NANDHA ENGINEERING COLLEGE

(An Autonomous Institution affiliated to Anna University Chennai and approved by AICTE, New Delhi) Erode-638 052, Tamil Nadu, India, Phone: 04294 - 225585

Curriculum and Syllabus
for
B.E - MECHANICAL ENGINEERING [R17 CBCS]

(This Curriculum and Syllabi are applicable to Students admitted from the academic year 2017-2018 onwards)

AUGUST 2021

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS):

PEO1: Graduates will be successful practitioners in solving industry's technological problems

PEO2: Graduates will be entrepreneurs and contribute to the economic growth of the country

PEO3: Graduates will pursue higher studies in engineering or management successfully

PEO4: Graduates will make successful career paths in teaching / industry / research

PEO5: Graduates will function in their career with professional and ethical responsibilities

PROGRAM OUTCOMES:

At the end of a programme a students will be able to demonstrate ability to

a-l	GRADUATE ATTRIBUTEs	PO No.	PROGRAMME OUTCOMEs
a	Engineering Knowledge	PO1	An ability to apply knowledge of mathematics, science and engineering
b	Problem Analysis	PO2	An ability to design and conduct experiments, as well as to analyze and interpret data
c	Design and Development of Solutions	PO3	An ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, ethical, safety, manufacturability and sustainability
d	Investigation of Complex Problems	PO4	An ability to function on multidisciplinary teams to solve complex problems
e	Modern Tool Usage	PO5	An ability to use the techniques, skills and modern engineering tools necessary for engineering practice
f	The Engineer and Society	PO6	An ability to infer societal, health, safety, legal & cultural issues and consequent responsibilities relevant to the professional engineering practice
g	Environment and Sustainability	PO7	An ability to explain, compare and summarize the impact of engineering solutions for sustainable development with societal and environmental perspective
h	Ethics	PO8	An understanding of professional and ethical responsibility
i	Individual and Team Work.	PO9	An ability to function effectively as an individual / team in different environments
j	Communication	PO10	An ability to communicate effectively
k	Project Management and Finance	PO11	An ability to apply knowledge of engineering and management principles to the projects
l	Lifelong Learning	PO12	An ability to recognize the need for life-long learning

PROGRAMME SPECIFIC OUTCOMES:

PSO1: Ability to design mechanical systems with required specifications using latest software packages
PSO2: Ability to identify sustainable materials and technologies for alternate engineered solutions
PSO3: Ability to apply the concepts and principles of manufacturing engineering to innovate and to create products and processes with sustainable manufacturing
PSO4: Ability to provide solution to challenges in the solar thermal systems

Contribution **1: Reasonable** **2: Significant** **3: Strong**

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the Programme Educational Objectives and the Programme Outcomes is given in the following table

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES (PO)											
	a	b	c	d	e	f	g	h	i	j	k	l
PEO1	3	3	3	3	3	3	1	2	2	1	3	2
PEO2	3	3	3	3	2	3	1	2	2	2	1	1
PEO3	3	3	3	3	3	2	2	2	1	2	2	3
PEO4	3	3	3	3	3	2	1	2	3	2	3	3
PEO5	3	3	2	2	2	3	2	3	1	1	2	1

MAPPING OF PROGRAM SPECIFIC OUTCOMES WITH PROGRAMME OUTCOMES

A broad relation between the Program Specific Outcomes and the Programme Outcomes is given in the following table

PROGRAM SPECIFIC OUTCOMES	PROGRAMME OUTCOMES (PO)											
	a	b	c	d	e	f	g	h	i	j	k	l
PSO1	3	3	3	3	3	2	1	1	3	3	2	2
PSO2	3	3	3	3	3	1	1	1	2	3	2	3
PSO3	3	3	3	3	3	3	2	1	2	3	2	3
PSO4	3	3	3	1	1	2	3	3	1	2	2	2

NANDHA ENGINEERING COLLEGE (AUTONOMOUS), ERODE - 638 052

REGULATIONS - 2017 (R17) CHOICE BASED CREDIT SYSTEM (CBCS)

B.E. MECHANICAL ENGINEERING

CURRICULA : I - VIII SEMESTERS SYLLABI : I - VIII SEMESTERS

SEMESTER : I									
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	17EYA01	Professional English - I	HS	-	4	2	0	2	3
2	17MYB01	Calculus and Solid Geometry	BS	-	5	3	2	0	4
3	17PYB01	Physics for Engineers	BS	-	3	3	0	0	3
4	17CYB01	Applied Chemistry	BS	-	3	3	0	0	3
5	17MEC01	Engineering Graphics	ES	-	4	2	2	0	3
6	17ECC02	Basic Electrical, Electronics and Instrumentation Engineering	ES	-	3	3	0	0	3
PRACTICALS									
7	17GYP01	Physics and Chemistry Laboratory	BS	-	4	0	0	4	2
8	17GYP02	Engineering Practices Laboratory	ES	-	4	0	0	4	2
9	17GEP01	Personal Values	HS	-	2	0	0	2	0
				TOTAL	**32**	**16**	**4**	**12**	**23**

SEMESTER : II									
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	17EYA02	Professional English - II	HS	17EYA01	4	2	0	2	3
2	17MYB02	Complex Analysis and Laplace Transform	BS	17MYB01	5	3	2	0	4
3	17PYB03	Materials Physics	BS	17PYB01	3	3	0	0	3
4	17CYB03	Environmental Science	BS	-	3	3	0	0	3
5	17MEC02	Engineering Mechanics	ES	-	5	3	2	0	4
6	17CSC01	Problem Solving and Python Programming	ES	-	3	3	0	0	3
PRACTICALS									
7	17MEP02	Computer Aided Modeling and Drafting Laboratory	ES	17MEC01	4	0	0	4	2
8	17CSP01	Problem Solving and Python Programming Laboratory	ES	-	4	0	0	4	2
9	17GEP02	Interpersonal Values	HS	17GEP01	2	0	0	2	0
				TOTAL	**33**	**17**	**4**	**12**	**24**

SEMESTER : III									
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	17MYB03	Fourier Series and Partial Differential Equations	BS	17MYB02	4	2	2	0	3
2	17MEC03	Materials Engineering and Technology	ES	-	3	3	0	0	3
3	17MEC04	Engineering Thermodynamics	PC	-	4	2	2	0	3
4	17MEC05	Fluid Mechanics and Machinery (Theory + Lab)	ES	-	5	3	0	2	4
5	17MEC06	Manufacturing Processes	PC	-	3	3	0	0	3
PRACTICALS									
6	17MEP03	Manufacturing Processes Laboratory	PC	-	4	0	0	4	2
7	17MEP04	Computer Aided Machine Drawing	ES	17MEP02	4	0	0	4	2
8	17GED01	Soft Skills - Listening and Speaking	EEC	-	2	0	0	2	0
				TOTAL	**29**	**13**	**4**	**12**	**20**

SEMESTER : IV									
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	17MYB06	Statistics and Numerical Methods	BS	17MYB03	4	2	2	0	3
2	17MEC08	Kinematics of Machinery (Theory + Lab)	PC	17MEC02	5	3	0	2	4
3	17MEC09	Thermal Engineering Systems	PC	17MEC04	4	2	2	0	3
4	17MEC10	Subtractive Manufacturing Processes	PC	17MEC06	3	3	0	0	3
5	17MEC11	Strength of Materials (Theory + Lab)	ES	17MEC03	5	3	0	2	4
6	E - 1	Elective - I (PSE)	PSE	-	3	3	0	0	3
PRACTICALS									
7	17MEP05	Thermal Engineering Systems Laboratory	PC	-	4	0	0	4	2
8	17MEP06	Subtractive Manufacturing Processes Laboratory	PC	-	4	0	0	4	2
9	17GED02	Soft Skills - Reading and Writing	EEC	-	2	0	0	2	0
10	17GED03	Personality and Character Development	EEC	-	1	0	0	1	0
				TOTAL	**35**	**16**	**4**	**15**	**24**

SEMESTER : V									
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	17MEC13	Design of Machine Elements	PC	17MEC11	4	2	2	0	3
2	17MEC14	Heat and Mass Transfer (Theory + Lab)	PC	17MEC09	5	3	0	2	4
3	17MEC15	Dynamics of Machinery	PC	17MEC08	4	2	2	0	3
4	17MEC16	Fluid Power System	PC	17MEC05	3	3	0	0	3
5	E - 2	Elective - II (PSE)	PSE	-	3	3	0	0	3
6	E - 3	Elective - III (PSE)	PSE	-	3	3	0	0	3
PRACTICALS									
7	17MEP08	Dynamics of Machinery Laboratory	PC	-	4	0	0	4	2
8	17GED07	Constitution of India	EEC	-	2	2	0	0	0
				TOTAL	**28**	**16**	**4**	**6**	**21**

SEMESTER : VI									
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	17MEC17	Mechatronics	PC	17MEC06	3	3	0	0	3
2	17MEC18	Design of Transmission Systems	PC	17MEC13	4	2	2	0	3
3	17MEC19	Metrology and Measurements (Theory + Lab)	PC	17MEC01 17MEC13	5	3	0	2	4
4	E - 4	Elective - IV (PSE/ OE)	PSE / OE	-	3	3	0	0	3
5	E - 5	Elective - V (PSE)	PSE	-	3	3	0	0	3
PRACTICALS									
6	17MEP09	Mechatronics Laboratory	PC	-	4	0	0	4	2
7	17GED06	Comprehension	EEC	-	2	0	0	2	0
8	17GED08	Essence of Indian Traditional Knowledge	EEC	-	2	2	0	0	0
				TOTAL	**26**	**16**	**2**	**8**	**18**

SEMESTER : VII									
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	17MEC20	CAD / CAM / CIM	PC	17MEC06	3	3	0	0	3
2	17MEC21	Finite Element Analysis	PC	17MEC11	4	2	2	0	3
3	17MEC22	Power Plant Technology	PC	17MEC04	3	3	0	0	3
4	E - 6	Elective - VI (PSE/ OE)	PSE / OE	-	3	3	0	0	3
5	E - 7	Elective - VII (OE)	OE	-	3	3	0	0	3
PRACTICALS									
6	17MEP10	CAD / CAM Laboratory	PC	-	4	0	0	4	2
7	17MEP11	Computer Aided Analysis Laboratory	PC	-	4	0	0	4	2
8	17MED01	Project Work - I	EEC	-	8	0	0	8	4
				TOTAL	**32**	**14**	**2**	**16**	**23**

SEMESTER : VIII									
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	E - 8	Elective - VIII (PSE)	PSE	-	3	3	0	0	3
2	E - 9	Elective - IX (OE)	OE	-	3	3	0	0	3
PRACTICALS									
3	17MED02	Project Work - II	EEC	17MED01	16	0	0	16	8
				TOTAL	**22**	**6**	**0**	**16**	**14**

Total Credits: 23 + 24 + 20 + 24 + 21 + 18 + 23 + 14 = 167

(A) HS, BS AND ES COURSES										
(a) Humanities and Social Sciences (HS)			Credit Distribution: 12 - 17		AICTE norm: 5 - 10%					
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	P.S
1	17EYA01	Professional English - I	HS	-	4	2	0	2	3	I
2	17GEP01	Personal Values	HS	-	2	0	0	2	0	I
3	17EYA02	Professional English - II	HS	17EYA01	4	2	0	2	3	II
4	17GEP02	Interpersonal Values	HS	17GEP01	2	0	0	2	0	II

(b) Basic Sciences (BS)			Credit Distribution: 17 - 21		AICTE norm: 17 - 20%					
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	P.S
1	17MYB01	Calculus and Solid Geometry	BS	-	5	3	2	0	4	I
2	17MYB02	Complex Analysis and Laplace Transform	BS	17MYB01	5	3	2	0	4	II
3	17MYB03	Fourier Series and Partial Differential Equations	BS	17MYB02	5	2	2	0	3	III
4	17MYB06	Statistics and Numerical Methods	BS	17MYB03	5	2	2	0	3	IV
5	17PYB01	Physics for Engineers	BS	-	3	3	0	0	3	I
6	17PYB03	Materials Physics	BS	17PYB01	3	3	0	0	3	II
7	17CYB01	Applied Chemistry	BS	-	3	3	0	0	3	I
8	17CYB03	Environmental Science	BS	-	3	3	0	0	3	II
9	17GYP01	Physics and Chemistry Laboratory	BS	-	4	0	0	4	2	I

(c) Engineering Sciences (ES)			Credit Distribution: 17 - 21		AICTE norm: 17 - 20%					
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	P.S
1	17MEC01	Engineering Graphics	ES	-	4	2	2	0	3	I
2	17GYP02	Engineering Practices Laboratory	ES	-	4	0	0	4	2	I
3	17ECC02	Basic Electrical, Electronics and Instrumentation Engineering	ES	-	3	3	0	0	3	I
4	17MEP02	Computer Aided Modeling and Drafting Laboratory	ES	17MEC01	4	0	0	4	2	II
5	17CSC01	Problem Solving and Python Programming	ES	-	3	3	0	0	3	II
6	17CSP01	Problem Solving and Python Programming Laboratory	ES	-	4	0	0	4	2	II
7	17MEC02	Engineering Mechanics	ES	-	5	3	2	0	4	II

8	17MEC03	Materials Engineering and Technology	ES	-	3	3	0	0	3	III
9	17MEC05	Fluid Mechanics and Machinery (Theory + Lab)	ES	-	5	3	0	2	4	III
10	17MEC11	Strength of Materials (Theory + Lab)	ES	17MEC03	5	3	0	2	4	IV
12	17MEP04	Computer Aided Machine Drawing	ES	17MEP02	4	0	0	4	2	III

(B) PROFESSIONAL CORE COURSES (PC)			Credit Distribution: 63 - 72		AICTE norm: 30 - 40%					
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	P.S
1	17MEC04	Engineering Thermodynamics	PC	-	4	2	2	0	3	III
2	17MEC06	Manufacturing Processes	PC	-	3	3	0	0	3	III
3	17MEP03	Manufacturing Processes Laboratory	PC	-	4	0	0	4	2	III
4	17MEC08	Kinematics of Machinery (Theory + Lab)	PC	17MEC02	5	3	0	2	4	IV
5	17MEC09	Thermal Engineering Systems	PC	17MEC04	4	2	2	0	3	IV
6	17MEC10	Subtractive Manufacturing Processes	PC	17MEC06	3	3	0	0	3	IV
7	17MEP05	Thermal Engineering Systems Laboratory	PC	-	4	0	0	4	2	IV
8	17MEP06	Subtractive Manufacturing Processes Laboratory	PC	-	4	0	0	4	2	IV
9	17MEC13	Design of Machine Elements	PC	17MEC11	4	2	2	0	3	V
10	17MEC14	Heat and Mass Transfer (Theory + Lab)	PC	17MEC09	5	3	0	2	4	V
11	17MEC15	Dynamics of Machinery	PC	17MEC08	4	2	2	0	3	V
12	17MEC16	Fluid Power Systems	PC	17MEC05	3	3	0	0	3	V
13	17MEP08	Dynamics of Machinery Laboratory	PC	-	4	0	0	4	2	V
14	17MEC17	Mechatronics	PC	17MEC06	3	3	0	0	3	VI
15	17MEC18	Design of Transmission Systems	PC	17MEC13	4	2	2	0	3	VI
16	17MEC19	Metrology and Measurements (Theory + Lab)	PC	17MEC01 17MEC13	5	3	0	2	4	VI
17	17MEP09	Mechatronics Laboratory	PC	-	4	0	0	4	2	VI
18	17MEC20	CAD / CAM / CIM	PC	17MEC06	3	3	0	0	3	VII
19	17MEC21	Finite Element Analysis	PC	17MEC11	4	2	2	0	3	VII
20	17MEC22	Power Plant Technology	PC	17MEC04	3	3	0	0	3	VII
21	17MEP10	CAD / CAM Laboratory	PC	-	4	0	0	4	2	VII
22	17MEP11	Computer Aided Analysis Laboratory	PC	-	4	0	0	4	2	VII

(C) ELECTIVE COURSES										
(a) PROGRAMME SPECIFIC ELECTIVES			Credit Distribution: 18 - 21		AICTE norm: 10 to 15%					
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PREREQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	**PREFERRED SEMESTER**
Design Stream										
1	17MEX01	Composite Materials and Mechanics	PSE	-	3	3	0	0	3	IV / V
2	17MEX02	Micro Electro Mechanical Systems	PSE	-	3	3	0	0	3	IV / V
3	17MEX03	Engineering Failure Analysis	PSE	-	3	3	0	0	3	V / VI
4	17MEX04	Product Design	PSE	-	3	3	0	0	3	IV / V / VI
5	17MEX05	Tool Design	PSE	-	3	3	0	0	3	VII / VIII
6	17MEX06	Tribology	PSE	-	3	3	0	0	3	IV / V / VI
7	17MEX07	Design for Manufacturing and Assembly	PSE	-	3	3	0	0	3	VII / VIII
8	17MEX08	Mechanical Vibrations	PSE	-	3	3	0	0	3	VII / VIII
9	17MEX31	New Product Development	PSE	-	3	3	0	0	3	VII / VIII
10	17MEX36	Biomechanics	PSE	-	3	3	0	0	3	V / VI / VII
11	17MEX37	Geometric Dimensioning and Tolerancing	PSE	-	3	3	0	0	3	V / VI / VII
Thermal Stream										
1	17MEX09	Fuels and Combustion	PSE	-	3	3	0	0	3	IV / V
2	17MEX10	Refrigeration and Air Conditioning	PSE	-	3	3	0	0	3	V / VI
3	17MEX11	Cryogenic Engineering	PSE	-	3	3	0	0	3	VI / VII / VIII
4	17MEX12	Internal Combustion Engines	PSE	-	3	3	0	0	3	V / VI / VII
5	17MEX13	Gas Dynamics and Jet Propulsion	PSE	-	3	3	0	0	3	VII / VIII
6	17MEX14	Computational Fluid Dynamics	PSE	-	3	3	0	0	3	VI / VII / VIII
7	17MEX15	Solar Thermal Systems	PSE	-	3	3	0	0	3	VII / VIII
8	17MEX16	Automobile Engineering	PSE	-	3	3	0	0	3	VI/ VII / VIII
9	17MEX32	Renewable Sources of Energy	PSE	-	3	3	0	0	3	IV/ V / VI
10	17MEX38	Fuel Cells and Applications	PSE	-	3	3	0	0	3	V / VI / VII
Manufacturing, Industrial Engineering and Management										
1	17MEX17	Nanotechnology	PSE	-	3	3	0	0	3	IV / V / VI
2	17MEX18	Metal Casting Technology	PSE	-	3	3	0	0	3	IV / V / VI
3	17MEX19	Metal Forming Technology	PSE	-	3	3	0	0	3	VI / VII
4	17MEX20	Welding Engineering	PSE	-	3	3	0	0	3	VII / VIII
5	17MEX21	Non-Destructive Testing and Evaluation	PSE	-	3	3	0	0	3	IV / V / VI
6	17MEX22	Additive Manufacturing Processes	PSE	-	3	3	0	0	3	V / VI / VII
7	17MEX23	Surface Engineering	PSE	-	3	3	0	0	3	VII / VIII
8	17MEX24	Process Planning and Cost Estimation	PSE	-	3	3	0	0	3	IV / V / VI

9	17MEX25	Industrial Engineering and Management	PSE	-	3	3	0	0	3	IV / V / VI
10	17GEA05	Engineering Economics and Cost Analysis	PSE	-	3	3	0	0	3	V / VI / VII
11	17MEX26	New Venture Planning and Management	PSE	-	3	3	0	0	3	VI / VII
12	17GEA03	Total Quality Management	PSE	-	3	3	0	0	3	V / VI / VII
13	17MEX27	Lean and Agile Manufacturing	PSE	-	3	3	0	0	3	V / VI / VII
14	17MEX28	Industrial Robotics	PSE	-	3	3	0	0	3	V / VI / VII
15	17MEX29	Operations Research	PSE	-	3	3	0	0	3	VII / VIII
16	17MEX30	Entrepreneurship Development	PSE	-	3	3	0	0	3	VI / VII / VIII
17	17MEX33	Artificial Intelligence and Neuro-Fuzzy Theory	PSE	-	3	3	0	0	3	VI / VII / VIII
18	17MEX34	Industrial Internet of Things	PSE	-	3	3	0	0	3	V / VI / VII
19	17MEX40	Flexible Manufacturing Systems	PSE	-	3	3	0	0	3	V / VI / VII
20	17MEX41	Advanced Welding Processes	PSE	-	3	3	0	0	3	V / VI / VII

NB: One course from each stream of Program Specific Electives should be compulsory opted.

