	**3**
CO5	Apply various control techniques to monitor the progress of activities and to take corrective measures accordingly.	**3**

TEXT BOOKS:

1. Stephen A. Robbins, David A. Decenzo, Sanghamitra, Bhattacharyya, Madhushree Nanda Agarwal "Fundamentals of Management" 6th Edition, Pearson Education, 2011.
2. Stephen P. Robbins, Mary Coulter and Agna Fernandez, "Management", 14th Edition, Prentice Hall (India) Pvt. Ltd., 2019.

REFERENCES:

1. Harold Koontz & Heinz Weihrich "Essentials of management" 10th edition, Tata Mc Graw Hill, 2015.
2. Heinz Weihrich, Mark V Cannice, and Harold Koontz "Management: A Global, Innovative and Entrepreneurial Perspective", 15th Edition, McGrawHill, 2019.
3. JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", 6th Edition, Pearson Education, 2004.

WEB RESOURCES:

1. https://nptel.ac.in/courses/110105069/
2. https://nptel.ac.in/courses/122108038/
3. https://nptel.ac.in/courses/110/102/110102016/

AE22064 SIMULATION OF IC ENGINES L T P C
3 0 0 3

OBJECTIVES:

- To learn the simulation of engine combustion.
- To learn the combustion theory based on first and second law of thermodynamics.
- To do the modeling of SI engines.
- To do the modeling of CI engines.
- To do the modeling of Two stroke engines.

(Use of Standard Simulation Data Book permitted)

UNIT I INTRODUCTION TO SIMULATION 9

Basic knowledge to simulation, advantages of engine simulation - Classification of engine models- Intake and exhaust flow models - Open and closed cycle models - Simulation of Various cycles - Step by step approach in engine simulation.

UNIT II COMBUSTION THEORY 9

Theories of combustion- Laminar and Turbulent flame propagation in engines -First and second law of thermodynamics applied to combustion- combustion equation for hydrocarbon fuels- Heat of reaction- Constant volume adiabatic combustion, constant pressure adiabatic combustion.

UNIT III SIMULATION OF COMBUSTION IN SI ENGINES 9

Combustion in SI engines, Flame propagation and velocity, Single zone models – Multi zone models – Mass burning rate, Turbulence models – One dimensional models – Chemical kinetics modeling – Multidimensional models, Flow chart preparation.

UNIT IV SIMULATION OF COMBUSTION IN CI ENGINES 9

Combustion in CI engines Single zone models – Premixed-Diffusive models – Wiebe model – Whitehouse way model, Two zone models – Multi zone models- Meguerdichian and Watson's model, Hiroyasu's model, Lyn's model – Introduction to Multidimensional and spray modeling, Flow chart preparation.

UNIT V SIMULATION OF TWO STROKE ENGINES 9

Thermodynamics of the gas exchange process - Flows in engine manifolds – one dimensional and multidimensional models, Flow around valves and through ports Models for scavenging in two stroke engines – Isothermal and non-isothermal models, Heat Transfer and Friction.

TOTAL: 45 PERIODS

OUTCOMES:

COs	Course Outcomes	RBT LEVEL
Students will be able to		
CO1	Describe the importance of simulation tools in modeling of IC engine.	**3**
CO2	Analyze the adiabatic flame temperature at constant volume and constant pressure combustion.	**3**
CO3	Explain the principles of simulation of combustion in SI engines.	**3**
CO4	Explain the principles of simulation of combustion in CI engines.	**3**
CO5	Discuss the principles of simulation of combustion in two stroke engines.	**3**

TEXTBOOKS:

1. Ganesan.V, "Computer Simulation of Spark-Ignition Engine Processes", Universities Press, 2000.
2. Ganesan.V, "Computer Simulation of Compression-Ignition Engine Processes," Universities Press, 2000.

REFERENCES :

1 Bordon P. Blair, “The Basic Design of two-Stroke engines”, SAE Publications, 1990.

2. Horlock and Winterbone, “The Thermodynamics and Gas Dynamics of Internal Combustion Engines”, Vol. I & II, Clarendon Press, 1986.

3. Mattavi.J.N and Amann. C.A, “Combustion Modeling in Reciprocating Engines”, Plenum Press, 1980.

4. Ramos. J.I, “Internal Combustion Engine Modeling”, Butterworth – Heinemann ltd, 1999.

5. Saravanamuttoo, Cohen H. Rogers GEC,“Gas Turbine Theory”, Fifth edition, Pearson Education India, 2017.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	1	2	1	3	1	1	1	1	1	1	2	3	2
CO2	3	3	2	2	2	1	1	1	1	1	1	2	3	1
CO3	3	2	3	2	2	1	1	1	1	1	1	2	3	1
CO4	3	2	3	2	2	1	1	1	1	1	1	2	3	1
CO5	3	2	3	2	2	1	1	1	1	1	1	2	3	1
Average	**3**	**2**	**2.6**	**1.8**	**2.2**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**3**	**1.2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22065 VEHICLE DESIGN DATA CHARACTERISTICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To familiarize the various assumption involved in the vehicle design.
- To impart the knowledge to the students about the various resistances acting on the vehicle.
- To learn to use important technical specifications and to interpret the performance characteristics of IC engines.
- To familiarize the procedure to find the performance characteristic of forces and moments acting on the piston.
- To familiarize the various steps involved in the design a automotive gearbox system.

UNIT I INTRODUCTION **9**

Assumptions to be made in designing a vehicle Range of values for Gross Vehicle Weight, Frontal Area, maximum speed, maximum acceleration, gradability in different gears, Basics of Automobile Design, Design variables and operating variables affecting performance and emission.

UNIT II RESISTANCE TO VEHICLE MOTION **9**

Calculation, Tabulation and Plotting of Curves for Air and Rolling Resistances at various vehicles speeds, Calculation and Plotting of Driving force, Power requirement for different loads and acceleration, Maximum Power calculation.

UNIT III PERFORMANCE CURVES – I **9**

Calculation, Tabulation and Plotting of Torque and Mechanical Efficiency for different vehicle speeds, Interpolation of Pressure – Volume diagram, Calculation of frictional Mean Effective Pressure, Calculation of Engine Cubic Capacity, Bore and Stroke Length, Calculation of Power and torque curve.

UNIT IV PERFORMANCE CURVES – II **9**

Connecting rod length to Crank Radius Ratio, Plotting of Piston Velocity and Acceleration against Crank Angle, Plotting Gas force, Inertia force and Resultant force against Crank Angle, Turning Moment and Side Thrust against Crank Angle.

UNIT V GEAR RATIOS **9**

Requirements of Gear box, Determination of Gear Ratios, Acceleration and Gradability, Typical Problems on Vehicle performance.

TOTAL: 45 PERIODS

OUTCOMES:

COs	Course Outcomes	RBT LEVEL
Students will be able to		
CO1	Examine the assumptions in basic design of vehicle and discuss the effect of design and operating variables on performance and emission.	**3**
CO2	Examine and compare the various resistances acting on the vehicle.	**3**
CO3	Investigate the performance characteristics of internal combustion engines.	**3**
CO4	Solve velocity and acceleration of piston against crank angle and examine the performance characteristic of forces and moments acting on the piston.	**3**
CO5	Use the basic principles to design the gearbox of the vehicle.	**3**

TEXTBOOKS:

1. Giri. N. K., "Automotive Mechanics", Khanna Publishers, New Delhi, 2008.
2. Heldt, P.M., "High Speed Combustion Engines", Oxford and I.B.H. Publishing Co., Kolkata, 2002.

REFERENCES:

1. FischerR, Kucukay F, Jurgens G, Najork R and Pollak B, "The Automotive Transmission Book", Springer International Publishers, 2015.
2. Ganesan V, "Internal Combustion Engines", Fourth Edition, Tata McGraw Hill, 2017.
3. Gupta R.B, "Automobile Engineering", 1st edition, Sathya Prakashan, 2016.
4. Heinz Heisler, "AdvancedVehicle Technology", Butterworth-Heinemann, Elsevier, India Edition, 2011.
5. Thomas Bevan, "Theory of Machines", 3rd edition, CBS Publishers and Distributors, , 2009.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	2	3	2	1	1	3	1	1	1	1	2	3	2
CO2	2	3	2	3	1	1	1	1	1	1	1	2	3	1
CO3	3	2	2	3	1	1	1	1	1	1	1	2	3	1
CO4	3	3	2	3	1	1	1	1	1	1	1	2	3	1
CO5	3	2	3	2	1	1	1	1	1	1	1	2	3	1
Average	**2.8**	**2.4**	**2.4**	**2.6**	**1**	**1**	**1.4**	**1**	**1**	**1**	**1**	**2**	**3**	**1.2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

AE22066 VIRTUAL INSTRUMENTATION IN AUTOMOBILE ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn the Fundamentals in Virtual instrumentation.
- To Understand the programming data acquisition.
- To Understand the Communication Networked modules.
- To learn the concepts of Real time control.
- To implement the concepts in Automotive Applications.

UNIT I INTRODUCTION **9**

Virtual Instrumentation – Definition and Flexibility – Block Diagram and Architecture of Virtual Instrumentation – Virtual instruments versus Traditional instruments – Review of software in virtual instrumentation- VI Programming techniques – VI, sub VI Loops and charts, Arrays, clusters and Graphs, Case and sequence structures, Formula nodes, string and File input/output.

UNIT II DATA ACQUISITION IN VI **9**

A/D and D/A Converters, plug – in – Analog input/output cards- Digital input and output cards, organization of the DAQ VI system – Opto isolation – performing analog input and analog output – scanning multiple analog channels – issues involved in selection of data acquisition cards – data acquisition modules with serial communication – design of digital voltmeter with transducer input- Timers and counters.

UNIT III COMMUNICATION NETWORKED MODULES **9**

Introduction to PC buses – local buses – ISA, PC1, RS232, RS 422 and RS 485 – Interface buses – USB, PCMCIA, VXI,SCXI and PXI – Instrumentation buses – Modbus and GPIB – Networked buses – ISO/OSI reference model, Ethernet and TCP/IP Protocols.

UNIT IV REAL TIME CONTROL IN VI **9**

Design of ON/OFF controller and proportional controller for a mathematically described processes using VI Software – Modeling and basic control of level and Reactor Processes – Case Studies on development of HMI, SCADA in VI.

UNIT V AUTOMOTIVE APPLICATIONS **9**

PC based digital storage oscilloscope – sensor technology and signal processing – virtual laboratory- spectrum analyzer – wave form generator- Data Visualization and multiple locations- Distributed monitoring and control – Vision and motion control. Case study related to automotive applications.

TOTAL: 45 PERIODS

OUTCOMES:

COs	Course Outcomes	RBT LEVEL
Students will be able to		
CO1	Explain the concepts of virtual instrumentation.	**3**
CO2	Discuss the application of data acquisition in automobile engineering.	**3**
CO3	Discuss the application of instrument control in automobile engineering.	**3**
CO4	Experiment and analyze the automobile laboratory prototype measurement systems using a computer and plug-in DAQ interfaces.	**3**
CO5	Outline the implementation in small automotive related projects in virtual instrumentation.	**3**

TEXTBOOKS:

1. Bitter R, Mohiuddin, T. and Nawricki M, "Labview Advanced programming Technique", 2nd Edition, CRC Press, 2007.
2. Gupta S and Gupta J.P, "PC Interfacing for Data Acquisition and Process Control", Instrument Society of America, 1995.