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(b)(i) Open Electives			**AICTE Credit Distribution Norm:18**							
Sl. No.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	**P.S**
1.	17AGZ01	Baking and Confectionery Technology	OE	-	3	3	0	0	3	VII
2.	17AGZ02	Food safety and quality control system	OE	-	3	3	0	0	3	VII
3.	17AGZ03	Farm Mechanization	OE	-	3	3	0	0	3	VIII
4.	17AGZ04	Processing of Fruits and Vegetables	OE	-	3	3	0	0	3	VIII
5.	17CHZ01	Waste Water Treatment	OE	-	3	3	0	0	3	VII
6.	17CHZ02	Piping Engineering	OE	-	3	3	0	0	3	VII
7.	17CHZ03	Process Automation	OE	-	3	3	0	0	3	VII
8.	17CHZ04	Process Instrumentation	OE	-	3	3	0	0	3	VII
9.	17CEZ01	Energy conservation in buildings	OE	-	3	3	0	0	3	VII
10.	17CEZ02	Air Pollution Management	OE	-	3	3	0	0	3	VIII
11.	17CEZ03	Building Services	OE	-	3	3	0	0	3	VIII
12.	17CEZ04	Road Safety Management	OE	-	3	3	0	0	3	VII
13	17CEZ05	Waste Management	OE	-	3	3	0	0	3	VII/VIII
14.	17CSZ01	Design Thinking	OE	-	3	3	0	0	3	VII

15.	17CSZ02	Digital Marketing	OE	-	3	3	0	0	3	VII
16.	17CSZ03	Software Engineering	OE	-	3	3	0	0	3	VIII
17.	17CSZ04	Unified Functional Testing	OE	-	3	3	0	0	3	VIII
18	17CSZ05	C Programming	OE	-	3	3	0	0	3	VI
19.	17CSZ06	Data Structures	OE	-	3	3	0	0	3	VI
20.	17CSZ07	Web Services using Java	OE	-	3	3	0	0	3	VI
21.	17ECZ01	Modern wireless communication system	OE	-	3	3	0	0	3	VII
22.	17ECZ02	Consumer Electronics	OE	-	3	3	0	0	3	VII
23.	17ECZ03	Automotive Electronics	OE	-	3	3	0	0	3	VIII
24.	17ECZ04	Electronic Testing	OE	-	3	3	0	0	3	VIII
25.	17EEZ01	Renewable Energy Technology	OE	-	3	3	0	0	3	VII
26.	17EEZ02	Smart Grid	OE	-	3	3	0	0	3	VII
27	17EEZ03	Energy Auditing, Conservation and Management	OE	-	3	3	0	0	3	VIII
28	17EEZ04	Electrical Machines	OE	-	3	3	0	0	3	VIII
29	17EIZ01	Autotronix	OE	-	3	3	0	0	3	VII
30	17EIZ02	Industrial Automation	OE	-	3	3	0	0	3	VII
31.	17EIZ03	Fiber Optic Sensors	OE	-	3	3	0	0	3	VIII
32.	17EIZ04	Ultrasonic Instrumentation	OE	-	3	3	0	0	3	VIII
33.	17ITZ01	Software Testing Tool	OE	-	3	3	0	0	3	VII
34.	17ITZ02	User Experience	OE	-	3	3	0	0	3	VII
35.	17ITZ03	Developing Mobile Apps	OE	-	3	3	0	0	3	VIII
36.	17ITZ04	Software Project Management	OE	-	3	3	0	0	3	VIII
37.	17ITZ05	Java Programming	OE	-	3	3	0	0	3	VII
38.	17MEZ01	Engineering Ergonomics	OE	-	3	3	0	0	3	VII / VIII
39.	17MEZ02	Energy Audit and Resource Management	OE	-	3	3	0	0	3	VII / VIII
40.	17MEZ03	Electric Vehicle Technology	OE	-	3	3	0	0	3	VII / VIII
41.	17MEZ04	Value Engineering	OE	-	3	3	0	0	3	VII / VIII
42.	17MEZ05	Smart Mobility	OE	-	3	3	0	0	3	VII / VIII

43.	17MEZ06	Smart Sensor Systems	OE	-	3	3	0	0	3	VII / VIII
44.	17MYZ01	Mathematical Structures	OE	-	3	3	0	0	3	VII
45.	17MYZ02	Optimization Techniques	OE	-	3	3	0	0	3	VII
46.	17MYZ03	Statics for Engineers	OE	-	3	3	0	0	3	VII
47.	17MYZ04	Statistics for Engineers	OE	-	3	3	0	0	3	VII
48.	17PYZ01	Nanomaterials	OE	-	3	3	0	0	3	VII
49.	17PYZ02	Nuclear physics and Reactors	OE	-	3	3	0	0	3	VII
50..	17PYZ03	Space science and technology	OE	-	3	3	0	0	3	VII
51	17CYZ01	Chemistry for Every Day Life	OE	-	3	3	0	0	3	VII
52	17CYZ02	E - Waste Management	OE	-	3	3	0	0	3	VII
53	17CYZ03	Industrial Chemistry	OE	-	3	3	0	0	3	VII
54	17EYZ01	Communicative Hindi	OE	-	3	3	0	0	3	VII
55	17EYZ02	Fundamentals of German	OE	-	3	3	0	0	3	VII
56	17EYZ03	Basics of Japanese	OE	-	3	3	0	0	3	VII
57	17EYZ04	Employability Enhancement and Analytical Skills	OE	-	3	3	0	0	3	VII
58	17EYZ05	Workplace Communication	OE	-	3	3	0	0	3	VII
59.	17GYZ01	Biology for Engineers	OE	-	3	3	0	0	3	VII
60.	17BMZ01	Health care technology	OE	-	3	3	0	0	3	VII
61.	17BMZ02	Telemedicine	OE	-	3	3	0	0	3	VII
62.	17BMZ03	Epidemiology and Pandemic Management	OE	-	3	3	0	0	3	VII
63	17BMZ04	Medical Ethics	OE	-	3	3	0	0	3	VII
64	17EYX01	Effective Communication	OE	-	3	3	0	0	3	VII
65	17AIZ01	Fundamentals of artificial intelligence and machine learning	OE	-	3	3	0	0	3	VII
66	17AIZ02	Data science fundamentals	OE	-	3	3	0	0	3	VII
67	17AIZ03	Introduction to Business analytics	OE	-	3	3	0	0	3	VIII
68	17AIZ04	Augmented reality/virtual reality technologies	OE	-	3	3	0	0	3	VII

(b) (ii) Additional Open Electives for Mechanical Engineering program										
Sl. No.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	**P.S**
1.	17CSX31	Problem Solving and Programming	OE	-	3	3	0	0	3	V/VI
2.	17ITX26	Problem Solving and Algorithmic Skills	OE	-	3	3	0	0	3	V/VI

(D) PROJECT			Credit Distribution: 12		AICTE norm: 7 to 12%					
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	**P.S**
1	17MED01	Project Work - I	EEC	-	8	0	0	8	4	VII
2	17MED02	Project Work - II	EEC	17MED01	16	0	0	16	8	VIII
(E) Skill/Proficiency based courses (Not to be included in CGPA)			Credit Distribution: Non credit		AICTE norm: 3%					
Sl. No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	**P.S**
1	17GED06	Comprehension	EEC	-	2	0	0	2	0	VI
2	17GED01	Soft Skills - Listening and Speaking	EEC	-	2	0	0	2	0	III
3	17GED02	Soft Skills - Reading and Writing	EEC	-	2	0	0	2	0	IV
4	17GED03	Personality and Character Development	EEC	-	1	0	0	1	0	IV
5	17GED07	Constitution of India	EEC	-	2	2	0	0	0	V
6	17GED08	Essence of Indian Traditional Knowledge	EEC	-	2	2	0	0	0	VI

Honor Degree Courses*									
Vertical I - Digital and Green Manufacturing									
Sl. No.	**COURSE CODE**	**COURSE TITLE**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	**P.S**
1	17MEX39	3D Printing Technology	-	3	3	0	0	3	V/VI/VII
2	17MEX42	Digital Manufacturing and IoT	-	3	3	0	0	3	V/VI/VII
3	17MEX43	Lean Manufacturing	-	3	3	0	0	3	V/VI/VII
4	17MEX44	Modern Robotics	-	3	3	0	0	3	V/VI/VII
5	17MEX45	Green Manufacturing Design and Practices	-	3	3	0	0	3	V/VI/VII
6	17MEX46	Environment Sustainability and Impact Assessment	-	3	3	0	0	3	V/VI/VII
7	17MEX47	Energy Saving Machinery and Components	-	3	3	0	0	3	V/VI/VII
8	17MEX48	Green Supply Management	-	3	3	0	0	3	V/VI/VII

Vertical II - Modern Mobility Systems									
Sl. No.	**COURSE CODE**	**COURSE TITLE**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	**P.S**
1	17MEX49	Automotive Materials, Components, Design and Testing	-	4	2	0	2	3	V/VI/VII
2	17MEX50	Conventional and Futuristic Vehicle Technology	-	3	3	0	0	3	V/VI/VII
3	17MEX51	Renewable Powered Off Highway Vehicles and Emission Control Technology	-	3	3	0	0	3	V/VI/VII
4	17MEX52	Vehicle Health Monitoring, Maintenance and Safety	-	3	3	0	0	3	V/VI/VII
5	17MEX53	CAE and CFD Approach In Future Mobility	-	3	3	0	0	3	V/VI/VII
6	17MEX54	Hybrid and Electric Vehicle Technology	-	3	3	0	0	3	V/VI/VII
7	17MEX55	Thermal Management of Batteries and Fuel Cells	-	3	3	0	0	3	V/VI/VII
8	17MEX55	Smart Mobility and Intelligent Vehicles	-	3	3	0	0	3	V/VI/VII

Minor Degree Courses*									
Electric Vehicle Technologies									
Sl. No.	**COURSE CODE**	**COURSE TITLE**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	**P.S**
1	17MEM01	Basics of Electric Vehicles	-	3	3	0	0	3	V/VI/VII
2	17MEM02	Electric Vehicle Architecture and Control System	-	3	3	0	0	3	V/VI/VII
3	17MEM03	Materials for Electric Vehicles	-	3	3	0	0	3	V/VI/VII
4	17MEM04	Powertrain Design for Electric Vehicles	-	3	3	0	0	3	V/VI/VII
5	17MEM05	Battery Management	-	3	3	0	0	3	V/VI/VII
6	17MEM06	AI and IoT for Electric Vehicles	-	3	3	0	0	3	V/VI/VII
7	17MEM07	Autonomous Vehicles	-	3	3	0	0	3	V/VI/VII
8	17MEM08	Fuel Cell Technology & Safety Regulations	-	3	3	0	0	3	V/VI/VII

*** Approved by 11th Academic council**

SUMMARY

SL. No.	SUBJECT AREA	CREDITS AS PER SEMESTER								CREDITS TOTAL
		I	II	III	IV	V	VI	VII	VIII	
1	HS	3	3	0	0	0	0	0	0	6
2	BS	12	10	3	3	0	0	0	0	28
3	ES	8	11	9	4	0	0	0	0	32
4	PC	0	0	8	14	15	12	13	0	62
5	PSE	0	0	0	3	6	3	3	3	18
6	OE	0	0	0	0	0	3	3	3	9
7	EEC	0	0	0	0	0	0	4	8	12
	TOTAL	23	24	20	24	21	18	23	14	167
	Non Credit / Mandatory (EEC)			1	2	1	2			

17EYA01 - PROFESSIONAL ENGLISH - I *(Common to All Branches)*					
			L	**T**	**P**	**C**
			2	**0**	**2**	**3**
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 1**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		**Course Outcomes**		**Related Program outcomes**
1.0	To articulate and enunciate words and sentences clearly and efficiently using grammatical structures.	**1.1**	The students will be able to construct clear, grammatically correct sentences using a variety of sentence structures and appropriate vocabulary.	**f, g, h, i, j, l**
2.0	To acquire information through listening and apply it to persuade or articulate one's own point of view.	**2.1**	The students will be able to utilize listening skills to articulate one's own point of view in different circumstances.	**f, i, j, l**
3.0	To enable students to express themselves fluently and appropriately in social and professional contexts.	**3.1**	The students will be able to apply appropriate communication skills across settings, purposes, and audiences.	**f, g, h, i, j, l**
4.0	To summarize and paraphrase information in a text through reading skills.	**4.1**	The students will be able to distinguish main ideas and supporting details and employ active reading strategies to understand texts at the maximum level.	**f, j, l**
5.0	To understand different techniques and contents based on the written communication.	**5.1**	The students will be able to equip themselves with writing skills needed for academic as well as workplace contexts.	**i, j, l**

UNIT I - FOCUS ON LANGUAGE	**(6+6)**
Parts of speech - articles - primary auxiliaries - modal auxiliaries - questions ('Yes/No' and 'Wh' Type) - negatives - prepositions - conjunctions - tenses (simple, continuous, perfect, perfect continuous) - vocabulary (synonyms and antonyms) - homophones - homonyms - one word substitution	
UNIT II - LISTENING FOR EFFECTIVENESS	**(6+6)**
Listening to short conversations or monologues - listening to verbal and non-verbal communication - listening to announcements - listening and note-taking - listening to telephonic conversations - listening to TED/ Ink talks - intensive listening to fill in the gapped text	
UNIT III - COMMUNICATION BOOSTERS	**(6+6)**
Introducing oneself - exchanging personal information (likes and dislikes) - talking about family and friends - asking about routine actions and expressing opinions - participating in short conversations - situational talk	
UNIT IV - PROFESSIONAL READING	**(6+6)**
Skimming - scanning (short texts and longer passages) - inferring technical texts - reading for interrogation - reading newspaper, advertisements and interpreting - practicing speed reading - reading comprehension (multiple choice / short / open ended questions) - gap filling	
UNIT V - TECHNICAL CORRESPONDENCE	**(6+6)**
Seeking permission for industrial visit and In-plant training - checklist - instruction - e-mail writing - report writing (accident and survey)	
TOTAL (L:30 + P:30) = 60 PERIODS	

TEXTBOOKS / REFERENCE BOOKS:

1. Sudharshana. N.P and Saveetha. C, “English for Technical Communication”, New Delhi, Cambridge University Press, 2016.
2. Jackman, Vanessa and Russell, Whitehead. “Cambridge English Business Preliminary Practice Tests”. New Delhi: Oxford University Press, 2016.
3. Rizvi, Ashraf M. “Effective Technical Communication”. New Delhi: Tata McGraw Hill Publishing Company Limited, 2006.
4. Hewings, M. “Advanced English Grammar”. Chennai: Cambridge University Press, 2000.

17MYB01 - CALCULUS AND SOLID GEOMETRY *(Common to All Branches)*				
L	**T**	**P**	**C**
3	**2**	**0**	**4**

PREREQUISITE : NIL	**QUESTION PATTERN: TYPE - 4**

COURSE OBJECTIVES AND OUTCOMES:

	Course Objectives		Course Outcomes	Related Program outcomes
1.0	To develop the use of matrix algebra techniques those are needed by engineers for practical applications.	**1.1**	Apply the concept of orthogonal reduction to diagonalise the given matrix.	**a, b, c, e, g, i, k**
2.0	Use the techniques, Skills and Engineering tools necessary for engineering practice, with Geometric concepts.	**2.1**	Have knowledge about the geometrical aspects of sphere.	**a, b, c, e, f, i, k**
3.0	To improve their ability in solving geometrical applications of differential calculus problems.	**3.1**	Find the radius of curvature, circle of curvature and centre of curvature for a given curve.	**a, b, c, i, k**
4.0	To learn the important role of Mathematical concepts in engineering applications with the functions of several variables.	**4.1**	Classify the maxima and minima for a given function with several variables, through by finding stationary points.	**a, b, c, d, k**
5.0	To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.	**5.1**	Demonstrate the use of double and triple integrals to compute area and volume.	**a, b, c, d, f, i, k**

UNIT I - MATRICES	**(9+6)**
Characteristic equation - eigen values and eigen vectors of a matrix - properties (statement only) - Cayley Hamilton theorem and its applications - orthogonal transformation of a symmetric matrix to a diagonal form - quadratic form - reduction of a quadratic form to canonical form by orthogonal transformation.	
UNIT II - ANALYTICAL GEOMETRY OF THREE DIMENSIONS	**(9+6)**
Equation of a plane - angle between two planes - equation of straight lines - coplanar lines - skew lines - equation of a sphere - orthogonal spheres.	
UNIT III - GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS	**(9+6)**
Curvature - curvature in cartesian co-ordinates - centre and radius of curvature - circle of curvature - evolutes and involutes - envelopes.	
UNIT IV - FUNCTIONS OF SEVERAL VARIABLES	**(9+6)**
Partial derivatives - Euler's theorem on homogeneous function - Jacobian - Maxima and Minima of functions of two variables - Constrained Maxima and Minima by Lagrange's multiplier method.	
UNIT V - MULTIPLE INTEGRALS	**(9+6)**
Double integration in cartesian co-ordinates - change of order of integration - area as double integral - triple integration in cartesian co-ordinates - volume as triple integrals.	
TOTAL (L:45 + T:30) = 75 PERIODS	

Note : Simulation of engineering problems (Qualitative analysis) using open source software

TEXTBOOKS:

1. Dr.B.S.Grewal, "Higher Engineering Mathematics", 42nd Edition, Khanna publications, 2012.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley and sons, 2013.
3. Veerarajan.T, "Engineering Mathematics for Semester I and II", 3rd Edition, Tata McGraw Hill, 2014.

REFERENCES:

1. N.P.Bali, Manish Goyal, "A text book of Engineering Mathematics: Semester-II", 5th Edition, Laxmi Publications, 2011.
2. Kandasamy .P, Thilagavathy .K, Gunavathy .K, "Engineering Mathematics for first Year", 9th Rv. Ed., S.Chand and Co Ltd, 2013.
3. Glyn James, "Advanced Engineering Mathematics", 7th Edition, Wiley India, 2007.

17PYB01 - PHYSICS FOR ENGINEERS *(Common to All Branches except CSE and IT)*					
			L	**T**	**P**	**C**
			3	**0**	**0**	**3**
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 1**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To provide the basic ideas in all the kinds of engineering branches	**1.1**	Acquire knowledge regarding acoustics and ultrasonic		**a, d**
2.0	To develop the skills of the students in physics under various applications	**2.1**	Applying knowledge in the fields of optics and laser technology		**a, e**
3.0	To cultivate the censor designing ability of the students	**3.1**	Design the sensors using the knowledge of fiber optics		**d, e**
4.0	To provide knowledge in wave and particle physics	**4.1**	Gain the knowledge of wave, particle nature and matter waves		**b, d**
5.0	To provide the fundamental knowledge in basics of crystals	**5.1**	Analyze the different kind of crystal structures and crystal growth		**A**

UNIT I - ULTRASONICS AND ACOUSTICS	**(9)**
Ultrasonics: Introduction - properties of ultrasonics - magnetostriction and piezo electric methods - measurement of velocity using acoustic grating - Ultrasonic A B C scan methods - Sonogram. Acoustics: Characteristics of musical sound - loudness - Weber - Fechner law - absorption coefficient - reverberation - reverberation time - factors affecting acoustics of buildings and their remedies	
UNIT II - OPTICS AND LASER TECHNOLOGY	**(9)**
Interference: Air wedge - theory - uses - testing of flat surfaces - determination of thickness of a thin wire. Types of lasers - Nd - YAG laser - CO_2 laser - semiconductor laser (homojunction and hetrojuction). Applications: determination of particle size using laser - holography - construction - reconstruction - lasers in industry (material processing) and medical field (surgery)	
UNIT III - FIBER OPTICS AND SENSORS	**(9)**
Principle of light transmission through fiber - expression for acceptance angle and numerical aperture - fabrication of optical fibers - double crucible method - types of optical fibers (material, refractive index profile and mode) fiber optic communication system - splicing - applications of optical fiber - sensors - temperature - pressure sensor and displacement sensor medical endoscope.	
UNIT IV - WAVE AND PARTICLE PHYSICS	**(9)**
Development of quantum theory - de Broglie wavelength - properties of matter waves - G.P Thomson experiment - Schrödinger's wave equation - time dependent - time independent wave equations - physical significance - applications - particle in a one dimensional potential box - Compton Effect - theory and experimental verification.	
UNIT V - CRYSTALOGRAPHY	**(9)**
Lattice - unit cell - Bravais lattices - lattice planes - Miller indices - 'd' spacing in cubic lattice - calculation of number of atoms per unit cell - atomic radius - coordination number - packing factor for SC, BCC, FCC and HCP structures - Crystal growth techniques - solution, melt (Czochralski) and vapour growth techniques (qualitative)	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. V. Rajendran, “Engineering Physics”, Tata McGraw-Hill, New Delhi, 2011.
2. Senthilkumar. G, “Engineering Physics I”, VRB Publishers, 2011.

REFERENCES:

1. P. K. Palanisami, “Physics for Engineers, Vol. 1”, Scitech Pub. (India) Pvt. Ltd., Chennai, 2002.
2. M. N. Avadhanulu and P. G. Kshirsagar, “A Textbook of Engineering Physics”, S. Chand and Company Ltd., New Delhi, 2005.
3. R. K. Gaur and S. L. Gupta, “Engineering Physics”, Dhanpat Rai Publishers, New Delhi, 2006.

17CYB01 – APPLIED CHEMISTRY *(Common to AGRI., CHEMICAL, CIVIL AND MECHANICAL ENGG. Branches)*					
			L	**T**	**P**	**C**
			3	**0**	**0**	**3**
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To understand the principles of water characterization and treatment methods	**1.1**	Apply knowledge of fundamental principles of chemistry		**a, b, c, k**
2.0	To introduce the basic concepts of electrode potential and batteries	**2.1**	Define and solve engineering problems, including the utilization of creative and innovative skills		**a, d, e, g, d**
3.0	To understand the principles and applications of corrosion	**3.1**	Gain practical experience with chemical process equipment as well as to analyze and interpret data		**a, b, e, k**
4.0	To gain knowledge on engineering materials and industrial importance of fuels and combustion	**4.1**	Understand the impact of engineering solutions in a global, economic, environmental and societal content		**a, c, f, g**
5.0	To understand the concept of various analytical techniques	**5.1**	Understand the concept of engineering materials		**a, e, h, k**

UNIT I - WATER TECHNOLOGY	**(9)**
Hardness - types - estimation by EDTA method - domestic water treatment - disinfection methods (chlorination, ozonation and UV treatment) - boiler troubles (scale, sludge, priming, foaming and caustic embrittlement) – internal conditioning(carbonate, phosphate and calgon) - external conditioning - demineralization process - desalination - reverse osmosis method.	
UNIT II - ELECTROCHEMISTRY	**(9)**
Electrochemistry - electrode potential - Nernst equation and problems - reference electrode - standard hydrogen electrode - calomel electrode - potentiometric titration (redox) - conductometric titration (strong acid - strong base) - Batteries - types - lead acid battery - fuel cell - hydrogen and oxygen fuel cell.	
UNIT III - CORROSION SCIENCE	**(9)**
Corrosion - definition - types - chemical and electrochemical corrosion (mechanism) - galvanic corrosion – differential aeration corrosion - pitting corrosion - factors influencing corrosion - corrosion control - sacrificial anode method.	
UNIT IV - FUELS AND COMBUSTION	**(9)**
Fuels -Solid fuels - coal - proximate analysis - metallurgical coke - manufacture by Otto-Hoffmann method - liquid fuels - synthetic petrol - Fischer Tropsch and Bergius processes - knocking - octane number - cetane number - gaseous fuels - water gas - producer gas - combustion - flue gas analysis - Orsat apparatus.	
UNIT V - ANALYTICAL TECHNIQUES	**(9)**
Colorimetry - principles - estimation of Iron by colorimetry - UV-Visible spectroscopy - principles – instrumentation (block diagram only) - IR spectroscopy - principles - instrumentation (block diagram only) - flame photometry - principles - instrumentation (block diagram only) - estimation of sodium by flame photometry - atomic absorption spectroscopy - principles - instrumentation (block diagram only) - estimation of nickel by atomic absorption spectroscopy.	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. P.C. Jain and Monica Jain, "Engineering Chemistry", Vol I and II, Dhanpat Rai Pub, Co., New Delhi,15th ed., 2013.
2. Dr. Ravikrishnan. A, "Engineering chemistry I and Engineering Chemistry II", Sri Krishna Hi-tech Publishing chem Co. Pvt Ltd., 13th ed., Chennai, 2014.

REFERENCES:

1. S.S. Dara, "A Text book of Engineering Chemistry", S.Chand and Co. Ltd., New Delhi, 2014.
2. N. Krishna murthy, D. Vallinayagam, "Engineering chemistry" PHI Learning Pvt Ltd., 2014.
3. B. Sivasankar, "Engineering Chemistry", Tata McGraw-Hill Pub. Co. Ltd., New Delhi (2012)

17MEC01 - ENGINEERING GRAPHICS *(Common to All Branches except CSE and IT)*					
			L	**T**	**P**	**C**
			2	**2**	**0**	**3**
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 2**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To gain knowledge about conic sections and plane curves	**1.1**	The Students can be able to construct conic sections and special curves of required specifications	**a, c, d, e, i, k, l**
2.0	To learn the concept of first angle projection of points, lines and plane	**2.1**	The Students can be able to apply the concept of first angle projection to create project of straight lines, planes, solids and section of solids	**a, c, d, i, k, l**
3.0	To understand and familiarize with the projection of solids	**3.1**	The Students can be able to develop a surface drawing of a solid model with given dimensions	**a, c, d, e, i, k, l**
4.0	To learn the concept of sectioning of solids and developing the surfaces	**4.1**	The Students can be able to build orthographic, isometric projections of a three dimensional object	**a, c, d, i, k, l**
5.0	To understand the orthographic, isometric and perspective projections of three dimensional objects	**5.1**	The Students can be able to make use of the knowledge of engineering drawing to create physical models	**a, c, d, i, k, l**

CONCEPTS AND CONVENTIONS:

Importance of graphics in engineering applications - use of drafting instruments - BIS conventions and specifications - size, layout and folding of drawing sheets - lettering and dimensioning – scales

UNIT I - PLANE CURVES **(6+6)**

Basic geometrical constructions, curves used in engineering practices - conics - construction of ellipse, parabola and hyperbola by eccentricity method - construction of cycloid - construction of involutes of square and circle - drawing of tangents and normal to the above curves - theory of projection - principle of multi-view orthographic projection - profile plane and side views - multiple views - representation of three dimensional objects - layout of views

UNIT II - FIRST ANGLE PROJECTION OF POINTS, LINES AND PLANE **(6+6)**

Principal planes - first angle projection - projection of points - projection of straight lines (only first angle projections) inclined to both the principal planes - determination of true lengths and true inclinations by rotating line method - projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III - PROJECTION OF SOLIDS **(6+6)**

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to both the principal planes by rotating object method

UNIT IV - SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES	(6+6)
Sectioning of solids (prism, cube, pyramid, cylinder and cone) in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other - obtaining true shape of section - development of lateral surfaces of simple and sectioned solids - prisms, pyramids cylinders and cones - development of lateral surfaces of solids with cut-outs and holes.	
UNIT V - ISOMETRIC, ORTHOGRAPHIC AND PERSPECTIVE PROJECTIONS	**(6+6)**
Principles of isometric projection - isometric scale - isometric projections of lines, plane figures, simple solids and truncated solids - prisms, pyramids, cylinders, cones - combination of two solid objects in simple vertical positions - free hand sketching of orthographic views from isometric views of objects. perspective projection of simple solids - cube, prisms and pyramids by visual ray method	
TOTAL (L:30+T:30) = 60 PERIODS	

TEXTBOOKS:

1. K.Venugopal and V.Prabhu Raja, "Engineering Graphics", New Age International (P) Limited, 2013.
2. N.S Parthasarathy and Vela Murali, "Engineering Drawing", Oxford University Press, 2015

REFERENCES:

1. N.D.Bhatt and V.M.Panchal, "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2. K.R.Gopalakrishna., "Engineering Drawing" (Vol I and II combined) Subhas Stores, Bangalore, 2007
3. K. V.Natarajan, "A text book of Engineering Graphics", 28th Edition, Dhanalakshmi Publishers, Chennai, 2015.
4. Dr. M. Saravanan, Dr. M. Arockia Jaswin and J. Bensam Raj, "Engineering Graphics", Tri Sea Publications.
5. Luzzader, Warren.J., and Duff, John M, "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production", Eastern Economy Edition, Prentice Hall of India Pvt Ltd, New Delhi, 2005
6. M.B.Shah and B.C.Rana, "Engineering Drawing", Pearson, 2nd Edition, 2009

INSTRUMENT: ***Use of Mini drafter is compulsory***

Special points applicable to End Semester Examinations on Engineering Graphics:

1. The answer paper shall be of A3 size drawing sheets.
2. Minimum one question and not more than two questions from a unit.
3. Question paper consists of Part A and Part B.
4. Part A: One compulsory question carries 20 marks from any one of five units.
5. Part B: 4 out of 8 open choice questions carry 20 marks each.

17ECC02 - BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING *(Mechanical Engineering Branch only)*					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To impart knowledge on electric circuit laws and network theorems.	**1.1**	The Students will be able to solve electric circuits by using electric laws and theorems.	**a, b, d, f**
2.0	To impart knowledge on working principles of electrical machines.	**2.1**	The Students will be able to identify the electrical components and explore the characteristics of electrical machines	**a, b, d, f**
3.0	To impart knowledge on working of semi-conductor devices and characteristics.	**3.1**	The Students will be able to identify the various electronic devices and understand the principles of working of the semiconductor devices.	**a, b, c, e, f**
4.0	To impart knowledge on working principles of rectifiers, filters and amplifiers.	**4.1**	The Students will be able to explain the working of rectifiers, filters and amplifiers.	**a, c, e, f**
5.0	To impart knowledge on measuring instruments and transducers.	**5.1**	The Students will be able to choose appropriate instruments for electrical measurement for a specific application.	**a, c, e, f**

UNIT I - ELECTRICAL CIRCUITS	**(9)**
Basic circuit components - Ohms law - Kirchhoff's law - instantaneous power - inductors – capacitors - independent and dependent sources - nodal analysis, mesh analysis - Study of basic circuit theorems : Thevenin's theorem, Norton's theorem, Maximum power transfer theorem and Superposition theorem.	
UNIT II - ELECTRICAL MACHINES	**(9)**
DC Generator - DC Motor - Single phase transformer - Single phase and three phase induction motor, alternator: construction, principle of operation, basic equations and applications.	
UNIT III - SEMICONDUCTOR DEVICES	**(9)**
Semiconductors - intrinsic, extrinsic, energy band diagram, PN junction diode - forward bias, reverse bias, drift and diffusion current - Hall effect - current equation - switching characteristics.	
UNIT IV - RECTIFIERS, FILTERS AND AMPLIFIERS	**(9)**
Rectifiers: Half Wave, Full Wave and Bridge, Filters, Transistor as amplifier, SCR - Operational amplifier: Inverting, Non–inverting amplifier.	
UNIT V - MEASUREMENTS AND INSTRUMENTATION	**(9)**
Introduction to transducers - Classification of transducers: piezo electric transducers - resistive - inductive, capacitive - thermo electric, photo electric, LVDT and mechanical - classification of instruments - types of indicating instruments: moving coil and moving iron - oscilloscopes	
	TOTAL (L:45) = 45 PERIODS

TEXTBOOKS:

1. R.Muthusubramanian, S.Salivahanan, "Basic Electrical and Electronics Engineering", Tata McGraw Hill Nineteenth reprint (2015).
2. S. Salivahanan, N. Suresh kumar and A. Vallavanraj, "Electronic Devices and Circuits", Tata McGraw Hill 3rd Edition (2013).

REFERENCES:

1. T.Nageswara Rao, “Circuit Theory”, A.R. Publications, Chennai, 2014.
2. Mittle and V. N. Mittle, “Basic Electrical Engineering”, Tata McGraw Hill Edition, New Delhi, 2005.
3. J.B.Gupta, “Electronic Devices and Circuits,” S. K. Kataria and Sons, 2009.

17GYP01 - PHYSICS AND CHEMISTRY LABORATORY *(Common to All Branches Except CSE and IT)*				
	L	**T**	**P**	**C**
	0	**0**	**4**	**2**

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To provide the basic practical exposure to all the engineering and technological streams in the field of physics.	**1.1**	The students will be able to acquire the fundamental knowledge in optics such as interference, Diffraction and Understand about the spectral instruments etc	**a, b, d, g, l**
2.0	To provide the basic practical exposure to all the engineering and technological streams in the field of chemistry	**2.1**	The students will be able to gain the basic knowledge about handling the laser light and Identify the basic parameters of an optical fibre	**a, b, d, g**
3.0	To know about the water containing impurities and some physical parameters	**3.1**	The students will be able to analyze the properties of matter with sound waves	**a, b, d**
4.0	To gain the knowledge about light, sound, laser, fiber optics and magnetism	**4.1**	The students will be able to apply knowledge of measurement of hardness producing ions, chloride, alkalinity, DO, conductance, EMF and pH	**a, b, d, g**
5.0	To develop the knowledge of conductometric titration and viscometry	**5.1**	The students will be able to understand the impact of water quality and solve engineering problems	**a, b, d, g**

Physics Laboratory (Any Five – Branch specific)

1. Determination of rigidity modulus – Torsion pendulum
2. Determination of Young's modulus by non-uniform bending method
3. (a) Determination of wavelength, and particle size using Laser (b) Determination of acceptance angle in an optical fiber.
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
6. Determination of wavelength of mercury spectrum – spectrometer grating
7. Determination of band gap of a semiconductor
8. Determination of thickness of a thin wire – Air wedge method

Chemistry Laboratory (Any Five)

1 Determination of total, temporary and permanent hardness of water by EDTA method.
2 Determination of alkalinity in water sample.
3 Determination of chloride content of water sample by argentometric method.
4 Conductometric titration of strong acid vs strong base.
5 Estimation of iron content of the given solution using potentiometer.
6 Determination of strength of given hydrochloric acid using pH meter
7 Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
8 Estimation of iron content of the water sample using spectrophotometer

17GYP02 – ENGINEERING PRACTICES LABORATORY *(Common to All Branches)*					
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To provide hands on training on various basic engineering practices in Civil Engineering	**1.1**	The students will be able to understand various civil engineering practices like plumbing, carpentry and relevant tools	**a, d, f, i, k, l**	
2.0	To provide hands on training on various basic engineering practices in Mechanical Engineering	**2.1**	The students will be able to understand various manufacturing processes like welding, machining and sheet metal work	**a, d, f, i, k, l**	
3.0	To understand the basic working principle of electric components	**3.1**	The students will be able to do residential house wiring and Measure energy and resistance to earth of an electrical equipment	**a, e, f, h**	
4.0	To understand the basic working principle of electronic components	**4.1**	The students will be able to perform the assembling and testing of the PCB based electronic circuits.	**a, j, k, l**	
5.0	To develop the skill to make / operate/utilize the simple engineering components	**5.1**	The students will be able to make / operate / utilize the simple engineering components	**e, j**	

GROUP-A (MECHANICAL AND CIVIL ENGINEERING)	
I - CIVIL ENGINEERING PRACTICE	**(15)**
Buildings: a. Study of plumbing and carpentry components of residential and industrial buildings, Safety aspects	
Plumbing Works: a. Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings b. Study of pipe connections requirements for pumps and turbines c. Preparation of plumbing line sketches for water supply and sewage works d. Hands-on-exercise: Basic pipe connections - Mixed pipe material connection - Pipe connections with different joining components e. Demonstration of plumbing requirements of high-rise buildings	
Carpentry using Power Tools only: a. Study of the joints in roofs, doors, windows and furniture b. Hands-on-exercise: Planning, Tee joints	
II - MECHANICAL ENGINEERING PRACTICE	**(15)**
Welding: a. Preparation of edges for welding and study of welding symbols b. Arc welding- butt joints, lap joints and tee joints c. Gas welding d. Study of standard size of bars, rods, sections, sheet metals e. Study of work piece types and parameters of welding such as welding current, air gap, filler metal	

Basic Machining:

a. Facing and Plain turning
b. Drilling Practice
c. Study of different types of screw drivers, screws, bolts and nuts

Sheet Metal Work:

a. Model making using bending and forming - Trays, cone
b. Study of thickness gauges, wire gauges

GROUP - B (ELECTRICAL AND ELECTRONICS)

I - ELECTRICAL ENGINEERING PRACTICE	**(15)**

a. Residential house wiring using switches, fuse, indicator, lamp and energy meter
b. Fluorescent lamp wiring
c. Stair case wiring
d. Measurement of electrical quantities - voltage, current, power and power factor in RLC circuit
e. Measurement of energy using single phase energy meter
f. Measurement of resistance to earth of electrical equipment.

II - ELECTRONICS ENGINEERING PRACTICE	**(15)**

a. Study of Electronic components - Resistor (Colour coding), Inductor, Capacitor.
b. Measurement of AC signal parameter (peak-peak, RMS period, frequency) using CRO.
c. Study of logic gates AND, OR, XOR and NOT.
d. Study of Clock Signal.
e. Soldering practice -Components Devices and Circuits - Using general purpose PCB.
f. Study of Half Wave Rectifier (HWR) and Full Wave Rectifier (FWR).
g. Study of Telephone, FM Radio and Cell Phone.

TOTAL(P:60) = 60 PERIODS

17GEP01 - PERSONAL VALUES *(Common to All Branches)*					
		L	**T**	**P**	**C**
		0	**0**	**2**	**0**
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To make students to learn individual in knowing them self	**1.1**	The students will become an individual in knowing the self	**a, f**	
2.0	To enable the student to understand gratitude, truthfulness, punctuality, cleanliness and fitness.	**2.1**	The students will acquire and express gratitude, truthfulness, punctuality, cleanliness and fitness.	**a, g**	
3.0	To enable the student to understand physical exercise and breathing techniques	**3.1**	The students will be able to practice simple physical exercise and breathing techniques	**a, c**	
4.0	To make the students to practice Yoga asana that will enhance the quality of life.	**4.1**	The students will be able to practice Yoga asana which will enhance the quality of life.	**a, c, f**	
5.0	To motivate the students to practice Meditation and get benefited	**5.1**	The students will be able to practice Meditation and get benefited.	**a, f**	

VALUES THROUGH PRACTICAL ACTIVITIES:

1.KNOWING THE SELF

Introduction to value education - Need and importance of Value education - Knowing the self - realization of human life - animal instinct vs sixth sense.

2. MENTAL HEALTH

Evolution of senses - functioning steps of human mind - Body and Mind coordination - Analysis of thoughts - moralization of desires - autosuggestions - power of positive affirmations - Meditation and its benefits.

3.PHYSICAL HEALTH

Physical body constitution - Types of food - effects of food on body and mind - healthy eating habits - food as medicine - self healing techniques.

4.CORE VALUE SELF-LOVE AND SELF-CARE:

Gratitude - Happiness - Optimistic - Enthusiasm - Simplicity - Punctual - Self Control - Cleanliness and personal hygiene - Freedom from belief systems.

5.FITNESS

Simplified physical exercises - Sun salutation - Lung strengthening practices: Naadi suddhi pranayama – Silent sitting and listening to nature - Meditation.

TOTAL(P:30) = 30 PERIODS

REFERENCES:

1. Know Yourself - Socrates - pdf format at www.au.af.mil/au/awc/awcgate/army/rotc_self-aware.pdf.
2. Steps to Knowledge: The Book of Inner Knowing - pdf format at www.newmessage.org/wp content/uploads/pdfs/books/stk_nkl_v1.5.pdf.
3. Promoting Mental Health - World Health Organization - pdf.
4. www.who.int/mental_health/evidence/mh_promotion_book.pdf
5. Learning to be: A Holistic and Integrated Approach to Values - UNESCO pdf format at www.unesdoc.unesco.org/images/0012/001279/127914e.pdf
6. Personality Development by Swami Vivekananda -www.estudantedavedanta.net/personality-development.pdf

17EYA02 - PROFESSIONAL ENGLISH - II *(Common to All Branches)*					
			L	**T**	**P**	**C**
			2	**0**	**2**	**3**
PREREQUISITE : 17EYA01		**QUESTION PATTERN : TYPE - 1**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		**Course Outcomes**		**Related Program outcomes**
1.0	To enable students to get familiar with words, phrases and sentences relevant to the immediate communication tasks.	**1.1**	The students will be able to communicate using a variety of sentence structures and appropriate vocabulary.	**f, g, h, i, j, l**
2.0	To help students to develop their listening skills and comprehend them by asking questions.	**2.1**	The students will be able to comprehend conversations and short talks delivered in English and respond accordingly.	**f, i, j, l**
3.0	To enhance students' speaking skills by making them to participate in Technical Presentation, Group Discussion, etc.	**3.1**	The students will be able to speak appropriately and effectively in various situations.	**f, g, h, i, j, l**
4.0	To inculcate reading habit and to develop effective reading skills.	**4.1**	The students will be able to employ active reading strategies to understand texts at the maximum level.	**f, j, l**
5.0	To foster the ability to write convincing Job Application and effective Formal Letters.	**5.1**	The students will be able to equip themselves with writing formal letters and winning Job Application.	**i, j, l**

UNIT I - LANGUAGE DEVELOPMENT	**(6+6)**
Vocabulary (prefixes and suffixes) - active voice and passive voice - impersonal passive voice - conditional clauses - subject - verb agreement - direct and indirect speech - idioms and phrases - discourse markers - error spotting	
UNIT II - LISTENING COMPREHENSION	**(6+6)**
Listening for specific information and match / choose / fill in the texts - short films, news, biographies, roles and responsibilities in corporate, funny shows - listening to iconic speeches and making notes - listening to interviews	
UNIT III - ACQUISITION OF ORAL SKILLS	**(6+6)**
Describing a person - making plans - asking for and giving directions - talking about places - talking over phone - narrating incidents - introduction to technical presentation - story telling - group discussion	
UNIT IV - READING NUANCES	**(6+6)**
Intensive reading - extensive reading - finding key information in a given text - reading and understanding technical articles - reading and interpreting visual materials	
UNIT V - EXTENDED WRITING	**(6+6)**
Job application with resume - recommendation - inviting dignitaries - accepting and declining invitation - paragraph writing (topics and images)	

LIST OF SKILLS ASSESSED IN THE LABORATORY

1. Language Skills.
2. Listening Skills.
3. Speaking Skills.
4. Reading Skills
5. Writing Skills

TOTAL (L:30 + P:30) = 60 PERIODS

TEXTBOOKS / REFERENCE BOOKS:

1. E. Suresh Kumar, “Engineering English”, Orient BlackSwan, Hyderabad, 2015
2. Meenakshi Raman and Sangeetha Sharma, “Technical Communication: Principles and Practice”, Oxford University Press, New Delhi, 2014
3. Board of Editors, “Fluency in English - A Course Book for Engineering and Technology”, Orient Blackswan, Hyderabad, 2016
4. Jeremy Comfort, Pamela Rogerson, Trish Stott and Derek Utley, “Speaking Effectively: Developing Speaking Skills for Business English”, Cambridge University Press: Cambridge, 2011

17MYB02 - COMPLEX ANALYSIS AND LAPLACE TRANSFORMS *(Common to All Branches)*					
		L	**T**	**P**	**C**
		3	**2**	**0**	**4**
PREREQUISITE : 17MYB01		**QUESTION PATTERN : TYPE - 4**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To expose the concepts of differential equations.	**1.1**	Predict the suitable method to solve second and higher order differential equations	**a, b, c, d, f, i, k**
2.0	To communicate the problem solutions using correct Mathematical terminology of vector calculus.	**2.1**	Apply the concepts of Differentiation and Integration to Vectors.	**a, b, c, f, g, k**
3.0	Apply rigorous and analytic approach to analyse the conformal mapping.	**3.1**	Compute an analytic function, when its real or imaginary part is known.	**a, b, c, d, e, i, k**
4.0	Acquiring the knowledge of evaluating contour integrals using residue theorem.	**4.1**	Identify the Singularities and its corresponding Residues for the given function.	**a, b, c, d, e, k**
5.0	Apply the concepts of Laplace transforms and its applications to various problems related to Engineering.	**5.1**	Predict a suitable method to evaluate the Contour integration.	**a, b, c, d, e, f, i, k**

UNIT I - ORDINARY DIFFERENTIAL EQUATIONS	**(9+6)**
Higher order linear differential equations with constant coefficients - method of variation of parameters - Cauchy's and Legendre's linear equations	
UNIT II - VECTOR CALCULUS	**(9+6)**
Gradient and Directional derivative -Divergence and Curl – Irrotational,solenoidal and scalar potential –Line integral over a plane curve-Surface Integral and Volume Integral-Green's theorem in a plane-Gauss divergence theorem and Stokes Theorem (Excluding Proofs)-Simple Applications Involving Square, Rectangles, Cube and Parallelopiped.	
UNIT III - ANALYTIC FUNCTIONS	**(9+6)**
Functions of a complex variable-Analytic functions– Necessary and sufficient conditions of Cauchy's -Riemann Equations in Cartesian Coordinates (Excluding Proofs) – Properties of Analytic Functions – Harmonic conjugate – Construction of an analytic function by Milne's Thomson Method– Conformal mapping :w = c+z , cz, 1/z and Bilinear Transformation	
UNIT IV - COMPLEX INTEGRATION	**(9+6)**
Statement and Simple applications of Cauchy's integral theorem and Cauchy's integral formula(Excluding Proofs) – Taylor's and Laurent's Series Expansions - Singularities - Residues – Cauchy's Residue theorem (Statement only) – Evaluation of contour integration over unit circle and semi circle (Excluding poles on Real axis).	
UNIT V - LAPLACE TRANSFORM	**(9+6)**
Condition for existence - Transforms of Elementary functions –Basic Properties- First and Second Shifting Theorems (Statement only) –Transforms of derivatives and integrals- Transform of periodic functions - Initial and Final value Theorems. Inverse Laplace transforms -Convolution theorem (Statement only) –Solution of linear second order Ordinary differential equations with constant coefficients using Laplace transforms.	
TOTAL (L:45 + T:30) = 75 PERIODS	

Note : Simulation of Engineering Problems (Qualitative Analysis) using open source software

TEXTBOOKS:

1. Dr.B.S.Grewal, "Higher Engineering Mathematics", 42nd Edition, Khanna publications, 2012
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley and sons, 2013
3. Veerarajan.T, "Engineering Mathematics for Semester I and II", 3rd Edition, Tata McGraw Hill, 2014

REFERENCES:

1. N.P.Bali and Manish Goyal, "A text book of Engineering Mathematics : Semester-II", 5th Edition, Laxmi Publications, 2011
2. Kandasamy .P, Thilagavathy .K and Gunavathy .K, "Engineering Mathematics for first Year", 9th Rv. Ed., S.Chand and Co Ltd, 2013
3. Glyn James, "Advanced Engineering Mathematics", 7th Edition, Wiley India, 2007

17PYB03 – MATERIALS PHYSICS *(Common to Civil and Mechanical Engineering)*					
			L	**T**	**P**	**C**
			3	**0**	**0**	**3**
PREREQUISITE: 17PYB01		**QUESTION PATTERN : TYPE - 1**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To provide the basic ideas in conduction in various materials.	**1.1**	Understand the electrical and thermal conduction in different materials.	**a, b**
2.0	To understand origin of magnetic field in materials and applications of magnetic materials as major storage devices.	**2.1**	Understand magnetic properties of materials and maneuver those materials for different applications.	**a, b**
3.0	To gain fundamental knowledge about thermal physics and that will help students to study further subjects like thermodynamics, heat and mass transfer etc	**3.1**	Understand the various form of heat conduction and thermal conductivity of good and bad Conductors	**b, e**
4.0	To update the modern techniques for the analysis of physical properties of solids.	**4.1**	Examine the materials using different methods during the manufacturing process	**a, e**
5.0	To update the recent developments in smart materials and mechanical properties.	**5.1**	Acquire information regarding new engineering materials and mechanical properties.	**a, e**

UNIT I - CONDUCTION IN MATERIALS	**(9)**
Conductors: Electron theories of conductivity - postulates of classical free electron theory - derivation of electrical and thermal conductivity of metals - Weidman-Franz law verification - merits and demerits. **Semiconductors:** elemental and compound semiconductors - intrinsic and extrinsic semiconductors (qualitative) - Hall effect - determination of Hall coefficient - Applications. **Superconductivity:** Properties - types of super conductors - BCS theory of superconductivity.	
UNIT II - MAGNETIC MATERIALS	**(9)**
Origin of magnetic moment - Bohr magneton - types of magnetic materials - Domain theory - Hysteresis - soft and hard magnetic materials. Ferrites - applications - magnetic recording and readout - tapes, floppy and magnetic disc drives.	
UNIT III - THERMAL PHYSICS	**(9)**
Mode of heat transfer - thermal conductivity - Newton's law of cooling - thermal conduction through compound media (bodies in series and parallel) - thermal conductivity of a good conductor - Forbe's method - thermal conductivity of bad conductor - Lee's disc - radial flow of heat - expression for thermal conductivity of rubber - experimental determination - practical applications of conduction.	
UNIT IV - MATERIAL TESTING MECHANISMS	**(9)**
Testing of materials - classification of tests - destructive test - tensile test on a metal - hardness test - Non Destructive Testing - Various steps involved in NDT process - X-ray radiographic technique - displacement method - merits, demerits and application of X-ray radiography - X-ray fluoroscopy - liquid penetrant method - advantages, disadvantages and application.	