REFERENCES:

1. Buchanan W, "Computer Busses", CRC Press, 2000.
2. Jamal R and Picklik H, "Labview – Applications and Solutions", National Instrument Release, 2019.
3. Johnson G, "Lab view Graphical Programming", McGraw – Hill, New York, 1997.
4. Nadovich C, "Synthetic Instruments Concepts and Applications", Elsevier 2005.
5. Wells L.K and Travis J, "Labview for everyone", Prentice Hall, New Jersey, 1997.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	1	1	1	3	1	1	1	1	2	1	2	2	2
CO2	3	2	2	2	3	1	2	1	1	2	1	2	3	3
CO3	3	2	2	2	3	1	2	1	1	2	1	2	3	3
CO4	3	2	2	3	3	1	1	1	2	2	2	2	3	2
CO5	3	2	3	2	3	1	2	1	2	3	2	2	3	3
Average	**3**	**1.8**	**2**	**2**	**3**	**1**	**1.6**	**1**	**1.4**	**2.2**	**1.4**	**2**	**2.8**	**2.6**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

OE22101	AUTOMOTIVE FAULT DIAGNOSTICS	L	T	P	C
	(Common to AE, AM)	3	**0**	**0**	**3**

OBJECTIVES:

- To educate about the various requirements for a workshop to carry out the automotive faulty diagnosis.
- To present an overview of various types of fault detection methods for automotive fault diagnosing.
- To impart knowledge and skills needed to design and diagnose faults in various systems and sub systems of automobile.
- To impart the knowledge on fundamentals about electrical systems and its diagnosis
- To explore the advanced diagnosis techniques.

UNIT I MAINTENANCE, WORKSHOP PRACTICES, SAFETY AND TOOLS 9

Maintenance – need, importance, primary and secondary functions, policies, Classification of maintenance work, basic problem diagnosis, automotive service procedures, workshop operations, Preparation of workshop forms, vehicle identification, Safety – personnel, machines and equipment, vehicles, Fire safety – First aid., Basic tools – special service tools, measuring instruments.

UNIT II DIAGNOSTICS ON ENGINE SYSTEMS 9

Introduction to various engine system, Diagnostics on – engine system, fuel system, exhaust system, air supply system, cooling system, lubrication system, battery, starting system and charging system.

UNIT III DIAGNOSTICS ON CHASSIS SYSTEM AND TRANSMISSION SYSTEM 9

Introduction to various chassis systems and transmission systems, diagnostics on Brakes, ABS, Steering system, Suspension system and Transmission system.

UNIT IV DIAGNOSTICS ON ELECTRICAL SYSTEMS 9

Introduction and diagnostics on – exterior and interior lighting, electric horn, wiper motors, Heating Ventilation and Air Conditioning, Cruise control and Airbag, Seat belt and Pre-tensioners.

UNIT V ADVANCED DIAGNOSTICS METHODS 9

Introduction to tools and equipment – basic equipment, Oscilloscopes, Scanner, Engine analyzers, Oscilloscope diagnostics – introduction, diagnostics of various sensors using oscilloscopes, On-Board Diagnostics (OBD)- Introduction, needs, OBD on Vehicle emission control strategies, OBD2, enhanced OBD, Malfunction Indicator Lamp, Fault codes.

TOTAL: 45 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Explain the service procedures and safety methods practiced in an automotive workshop.	**3**
CO2	Discuss the diagnostic procedures employed on engine and its subsystems.	**3**
CO3	Outline the diagnostic procedures employed on various systems of automotive chassis.	**3**
CO4	Outline the diagnostic procedures employed on automotive electrical systems.	**3**
CO5	Discuss the advanced tools, equipment and methods used for fault diagnostics.	**3**

TEXT BOOKS:

1. Tom Denton, "Advanced Automotive Fault Diagnostics", Fourth Edition, Routledge Publisher, 2016.
2. William H Crouse and Donald L Anglin, "Automotive Mechanics", Tenth Edition, Mc Graw Hill Publications 2006.

REFERENCES:

1. James D. Halderman, "Automotive Technology: Principles, Diagnosis, and Service", 5th Edition, Pearson Publishers, 2015.
2. Janos J. Gertler, "Fault Detection and Diagnosis in Engineering systems", 2nd Edition, Marcel Dekker, 1998.
3. Rolf Isermann, **"**Fault-Diagnosis Systems an Introduction from Fault Detection to Fault Tolerance", Springer Verlag, 2006.
4. Steven X. Ding, "Model based Fault Diagnosis Techniques: Schemes, Algorithms, and Tools", Springer, 2008.
5. Tom Denton, "Automobile Electrical and Electronics Systems", Fifth Edition, Taylor & Francis Group, 2018.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	1	1	1	1	2	2	1	2	2	2	1	2	1	2
CO2	3	3	2	3	3	2	2	2	2	2	1	3	3	3
CO3	3	3	2	3	3	2	2	2	2	2	1	3	2	3
CO4	3	3	2	3	3	2	2	2	2	2	1	3	2	3
CO5	3	3	2	3	3	2	1	2	2	2	1	3	3	3
Average	**2.6**	**2.6**	**1.8**	**2.6**	**2.8**	**2**	**1.6**	**2**	**2**	**2**	**1**	**2.8**	**2.2**	**2.8**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

OE22102 FUNDAMENTALS OF AUTOMOBILE ENGINEERING **L T P C**

(Common to AE, AM) 3 **0 0 3**

OBJECTIVES:

- In the end, the student get familiarize in the engine construction and working.
- To understand the construction and working principle of carburetor, injection and ignition systems.
- To have the practice for assembling and dismantling of engine parts and transmission system.
- To make the students to understand the importance of steering and suspension system in vehicle**.**
- In the end the students will gain knowledge on different types of wheels and brake used in the vehicle.

UNIT I VEHICLE STRUCTURE AND ENGINES 9

Types of automobiles, vehicle construction and different layouts, IC engines –working of four stroke and two stroke Spark Ignition & Compression Ignition engines, Engine emission control techniques, Emission norms (Euro and BS), Layout of Electric and Hybrid vehicle.