UNIT V - MECHANICAL PROPERTIES OF MATERIALS AND SMART MATERIALS	(9)
Metallic glasses: preparation, properties and applications. Shape Memory Alloys (SMA): characteristics, properties of Ni-Ti alloy, application, advantages and disadvantages of SMA. **Mechanical properties of materials:** tension, compression, shear and torsional test of metals - stress-strain behavior of ferrous and non-ferrous metals, polymer and ceramics - true stress and strain relations.	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Rajendran.V, "Engineering Physics", Tata McGraw-Hill, New Delhi. 2011
2. Gaur.R.K and Gupta.S.L, "Engineering Physics", Dhanpat Rai Publications, 2007
3. Raghavan. V., "Material Science and Engineering", 5th ed., Prentice-Hall of India, 2004

REFERENCES:

1. SenthilKumar.G and N.Iyandurai, "Physics-II", VRB Publishers, Revised Edition, 2005-2006
2. Pillai.S.O, "Solid State Physics", New Age International Publications, New Delhi, 2010

17CYB03 - ENVIRONMENTAL SCIENCE *(Common to All Branches)*					
			L	**T**	**P**	**C**
			3	**0**	**0**	**3**
PREREQUISITE: NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand the constitutes of the environment	**1.1**	Design a system, component, or process to meet desired needs.	**b, c, l**	
2.0	The students should be conversant with valuable resources	**2.1**	Identify, formulate, and solve environmental engineering problems	**d, i**	
3.0	To know about the role of a human being in maintaining a clean environment.	**3.1**	Understand the professional and ethical responsibility as related to the practice of environmental engineering and the impact of engineering solutions in a global context.	**e, f, g, h**	
4.0	To maintain ecological balance and preserve bio-diversity.	**4.1**	Use the techniques, skills, and modern engineering tools necessary for environmental engineering practice.	**a, e, f**	
5.0	To get knowledge about the conservation of environment for the future generation.	**5.1**	Acquire the knowledge of information technology in environmental science.	**a, c, g, i, k**	

UNIT I - INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES	**(9)**
Environment: Scope - importance - need for public awareness - Forest resources - Use-over exploitation - deforestation- Water resources - use-over utilization of surface and ground water - conflicts over water - Mineral resources - use-exploitation - environmental effects of extracting and using mineral resources - Food resources - world food problems changes caused by agriculture - Effects of modern agriculture - fertilizer- pesticide problems - Energy resources - Renewable energy sources - solar energy - wind energy. Land resources - land degradation - soil erosion - role of an individual in conservation of natural resources.	
UNIT II - ECOSYSTEMS AND BIODIVERSITY	**(9)**
Concepts of an ecosystem - structure and function of an ecosystem - producers, consumers and decomposers - food chains - food webs - types of ecosystem - structure and functions of forest ecosystem and river ecosystem - Biodiversity - value of biodiversity - consumptive use-productive use - social values - ethical values - aesthetic values - hotspots of biodiversity - threats to biodiversity - habitat loss - poaching of wildlife and man wildlife conflicts - conservation of biodiversity - In-situ and Ex-situ conservation of biodiversity.	
UNIT III - ENVIRONMENTAL POLLUTION	**(9)**
Pollution: causes - effects and control measures of air pollution - water pollution - soil pollution and noise pollution - solid waste management - causes - effects - control measures of urban and industrial wastes - role of an individual in prevention of pollution - disaster managements - floods - cyclone - landslides.	

UNIT IV - SOCIAL ISSUES AND THE ENVIRONMENT	(9)
Water conservation - rain water harvesting - global warming - acid rain - ozone layer depletion - Environment protection act - Air (Prevention and control of pollution) Act - Water (Prevention and control of pollution) Act - Green Chemistry - principle of green chemistry - application of green chemistry.	
UNIT V - HUMAN POPULATION AND THE ENVIRONMENT	**(9)**
Population growth - variation among nations - population explosion - family welfare programme - human rights - HIV/AIDS - human health and environment - women and child welfare - role of information technology in environment and human health.	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1 Anubha Kaushik and C.P. Kaushik, "Environmental Science and Engineering", New Age International Publishers, New Delhi, 2015

2. Dr. A.Ravikrishan, "Environmental Science and Engineering", Sri Krishna Hitech Publishing co. Pvt. Ltd., Chennai,12th Edition, 2016

REFERENCES:

1. Masters, Gilbert M, "Introduction to Environmental Engineering and Science", Second Edition, Pearson Education, New Delhi, 2012
2. Santosh Kumar Garg, Rajeshwari Garg and Dr. Ranjni Garg, "Ecological and Environmental Studies", Khanna Publishers, Nai Sarak, Delhi, 2014
3. Miller T.G. Jr., "Environmental Science", 10th Edition, Wadsworth Publishing Co., 2015

17MEC02 – ENGINEERING MECHANICS *(Common to Agri. and Mechanical Branches)*					
		L	**T**	**P**	**C**
		3	**2**	**0**	**4**
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 1**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To acquire knowledge on the behaviour of a particle under the action of forces	**1.1**	The students will be able to solve the engineering problems on stable particles using conditions for equilibrium	**a, b, d, j, l**
2.0	To analyse the behaviour of the rigid body under the action of forces	**2.1**	The students will be able to calculate the reaction forces of various supports and resultant forces on rigid bodies	**a, b, c, d, l**
3.0	To gain knowledge related to friction and their types	**3.1**	The students will be able to solve the problems involving dry friction under equilibrium conditions	**a, b, c, d, l**
4.0	To introduce the geometric properties of the different surfaces and solids	**4.1**	The students will be able to determine the centroid, centre of gravity and moment of inertia of various surfaces and solids	**a, b, c, d, l**
5.0	To teach energy and momentum methods related to Dynamics of particles	**5.1**	The students will be able to solve the problems involving dynamics of particles and rigid bodies	**a, b, c, d, l**

UNIT I - STATICS OF PARTICLE	**(9+6)**
Units and dimensions - fundamental principles - laws of mechanics, lame's theorem, parallelogram and triangular law of forces, principle of transmissibility - coplanar forces - resultant force - statics of particles in two dimension - equilibrium of particles in two dimension	
UNIT II - STATICS OF RIGID BODY	**(9+6)**
Equilibrium of rigid free body diagram - types of supports and their reactions - requirements of stable equilibrium - moments and couples - moment of a force about a point and about an axis - Varignon's theorem - equilibrium of rigid bodies in two dimensions	
UNIT III - FRICTION	**(9+6)**
Frictional force - Laws of Coulomb friction - angle of friction - cone of friction - simple contact friction - ladder friction - belt friction - transmission of power through belts - rolling resistance - problems involving the equilibrium of a rigid bodies with frictional forces	
UNIT IV - PROPERTIES OF SECTIONS	**(9+6)**
Centroid - first moment of area - Theorems of Pappus and Guldinus - second moment of area - moment and product of inertia of plane areas - transfer theorems - parallel axis theorem and perpendicular axis theorem - polar moment of inertia - principal axes and principal moment of inertia	
UNIT V - DYNAMICS OF PARTICLES	**(9+6)**
Displacements, velocity and acceleration, their relationship - absolute and relative motion method - linear motion - curvilinear motion - Newton's law - work energy equation of particles - impulse and momentum - impact of elastic bodies	
TOTAL (L:45 + T:30) = 75 PERIODS	

TEXTBOOKS:

1. Vela Murali, “Engineering Mechanics”, Oxford University Press (2010)
2. Ferdinand P. Beer and E. Russell Johnson, “Vector Mechanics for Engineers: Statics and Dynamics”, 9th ed., Tata McGraw Hill International Edition, 2010

REFERENCES:

1. Irving H. Shames, “Engineering Mechanics : Statics and Dynamics”, Prentice Hall of India Private limited, 2003
2. Russell C Hibbeler, “Engineering Mechanics: Statics and Dynamics”, 12th ed., Prentice Hall, 2009
3. Anthony M. Bedford and Wallace Fowler, “Engineering Mechanics: Statics and Dynamics”, 5th ed., Prentice Hall, 2007
4. Palanichamy, M.S and Nagan,S, “Engineering Mechanics - Statics and Dynamics”, 3rd ed., Tata McGraw-Hill, NewDelhi, 2005
5. Meriam.J.L and Kraige.L.G, “Engineering Mechanics: Statics and Dynamics”, 6th ed., Wiley Publishers, 2006
6. Rajasekaran.S and Sankarasubramanian.G, “Fundamentals of Engineering Mechanics”, 3rd ed., Vikas Publishing House Pvt.Ltd., New Delhi, 2005

17CSC01 – PROBLEM SOLVING AND PYTHON PROGRAMMING *(Common to Agri., Chemical, Civil and Mechanical Branches)*					
			L	**T**	**P**	**C**
			3	**0**	**0**	**3**
PRE REQUISITE : NIL		**QUESTION PATTERN : TYPE - 1**				
COURSE OBJECTIVES AND OUTCOMES:						
Course Objectives		**Course Outcomes**			**Related Program outcomes**	
1.0	To gain knowledge about the basics of computer	**1.1**	The students will be able to understand the working of computers		**a, c, j, k**	
2.0	To educate about problem solving strategies	**2.1**	The students will be able to solve problems using various strategies		**a, c, j**	
3.0	To impart the fundamental concepts of Python Programming	**3.1**	The students will be able to understand the basics of Python Programming constructs		**a, b, c, j, k**	
4.0	To gain exposure about string manipulation, list, and tuples	**4.1**	The students will be able to realize the need of strings, list, and tuples		**a, b, c, k**	
5.0	To get knowledge about dictionaries, function and modules	**5.1**	The students will be able to design programs involving dictionaries and function		**a, b, c, k**	

UNIT I - BASICS OF COMPUTERS	**(9)**
Computer basics - applications and characteristics of computer - generations of computers - computer organization - computer software -types of software - software development steps - basic internet terminologies.	
UNIT II - PROBLEM SOLVING STRATEGIES	**(9)**
Number system and arithmetic - algorithms, building blocks of algorithms (instructions/statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), simple strategies for developing algorithms (iteration, recursion) - programming errors - programming paradigm.	
UNIT III - INTRODUCTION TO PYTHON	**(9)**
History - features - execution of python program - flavors of python - comments - data types - built-in data types - sequences - literals - operators - input and output statements - Conditional Statements : if - if-else - Nested if-else - for - while - nested loops - break - continue - pass - assert - return	
UNIT IV - STRINGS, LISTS AND TUPLES	**(9)**
Strings and characters: creating - length - indexing - slicing - repeating - concatenation - comparing - removing spaces - finding sub strings - counting substrings in a string - strings are immutable - replacing a string with another string - splitting and joining strings - changing case of a string - checking starting and ending of a string - formatting the strings - working with characters - sorting strings - searching - finding number. Lists: creating lists - updating - concatenation - repetition - methods - sorting. Tuples: creating - accessing - operations - functions - nested tuples - inserting elements, modifying elements and deleting elements from a tuples.	
UNIT V - DICTIONARIES AND FUNCTIONS	**(9)**
Dictionaries: Operations - methods - using for loop with dictionaries - sorting the elements of a dictionary using lambdas - converting lists and strings into dictionary - passing dictionaries to functions - ordered dictionaries. Functions: defining - calling - returning - pass by object reference - formal, actual, positional, keyword, default and variable length arguments - local and global variables - recursive functions - lambdas - function decorators.	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Ashok.N. Kamthane, “Computer Programming”, 2nd ed., Pearson Education (India), 2012
2. Dr. R. Nageswara Rao, “Core Python Programming - II”, Dreamtech Press, 2017

REFERENCES:

1. Kenneth A. Lambert, “Fundamentals of Python : First Programs”, Cengage Learning, 2012
2. Wesley J. Chun, “Core Python Programming”, Pearson Education, 2nd ed., 2010

17MEP02 – COMPUTER AIDED MODELING AND DRAFTING LABORATORY					
		L	T	P	C
		0	0	4	2
PREREQUISITE : 17MEC01					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand the fundamentals of modeling and drafting	**1.1**	The students will be able to create orthogonal views of given three dimensional object	**a, d, f, i, k, l**	
2.0	To develop 2D model drawings of various 3D objects	**2.1**	The students will be able to make use of two dimensional model to represent three dimensional models	**a, b, d, f, i, k, l**	
3.0	To gain knowledge on developing sectional view of various solids	**3.1**	The students will be able to develop sectional view of various solids using drafting software	**a, d, f, i, k, l**	
4.0	To learn the conversion of 3D model drawings to 2D drawings	**4.1**	The students will be able to construct three dimensional model of simple objects	**a, b, d, f, i, k, l**	
5.0	To model 3D drawings of machine components using modeling software	**5.1**	The students will be able to create 3D models of machine components	**a, b, d, f, i, k, l**	

LIST OF THE EXPERIMENTS

1. Manual orthographic drafting of protected type Flanged Coupling assembly.
2. Manual orthographic drafting of Knuckle Joint assembly.
3. Manual orthographic drafting of Cotter Joint with sleeve assembly.
4. Computer aided drafting of front and top views of given solid models.
5. Computer aided drafting of front and top views of cylinder, cone and dimensioning of the objects.
6. Computer aided drafting of sectional views of prism and pyramid.
7. Computer aided drafting of sectional views of cylinder and cone.
8. Computer aided 3D Modeling of simple objects and obtaining 2D multi-view drawings from 3D model.
9. Computer aided 3D modeling of Nut and Bolt.
10. Computer aided 3D modeling of Geneva Gear.

TOTAL (P:60) = 60 PERIODS

17CSP01 - PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY *(Common to Agri., Chemical, Civil and Mechanical Branches)*				
L	**T**	**P**	**C**
0	**0**	**4**	**2**

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To identify and understand word document and excel sheets.	**1.1**	The student will be able to use MS Word and MS Excel for document preparation.	**a, c, j**
2.0	To impart the fundamental concepts of Python Programming	**2.1**	The students will be able to understand the basics of Python Programming constructs	**a, b, k**
3.0	To gain exposure about string manipulation, list and tuples	**3.1**	The students will be able to realize the need of string manipulation, list and tuples	**a, b, c, i, k**
4.0	To get knowledge about dictionaries, function and modules	**4.1**	The students will be able to design programs involving dictionaries, function and modules.	**a, b, c, i, k**
5.0	To learn about exception handling	**5.1**	The students will be able to develop simple programs with exception handling	**a, b, e, i**

Word Processing

1. Document creation, text manipulation with scientific notations.
2. Table creation, table formatting and conversion.
3. Mail merge and letter preparation

Spread Sheet

4. Chart - Line, XY, Bar and Pie.
5. Formula - formula editor

RAPTOR –Tool

6. Drawing - flow Chart

Python – Programming

7. Program using operators
8. Program using conditional statements
9. Program using looping
10. Program using strings
11. Program using lists
12. Program using dictionaries
13. Program using functions

HARDWARE / SOFTWARE REQUIRED FOR A BATCH OF 30 STUDENTS

Hardware

LAN System with 33 nodes (OR) Standalone PCs - 33 Nos, Printers - 3 Nos.

Software

OS - Windows / UNIX Clone

Application Package - Office suite

RAPTOR –Tool

TOTAL (P:60) = 60 PERIODS

17GEP02 - INTERPERSONAL VALUES *(Common to All Branches)*					
		L	**T**	**P**	**C**
		0	**0**	**2**	**0**
PREREQUISITE : 17GEP01					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To know interpersonal values	**1.1**	Develop a healthy relationship and harmony with others	**a, f**	
2.0	To train the students to maneuver their temperaments.	**2.1**	Practice respecting every human being	**a, g**	
3.0	To achieve the mentality of appreciating core values of a person.	**3.1**	Practice to eradicate negative temperaments	**a, c**	
4.0	To analyze the roots of problems and develop a positive attitude about the life.	**4.1**	Acquire respect, honesty, empathy, forgiveness and equality	**a, c, f**	
5.0	To understand the effects of physical activities on mental health.	**5.1**	Practice exercises and meditation to lead a healthy life and manage the cognitive abilities of an individual	**a, f**	

UNIT II - INTRODUCTION	**(6)**
Introduction to interpersonal values - developing harmony with others - healthy relationship - need and importance of interpersonal values for dealing with others and team - effective communication with others.	
UNIT II - MANEUVERING THE TEMPERAMENTS	**(6)**
From Greed To Contentment - Anger To Tolerance - Miserliness To Charity - Ego To Equality - Vengeance To Forgiveness.	
UNIT III - CORE VALUE	**(6)**
Truthfulness **-** Honesty - Helping - Friendship - Brotherhood - Tolerance - Caring and Sharing - Forgiveness - Charity - Sympathy - Generosity - Brotherhood - Adaptability.	
UNIT IV - PATHWAY TO BLISSFUL LIFE	**(6)**
Signs of anger - Root cause - Chain reaction - Evil effects on Body and Mind - Analyzing roots of worries - Techniques to eradicate worries.	
UNIT V - THERAPEUTIC MEASURES	**(6)**
Spine strengthening exercises - Nero muscular breathing exercises - Laughing therapy - Mindfulness meditation.	
	TOTAL (P:30) = 30 PERIODS

REFERENCES:

1. Interpersonal Skills Tutorial (Pdf Version) – TutorialsPoint www.tutorialspoint.com/interpersonal_skills/interpersonal_skills_tutorial.pdf
2. Interpersonal relationships at work - Ki Open Archive – Karolinska www.publications.ki.se/xmlui/bitstream/handle/10616/39545/thesis.pdf?sequence=1
3. Values education for peace, human rights, democracy – UNESCO. www.unesdoc.unesco.org/images/0011/001143/114357eo.pdf
4. Maneuvering Of Six Temperaments - Vethathiri Maharishi. www.ijhssi.org/papers/v5(5)/F0505034036.pdf
5. The Bliss of inner fire: Heart practice of the six. – Wisdom Publications - www.wisdompubs.org/sites/.../Bliss%20of%20Inner%20Fire%20Book%20Preview.pd

17MYB03 FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATION *(Common to Agriculture, Civil , Mechanical and Chemical Branches)*					
			L	T	P	C
			2	2	0	3
PREREQUISITE : NIL		**QUESTION PATTERN: TYPE - IV**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To acquire knowledge to solve half range Fourier series and harmonic analysis.	**1.1**	Ability to have fundamental understanding of Fourier series and give Fourier expansions of a given function.		**a,b,c,d,k,l**
2.0	To understand the concept of Fourier transforms and enhance the problem solving skill.	**2.1**	Apply transform techniques to solve engineering problems.		**a,b,c,f,g**
3.0	To introduce how to solve linear partial differential equations with different methods.	**3.1**	Analyze and simulate the first and second order linear partial differential equations.		**a,b,c,i,k,l**
4.0	To get the analytical solution for second and higher order homogeneous linear PDE's.	**4.1**	Demonstrate a firm understanding of the solution techniques for homogeneous linear PDE's.		**a,b,c,d,e,l**
5.0	To solve different forms of wave and heat equations.	**5.1**	Ability to apply partial differential techniques to solve the physical engineering problems.		**a,b,c,d,k**

UNIT - I FOURIER SERIES	**(6+6)**
Dirichlet's conditions - Fourier series: Half range sine series - Half range cosine series - Parseval's identity for half range series - Root -Mean square value of a function - Harmonic Analysis (π, degree and T- forms).	
UNIT - II FOURIER TRANSFORMS	**(6+6)**
Fourier integral theorem (statement only) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem.	
UNIT- III FIRST ORDER NON LINEAR PARTIAL DIFFERENTIAL EQUATIONS	**(6+6)**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solution of standard types of first order partial differential equations: (i) f(p,q)=0, (ii) Clairaut's type, (iii) f(z,p,q) = 0, (iv) f(x,p) = g(y,q).	
UNIT IV LINEAR PARTIAL DIFFERENTIAL EQUATIONS	**(6+6)**
General solution of Lagrange's linear equation Pp+Qq = R - Solutions of simultaneous equations dx/P=dy/Q =dz/R by the method of grouping and method of multipliers-Homogeneous linear partial differential equations of second and higher order with constant coefficients (R.H.S = 0, e^{ax+by}, cos(ax+by), sin(ax+by), $x^r y^s$).	
UNIT- V APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	**(6+6)**
Classification of second order quasi linear partial differential equations - Solutions of one dimensional wave equation(zero and Non-zero Boundary conditions) - One dimensional heat equation(Reduced to zero and non zero temperature)- Steady state solution of two dimensional heat equation (Finite and infinite plate).	
TOTAL (L:30 +P:30) = 60 PERIODS	

TEXT BOOKS

1. Veerarajan,T. "Transforms and Partial Differential Equations", 2nd ed., Tata Mc Graw Hill, New Delhi, Second reprint, 2015.
2. Kandasamy, P., Thilagavathy, K., and Gunavathy, K**.,** "Engineering Mathematics; Volume III", S. Chand and Co Ltd., 2008.

REFERENCES

1. Goyal. Manish and Bali, N.P, "A Textbook of Engineering mathematics", 6th ed., Laxmi Publication (P) Ltd. New Delhi, 2012.
2. Grewal, B.S. "Higher Engineering Mathematics", 42nd ed., Khanna publishers, New Delhi, 2012.
3. Kreyszig, Erwin. "Advanced Engineering Mathematics", 9th ed., Wiley Publications, New Delhi, 2006.

17MEC03 - MATERIALS ENGINEERING AND TECHNOLOGY					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To understand the basic structure of elements and its defects	**1.1**	Classify the materials and the types of defects	**a, b, f, k, l**	
2.0	To understand the importance of various Engineering materials phase diagram	**2.1**	Identify the different forms of phases with respect to temperature and composition	**a, b, e, k, l**	
3.0	To choose the suitable method to Enhance the property of a metal	**3.1**	Recommend suitable heat treatment method to enhance the surface characteristics of particular material	**a, b, e, k, l**	
4.0	To choose appropriate metallurgical process to improve the properties of metals and alloys	**4.1**	Measure the mechanical properties of materials using various equipment	**a, b, d, f, k, l**	
5.0	To understand the behaviour and production of products using Non-metallic materials	**5.1**	Categorize the engineering applications of non-ferrous and advanced materials	**a, b, c, f, k, l**	

UNIT I : BASIC CONCEPTS	**(9)**
Materials Science - Simple Crystal Structures - BCC, FCC, HCP Structures - Unit Cell - Defects - Point, Line, Surface, Volume - Slip planes and slip systems - Schmid's rule - Polymorphism	
UNIT II : PHASE DIAGRAMS AND PHASE TRANSFORMATION	**(9)**
Gibbs's Phase rule - Solidification and Solid Solutions - Equilibrium Diagrams - Classification of Equilibrium Diagrams - Isomorphous System - Eutectic systems, Eutectoid and Peritectic system - Iron-Iron carbide phase diagram - Phase, Time - Temperature - Transformation (TTT), Continuous Cooling Transformation (CCT) and Martensitic Transformation - Types and applications of Steels and Cast Irons.	
UNIT III : HEAT TREATMENT PROCESS	**(9)**
Heat Treatment - Annealing and its types, Normalizing, Hardening and its types - Quench Cracks, Tempering, Hardenability - Surface hardening processes - Casehardening, Flame Hardening and induction hardening, Cyaniding and Nitriding	
UNIT IV : MECHANICAL PROPERTIES OF MATERIALS	**(9)**
Testing of Materials - Classification of tests, Tensile test, Impact test, Hardness test Tension and Torsion test - Stress-strain Curve - Fractures in metals - Ductile Fracture, Brittle Fracture - Methods of protection against fracture - Creep test - stages of creep - Prevention of Creep Fracture	
UNIT V : NON FERROUS METALS AND ALLOYS	**(9)**
Non Ferrous Metals - Aluminium, Copper, Nickel, Magnesium, Zinc, Lead, Non Ferrous Alloys - Copper alloys, Aluminium alloys, Magnesium alloys and Nickel alloys. Non Metallic Materials - Polymers, Ceramics and Composites	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Raghavan. V, "Materials Science and Engineering", 6th ed., Prentice Hall of India Pvt. Ltd, 2015
2. Sidney H Avner, "Introduction to Physical Metallurgy", 2nd ed., Tata McGraw Hill Publishing Company Limited, 2008

REFERENCES:

1. Anderson.C, Leaver.K.D, Leavers.P and Rawlings.R.D, “Materials Science for Engineers”, 5th ed., CRC Press, 2003
2. Balasubramaniam.R, “Callister's Materials Science and Engineering (With CD)”, 2nd ed., Wiley India Pvt Ltd 2014
3. William F. Smith and Javad Hashemi, “Foundations of Materials Science and Engineering”, 5th ed., McGraw Hill, 2009
4. Rajput.R.K, “Engineering Materials and Metallurgy”, 6th ed., S.Chand and Company Pvt.Ltd, 2013
5. Kenneth G. Budinski, “Engineering Materials Properties and Selection”, 9th ed., PHL Learning Private Limited, 2013

17MEC04 - ENGINEERING THERMODYNAMICS *(Use of Steam Tables and Psychrometric Chart permitted)*					
		L	**T**	**P**	**C**
		2	**2**	**0**	**3**
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 4**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To teach the basic concept of thermodynamics and applications of first law of thermodynamics	**1.1**	Describe the concepts of conservation of mass, conservation of energy, work interaction, heat transfer and first law of thermodynamics	**a, b, d, e, f, h, j, k, l**
2.0	To introduce the concept of second law of thermodynamics and entropy	**2.1**	Apply the concept of second law to analyze the performance of thermal equipments	**a, c, e, f, k, l**
3.0	To teach steps involved in analysis of gas power cycles	**3.1**	Determine the performance characteristics of various gas power cycles	**a, c, e, f, k, l**
4.0	To provide knowledge on the process of steam formation at various conditions	**4.1**	Demonstrate the stages in steam formation and/or analyze the properties of steam	**a, c, e, f, h, k, l**
5.0	To impart the knowledge in Psychrometry and Psychrometric processes	**5.1**	Analyze the types of Psychrometric processes under various operating conditions	**a, b, c, d, e, f, j, k, l**

UNIT I : BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS	**(6+6)**
Definitions - Thermodynamic systems - macroscopic and microscopic view - thermodynamic equilibrium - properties, state, process and cycle - point and path function - temperature - Zeroth law - reversible and Irreversible processes - energy, work and heat - internal energy - First Law - energy as a property of a system - PMM 1 - application of first law to closed system and steady Flow processes - applications of steady flow energy equation - steam turbine, centrifugal compressor, nozzle - limitations of first law	
UNIT II : SECOND LAW OF THERMODYNAMICS AND ENTROPY	**(6+6)**
Second Law - performance of heat engines and reversed heat engines - reversible processes - statements of Second Law - PMM 2 - Clausius inequality - Carnot cycle - Carnot's theorem and corollary - efficiency of the reversible heat engine - entropy - entropy as a property of a system - entropy and irreversibility - change in entropy of the universe - entropy changes for a closed system and open system - Third Law of Thermodynamics	
UNIT III : GAS POWER CYCLES	**(6+6)**
Air standard efficiency - Carnot cycle - Otto cycle - Diesel cycle - dual combustion cycle - comparison of Otto, Diesel and dual combustion cycles - Brayton cycle - work ratio - pressure ratio for maximum work - calculation of air standard efficiency - mean effective pressure	
UNIT IV : PROPERTIES OF PURE SUBSTANCES	**(6+6)**
Pure substances - definition - phase change - p-T diagram - P-V-T surface - phase change terminologies - formation of steam - important terms - thermodynamic properties of steam and steam tables - external work done during evaporation - internal latent heat - internal energy of steam - Entropy of water, evaporation, wet steam, superheated steam - Mollier diagram - determination of dryness fraction of steam- working principles of tank, throttling, separating and throttling calorimeters	

UNIT V : PSYCHROMETRY	(6+6)
Concept of psychrometry and psychrometrices - definitions - psychrometric Relations - pressure, specific humidity, degree of saturation, relative humidity, enthalpy of moist air - Sling psychrometer - psychrometric charts - Psychrometric processes	
TOTAL (L: 30 + T: 30) = 60 PERIODS	

TEXTBOOKS:

1. Michael A. Boles, Yunus A. Cengel, "Thermodynamics: An Engineering Approach", 8th ed., Tata McGraw - Hill Education, 2017
2. Rajput.R.K, "A Textbook of Engineering Thermodynamics", 5th ed., Laxmi Publications, 2016

REFERENCES:

1. Nag.P.K, "Engineering Thermodynamics", 5th ed., McGraw Hill Education, 2013
2. Arora.C.P, Thermodynamics, Tata McGraw - Hill Education, 2003
3. Moran, Shapiro, Boettner and Bailey "Principles of Engineering Thermodynamics", 8th ed., Wiley India Pvt Ltd-2015
4. Holman.J.P, "Thermodynamics", 10th ed., McGraw Hill Education, 2011
5. Rao.Y.V.C, "An Introduction to Thermodynamics", Revised Edition, Orient Longman, 2009

17MEC05 - FLUID MECHANICS AND MACHINERY *(Mechanical Branch)*				
	L	**T**	**P**	**C**
	3	**0**	**2**	**4**
PREREQUISITE : NIL	**QUESTION PATTERN : TYPE - 4**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To introduce the fundamentals of fluid mechanics, fluid properties and understand the importance of flow measurement which is used in hydraulic machineries	**1.1**	Explain the fluid properties and flow parameters	**a, b, e, f, j, l**
2.0	To analyze and appreciate the complexities involved in solving the fluid flow problems	**2.1**	Analyze the complexities involved in solving the fluid flow problem	**a, b, e, f, j, l**
3.0	To understand the energy exchange process in fluid mechanics handling incompressible fluids	**3.1**	Demonstrate knowledge about the energy exchange process in fluid mechanics handling incompressible fluids	**a, b, e, f, j, l**
4.0	To understand the importance of various types of flow, working principles, performance of turbines	**4.1**	Find out the performance of various hydraulic machines	**a, b, c, e, f, j, l**
5.0	To teach design principles, performance of pumps and use them in engineering applications	**5.1**	Analyze the performance of hydraulic pumps	**a, b, c, e, f, j, l**

UNIT I : BASIC CONCEPTS AND PROPERTIES	**(9+6)**
Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, surface tension and capillarity - Fluid statics: concept of fluid static pressure, absolute and gauge pressures -Pascal's law - hydrostatic law - pressure measurements using simple manometers - fluid kinematics - types of flow - continuity equation (one dimensional only)	
UNIT II : FLUID DYNAMICS AND INCOMPRESSIBLE FLUID FLOW	**(9+6)**
Fluid dynamics - equations of motion - Euler's equation along a streamline - Bernoulli's equation - Viscous flow - Navier-Stoke's equation (Statement only) - Laminar flow through circular tubes (Hagen Poiseulle's) - Shear stress, pressure gradient relationship - flow through pipes - Darcy - Weisbach equation - friction factor - Moody's diagram - minor losses- flow through pipes in series and in parallel	
UNIT III : DIMENSIONAL ANALYSIS	**(9+6)**
Need for dimensional analysis - methods of dimensional analysis - similitude - types of similitude - dimensionless parameters - applications - model analysis	
UNIT IV : HYDRAULIC TURBINES	**(9+6)**
Classification of turbines - heads and efficiencies - velocity triangles - Pelton wheel, Francis turbine and Kaplan turbines - working principles - work done	
UNIT V : HYDRAULIC PUMPS	**(9+6)**
Classification of pumps - centrifugal pumps - working principle and work done - velocity triangle - performance curves - reciprocating pump - working principle - work done	

LIST OF EXPERIMENTS

A. FLOW MEASUREMENT

1. Determination of co-efficient of discharge of given Orifice meter / Venturi meter
2. Calculation of rate of flow using Rota meter
3. Verification of Bernoulli's theorem
4. Determination of co-efficient of velocity of given Flow through Pitot

B. PUMPS

5. Performance test on Centrifugal pumps
6. Performance test on Submersible pump
7. Performance test on Reciprocating pump

C. TURBINES

8. Performance test on Impulse turbine
9. Performance test on Reaction turbine

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

TEXTBOOKS:

1. Bansal.R.K, "A Textbook of Fluid Mechanics and Hydraulic Machines", Revised 9th ed, Laxmi Publications (P) Ltd., 2011
2. Yunus Cengel and John Cimbala , "Fluid Mechanics Fundamentals and Applications", 3rd ed, McGraw-Hill Higher Education, 2013

REFERENCES:

1. Kumar.D.S, "Fluid Mechanics and Fluid Power Engineering", S K Kataria and Sons, New Delhi, 2013
2. Modi.P.N and Seth.S.M, "Hydraulics and Fluid Mechanics Including Hydraulics Machines", 20th Revised and Enlarged Edition, Standard Publishers Distributors, 2013
3. Rajput.R.K, "Fluid Mechanics and Hydraulic Machines", 3rd Revised Edition, S.Chand (G/L) and Company Ltd, 2006
4. Vijay Gupta and Santosh Kumar Gupta, "Fluid Mechanics and Applications", 3rd ed., New Age International, 2015
5. Victor Streeter, Benjamin Wylie.E, Bedford.K.W, "Fluid Mechanics", 9th ed., Tata McGraw - Hill Education, 2010

17MEC06 - MANUFACTURING PROCESSES					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To acquire knowledge on basic concepts of foundry and casting processes	**1.1**	Describe the principles of foundry and casting	**a c, d, e, f, h**
2.0	To gain knowledge related to metal forming and their types	**2.1**	Demonstrate the concept of metal forming processes for various applications	**a, b, e, f, h, j, k, l**
3.0	To introduce various methods of welding processes	**3.1**	Select a metal joining process for various materials	**a, c, e, f, k, l**
4.0	To understand powder metallurgy, molding, and thermoforming	**4.1**	Explain the manufacturing processes under powder metallurgy and plastics	**a, c, e, f, h, k, l**
5.0	To teach ceramics, glass and composite materials	**5.1**	Understand the manufacturing process for ceramics, glass and composite materials	**a, b, c, d, e, f, h, j, k, l**

UNIT I : CASTING PROCESSES **(9)**

Patterns - mould making - core - moulding sand - melting equipment - melting and pouring - gating system - cooling and solidification - casting - preparation, design - sand, shell mould, ceramic, vacuum, investment, die, centrifugal, continuous casting processes - casting defects, inspection and testing

UNIT II : METAL FORMING PROCESSES **(9)**

Cold and hot working - rolling - forging - extrusion - drawing - metal stamping and forming - bending, deep drawing, stretch forming, metal spinning, shear and flow forming, blanking, piercing, embossing and coining, roll forming - forming defects - shot peening - types of dies, presses - comparison of forming processes

UNIT III : METAL JOINING PROCESSES **(9)**

Metal fusion welding processes - oxy-fuel gas welding - Electric arc welding processes - consumable electrode - SMAW-SAW - GMAW - FCAW -non-consumable electrode - GTAW - AHW - PAW - assembly of structures - solid state welding processes - ultrasonic welding - friction welding - friction stir welding - explosive welding - diffusion welding - MIG and TIG welding - resistance welding - weld defects and testing

UNIT IV : POWDER METALLURGY AND PLASTICS **(9)**

Production of metal powders - compaction - hot and cold compaction - sintering and finishing - design considerations for powder metallurgy - Plastics - types - thermoplastics and thermosetting plastics - types of Molding - injection molding, blow molding, compression molding, transfer molding, thermoforming

UNIT V : CERAMICS, GLASS AND COMPOSITE MATERIALS **(9)**

Processing of ceramics - shaping, drying and firing - finishing operations - Glass - fabrication, classification, uses and design considerations - composite materials - particle reinforced and fiber reinforced composites - design considerations

TOTAL (L:45) = 45 PERIODS

TEXTBOOKS:

1. Rajput.R.K, "A Textbook of Manufacturing Technology", 2nd ed., Laxmi Publications (P) Ltd, 2016
2. Black.J.T and Ronald A Kohser, "DeGarmo's Materials and Processes in Manufacturing", SI version, Willey India Pvt. Ltd, 2017

REFERENCES:

1. Hajra Choudhury S.K, Hajra Choundhury A.K and Nirjhar Roy, “Elements of Workshop Technology”, Vol. 1, 2017
2. HMT, “Production Technology”, “McGraw Hill Education”, 2017
3. Rao.P.N, “Manufacturing Technology : Foundry, Forming and Welding - Volume 1”, 4th ed., McGraw Hill Education, 2013
4. Serope Kalpakjian, Steven R. Schmid, “Manufacturing Engineering and Technology”, 4th ed., Pearson Education, 2014
5. Sharma.P.C, “A Textbook of Production Technology”, S. Chand Publications, 2014

17MEP03 - MANUFACTURING PROCESSES LABORATORY					
		L	T	P	C
		0	0	4	2
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To provide hands on training in welding practices	**1.1**	Develop a fabricated product using welding joints	**a c, d, e, f, h**	
2.0	To have a practice on preparing sand mould, foundry operations	**2.1**	Create types of moulds based on the given patterns	**a, b, e, f, h, j, k, l**	
3.0	To know the metal forming processes	**3.1**	Apply forging to fabricate a part with given specifications	**a, c, e, f, k, l**	
4.0	To understand the types of moulding sand properties	**4.1**	Estimate the sand mould properties	**a, c, e, f, h, k, l**	
5.0	To provide exposure to the students with hands on experience on various manufacturing processes	**5.1**	Create sheet metal models using metal forming methods	**a, b, c, d, e, f, h, j, k, l**	

LIST OF EXPERIMENTS
UNIT I - JOINING EXERCISES
1. Fabrication of a structure using welded joints (based on AWS Standards) 2. Preparation of metal joints using gas welding
UNIT II - SAND MOULD
1. Preparation of Mould and Casting of aluminium component using solid pattern 2. Preparation of Mould and Casting of aluminium component using split pattern 3. Preparation of Mould and Casting of aluminium component using loose piece pattern 4. Preparation of Mould and Casting of aluminium component using core 5. Determination of Grain Fineness Number 6. Estimation of permeability of moulding sand
UNIT III - METAL FORMING
1. Conversion of round rod in to square rod
TOTAL (P:60) = 60 PERIODS

17MEP04 - COMPUTER AIDED MACHINE DRAWING LABORATORY					
			L	T	P	C
			0	0	4	2
PREREQUISITE : 17MEP02					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To know the specifications and symbols of standard machine components used in machine drawing	**1.1**	Relate the standards of engineering drawing with machines and components	**a, b, f, h, i, k, l**	
2.0	To gain knowledge about the procedure for modeling and drafting using standard CAD packages	**2.1**	Develop a surface model of given product using a CAD package	**a, b, f, h, i, k, l**	
3.0	To understand the drawings of machine components and simple assemblies using standard CAD packages	**3.1**	Illustrate the steps involved in creating 3D drawings	**a, b, f, h, i, k, l**	
4.0	To understand the simple assemblies using standard CAD packages	**4.1**	Construct assembly drawing from the given part drawings	**a, b, f, h, i, k, l**	
5.0	To understand the drawings of machine components and simple assembly drawings	**5.1**	Interpret a drawing and identify the fit, form and functional aspects	**a, b, f, h, i, k, l**	

LIST OF THE EXPERIMENTS

1. Preparation of 3D Model of gears (Spur gear and helical gear)
2. Preparation of 3D Model of Stepped Pulley
3. Preparation of 3D Model of Piston (manual)
4. Preparation of 3D Model of Connecting Rod
5. Preparation of 3D Model of Crank Shaft (manual)
6. Preparation of 3D Model of Solid type journal bearing (manual)
7. Preparation of 3D Model and Assembly drawing of Knuckle Joint
8. Preparation of 3D Model and Assembly drawing of Universal Coupling
9. Preparation of 3D Model and Assembly drawing of Plummer Block
10. Preparation of 3D Model and Assembly drawing of Screw Jack
11. Drafting of Industrial drawings

TOTAL (P:60) = 60PERIODS

17GED01 - SOFT SKILLS - LISTENING AND SPEAKING					
			L	T	P	C
			0	0	2	0
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To recollect the functional understanding of basic grammar and its structure	**1.1**	Apply the knowledge of basic grammar to classify the types of verbs and questions and to construct the sentences	**i, j, l**	
2.0	To acquire the listening skills through note completion, matching and multiple choice modes	**2.1**	Develop the listening skills through note completion, matching and multiple choice modes	**i, j, l**	
3.0	To develop speaking skills through self-introduction, short talk and topic discussion	**3.1**	Organize a presentation on the given topic	**i, j, l**	

UNIT I : GRAMMAR	**(10)**
Tenses - Verb (Auxiliary and Modal) - 'Yes/No' Type Questions - Reported Speech - Gerund - Phrasal Verbs	
UNIT II : LISTENING	**(10)**
Part I : Note completion Part II: Matching Part III: Multiple Choice	
UNIT III : SPEAKING	**(10)**
Part I : Self Introduction Part II: Short talk on business topics Part III: Discussion in pairs	
TOTAL (P:30) = 30 PERIODS	

TEXTBOOKS / REFERENCE BOOKS:

1. Murphy, Raymond, "Essential Grammar in Use", Cambridge University Press, UK, 2007
2. Whitby, Norman, "Business Benchmark Pre- Intermediate to Intermediate Preliminary", 2nd ed., Cambridge University Press, 2013

17MYB06 STATISTICS AND NUMERICAL METHODS *(Common to Agriculture and Mechanical Branches)* *[Use of Normal, t, F and Chi-square Tables permitted]*				
	L	**T**	**P**	**C**
	2	**2**	**0**	**3**
PREREQUISITE : NIL	**QUESTION PATTERN: TYPE - IV**			

COURSE OBJECTIVES AND OUTCOMES:

	Course Objectives		Course Outcomes	Related Program outcomes
1.0	To provide students with the foundations of probabilistic and statistical analysis.	**1.1**	Ability to understand the common statistical techniques.	**a,b,e,k,l**
2.0	To understand the knowledge of design of experiments.	**2.1**	Apply Analysis of Variance for the data set of selected number factors for analyzing the significance	**a,b,e,k,l**
3.0	To understand the method of solving algebraic and transcendental equations using direct and indirect method.	**3.1**	Apply the suitable numerical techniques to solve practical engineering problems.	**a,b,d,k,l**
4.0	To understand the numerical methods of interpolation and integration.	**4.1**	Demonstrate the concept of interpolation and numerical integration when dealing with empirical data sets.	**a,b,d,e,k,l**
5.0	To introduce the numerical solution methods for solving ordinary differential equations	**5.1**	Make use of numerical methods in the solution of ordinary differential equations which are useful in solving engineering problems	**a,b,d,g,k,l**

UNIT I : STATISTICS	**(6+6)**
Introduction of basic statistics-Probability distributions: Binomial, Poisson and Normal-Evaluation of statistical parameters for these three distributions- Regression and correlation.	
UNIT II :TESTING OF HYPOTHESIS	**(6+6)**
Introduction to Sampling distributions - Large Sample-Tests for single mean, Difference of means - Small sample-Students t-test - F-test -Chi-square test for goodness of fit - Independence of attributes using Binomial distribution.	
UNIT III: SOLUTIONS OF ALGEBRAIC AND TRANSCENDENTAL EQUATIONS	**(6+6)**
Newton Raphson method - Direct methods - Gauss Elimination method - Gauss Jordan method - Iterative methods - Gauss Jacobi and Gauss Seidel method - Matrix Inversion by Gauss Jordan method.	
UNIT IV : INTERPOLATION AND NUMERICAL INTEGRATION	**(6+6)**
Lagrange's and Newton's divided difference interpolation - Newton's forward and backward difference interpolation-Numerical Integration using Trapezoidal rule and Simpson's rule.	