UNIT II FUEL INJECTION AND IGNITION SYSTEM 9

Carburetor types, Theory of simple carburetor, Petrol injection, Electronic fuel injection, Types of injection systems, fuel pump, Types of fuel injectors, and types of nozzles, Ignition system, Battery coil ignition system, Electronic ignition system.

UNIT III TRANSMISSION SYSTEMS 9

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

UNIT IV SUSPENSION SYSTEMS AND STEERING SYSTEMS 10

Types of suspension Springs, Leaf spring, coil spring, Torsion bars, Rubber spring, Telescopic type shock absorber, Independent suspension, Steering geometry and types of steering gear box, Power Steering, steering linkages, steering gears, Types of Front Axle.

UNIT V WHEELS TYRES AND BRAKES 8

Types of wheels, Compare different types of wheel, Types of tyre, Compare different types of tyres, Tyre materials, Electric brake, Servo brake system, Power brake, Disc brake, Drum Brake, Air brake, ABS.

TOTAL: 45 PERIODS

COs	**COURSE OUTCOMES**	**RBT LEVEL**
Students will be able to		
CO1	Outline the layout of conventional chassis, electric and hybrid vehicle and discuss the construction and working of automotive engines.	**3**
CO2	Discuss the fuel system and ignition in automotive engines.	**3**
CO3	Outline the construction and working of automotive transmission system.	**3**

CO4	Describe the types of suspension systems, steering systems and discuss the steering geometry.	
CO5	Compare different types of wheel, tyre and brakes used in automobiles.	**3**

TEXT BOOKS:

1. Jain K.K. and Asthana .R.B, "Automobile Engineering", Tata McGraw Hill Publishers, 2002.
2. Kirpal Singh, "Automobile Engineering", Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 2017.
3. Rahman MD Arafat, "A Text Book of Automobile Engineering", VDM Verlag Publisher, 2011.

REFERENCES:

1. Heinz Hazler, "Modern Vehicle Technology", Butterworth, London, 2005.
2. Joseph Heitner, "Automotive Mechanics", Second Edition, East-West Press, 2017.
3. Martin W, Stockel and Martin T Stockle, "Automotive Mechanics Fundamentals", The Good heart –Will Cox Company Inc, USA, 1978.
4. Newton Steeds and Garret, "Motor Vehicles" 13th Edition,Butterworth, London, 2005.
5. R.K. Rajput, "A Text–Book of Automobile Engineering", Laxmi Publications Private Limited.

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	2	3	2	2	1	2	1	1	1	1	3	3	3
CO2	3	2	3	2	2	1	2	1	1	1	1	3	3	2
CO3	3	2	3	2	2	1	2	1	1	1	1	3	3	2
CO4	3	2	3	2	2	1	2	1	1	1	1	3	2	3
CO5	2	2	3	2	2	1	2	1	1	1	1	3	2	3
Average	**2.8**	**2**	**3**	**2**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**3**	**2.6**	**2.6**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

OE22103 FUNDAMENTALS OF AUTOMOTIVE AIR-CONDITIONING **L T P C**
(Common to AE, AM) **3 0 0 3**

OBJECTIVES:

- To deliver the fundamental knowledge on psychrometry.
- To make the students to understand the constructional details and the working of various automotive air-conditioning components.
- To impart the knowledge about the refrigerant.
- To make the students to understand air routine for air-conditioning system.
- To make the students to understand the automatically controlled air conditioner.

UNIT I PSYCHROMETRY **9**

Moist air behaviour, psychrometric chart, psychrometric processes - Summer and winter air-conditioning.

UNIT II INTRODUCTION TO AIR CONDITIONING **9**

Air conditioning system - Schematic layout, compressor, condenser, expansion valve, evaporator, Electrical system of air conditioning system.

UNIT III REFRIGERANT **9**

Properties of refrigerants, common refrigerants, containers, handling refrigerants, tapping into the refrigerant container, ambient conditions affecting air conditioning system, refrigeration system diagnostics.

UNIT IV VENTILATION **10**

Air flow through recirculation unit and automatic temperature control, Duct system - Controlling flow, vacuum reserve, testing the air control and handling systems.

UNIT V AIR CONDITIONING **8**

Automotive heaters - Heater system, manually and automatically controlled air conditioner, air conditioning in cars.

TOTAL: 45 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Discuss the basic principles of psychrometry.	**3**
CO2	Describe the construction details and working of various components used in vehicle air conditioning system.	**3**
CO3	Outline the behavior of the refrigerant while handling.	**3**
CO4	Discuss the constructional details and working of ventilation system.	**3**
CO5	Explain the construction and working of manual and automatic air conditioning systems.	**3**

TEXT BOOKS:

1. Warren Farnell and James D.Halderman, "Automotive Heating, Ventilation, and AirConditioning systems", Classroom Manual, Pearson Prentice Hall, 2004.
2. Warren Farnell and James D.Halderman, "Automotive Heating, Ventilation, and Air Conditioning systems", Shop Manual, Pearson Prentice Hall, 2004.

REFERENCES:

1. Boyce H Dwiggins, "Automotive Air conditioning", Delmar Cengage Learning, Stamford, 2002.
2. Paul Weisler, "Automotive Air Conditioning", Reston Publishing Co. Inc., 199
3. Robert McDowall, "Fundamentals of HVAC Systems", Elsevier Science, 2006 4. Mark Schnubel, "Automotive Engineering Heating & Air Conditioning", Cengage Learning, Stamford, 2010.
4. Russel Carrigan, John Eichelberer, "Automotive Technology Heating and Air Conditioning", Cengage Learning, Stamford, 2011.
5. Steven Daly, "Automotive Air Conditioning and Climate Control Systems", Butterworth Heinemann, Burlington, 2011.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	1													
CO2	1	1	2	1	2	1	2	1	1	1	1	2	1	2
CO3	2	2	1	2	1	1	2	1	1	1	1	2	1	2
CO4	2	2	2	2	1	1	2	1	1	1	1	2	1	2
CO5	2	2	2	2	1	1	2	1	1	1	1	2	1	2
Average	**1.6**	**1.75**	**1.75**	**1.75**	**1.25**	**1**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

OE22104	FUNDAMENTALS OF AUTOMOTIVE POLLUTION AND CONTROL METHODS	L	T	P	C
		3	0	0	3

(Common to AE, AM)

OBJECTIVES:

- To impart knowledge on automotive pollution and emphasize the various causes to Environment and Humans due to Automotive Pollution.
- To impart knowledge in automotive pollution control.
- The detailed concept of formation and control techniques of pollutants like Un-Burnt Hydro Carbon (UBHC), Carbon Monoxide (CO), Oxides of Nitrogen (NO_x), particulate matter (PM) and smoke for both Spark Ignition (SI) and Compression Ignition (CI) engine will be taught to the students.
- The instruments for measurement of pollutants and emission standards will also be introduced to the students.
- To educate the students about the fundamental of noise, vibration and harshness from automobiles.

UNIT I INTRODUCTION 9

Introduction - engine development, Impact of urban and Global air pollution, Engine configuration and components, engine types and classifications, Sources of engine emission, emission effects on health and environment, Global warming, acid rain.

UNIT II EMISSION STANDARDS 9

Emission standards - Light Duty Vehicles, Heavy Duty Engines, Diesel Smoke standards, Motorcycle Emission Standards, Emission Test Cycles - Light duty vehicles, Heavy duty vehicles and Motorcycles, History of Indian Emission norms, comparison between Bharat Stage - IV and Bharat Stage-VI norms, Indian Driving Cycles.

UNIT III EMISSIONS IN SPARK IGNITION (SI) & COMPRESSION IGNITION (CI) ENGINE 9

Formation of Carbon Monoxide, NO formation in SI and CI Engines, HC Emissions from SI Engines and HC Emissions from CI Engines, Soot and Particulate Formation - Composition, mechanism and smoke. List of operating and design variables in SI and CI engine.

UNIT IV EMISSION CONTROL TECHNIQUES AND INTRUMENTATION FOR EMISSION TEST AND MEASUREMENTS 10

Exhaust after treatment devices - Thermal reactors, Catalytic converter, Diesel Particulate Filter, Selective Catalytic Reduction technique, Emission Measurement - Non Dispersive InfraRed Analyzers, Flame Ionization Detector, Chemiluminescence Analyzers, Smokemeters, Constant Volume Sampler, Particulate Emission measurement.

UNIT V NOISE, VIBRATION, AND HARSHNESS FROM AUTOMOBILES 8

Noise, Vibration And Harshness, sources of noise, measurement of noise, Engine combustion noise, inlet And exhaust noise, traffic noise, vehicle body noise, control of noise, control devices and noise proof materials.

TOTAL: 45 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Outline the important sources of pollutant and effects of emission.	**3**
CO2	Discuss the emission standards for two and four wheelers.	**3**
CO3	Describe the formation of emissions in SI engines and CI Engine.	**3**
CO4	Explain the various techniques for emission reduction and measurement.	**3**
CO5	Discuss the automotive noise, vibration and harshness.	**3**

TEXTBOOKS:

1. Paul Degobert, "Automobiles and Pollution", Editions Technip, 1995.
2. Pundir. B.P, "IC Engines Combustion and Emissions" Narosa Publishers, 2014.

REFERENCES:

1. Automobiles and Pollution SAE Transaction, 1995.
2. Charles Fayette Taylor, "The Internal Combustion Engine in Theory and Practice: Vol. 1 - 2nd Edition, Revised: Thermodynamics, Fluid Flow, Performance", The MIT Press;
3. Eran Sher, "Handbook of Air Pollution from Internal Combustion Engines 1st Edition",
4. Ganesan V, "Internal Combustion Engines", Tata McGraw Hill Co., 4th edition, 2017.
5. Heywood, J.B., "Internal Combustion Engine Fundamentals", 1st edition, McGraw Hill Book Co., 2017.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	2	2	2	1	3	1	1	1	1	3	2	3
CO2	2	3	2	2	3	2	3	1	2	2	1	3	3	2
CO3	3	3	2	3	3	3	2	1	3	3	2	2	3	2
CO4	3	3	3	3	3	2	3	2	3	3	2	3	3	2
CO5	2	3	3	2	3	2	2	1	3	2	1	3	3	2
Average	**2.6**	**3**	**2.4**	**2.4**	**2.8**	**2**	**2.6**	**1.2**	**2.4**	**2.2**	**1.4**	**2.8**	**2.8**	**2.2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

VD22101	BASICS OF ML ALGORITHMS FOR AUTOMOTIVE INDUSTRIES	L	T	P	C
		1	0	2	2

OBJECTIVES

The Student should be made to:

- To understand the fundamental concepts of Machine learning techniques.
- To study the concepts on Feature Engineering.
- To enable the students to gain knowledge on supervised machine learning approaches.
- To enable the students to gain knowledge on unsupervised ML approaches.
- To apply ML algorithms in automotive industries.

UNIT I INTRODUCTION TO MACHINE LEARNING AND FEATURE ENGINEERING 9

A Gentle Introduction to Machine Learning - Important Elements in Machine Learning - Data formats – Learnability - Statistical learning approaches; Feature Selection and Feature Engineering - Managing missing features - Data scaling and normalization - Feature selection and filtering - Principal component analysis.

UNIT II SUPERVISED MACHINE LEARNING ALGORITHM I 9

Linear Regression - Linear models - Linear regression with higher dimensionality; Logistic Regression - Implementation and optimizations - Stochastic gradient descent algorithms; Naive Bayes: Bayes' theorem, Naive Bayes classifier.