UNIT V : NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS (6+6)
Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order and simultaneous equations - Adam's and Milne's predictor and corrector methods for solving first order equations.
TOTAL (L: 30+T:30) = 60 PERIODS

TEXT BOOKS:

1. S.C.Gupta and V.K.Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, New Delhi- 2006.
2. P.Kandasamy, K.Thilagavathy and K.Gunavathy, "Numerical Methods", S.Chand and Co. Ltd. New Delhi, 2003.

REFERENCES:

1. Spiegel, M.R. J. Schiller and Srinivasan. R.A, "Schaum's Outlines Probability and Stastistics", 3rd ed., Tata McGraw Hill, New Delhi, 2010.
2. Chapra.C, Steven and Canale. P, Raymond, "Numerical Methods for Engineers", 5th ed., Tata McGraw Hill, New Delhi, 2007.
3. T.Veerarajan and T.Ramachandran, "Numerical methods with Programming in C", 2nd edition, Tata McGraw Hill 2006, Eighth reprint-2011.
4. Jay L.DeVore,"Probability And Statistics for Engineering and the Sciences" , 8th ed, Cengage learning, 2011.

17MEC08 - KINEMATICS OF MACHINERY					
		L	T	P	C
		3	0	2	4
PREREQUISITE : 17MEC02		**QUESTION PATTERN : TYPE - 4**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the basic types of mechanisms, joints and degrees of freedom, machines	**1.1**	Demonstrate the working of various mechanisms and machines	**a, g, j, l**	
2.0	To know the steps in position, velocity and acceleration analysis of mechanisms using graphical and analytical methods	**2.1**	Analyze the velocity and acceleration of linkages in mechanism design	**a, b, c, g, j, l**	
3.0	To introduce the concept of kinematic analysis of cam drives and drawing profile of cams	**3.1**	Select a layout of cam for specified motion in power transmission of machine elements	**a, b, c, j, l**	
4.0	To introduce the concept of power transmissions in gear drives for different applications	**4.1**	Investigate the gear drives with their selection for transmission of mechanical power in machines	**a, b, c, g, j, l**	
5.0	To acquire knowledge on different types of friction and its effects	**5.1**	Apply the concept of friction in various engineering applications like belt, clutch, brake etc.,	**a, b, c, g, j, l**	

UNIT I : BASICS OF MECHANISMS	**(9+6)**
Mechanisms and its terminologies - Degree of freedom - Mobility - Kutzbach criterion - Grubler's criterion for planar mechanisms - Grashof's Law - Kinematic Inversions of Four bar chain, Single slider and Double slider crank chains - Quick return mechanisms - Mechanical advantage and Transmission angle - Classification of mechanisms	
UNIT II : KINEMATIC ANALYSIS OF SIMPLE MECHANISMS	**(9+6)**
Displacement, velocity and acceleration analysis of Four bar and Slider crank mechanisms with turning and sliding pairs - Instantaneous center method and Relative velocity method - Analytical method for slider crank mechanism	
UNIT III : KINEMATICS OF CAMS	**(9+6)**
Classifications of Cams and Followers - definitions in cam profile - derivatives of follower motion - Displacement diagrams for uniform velocity, simple harmonic motion, constant acceleration and deceleration, cycloidal motions- Graphical layout of disc cam profile for knife edge, roller and flat faced followers - Undercutting - Basics of tangent cam and circular arc cam	
UNIT IV : KINEMATICS OF GEARS AND GEAR TRAINS	**(9+6)**
Spur gear terminology and definitions - law of gearing - comparison of involute tooth and cycloidal tooth forms - interchangeable gears - gear tooth action - interference and undercutting - basics of nonstandard gear teeth - helical, bevel, worm, rack and pinion gears - Gear trains - speed ratio, train value -parallel axis gear trains - epicyclic gear trains - Sun and planet gears	
UNIT V : FRICTION DRIVES	**(9+6)**
Torque transmitted in plate clutches - calculation of torque and power - Selection of a belt drive, velocity ratio, limiting ratio of belt and rope tensions, centrifugal tensions - condition for maximum power transmission - working principle of shoe and band brakes	

LIST OF THE EXPERIMENTS

1. Experimental study of inversions of mechanisms
2. Determination of Ratio of time of cutting stroke to return stroke and Length of stroke of Quick return mechanism
3. Determination of velocity and acceleration of components using Slider crank mechanism
4. Determination of angular velocity of Rocker for the given angular position of crank using Four bar mechanism
5. Determination of jump speed the cam
6. Drawing the profile of the cam
7. Experimental study of Gears, Gear trains and Differential unit
8. Determination of moment of inertia of an object by oscillation method
9. Determination of radius of gyration using bifilar suspension system

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

TEXTBOOKS:

1. John J. Uicker, Jr., Gordon R. Pennock and Joseph E. Shigley, "Theory of Machines and Mechanisms - SI Edition", 4th ed., Oxford University Press, 2014
2. Khurmi.R.S and Gupta.J.K, "Theory of Machines", 14th ed., S.Chand and Company Pvt. Ltd., 2015

REFERENCES:

1. Rattan.S.S, "Theory of Machines", 4th ed., McGraw Hill Education India Private Limited, 2017
2. Ambekar A.G, "Mechanism and Machine Theory",1st ed., Prentice Hall of India, 2013
3. Bansal.R.K and Brar.J.S, "Theory of Machines", 5th ed., Laxmi Publications, Revised 2016
4. Ghosh A. and Mallick A.K., "Theory of Mechanisms and Machines", East-West Publications, 2008
5. Kenneth J Waldron and Gary L Kinzel, "Kinematics, Dynamics, and Design of Machinery", 3rd ed., Wiley India Pvt Ltd, 2016

17MEC09 - THERMAL ENGINEERING SYSTEMS					
		L	T	P	C
		2	2	0	3
PREREQUISITE : 17MEC04		**QUESTION PATTERN : TYPE - 4**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To acquire knowledge on the principles, working and performance of IC engines	**1.1**	Identify the various components and working of IC engine	**a, l**	
2.0	To know the working principles of vapour power cycles	**2.1**	Analyze the different properties of gas power cycles	**a, b, e, f, g,h,k, l**	
3.0	To introduce the working principle of steam nozzles and turbines	**3.1**	Demonstrate the performance parameters of steam nozzles and turbines	**a, b, e, f, g,h,k, l**	
4.0	To introduce the working principle of air compressors	**4.1**	Determine the various flow parameters of air compressors	**a, b, e, f, g,h,k, l**	
5.0	To introduce the working principle of refrigeration and air conditioning systems	**5.1**	Solve the practical problems based on Refrigeration cycles and/or explain the working of Air Conditioning systems	**a, b, e, f, g,h,k, l**	

UNIT I : INTERNAL COMBUSTION ENGINES	**(6+6)**
IC engines - terminologies, classification, different parts, applications-four stroke and two stroke cycle engines - comparison - ignition and fuel injection systems - electronic fuel injection - cooling and lubrication systems - combustion phenomenon in SI and CI engines - pre-ignition, detonation, octane number, delay period, diesel knock, cetane number - supercharging	
UNIT II : VAPOUR POWER CYCLES	**(6+6)**
Carnot Cycle - Rankine Cycle - Modified Rankine Cycle - Regenerative Cycle - Reheat Cycle - Binary Vapour Cycle	
UNIT III : STEAM NOZZLES AND TURBINES	**(6+6)**
Steam nozzles - steam flow through nozzles - nozzle efficiency - concept of supersaturated expansion of steam - Steam turbines - classification - common types - method of reducing rotor speed - compounding - velocity diagrams - single stage Impulse and Reaction turbines - bleeding - energy losses - governing and control	
UNIT IV : AIR COMPRESSORS	**(6+6)**
Classification of air compressors - reciprocating compressors, construction and working of single stage compressor, equation for work with and without clearance, volumetric efficiency, actual p-V diagram, multi stage compression, efficiency, effect of clearance volume, FAD and displacement - rotary compressors - working principles of roots blower, vane type blower, centrifugal compressor	
UNIT V : REFRIGERATION AND AIR CONDITIONING	**(6+6)**
Fundamentals of refrigeration - COP - working principles of air refrigeration systems - simple vapour compression system-layout and working principle of vapour absorption system - refrigerants, classification, properties - air conditioning systems- summer, winter, year round air conditioning - central system	
TOTAL (L:30 +T:30) = 60 PERIODS	

TEXTBOOKS:

1. Eastop.T.D and McConkey.A, "Applied Thermodynamics for Engineering Technologists", 5th ed., Pearson India, 2002
2. Rajput.R.K, "Thermal Engineering", 9th ed., Laxmi Publications Ltd, 2014

REFERENCES:

1. Michael A. Boles, Yunus A. Cengel, "Thermodynamics: An Engineering Approach", 8th ed., Tata McGraw - Hill Education, 2017
2. Ganesan V." Internal Combustion Engines", 3rd ed., Tata McGraw-Hill 2007
3. Manohar Prasad, "Refrigeration and Air Conditioning", 3rd ed., New Age International publications, 2015
4. Mathur.M.Land Sharma.R.P, "Internal Combustion Engines", Dhanpat Rai Publications, 2010
5. Onkar Singh, "Applied Thermodynamics", New Age International (P) Ltd., Publishers,2015
6. Rudramoorthy.R, "Thermal Engineering", Tata McGraw-Hill, New Delhi, 2003

17MEC10 - SUBTRACTIVE MANUFACTURING PROCESSES					
		L	T	P	C
		3	0	0	3
PREREQUISITE : 17MEC06		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To acquire knowledge on the mechanism of chip formation in machining, cutting tool materials, tool life and cutting fluids	**1.1**	Describe the fundamentals of metal cutting in machining operations	**a, e, h, k, l**	
2.0	To understand the working of machine tools namely lathe milling machines and allied machines	**2.1**	Identify the components of lathe, milling machine and explain their functioning	**a, l**	
3.0	To understand the working of machine namely shaping, planing, slotting and different drilling machines	**3.1**	List various machining processes such as shaping, planing, slotting and different drilling operations	**a, e, h, k, l**	
4.0	To understand the working of grinding and allied machines and gear generation machines	**4.1**	Choose the process parameters in grinding operations, finishing operations and gear generations for the given material	**a, e, h, k**	
5.0	To understand the basic concepts of Non Traditional Machining Processes	**5.1**	Explain the working principles and process parameters of various Non-Traditional Machining processes	**a, e, h, k**	

UNIT I : THEORY OF METAL CUTTING	**(9)**
Mechanism of chip formation - Orthogonal and Oblique cutting - Machining forces - Merchant's Circle Diagram - Thermal aspects of metal machining - Cutting fluids - Machinability - Cutting tool materials - Tool wear - Tool life calculations	
UNIT II : LATHE AND MILLING MACHINE	**(9)**
Lathe machine - Centre lathe, tool nomenclature, operations, machining time and power estimation- Milling - specifications - types - cutter nomenclature - operations - milling processes - indexing - gear forming	
UNIT III : MACHINE TOOLS AND HOLE MAKING	**(9)**
Types, specification and Quick return Mechanisms: Shaper, Planer and Slotter - Hole making operations - drilling, reaming, boring, counter boring, counter sinking and tapping	
UNIT IV : GRINDING AND GEAR MANUFACTURING	**(9)**
Grinding - types of grinding -grinding wheel designation and selection - honing, lapping, super finishing, polishing, burnishing and buffing- Gear generation - gear shaping and gear hobbing - specifications - cutting spur and helical gears	
UNIT V : NONTRADITIONAL MACHINING	**(9)**
Classification of Nontraditional Machining processes - Principle of operations - Process characteristics - applications - Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Chemical machining, Electro chemical machining, Electro chemical grinding, Laser beam machining, Electron beam machining	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Rajput R. K, “A Textbook of Manufacturing Technology”, Laxmi Publications (P) Ltd, New Delhi, 2016
2. Richard R Kibbe, John E Neely, Roland O Meyer and Warren T White, “Machine Tool Practices”, Prentice Hall of India, New Delhi, 10th Revised edition, 2014

REFERENCES:

1. Hajra Choudhury S.K, Hajra Choundhury A.K and Nirjhar Roy, “Elements of Workshop Technology”, Vol. II, Media Promoters and Publishers Pvt Ltd., 2017
2. Jain R.K. and Gupta S.C., “Production Technology”, Khanna Publishers, New Delhi, 2014
3. Rao P.N, “Manufacturing Technology - Metal Cutting and Machine Tools”, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2017
4. Serope Kalpakjian and Steven R Schmid, “Manufacturing Engineering and Technology”, Pearson Education, New Delhi, 2014
5. Sharma P.C., “A Textbook of Production Technology”, S.Chand and Company Ltd., 2014

17MEC11 - STRENGTH OF MATERIALS					
		L	T	P	C
		3	0	2	4
PREREQUISITE : 17MEC03		**QUESTION PATTERN : TYPE - 4**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To introduce the concept of stress, strain	**1.1**	Apply concepts of strength of materials to obtain solutions to real time engineering problems	**a, b, f, k, l**
2.0	To analyze the biaxial stress under given loading condition for various materials	**2.1**	Determine the stresses and deformations of objects under external loadings	**a, b, e, k, l**
3.0	To introduce the steps involved in construction of shear force and bending moment diagrams	**3.1**	Develop shear force and bending moment diagrams for various types of beams with given loading conditions	**a, b, e, k, l**
4.0	To acquire knowledge on deflection of beams	**4.1**	Find the slope and deflection of beams using double integration method, Macaulay's method, area moment theorems, conjugate beam method	**a, b, d, f, k, l**
5.0	To acquire knowledge on torsion and columns	**5.1**	Estimate torsional rigidity of given materials numerically using torsion equation, buckling effect of columns	**a, b, c, f, k, l**

UNIT I : STRESSES AND STRAINS	**(9+6)**
Definitions and derivations of normal stress, shear stress, normal strain and shear strain - stress-strain curve deformation of simple, stepped and composite bars - thermal stresses of simple and composite bars - elastic constants - Poisson's ratio - relationship between elastic constants - generalized Hooke's law - strain energy	
UNIT II : BIAXIAL STRESS SYSTEM	**(9+6)**
Biaxial state of stress - stress at a point - stresses on inclined planes - principal stresses and principal strains - Mohr's circle method - thin cylinders and shells - deformation of thin and thick cylinders and shells.	
UNIT III : SIMPLE BENDING	**(9+6)**
Beams - types - shear force and bending moment diagrams of cantilever, simply supported and overhanging beams - theory of simple bending - bending stresses and shear stresses in beams.	
UNIT IV : DEFLECTION OF BEAMS	**(9+6)**
Computation of slopes and deflections in cantilever and simply supported beams - double integration method - Macaulay's method - area moment theorems - conjugate beam method.	
UNIT V : TORSION AND COLUMNS	**(9+6)**
Torsion equation - stresses and deformations in circular solid, circular hollow and stepped shafts - stresses in helical springs - theory of columns - long column and short column - Euler's formula - Rankine's formula	

LIST OF EXPERIMENTS

1. Study of Stress / Strain curves for various materials
2. Tension test on steel rod
3. Double shear test in UTM
4. Rockwell Hardness test
5. Brinell Hardness Test
6. Izod impact test
7. Deflection test on Steel beam
8. Deflection test on Wooden beam

9. Compression test on Bricks
10. Compression test on helical spring

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

TEXTBOOKS:

1. Bansal.R.K, "A textbook of Strength of Materials: (Mechanics of Solids) SI Units", 6th ed., Laxmi Publications, 2017
2. Ferdinand Beer Jr., E. Russell Johnston Jr., John T. DeWolf and David F. Mazurek, "Mechanics of Materials", 7th ed., McGraw Hill, 2011

REFERENCES:

1. Punmia.B.C,, Ashok Kumar Jain, Arun Kumar Jain, "Mechanics of Materials", Laxmi Publications, 2017
2. Andrew Pytel and Jaan Kiusalaas, "Mechanics of Materials", 2nd ed., Cengage Learning, 2015
3. Egor P. Popov, "Mechanics of Materials", 2nd ed., Pearson Education, 2015
4. James M Gere and Stephen P Timoshenko, "Mechanics of Materials", SI Edition, Nelson Thornes Ltd, 2011
5. Ramamrutham.S and Narayanan.R, "Strength of Materials", Dhanpat Rai Publications, 2017
6. Rajput R.K, "Strength of Materials", 6th ed., S.Chand and Company Ltd, 2015

17MEP05 - THERMAL ENGINEERING SYSTEMS LABORATORY					
		L	T	P	C
		0	0	4	2
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To know the method to conduct performance measurement in thermal systems	**1.1**	Conduct the experiments on various thermal engineering systems and analyze the performance	**a,b,f,h,l,k,l**	
2.0	To understand the properties of fuels in thermal applications	**2.1**	Analyze the performance of blowers, fan and internal combustion engines	**a,b,f,h,l,k,l**	
3.0	To acquire knowledge on operating Characteristics of Internal Combustion engines	**3.1**	Know how to balance the heat energy available in engine cylinder after the combustion process	**a,b,f,h,l,k,l**	
4.0	To conduct the performance test on air compressors	**4.1**	Estimate the performance of air compressors	**a,b,f,h,l,k,l**	
5.0	To conduct the performance test on boiler and steam turbine	**5.1**	Determine performance of boiler and steam turbine	**a,b,f,h,l,k,l**	

LIST OF THE EXPERIMENTS
1. Valve timing and Port Timing Diagrams 2. Performance test on C.I engines 3. Morse test on multi cylinder engine 4. Determination of Frictional power using retardation test 5. Determination of flash point, fire point and viscosity of fuels 6. Performance test on reciprocating air compressor 7. Performance test on air blower 8. Measurement of lift and drag force of an aero foil model 9. Performance test on Boiler and Steam turbine. 10. Performance test on air conditioning system. 11. Performance test on Refrigeration system. 12. Heat balance test on C.I engines with Data Acquisition system
TOTAL (P:60) = 60 PERIODS

17MEP06 - SUBTRACTIVE MANUFACTURING PROCESSES LABORATORY					
		L	T	P	C
		0	0	4	2
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To carry out machining operations in lathe machines	**1.1**	Machine cylindrical and prismatic parts using metal removal process	**a, l**	
2.0	To understand the methods of calculating cutting forces	**2.1**	Estimate the cutting forces in machining operations of different materials	**a, b, e, h, k, l**	
3.0	To gain skills in performing shaping, slotting, milling, grinding machine, gear hobbing	**3.1**	Develop gear model by using gear gener ation and gear hobbing processes	**a, h, k, l**	
4.0	To acquire knowledge on the cutting forces, average chip-temperature and surface finish during metal removal processes	**4.1**	Identify the process parameters for machining various materials	**a, b, e, h, k, l**	
5.0	To understand the effect of process parameters on material removal processes	**5.1**	Select a suitable machining process by considering the product requirements	**a, e, l**	

LIST OF THE EXPERIMENTS
1. Experiment in Taper Turning, Thread Cutting, Knurling
2. Experiment in Drilling and boring using Capstan / Turret lathe
3. Experiment in Eccentric Turning and Groove cutting
4. Measurement of cutting forces using Lathe / Milling tool dynamometer
5. Experiment in Machining slots using Shaping and Slotting machine
6. Experiment in Drilling, Reaming and Tapping
7. Experiment in Gear Cutting using Horizontal Milling Machine
8. Experiment in Machining of Slots, Grooves using Vertical Milling machine
9. Experiment in Gear Cutting using gear hobbing machine
10. Abrasive machining of cylindrical shaft using cylindrical Grinding machine
11. Finishing of flat metal surface using Surface Grinding machine
12. Experiment in machining a shaft with key ways
TOTAL (P:60) = 60 PERIODS