UNIT III SUPERVISED MACHINE LEARNING ALGORITHM II 9

Support Vector Machines - Linear support vector machines - Controlled support vector machines; Decision Trees - Binary decision trees - Ensemble learning; Artificial neural networks- Perceptrons - Training a Perceptron-Learning Boolean Functions - Multilayer Perceptrons - Back propagation Algorithm.

UNIT IV UNSUPERVISED MACHINE LEARNING ALGORITHM 9

Clustering Fundamentals - K-means, DBSCAN, Spectral clustering; Hierarchical clustering - Hierarchical strategies, Agglomerative clustering.

UNIT V CASE STUDY ON AUTOMOTIVE INDUSTRY 9

Automatic road marking recognition for intelligent vehicle systems application - Travel mode detection method based on big smart phone global positioning system tracking data - Machine learning techniques for quality control in high conformance manufacturing environment

TOTAL (L : 15 + P : 30): 45 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Differentiate different types of machine learning algorithms.	**3**
CO2	Perform feature engineering.	**3**
CO3	Apply ML algorithms to various automotive industry use cases.	**3**
CO4	Identify suitable supervised machine learning algorithm based on the application.	**3**
CO5	Identify suitable unsupervised machine learning algorithm based on the application.	**3**

TEXT BOOKS:

1. Giuseppe Bonaccorso, Machine Learning Algorithms, Packt Publishing Ltd, 2017.
2. Yao, B., & Feng, T. Machine learning in automotive industry. Advances in Mechanical Engineering, Sage Publications, 2018.

REFERENCES:

1. Ethem Alpaydin, Introduction to Machine Learning, Third Edition, MIT Press, 2014.
2. T. M. Mitchell, "Machine Learning", McGraw Hill, 1997.
3. C. M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	2	3	2	3	3	2	1	2	3	2	1	3	2	1
CO2	3	3	2	3	3	2	1	2	3	2	1	3	2	1
CO3	3	3	2	3	3	2	1	2	3	2	1	2	3	2
CO4	3	3	2	3	3	2	1	2	3	2	1	3	3	2
CO5	3	3	2	3	3	2	1	2	3	2	1	2	3	2
Average	**2.8**	**3**	**2**	**3**	**3**	**2**	**1**	**2**	**3**	**2**	**1**	**3**	**2.6**	**1.6**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

VD22103	HANDS ON PROGRAMMING WITH R	L	T	P	C
		1	0	2	2

OBJECTIVES: By the end of the course students shall be confident and equipped with all the knowledge required to perform analytical activities in R. Specifically,

- Understand the fundamental syntax of R through readings, practice exercises, demonstrations, and writing R code.
- Apply critical programming language concepts such as data types, iteration, control structures, functions, and boolean operators by writing R programs and through examples.
- Import a variety of data formats into R using RStudio.
- Visualize data attributes using ggplot2 and other R packages.

UNIT I INTRODUCTION TO R PROGRAMMING 9

Introduction to R -Installing R and RStudio - RStudio Overview - Working in the Console - Arithmetic Operators - Logical Operations - while loops - for Loops - if / else.

UNIT II DATA STRUCTURES, VARIABLES, AND DATA TYPES 9

Creating Variables - Numeric, Character and Logical Data - Vectors - Data Frames - Factors - Sorting Numeric, Character, and Factor Vectors - Special Values.

UNIT III R PACKAGES AND SCRIPTS 9

Installing and loading packages - Setting up your working directory - Downloading and importing data - Working with missing data - Extracting a subset of a data frame - Writing R scripts - Adding comments and documentation - Creating report.

UNIT IV DATA EXPLORATION 9

Reading CSV and Excel Files - Reading text files - Writing and saving data objects to file - String operations in R - Regular Expressions - Dates in R.

UNIT V DATA VISUALIZATION 9

Scatter Plots and Box and-Whisker Plots Together – Histograms- Building data graphics for dynamic reporting.

TOTAL (L : 15 + P : 30): 45 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Discuss the basic syntax of R through readings, practice exercises, demonstrations, and writing R code.	**3**
CO2	Apply critical programming language concepts such as data types, iteration, control structures, functions, and boolean operators by writing R programs and through examples.	**3**

CO3	Import a variety of data formats into R using RStudio.	**3**
CO4	Analyze a data set in R and present findings using the appropriate R packages.	**3**
CO5	Visualize data attributes using ggplot2 and other R packages.	**3**

TEXT BOOKS:

1. R for Data Science,Wickham, H. &Grolemund, G. (2018),. O'Reilly: New York.
2. Hands on Programming with R, Wickham, H. &Grolemund, G, 2018, O'Reilly: New York.

REFERENCES:

1. R Project: http://www.r-project.org/
2. RStudio (additional libraries required): http://www.rstudio.com

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	1	1	1	2	2	1	1	1	1	1	1	2	1	1
CO2	2	2	1	2	3	1	1	1	2	1	1	3	1	1
CO3	2	2	1	2	3	1	1	1	2	1	1	3	1	1
CO4	2	3	1	3	3	1	1	1	2	2	1	3	1	1
CO5	2	3	1	3	3	1	1	1	2	2	1	3	1	1
Average	**1.8**	**2.2**	**1**	**2**	**2.2**	**1**	**1**	**1**	**1.8**	**1.4**	**1**	**2.8**	**1**	**1**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

VD22104 INTRODUCTION TO INTERNET OF THINGS AND CLOUD COMPUTING FOR AUTOMOBILE ENGINEERS

L	T	P	C
1	0	2	2

OBJECTIVES:

The course should enable the students to:

- Understand the architecture of Internet of Things and connected world.
- Explore on use of various communication and sensing technologies to build IoT applications.
- To understand fundamentals of cloud computing.
- Gain knowledge on the concept of virtualization and security in cloud computing.
- Illustrate the real time IoT applications to make smart world.
-

UNIT I INTRODUCTION TO INTERNET OF THINGS (IoT) 9

Definition and characteristics of IoT, physical design of IoT, logical design of IoT, IoT enabling technologies, IoT levels and deployment, domain specific IoTs.

UNIT II IoT AND M2M 9

Introduction, M2M, difference between IoT and M2M, software defined networking (SDN) and network function virtualization (NFV) for IoT, basics of IoT system management with NETCONF-YANG.

UNIT III CLOUD COMPUTING 9

Introduction - NIST Cloud Computing Reference Architecture. Cloud Computing and Service Models:- Characteristics – Cloud Services – Cloud models (IaaS, PaaS, SaaS) – Layered Cloud Architecture Development - Cloud ecosystem and enabling technologies.

UNIT IV VIRTUALIZATION AND CLOUD SECURITY 9

Introduction – Implementation Levels of Virtualization – Virtualization Structures/Tools and Mechanisms – Virtualization of CPU, Memory, and I/O Devices - Cloud Security and Trust Management.

UNIT V IoT PHYSICAL SERVERS AND CLOUD OFFERINGS 9

Case studies illustrating IoT design – home automation, smart cities, fleet management, connected cars, automotive maintenance system, autonomous vehicles, In-vehicle infotainment and telematics.

TOTAL (L : 15 + P : 30): 45 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Discuss the architecture of Internet of Things andconnected world.	**3**
CO2	Explore on use of various communication and sensing technologies to build IoT applications.	**3**
CO3	Outline the basics of cloud computing.	**3**
CO4	Outline the concept of virtualization and security in cloud computing.	**3**
CO5	Illustrate the real time IoT applications to makesmart world.	**3**

TEXT BOOKS:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-on-Approach", VPT, 1st Edition, 2014.
2. Kai Hwang, Geoffery C. Fox and Jack J. Dongarra, "Distributed and Cloud Computing: Clusters, Grids, Clouds and the Future of Internet", First Edition, Morgan Kaufman Publisher, an Imprint of Elsevier, 2012.

REFERENCES:

1. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", John Wiley and Sons2014.
2. Francis daCosta, **"**Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Apress Publications,1st Edition2013.
3. Thomas Erl , Ricardo Puttini, Zaigham Mahmood," Cloud Computing: Concepts, Technology & Architecture", First Edition, Prentice Hall,2013.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	2	3	2	2	3	1	1	1	2	2	1	3	1	1
CO2	3	3	2	3	3	1	1	1	2	2	1	3	1	1
CO3	2	2	2	2	3	1	1	1	2	2	1	3	1	1
CO4	3	3	3	3	3	2	1	2	2	2	1	3	1	1
CO5	3	3	3	3	3	2	1	2	2	2	1	3	1	1
Average	**2.6**	**2.8**	**2.4**	**2.6**	**3**	**1.4**	**1**	**1.4**	**2**	**2**	**1**	**3**	**1**	**1**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

VD22105 OBJECT ORIENTED PROGRAMMING CONCEPTS

L	T	P	C
1	0	2	2

OBJECTIVES: Upon completion of this course, students will be able:

- To comprehend the fundamentals of object oriented programming and C++.
- To understand and implement the concepts the types of constructors and overloading.
- To understand and apply the concepts of inheritance and its types.
- To understand the importance of Run time polymorphism.
- Learn to implement the concepts of Templates and Exception Handling.

UNIT I OBJECT ORIENTED FUNDAMENTALS 9

Object oriented programming concepts – Objects – Classes – Data members and member functions - Abstraction and encapsulation – Inheritance – Polymorphism - Introduction to C++ –Access specifier – Function and data members – Default arguments –Friend functions –Static members.

UNIT II CONSTRUCTOR AND COMPILE TIME POLYMORPHISM 9

Constructors –default constructor –Parameterized constructors –Constructor with dynamic Memory allocation –Copy constructor – Destructors –Constructor overloading- Function overloading - Operator overloading –Overloading through friend functions.

UNIT III INHERITANCE 9

Inheritance – private, public protected derivations – Multiple Inheritance –Multi level Inheritance - Hierarchical Inheritance- Hybrid Inheritance - Virtual base class - Constructors and Destructors in derived Classes – Composition Vs. Inheritance.

UNIT IV RUN TIME POLYMORPHISM 9

Runtime Polymorphism – Virtual function –This Pointer - Pure Virtual Function - Abstract Classes and Concrete Classes – Virtual Destructors – Dynamic Binding.

UNIT V TEMPLATES AND EXCEPTION HANDLING 9

Function and class templates – Exception handling – try-catch-throw paradigm–exception specification– terminate and unexpected functions– uncaught exception.

TOTAL (L : 15 + P : 30): 45 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Explain the concepts of Object Oriented Programming.	**3**
CO2	Implement types of constructor and overloading.	**3**
CO3	Analyze the appropriate inheritance type for the applications.	**3**
CO4	Implement the concept of Run time polymorphism.	**3**
CO5	Handle the Exceptions to ensure the flow of the program without break.	**3**

TEXT BOOKS:

1. B. Trivedi “Programming with ANSI C++”, second Edition, Oxford University Press 2012.

REFERENCES:

1. Bjarne Stroustrup, “The C++ programming language”, Fourth Edition, Addison Wesley, 2012.
2. E. Balagurusamy, “Object Oriented Programming with C++”, Sixth Edition, McGraw Hill Education (India) Pvt, Ltd, 2013.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	3	2	3	1	1	2	2	1	1	3	1	1
CO2	3	3	3	2	3	1	1	2	2	1	1	3	1	1
CO3	2	2	3	2	2	1	1	1	2	1	1	3	1	1
CO4	2	2	3	2	2	1	1	1	2	1	1	3	1	1
CO5	2	2	3	2	2	1	1	1	2	1	1	3	1	1
Average	**2.4**	**2.4**	**3**	**2**	**2.4**	**1**	**1**	**1.4**	**2**	**1**	**1**	**3**	**1**	**1**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

VD22106	RECOMMENDER SYSTEMS FOR AUTOMOTIVE INDUSTRIES	L	T	P	C
		1	0	2	2

OBJECTIVES: Upon completion of this course, students will be able to do the following:

- To learn approaches for making recommendations, including collaborative, content-based and non-personalized filtering.
- To automate choice-making strategies with the goal of providing affordable, personal, and good-quality recommendations in the field of Automotive Industry.