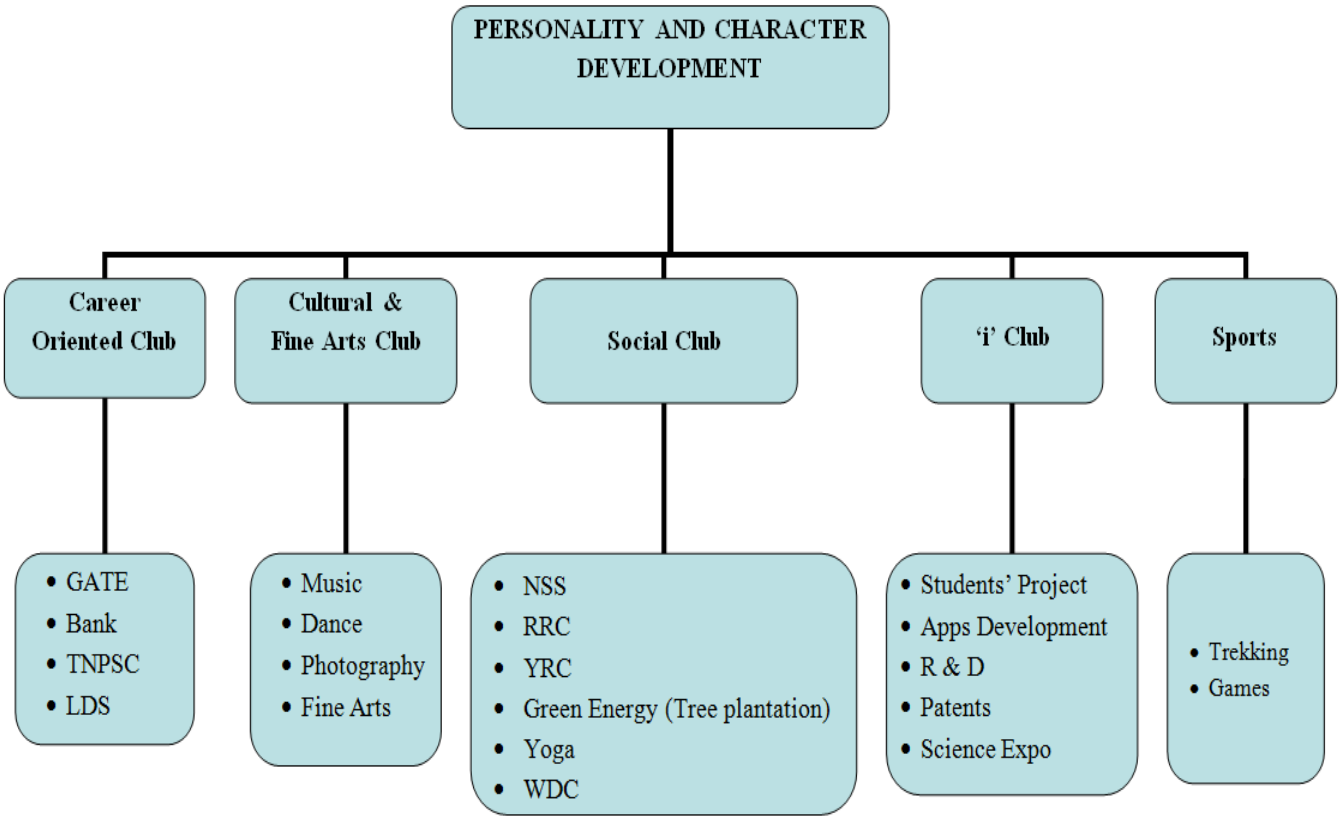
17GED02 - SOFT SKILLS - READING AND WRITING					
			L	T	P	C
			0	0	2	0
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To recollect the functional understanding of parts of speech and basic grammar	**1.1**	Apply the knowledge to identify the parts of speech and construct the sentences	**i, j, l**	
2.0	To acquire the reading skills through cloze texts, matching and multiple choice modes	**2.1**	Develop the reading skills through cloze texts, matching and multiple choice modes	**i, j, l**	
3.0	To enhance the writing skills for a variety of purposes	**3.1**	Interpret effectively through writing for a variety of purposes	**i, j, l**	

UNIT I : GRAMMAR	**(10)**
Articles - Adjectives - Conjunctions - Prepositions - Idioms and Phrases	
UNIT II : READING	**(10)**
Part I : Matching 7 sentences to four short texts Part II : Text with sentences missing Part III : Text with multiple choice questions Part IV : Text with multiple choice gaps Part V : Identification of additional unnecessary words in text	
UNIT III : WRITING	**(10)**
Part I : E-mail writing, Writing short notes, Memo, Agenda and Minutes Part II : Report Writing, Complaint Letter, Writing Proposals	
TOTAL (P:30) = 30 PERIODS	

TEXTBOOKS / REFERENCE BOOKS:

1. Murphy, Raymond, “Essential Grammar in Use”, Cambridge University Press, UK, 2007
2. Whitby, Norman, “Business Benchmark Pre - Intermediate to Intermediate Preliminary”, 2nd ed., Cambridge University Press, 2013

17GED03 - PERSONALITY AND CHARACTER DEVELOPMENT				
	L	T	P	C
	0	0	1	0



***LDS - Leadership Development Skills**

OBJECTIVES :				
Career Oriented Club	**Cultural and Fine Arts Club**	**Social Club**	**'i' club**	**Sports**
•To provide support for identifying specific career field of interests and career path •To provide support for preparing for competitive exams	•To bring out the hidden talent of students in music, dance and other fine arts. •To promote photography skill among the students •To develop and enhance the performance of students by participating in various events •To inculcate managerial capabilities such as event management and stage organization	•To create social awareness and develop a sense of social and civic responsibility •To inculcate socially and environmentally sound practices and be aware of the benefits •To encourage the students to work along with the people in rural areas, thereby developing their character, social consciousness, commitment, discipline and being helpful towards the community.	•To inculcate the basic concepts of innovation •To foster the networking between students, build teams, exchange ideas, do projects and discuss entrepreneurial opportunities •To enrich the academic experience, build competencies and relationships beyond the classroom	•To provide opportunities to excel at sports •To promote an understanding of physical and mental well-being through an appreciation of stress, rest and relaxation. •To develop an ability to observe, analyze and judge the performance of self and peers in sporting activities. •To develop leadership skills and nurture the team building qualities. **Trekking:** •To provide opportunities to explore nature and educating about the purity of nature •To improve physical and mental health.

OUTCOMES : At the end of this course, the students will be able to				
•Find a better career of their interest. •Make use of their knowledge during competitive exams and interviews.	•Take part in various events •Develop team spirit, leadership and managerial qualities	•Develop socially responsive qualities by applying acquired knowledge •Build character, social consciousness, commitment and discipline	•Apply the acquired knowledge in creating better solutions that meet new requirements and market needs •Develop skills on transforming new knowledge or new technology into viable products and services on commercial markets as a team	•Demonstrate positive leadership skills that contribute to the organizational effectiveness •Take part an active role in their personal wellness (emotional, physical, and spiritual) that supports a healthy lifestyle •Create inclination towards outdoor activity like nature study and Adventure.

TOTAL [2 x (P: 15)] = 30 PERIODS

(Cumulatively for Two Semesters)

17MEC13 - DESIGN OF MACHINE ELEMENTS *(Use of Approved Design data book is permitted)*					
		L	**T**	**P**	**C**
		2	**2**	**0**	**3**
PREREQUISITE : 17MEC11		**QUESTION PATTERN : TYPE - 4**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To introduce the design methodology of machine elements	**1.1**	Estimate the stresses acting on various machine elements by considering the operating conditions	**a, b, d, e, f, k, l**
2.0	To acquire knowledge on analysis of forces acting on the machine elements and appropriate design methodology	**2.1**	Predict the variables stresses on the machine elements and/or design shafts for the given loading conditions.	**a, c, e, f, k, l**
3.0	To analyse the stresses acting on the temporary and permanent joints	**3.1**	Determine the maximum stresses acting on the temporary and/or permanent joints under static loads	**a, c, e, f, k, l**
4.0	To gain knowledge about the design of couplings and/or springs	**4.1**	Adapt the design procedures to select couplings and/or springs	**a, c, e, f, k, l**
5.0	To teach various standards, and selection procedures of couplings	**5.1**	Select a suitable type of bearing for the design requirements	**a, b, c, d, e, f, k, l**

UNIT I : STRESSES IN MACHINE ELEMENTS	**(6+6)**
Procedure in design process - factors influencing machine design - selection of materials based on mechanical properties preferred numbers ,fits and tolerance - direct, bending and torsional stress equation - Modes of failure- bending stress in curved beams - crane hook and 'C' frame - factor of safety - theories of failures	
UNIT II : VARIABLE STRESSES AND DESIGN OF SHAFTS	**(6+6)**
Variable stresses in machine parts - stress concentration factor - cyclic stresses - fatigue and endurance limit - Goodman and Soderberg methods - combined normal stress and variable stress - design of solid and hollow shafts based on strength and rigidity	
UNIT III : PERMANENT AND TEMPORARY JOINTS	**(6+6)**
Welded joints - types - basic weld symbols - strength of transverse and parallel fillet welded joints - eccentrically loaded welded joints - screwed joints - terms - forms - design of bolted joints under eccentric loading - introduction to riveted joints	
UNIT IV : DESIGN OF COUPLINGS AND SPRINGS	**(6+6)**
Couplings - types - design of muff coupling, unprotected type flange coupling, bushed pin flexible coupling - springs- types, helical springs, materials, end connections, terms used in compression springs - stresses and deflection in helical springs of circular wire - surge in springs - design of leaf springs - stress and deflection equation, nipping	
UNIT V : BEARINGS	**(6+6)**
Sliding contact bearings - theory of lubrication, hydrodynamic bearings, Sommerfield number - design of hydrodynamic bearings - rolling contact bearings, static and dynamic load capacity, cubic mean load, variable load, probability of survival, selection of deep groove ball bearing	
TOTAL (L:30 +T:30) = 60 PERIODS	

TEXTBOOKS:

1. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 10th ed., McGraw-Hill Education, 2015
2. Bhandari V.B, "Design of Machine Elements", 4th ed., McGraw Hill Education India Private Limited, 2017

REFERENCES:

1. Khurmi.R.S and Gupta.J.K, "A Textbook of Machine Design", S.Chand and Company Ltd., New Delhi, 2014
2. Jalaludeen S.Md, "Machine Design (Volume-1)", 4th ed., Anuradha Publications, Chennai, 2011
3. Sundararajamoorthy T. V. Shanmugam. N, "Machine Design", Anuradha Publications, Chennai, 2003
4. Robert C. Juvinall, Kurt M. Marshek, "Machine Component Design", Wiley India Pvt Ltd., 2016
5. Ganesh Babu.K, Srithar.K, "Design of Machine Elements", 2nd ed., McGraw Hill Education (India) Private Limited, 2009

17MEC14 - HEAT AND MASS TRANSFER *HMT data book and Steam tables*					
		L	T	P	C
		3	0	2	4
PREREQUISITE : 17MEC09		**QUESTION PATTERN : TYPE - 4**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To introduce the concept of heat conduction in various systems	**1.1**	Determine the amount of heat transferred in various systems under steady state	**a, b, d, e, i, k, l**
2.0	To analyze about the internal heat generation and transient heat conduction	**2.1**	Solve numerical problems on heat transfer with internal heat generation and/or transient heat transfer	**a, c, e, k, l**
3.0	To acquire knowledge on convection in various systems	**3.1**	Estimate the heat transfer coefficient and the amount of heat transferred under convection	**a, c, e, k, l**
4.0	To acquire knowledge on Boiling and Condensation, radiation heat transfer	**4.1**	Analyze the radiation heat transfer and/or heat transfer by boiling and condensation	**a, c, e, k, l**
5.0	To introduce the concept of heat transfer with phase change and heat exchangers	**5.1**	Examine heat transfer in heat exchangers and/or diffusion and convective mass transfer	**a, b, c, d, e, i, k, l**

UNIT I : STEADY STATE HEAT CONDUCTION	**(9+6)**
Mechanisms of heat transfer - General heat conduction equation in Cartesian coordinates - representation of heat equation in cylindrical coordinates - One dimensional steady state heat conduction in composite plane walls with constant thermal conductivity - critical radius of insulation - Rectangular plate fins and pin fins with uniform cross section - Efficiency and effectiveness - circumferential fins	
UNIT II : CONDUCTION WITH HEAT GENERATION	**(9+6)**
Solid cylinder with internal heat generation - Transient heat conduction - plane wall with negligible internal resistance - heat flow in an infinitely thick plate - chart solutions of transient heat conduction problems in plane wall	
UNIT III : CONVECTION	**(9+6)**
Representation of continuity, momentum and energy equations - thermal and velocity boundary layer in flow over flat plate and flow through circular pipe - Dimensional analysis - forced convection - correlations for flow over flat plate - flow across tube banks - correlations for flow through circular tubes - Natural convection in vertical and horizontal plates	
UNIT IV : RADIATION, BOILING AND CONDENSATION	**(9+6)**
Thermal radiation - emissive power - absorption, reflection and transmission - Plank's, Wien's displacement, Stefan-Boltzmann, Kirchhoff's laws - emissivity - grey body - shape factor theorems - Electrical analogy - Radiation shields - pool boiling curve for water - boiling correlations - condensation on vertical surfaces and horizontal tubes	
UNIT V : HEAT EXCHANGERS AND MASS TRANSFER	**(9+6)**
Types of heat exchangers - overall heat transfer coefficient - fouling factors - LMTD and Effectiveness - NTU methods - Diffusion mass transfer - Fick's law of diffusion - diffusion coefficient - equimolar counter diffusion - concentration boundary layer - governing equations - convective mass transfer correlations	

LIST OF THE EXPERIMENTS

1. Thermal conductivity measurement using guarded plate apparatus
2. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus
3. Determination of heat transfer coefficient under natural convection from a vertical cylinder
4. Determination of heat transfer coefficient by forced convection inside tube
5. Efficiency calculation of a pin-fin apparatus (natural and forced convection modes)
6. Determination of Stefan - Boltzmann constant
7. Determination of emissivity of a given grey surface
8. Determine the effectiveness of parallel / counter flow heat exchanger
9. Determination of heat flux in boiling and condensation heat transfer

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

TEXTBOOKS:

1. Yunus A Cengel, "Heat and Mass Transfer", 5th ed., McGraw Hill Education (India) Pvt Ltd, 2015
2. Sachdeva.R.C, "Fundamentals of Engineering Heat and Mass transfer", 5th ed., New age international publishers,

REFERENCES:

1. Kothandaraman.C.P, "Fundamentals of Heat and Mass transfer", 4th ed., New age international publishers, 2012
2. Nag.P.K, "Heat and Mass Transfer", 3rd ed., McGraw Hill Education, 2011
3. Holman.J.P, "Heat Transfer", McGraw Hill Education (India) Pvt Ltd, 2017
4. Incropera and Dewitt, "Fundamentals of Heat and Mass Transfer", 7th ed., Wiley India Pvt Ltd, 2013
5. Ghoshdastidar.P.S, "Heat Transfer", 2nd ed., Oxford University Press, 2012

17MEC15 - DYNAMICS OF MACHINERY					
		L	T	P	C
		2	2	0	3
PREREQUISITE : 17MEC08		**QUESTION PATTERN : TYPE - 4**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the concepts of turning moment diagrams, flywheel design and the dynamics of reciprocating engines	**1.1**	Analyze the static and dynamic forces in mechanisms and flywheel	**a, b, e, g, l**	
2.0	To acquire knowledge on the balancing of rotating masses, reciprocating masses, rotors and engines.	**2.1**	Balance the rotary and reciprocating masses of mechanical systems	**a, b, c, e, l**	
3.0	To introduce the fundamentals of longitudinal vibration vibrations	**3.1**	Analyze the longitudinal vibrations of systems with single degree of freedom	**a, b, c, e, k, l**	
4.0	To impart knowledge on the concept of torsional vibratory systems and their analysis.	**4.1**	Determine the frequency of transverse and torsional systems	**a, b, c, e, k, l**	
5.0	To introduce the mechanisms for controlling	**5.1**	Demonstrate the mechanism control systems like governors and gyroscopes	**a, b, c, f, k, l**	

UNIT I : FORCE ANALYSIS AND FLYWHEELS	**(6+6)**
Static force analysis - static equilibrium conditions - free body diagrams - graphical force analysis without friction -four bar mechanism, slider crank mechanism - Dynamic force analysis in Reciprocating Engines –D'Alembert's principle - analytical method of engine force analysis without inertia - Turning moment diagrams - Flywheels of engines- fluctuation of energy	
UNIT II : BALANCING	**(6+6)**
Balancing of rotating masses - balancing of reciprocating masses - partial balancing of unbalanced primary force in a reciprocating engine - balancing of multi cylinder inline engines, V-engines - balancing machines	
UNIT III : LONGITUDINAL VIBRATION	**(6+6)**
Definitions - types of vibrations - basic features of vibratory systems - degrees of freedom - inertia effect of the mass of spring - damped vibrations - logarithmic decrement - Forced vibrations - forced damped vibrations - magnification factor - vibration isolation and transmissibility	
UNIT IV : TRANSVERSE, TORSIONAL VIBRATIONS AND VIBRATION MEASUREMENT	**(6+6)**
Transverse vibrations - Single concentrated load - uniformly loaded shaft - shaft carrying several loads - Dunkerley's method - whirling of shafts - Free torsional vibrations - single rotor system, two rotor and three rotor system, torsionally equivalent shaft – Vibration measuring instruments - accelerometers - frequency measurement - Fullarton, Frahm Tachometers, vibration absorbing materials	
UNIT V : MECHANISMS FOR CONTROL	**(6+6)**
Governors - Types - Watt, Porter, Proell, Hartnell Governors – Effect of friction, controlling force - sensitiveness, hunting, isochronisms, stability - Effort and power of governors - coefficient of Insentiveness - Gyroscope - angular velocity, acceleration - gyroscopic torque - gyroscopic effects in aeroplanes and naval ships	
TOTAL (L:30 +T:30) = 60 PERIODS	

TEXTBOOKS:

1. Joseph E. Shigley, Gordon R. Pennock, John J. Uicker. Jr, “Theory of machines and mechanisms”, 4th ed., Oxford university press, New Delhi, 2014
2. Bansal.R.K and Brar.J.S, “Theory of Machines”, 5th ed., Laxmi Publications, 5th ed., Revised 2016

REFERENCES:

1. Rattan.S.S, “Theory of Machines”, 4th ed., Tata McGraw Hill Education Pvt. Ltd, 2017.
2. Kenneth J Waldron, Gary L Kinzel and Sunil Agarwal, “Kinematics, Dynamics and Design of Machinery”, John-Wiley and Sons, 2016
3. Khurmi.R.S, Gupta.J.K, "Theory of Machines", 14th ed., S.Chand and Company Pvt. Ltd., Reprint 2015.
4. Singh.V.P, “Mechanical Vibrations”, 4th ed., Dhanpat Rai and Co Pvt. Ltd., 2014
5. Thomas Bevan, “Theory of Machines”, Pearson Education Publishers, 2010

17MEC16 - FLUID POWER SYSTEMS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : 17MEC05		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the basics of hydraulics and pneumatics	**1.1**	The students will be able to list the importance of fluid power technology in industries	**a, b, c, e, j, l**	
2.0	To acquire knowledge on hydraulic pumps and various power supply sources	**2.1**	The students will be able to explain the working principles of hydraulic and pneumatic components	**a, e, j, l**	
3.0	To introduce the types of cylinders, accumulators, valves and various control components	**3.1**	The students will be able to select the control components as per requirements	**a, e, j, l**	
4.0	To acquire knowledge on application circuits of fluid power system	**4.1**	The students will be able to illustrate the application circuits and their components in fluid power industry	**a, b, e, j, l**	
5.0	To know about the troubleshooting and maintenance of fluid power systems	**5.1**	The students will be able to solve problems of fluid power systems in industries	**a, b, e, j, l**	

UNIT I : BASICS OF FLUID POWER SYSTEMS	**(9)**
Introduction to fluid power, properties of hydraulic fluids- comparison between hydraulics and pneumatics - basic principle of hydraulics- Pascal's law-transmission and multiplication of force - application and advantages of fluid power - Types of fluid power systems - various hydraulic fluids- basic properties of air	
UNIT II : HYDRAULIC AND PNEUMATIC POWER SUPPLY	**(9)**
Hydraulic pump - graphic symbol - pump types - pump performance - air compressor - graphic symbols - compressor types, Piston compressors, vane compressor and screw compressors	
UNIT III : HYDRAULIC AND PNEUMATIC CONTROL COMPONENTS	**(9)**
Hydraulic cylinders - pressure control valves - directional control valves - flow control valves - types of accumulators – FRL - pneumatic valves check valve, flow control valve, shuttle valve, AND type valve, quick exhaust valve, time delay valve - pneumatic cylinders	
UNIT IV : CIRCUITS IN FLUID POWER SYSTEMS	**(9)**
DCV controlling single acting, double acting cylinder - intensifier press circuit - sequencing circuits, synchronizing circuits - regenerative circuit - counter balance circuit - fail safe circuit - meter in and meter out circuit for extended and retracted stroke - accumulator circuits - cascade circuit	
UNIT V : FLUID POWER SYSTEM MAINTENANCE	**(9)**
Hydraulic system installation - maintenance - Troubleshooting in hydraulics - possible causes and remedies for pumps, directional valves, flow control valves, hydraulic cylinder - Pneumatic system installation, maintenance, Troubleshooting - possible causes and remedies for compressor, FRL unit, air cylinder, air motor	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Antony Esposito, “Fluid Power with applications”, 7th ed., Pearson India, 2014
2. Srinivasan.R, “Hydraulic and Pneumatic Controls”, 2nd ed., Mcgraw Hill Education, 2008

REFERENCES:

1. Andrew Parr, “Hydraulics And Pneumatics”, 1st ed., Jaico Publications, 1993
2. Majumdar S. R, “Oil Hydraulics : Principles and Maintenance”, Mcgraw Hill Education, 2017
3. Majumdar S. R, “Pneumatic Systems : Principles And Maintenance”, 1st ed., Mcgraw Hill Education, 1995
4. Shanmuga Sundaram.K, “Hydraulics And Pneumatics”, 1st ed., S.Chand and Co, 2006
5. Soundararajan and Ilango, “Introduction to Hydraulics and Pneumatics”, 2nd ed., PHI Learning Pvt. Ltd, New Delhi, 2011

17MEP08 - DYNAMICS OF MACHINERY LABORATORY					
			L	T	P	C
			0	0	4	2

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To supplement the dynamic analysis and methods through experiment	**1.1**	Measure the deflection of fixed and cantilever beams under various loading conditions	**a, b, j, k, l**
2.0	To understand how certain measuring devices are used for dynamic testing	**2.1**	Determine the jump speed of given cam and plot the cam profile	**a, b, j, k, l**
3.0	To introduce the methods of static and dynamic balancing of rotating and reciprocating masses	**3.1**	Make use of experimental setups to find moment of inertia, natural frequency and whirling speed	**a, b, c, j, k, l**
4.0	To provide hands on experience on measurement of Whirling speed, MI, Natural frequency	**4.1**	Analyze the Characteristic curves of governors and/or gyroscopic couple	**a, b, c, k, l**
5.0	To acquire knowledge on characteristic curves of governors and gyroscopic couple	**5.1**	Adopt the methodology of dynamic balancing to determine the unbalance force and couple in rotating shafts	**a, b, c, f, j, k, l**

LIST OF THE EXPERIMENTS

1. Study of Balancing of rotating and reciprocating masses.
2. Deflection of Fixed and Cantilever beams.
3. Determination of Mass Moment of Inertia of axis symmetric bodies using Turn Table apparatus.
4. Dynamic balancing of rotating shafts.
5. Determination of natural frequency of vibration of the spring mass system.
6. Determination of whirling speed of shaft.
7. Determination of natural frequency of the free torsional vibration of the single and two rotor system.
8. Plotting the Characteristic curves for Watt governor.
9. Plotting the Characteristic curves for Porter governor.
10. Determination of gyroscopic couple using motorized gyroscope.