UNIT I INTRODUCTION 9

Introduction to Recommender systems - Basic Models of Recommender Systems - Domain Specific Challenges in Recommender systems.

UNIT II NEIGHBORHOOD-BASED COLLABORATIVE FILTERING 9

Introduction - Key Properties of Ratings Matrices - Predicting Ratings with Neighborhood Based Methods- Clustering and Neighborhood Based Methods - Dimensionality Reduction and Neighborhood methods.

UNIT III MODEL BASED COLLABORATIVE FILTERING 9

Introduction - Decision and Regression Trees - Rule based Collaborative Filtering - Naive Bayes Collaborative Filtering.

UNIT IV CONTENT BASED RECOMMENDER SYSTEMS 9

Introduction - Basic Components of Content-Based Systems - Preprocessing and Feature Extraction -Learning User Profiles and Filtering - Content-Based Versus Collaborative Recommendations.

UNIT V EVALUATING RECOMMENDER SYSTEMS 9

Introduction - Evaluation Paradigms - General Goals of Evaluation Design - Limitations of Evaluation measures – Applications of Recommender Systems in Automotive Industries.

TOTAL (L : 15 + P : 30): 45 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Build basic models of recommender systems.	**3**
CO2	Describe the neighborhood-based collaborative filtering methods.	**3**
CO3	Describe the model-based collaborative filtering techniques.	**3**
CO4	Differentiate content based and collaborative recommendations.	**3**
CO5	Evaluate recommender systems and apply recommender systems in the field of automotive industry.	**3**

TEXT BOOKS:

1. Aggarwal, Charu C. Recommender systems. Vol. 1. Cham: Springer International Publishing, 2016.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	1	2	1	1	2	1	1	1	2	1	1	3		
CO2	1	2	1	1	2	1	1	1	2	1	1	3		
CO3	1	2	1	1	2	1	1	1	2	1	1	3		
CO4	1	2	1	1	2	1	1	1	2	1	1	3		
CO5	2	3	1	2	3	1	1	1	2	2	1	3		
Average	**1.2**	**2.2**	**1**	**1.2**	**1.2**	**1**	**1**	**1**	**2**	**1.2**	**1**	**3**		

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

VD22107 **STATISTICS FOR ENGINEERS** **L T P C**
2 0 0 2

OBJECTIVES:

- To know the basic statistics for different engineering Applications.
- To learn about large sample tests for different measures of statistical parameters.
- Students exposed in small samples and its applications to relevant field of study.
- To apply the concepts in manufacturing sector to analyze and interpret statistical data.
- To understand the concept of Quality control using Statistics as a tool.

UNIT I DESCRIPTIVE STATISTICS 6

Introduction and Applications of Statistics-Measures of central tendency-Mean, Median, Mode– Measures of Dispersion – Range, Interquartile range, Standard deviation - Coefficient of variation and its applications.

UNIT II TESTING OF HYPOTHESIS-LARGE SAMPLES 6

Sampling distributions –Population and Samples – estimation of parameters - Statistical hypothesis – Large sample test for single mean, single proportion, difference of means and difference of proportions.

UNIT III TESTING OF HYPOTHESIS – SMALL SAMPLES 6

Tests based on t, F and chi-square distributions for mean, variance and proportion – Tests for independence – Goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS 6

Analysis of Variance - Completely randomized design- Randomized block design- Latin square design.

UNIT V STATISTICAL QUALITY CONTROL 6

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits.

TOTAL: 30 PERIODS

COs	COURSE OUTCOMES	RBT LEVEL
Students will be able to		
CO1	Acquire the basic skills of statistics.	**3**
CO2	Discuss sampling distributions and apply statistical techniques to engineering and management problems.	**3**
CO3	Apply statistical tests in manufacturing products life time and quality.	**3**
CO4	Apply the concepts of design of experiments for decision making analysis.	**3**
CO5	Test the quality of manufacturing products in Industries.	**3**

TEXT BOOKS:

1. S. C. Gupta and V. K. Kapoor, “Fundamentals of Mathematical Statistics”, Sultan Chand, 11th edition, 2005.

2. Richard A. Johnson, “Miller and Freund’s Probability and Statistics for Engineers”, Pearson Education, 8th edition, 2011.
3. J. Susan Milton and Jesse C. Arnold, “Introduction to Probability and Statistics”, Tata McGraw-Hill, 4th edition, 2007.

REFERENCES:

1. Irwin Miller and Marylees Miller, “John E. Freund’s Mathematical Statistics with Applications”, Pearson Education, 7th edition, 2004.
2. J. Medhi, “Statistical Methods- An Introductory Text”, New Age International, 1992.
3. Sheldon M. Ross, “Introduction to Probability and Statistics for Engineers and Scientists”, Academic Press, 3rd edition, 2005.

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	3	3	2	3	2	1	1	1	2	2	1	3		
CO2	3	3	2	3	2	1	1	1	2	2	1	3		
CO3	3	3	2	3	2	1	1	1	2	2	1	3		
CO4	3	3	3	3	3	1	2	1	2	2	1	3	3	2
CO5	3	3	3	3	3	1	2	1	2	2	1	3	3	2
Average	**3**	**3**	**2.4**	**3**	**2.4**	**1**	**1.4**	**1**	**2**	**2**	**1**	**3**	**3**	**2**

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)