TOTAL (P:60) = 60 PERIODS

17GED07 - CONSTITUTION OF INDIA					
		L	T	P	C
		2	0	0	0

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To educate about the constitutional law of India	**1.1**	The students will be able to gain knowledge about the constitutional law of India	**f, h, l**
2.0	To motivate students to understand the fundamental rights and duties of a citizen	**2.1**	The students will be able to understand the fundamental rights and duties of a citizen	**f, g, h**
3.0	To make students to understand about federal structure of Indian government	**3.1**	The students will be able to apply the concept of federal structure of Indian government	**f, g, h**
4.0	To understand about amendments and emergency provisions in the constitution	**4.1**	The students will be able to analyze the amendments and emergency provisions in the constitution	**f, g, h**
5.0	To educate a holistic approach in their life as a citizen of India	**5.1**	The students will be able to develop a holistic approach in their life as a citizen of India	**f, h, l**

UNIT I : INTRODUCTION TO INDIAN CONSTITUTION	**(6)**
Meaning of the constitution law and constitutionalism - historical perspective of the constitution - salient features and characteristics of the constitution of India	
UNIT II : FUNDAMENTAL RIGHTS	**(6)**
Scheme of the fundamental rights - right to equality - fundamental right under Article 19 -102 - scope of the right to life and liberty - fundamental duties and its legal status - directive principles of state policy - its importance and implementation	
UNIT III : FEDERAL STRUCTURE	**(6)**
Federal structure and distribution of legislative and financial powers between the union and the states - parliamentary form of government in India - the constitutional powers and status of the President of India	
UNIT IV : AMENDMENT TO CONSTITUTION	**(6)**
Amendment of the constitutional powers and procedure - the historical perspectives of the constitutional amendments in India	
UNIT V : EMERGENCY PROVISIONS	**(6)**
National emergency, president rule, financial emergency local self government - constitutional scheme in India	
TOTAL (L:30) = 30 PERIODS	

TEXTBOOKS:

1. Constitution of India - Ministry of Law and Justice - PDF format awmin.nic.in/coi/coiason29july08.pdf
2. Introduction to the Constitution of India by Durgadas Basu
3. The Constitution of India - Google free material - www.constitution.org/cons/india/const.html

17MEC17 - MECHATRONICS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : 17MEC06		**QUESTION PATTERN : TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To introduce the integrated approach of Mechatronics systems	**1.1**	The students will be able to identify the elements of Mechatronics system and/or describe the working principles of controllers	**a, g, k, l**
2.0	To acquire knowledge on sensors and familiarize different types of actuators used in mechatronics system	**2.1**	The students will be able to recommend the suitable sensors and type of actuators to achieve the desired output motion	**a, b, c, e, l**
3.0	To impart knowledge on working of microprocessor in mechatronics systems	**3.1**	The students will be able to Discuss the architecture of microprocessor and microcontroller	**a, b, c, e, l**
4.0	To provide knowledge on Programmable Logic Controller (PLC) used in mechatronics systems	**4.1**	The students will be able to demonstrate the knowledge on architecture of PLC and contrast it from PC	**a, b, c, e, l**
5.0	To know the design stages of mechatronics system	**5.1**	The students will be able to design Mechatronics systems with the help of Microprocessor, PLC, other Electrical and Electronics components for an engineering application	**a, b, c, e, k, l**

UNIT I : MECHATRONICS AND CONTROL SYSTEMS	**(9)**
Introduction to Mechatronics - Need for Mechatronics - Emerging areas of Mechatronics - systems - measurement systems - control systems - open and closed loop systems - heating a room, automatic control of water level - analogue and digital control systems - control modes - two step, proportional, derivative, integral and PID controllers	
UNIT II : SENSORS AND ACTUATORS	**(9)**
Sensor terminologies - Static and Dynamic Characteristics of Sensor - Potentiometers - Strain Gauges - Capacitance Sensors - LVDT - Eddy Current Sensor - Hall Effect Sensor -Temperature Sensors - Electrical actuation systems - solenoids, AC and DC motors - construction, working principle - BLDC motor applications - types of stepper motors	
UNIT III : MICROPROCESSOR BASED CONTROLLERS	**(9)**
Microprocessor - architecture of 8085 microprocessor - Pin Configuration - Addressing Modes - Instruction set, Timing diagram of 8085 - architecture of 8051 microcontroller - typical architecture of a CAN based system	
UNIT IV : PROGRAMMABLE LOGIC CONTROLLER	**(9)**
Programmable logic controller - Architecture – Input / Output Processing – Ladder diagrams - Latching, Sequencing, Timers, Counters and Internal relays – Data Handling – Selection of PLC - Application of PLCs for control	
UNIT V : MECHATRONICS SYSTEM DESIGN	**(9)**
Stages of mechatronics design process - comparison of traditional and mechatronics design concepts - case studies of mechatronics systems - pick and place robot - car park barriers - digital camera - car engine management	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Bolton. W, “Mechatronics - A Multidisciplinary Approach”, 4th ed., Pearson Education India, 2016
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th ed., 2015

REFERENCES:

1. Necsulescu. D, “Mechatronics”, 1st ed., Pearson Education India, 2002
2. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, 2nd ed., Cengage Learning India Pvt Ltd, New Delhi , 2012
3. Smaili.A and Mrad.F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, International Edition, 2008
4. Rajput. R. K, “A Text Book of Mechatronics”, 3rd ed., S Chand and Company, 2007
5. Michael B.Histand and Davis G.Alciatore, “Introduction to Mechatronics and Measurement systems”, 4th ed., McGraw Hill Education (India) Private Limited, 2014
6. Clarence W. de Silva, "Mechatronics - A Foundation Course", 1st ed., CRC Press, 2010

17MEC18 - DESIGN OF TRANSMISSION SYSTEMS *(Use of Approved Design data book is permitted)*					
		L	**T**	**P**	**C**
		2	**2**	**0**	**3**
PREREQUISITE : 17MEC13		**QUESTION PATTERN : TYPE - 4**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To introduce the design methodology of machine elements	**1.1**	Identify the design parameters of the Chain Drives and Belt Drives for power transmission	**a, b, d, f, l**
2.0	To acquire knowledge on analysis of forces acting on the machine elements and appropriate design methodology	**2.1**	Recommend the suitable Gear drive for an industrial application among spur and helical gears	**a, c, e, f, l**
3.0	To analyse the stresses acting on the temporary and permanent joints	**3.1**	Design Bevel and Worm Gears by considering various operating conditions	**a, c, e, f, l**
4.0	To gain knowledge about the design of couplings and/or springs	**4.1**	Select the Gear Box for variable operating speeds	**a, c, e, f, l**
5.0	To teach various standards, and selection procedures of couplings	**5.1**	Design Clutches and Brakes for the automobiles	**a, b, c, d, f, l**

UNIT I : DESIGN OF FLEXIBLE POWER TRANSMISSION SYSTEMS	**(6+6)**
Design flat belt and V belt drive based on manufacturer's catalogue - design of transmission chains and sprockets - introduction to timing belt and silent chain	
UNIT II : SPUR GEARS AND HELICAL GEARS	**(6+6)**
Gear materials - design of straight tooth spur gear and parallel axis helical gears based on speed ratio, number of teeth, fatigue strength, factor of safety, strength and wear considerations - forces on teeth - stresses on teeth - gear failures - helical gear - module - normal and transverse, equivalent number of teeth	
UNIT III : BEVEL AND WORM GEARS	**(6+6)**
Straight bevel gear - gear materials - tooth terminology - tooth forces and stresses - design of straight bevel gears by checking surface and bending stresses - worm gear - gear materials - tooth terminology, thermal capacity, forces and stresses, efficiency, design of worm gear drive by checking surface and bending stresses	
UNIT IV : DESIGN OF GEAR BOXES	**(6+6)**
Gear boxes - speed selection - geometric progression - standard step ratio - ray diagram, kinematic layout - design of multistage multi speed constant mesh gear boxes	
UNIT V : MOTION CONTROL: CLUTCHES AND BRAKES	**(6+6)**
Clutches - types - materials - design of single plate, multi plate and cone clutches - brakes - types - friction materials - design of single block brake, pivoted block brake, simple band brake, internal expanding brake	
TOTAL (L:30 +T:30) = 60 PERIODS	

TEXT BOOKS:

1. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 10th ed., Tata McGraw-Hill, 2015
2. Bhandari V.B, "Design of Machine Elements", 4th ed., Tata McGraw-Hill Book Co, 2017

REFERENCES:

1. Jalaludeen S.Md, "Machine Design (Volume-2)", 4th ed., Anuradha Publications, Chennai, 2012
2. Robert C. Juvinall, Kurt M. Marshek, "Machine Component Design", Wiley India Pvt Ltd., 2016
3. Sharma P. C, Aggarwal D. K., "A Textbook of Machine Design" S K Kataria and Sons-New Delhi, 2013
4. Spotts M. F, Shoup T. E , Hornberger L.E , David O. Kazmer, "Design of Machine Elements", 8th ed., Pearson India, 2006
5. Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2003

17MEC19 - METROLOGY AND MEASUREMENTS					
		L	T	P	C
		3	0	2	4
PREREQUISITE : 17MEC01, 17MEC13		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the principles of metrology and measurements	**1.1**	Describe the limits, fits, tolerance, errors, correction and calibration	**a, b, j, k, l**	
2.0	To acquire knowledge on measurement parameters and its applications	**2.1**	Explain the various methods of measuring mechanical parameters	**a, c, k, l**	
3.0	To acquire knowledge on the concept of various measurements like linear and angular measurements	**3.1**	Identify the types of linear and angular measurements for a component	**a, c, k, l**	
4.0	To impart knowledge on statistical measurements and surface finish	**4.1**	Select a type of form measurement methods for an application	**a, c, k, l**	
5.0	To gain knowledge on laser and advances in metrology system	**5.1**	Summarize various laser metrology and its advances	**a, b, c, j, k, l**	

UNIT I : MEASUREMENT SYSTEMS	**(9+6)**
General concept - units and standards - characteristics of measuring instruments - sensitivity, stability, range, accuracy and precision - static and dynamic response - repeatability, hysteresis - systematic and random errors - correction, calibration - interchangeability	
UNIT II : PARAMETER MEASUREMENTS	**(9+6)**
Measurement of force, torque, power using mechanical, pneumatic, hydraulic, electrical instruments - flow measurement - rotameter, pitot tube - Temperature measurement - bimetallic strip, thermocouple, electrical resistance thermometer	
UNIT III : LINEAR AND ANGULAR MEASUREMENTS	**(9+6)**
Linear measuring instruments - vernier, micrometer, slip gauges, tool maker's microscope - interferometry, optical flats, comparators - mechanical, pneumatic, electrical applications - angular measurements - sine bar, sine center, bevel protractor, autocollimator	
UNIT IV : METROLOGY OF SURFACES	**(9+6)**
Fundamentals of GD & T - measurement of straightness, flatness and roundness - measurement of surface finish - stylus based - Tomlinson surface meter and Taylor-Hobson Talysurf - optical measurement - light cross section method - Introduction to 3D surface metrology - contact, non-contact active, non-contact passive	
UNIT V : ADVANCED METROLOGY	**(9+6)**
Precision instruments based on laser principles - interferometer - application in linear, angular measurements - Coordinate Measuring Machine (CMM) - constructional features - types, applications - computer aided inspection - Introduction to machine vision system	

LIST OF THE EXPERIMENTS

1. Measurement of various dimensions using Vernier Caliper / Micrometer / Dial Gauge
2. Measurement of gauge block using Vernier Height Gauge and Vernier depth gauge
3. Measurement of Internal Bore diameter using Digital Bore Gauge
4. Measurement of Gear Tooth Dimensions using Gear Tooth vernier

5. Measurement of Taper Angle using Bevel Protractor / Sine bar / Slip Gauges
6. Measurement of thread parameters using Tool Makers Microscope / Floating Carriage Micrometer
7. Measurement of straightness and flatness of surface plate using Autocollimator
8. Measurement of various dimensions of the given component using Profile Projector
9. Measurement of the Surface Finish using Surface roughness tester
10. Measurement of Force and torque
11. Measurement of Temperature using thermo couples
12. Measurement of displacement using LVDT

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

TEXT BOOKS:

1. Thomas G. Beckwith, Roy D, Marangoni, John H.Lienhard V., "Mechanical Measurements", 6th ed., Pearson Education India, 2014
2. Jain R.K., "Engineering Metrology", 20th ed, Khanna Publishers, 2009

REFERENCES:

1. Raghavendra N.V, Krishnamurthy L, "Engineering Metrology and Measurements", 1st ed., Oxford University Press, 2013
2. Gupta.I.C., "Engineering Metrology", 10th ed., Dhanpat Rai Publications, 2013
3. Anand K Bewoor, Vinay A Kulkarni, "Metrology and Measurement", McGraw Hill Education, 2009
4. Mahajan.M, "Engineering Metrology", Dhanapat Rai publications, 2014
5. Tayal A.K, "Instrumentation and Mechanical Measurements", 4th ed., Galgotia Publications, 2000

17MEP09 - MECHATRONICS LABORATORY					
			L	T	P	C
			0	0	4	2
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the integrated approach of Mechatronics systems	**1.1**	The students will be able to simulate the electrical, hydraulic and pneumatic system using simulation software	**a, c, e, k, l**	
2.0	To design, model and analyze the electrical, hydraulic and pneumatic systems with mechatronics perspective	**2.1**	The students will be able to design mechatronics system with Microprocessor, PLC and other Electrical and Electronics control	**a, b, c, d, g, l**	
3.0	To understand the concepts of computerized data logging system	**3.1**	The students will be able to build interface between stepper motor and 8051 microcontroller	**a, b, c, d, g, l**	
4.0	To stimulate interfacing techniques between electromechanical and microcontrollers	**4.1**	The students will be able to Apply the concepts of computerized data logging in mechatronics system	**a, b, c, d, g, l**	
5.0	To know the design stages of mechatronics system	**5.1**	The students will be able to analyze the velocity and direction in fluid power circuits with the help of simulation software	**a, c, d, e, l**	

LIST OF EXPERIMENTS

1. Manual Control of single and double acting cylinders with direction control valves using pneumatic trainer kit
2. Simulation of cylinder sequencing using hydraulic control by Cascade method
3. Pneumatic cylinder sequencing using electrical control with Internal Relay
4. Process control using PID controller
5. Control of double acting cylinder using Timer, DPDT relay with solenoid operated valves
6. Speed - Torque characteristics of AC Servo motor
7. Stepper motor interfacing using 8051 microcontroller
8. Process control of Automatic bottle filling system using PLC
9. Computerized data logging system for process control variables like level and temperature
10. Design and testing of fluid power circuits to control direction, velocity and force in double acting cylinder using hydraulic trainer kit

TOTAL (P:60) = 60 PERIODS

17GED06 - COMPREHENSION					
			L	T	P	C
			0	0	2	0
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To comprehend the knowledge acquired from the first Semester to Sixth Semester of B.E. Degree course through periodic exercise	**1.1**	Recall the fundamentals of Thermodynamics and Thermal Engineering	**a, b, c, d, k, l**	
2.0	To inculcate the critical thinking required to appear for competitive exams	**2.1**	Summarize the concepts of Engineering Design and Fluid Mechanics	**a, d, k, l**	
3.0	To understand and formulate feasible ways of solving technical problems	**3.1**	Demonstrate an understanding on Manufacturing Practices and Material Science	**a, b, c, k, l**	
4.0	To practice the logical reasoning for the given circumstances	**4.1**	Outline the fundamental concepts of Strength of Materials and Engineering Mechanics	**a, c, d, k, l**	
5.0	To acquire knowledge on verbal and nonverbal reasoning	**5.1**	Relate the concepts of Engineering Graphics and Computer Aided Design and Drafting	**a, c, d, k, l**	

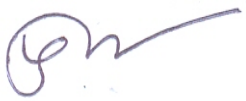
METHOD OF EVALUATION:
The students will be assessed 100% internally through weekly test by objective type questions on all the subject related topics
TOTAL (P:30) = 30 PERIODS

17GED08 - ESSENCE OF INDIAN TRADIONAL KNOWLEDGE					
		L	T	P	C
		2	0	0	0
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program Outcomes**
1.0	To understand the basics of Indian tradition and Indian traditional knowledge systems	**1.1**	The students will be able to gain knowledge about of Indian tradition and Indian traditional knowledge systems		**a, c, d, f, l**
2.0	To know about basics of technologies and its scientific perspectives	**2.1**	The students will be able to understand basics of technologies and its scientific perspectives		**a, f**
3.0	To study the basics of Indian traditional health care ,	**3.1**	The students will be able to study the basics of Indian traditional health care		**a,f,l**
4.0	To know the basics of Indian artistic tradition knowledge	**4.1**	The students will be able to know the basics of Indian artistic tradition		**a,f,l**
5.0	To develop the basics of linguistic tradition	**5.1**	The students will be able to develop the basics of linguistic tradition		**a,f,h**

UNIT I : INDIAN TRADITION	**(6)**
Fundamental unity of India - India's heroic role in world civilization - the Indian way of life - introduction to Indian tradition - the scientific outlook and human values	
UNIT II : INDIAN KNOWLEDGE SYSTEM AND MODERN SCIENCE	**(6)**
Relevance of science and spirituality - science and technology in ancient India - superior intelligence of Indian sages and scientists	
UNIT III : INDIAN TRADITIONAL HEALTH CARE	**(6)**
Importance and practice of yoga - pranayam and other prevailing health care techniques	
UNIT IV : INDIAN ARTISTIC TRADITION	**(6)**
Introduction and overview of significant art forms in ancient India such as painting, sculpture, civil engineering, architecture, music, dance, literature etc	
UNIT V : INDIAN LINGUISTIC TRADITION	**(6)**
Ancient Indian languages and literary heritages - phonology - morphology - syntax - semantics	
TOTAL (L:30) = 30 PERIODS	

TEXTBOOKS:

1. Sivaramakrishnan.V, "Cultural Heritage of India - Course Material", Bharatiya Vidya Bhavan, Mumbai 5th ed., 2014
2. Swami Jitatmananda, "Modern Physics and Vedanta", Bharatiya Vidya Bhavan, 2004.
3. Raman.V.V, "Glimpses of Indian Heritage", Popular Prakashan, 1993
4. Jha.V.N., "Language, Thought and Reality"
5. Krishna Chaitanya, "Arts of India", Abhinav Publications, 1987



17MEC20 - CAD / CAM / CIM					
		L	T	P	C
		3	0	0	3
PREREQUISITE : 17MEC06		**QUESTION PATTERN : TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To introduce the concept of geometric modeling	**1.1**	Explain various CAD models, stages in geometric modeling	**a, c, d, f, l**
2.0	To introduce the concept of computer graphics	**2.1**	List the steps involved in 2D and 3D transformations in computer graphics	**a, b, c, d, f, k**
3.0	To understand the stages of Computer Aided Manufacturing	**3.1**	Summarize the steps involved in Computer Aided Manufacturing and process planning	**b, c, d, f**
4.0	To understand the basics of CNC machine tools	**4.1**	Distinguish the NC, CNC and DNC systems and explain their working principles	**a, c, d, f, g, k**
5.0	To acquire knowledge on the concept of Computer Integrated Manufacturing and production planning	**5.1**	Describe the importance of Computer Integrated Manufacturing and stages in production planning	**a, c, d, f, k**

UNIT I : GEOMETRIC MODELLING TECHNIQUES	**(9)**
CAD implementation - design Process - Shigley, Pahl and Beitz, Ohsuga, Earle model - benefits of CAD - hardware - input and output devices - display devices - LCD, LED - geometric modeling - basics of wire frame, surface, solid modeling	
UNIT II : PRINCIPLES OF COMPUTER GRAPHICS	**(9)**
Graphic primitives - transformation in graphics - coordinate system used in graphics and windowing - viewport - 2D Transformation - homogeneous transformation - combination transformation - clipping - 3D transformation - projections - scan conversion - rendering	
UNIT III : COMPUTED AIDED MANUFACTURING	**(9)**
Function of CAM - benefits of CAM - integrated CAD/CAM organization - computed aided process planning - retrieval type CAPP, generative CAPP - product development cycle - sequential engineering - concurrent engineering	
UNIT IV : CNC MACHINE TOOLS	**(9)**
Principle of numerical control - component of NC system - NC procedure - types of CNC machine tools - programming of CNC machine tools - preparatory functions - miscellaneous functions - part programming - types - turning and machining center	
UNIT V : COMPUTER INTEGRATED MANUFACTURING AND PRODUCTION PLANNING	**(9)**
Types of manufacturing - evolution of computer integrated manufacturing - CIM hardware and CIM software - nature and role of the elements of CIM system - development of CIM - material requirement planning - capacity requirement planning - manufacturing resource planning - just in time - shop floor control	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Ibrahim Zeid and Sivasubramanian, R, “CAD/CAM Theory and Practice”, Tata McGraw Hill Publications, New Delhi, 2009
2. Radhakrishan.P, Subramanyan.S, Raju.V, “CAD/CAM/CIM”, 4th ed., New Age International Publishers Ltd., 2018

REFERENCES:

1. Chris McMohon and Jimmie Browne, “CAD/CAM Principles, Practice and Manufacturing Management”, 2nd ed., Pearson Education (Singapore) Pvt. Ltd., 2000
2. David F. Rogers, J. A. Adams, “Mathematical Elements for Computer Graphics”, Tata McGraw Hill Publications, 2017
3. Donald Hearn and M. Pauline Baker, “Computer Graphics” Eastern Economy Edition, 2007
4. Groover, M. P. and Zimmers, E. W., “CAD/ CAM”, Dorling Kingsley, 2008
5. Mikell P. Groover and Zimmers.W, “CAD/CAM - Computer Aided and Manufacturing”, Pearson India, 2008

17MEC21 - FINITE ELEMENT ANALYSIS					
		L	T	P	C
		2	2	0	3
PREREQUISITE : 17MEC11		**QUESTION PATTERN : TYPE - 4**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the concepts of Mathematical Modeling and numerical solution of engineering problems	**1.1**	The students will be able to understand the use of the FEM to solve problems in Mechanical Engineering	**a, b, d, e, k**	
2.0	To appreciate the use of Finite Element Method to a range of engineering problems	**2.1**	The students will be able to use the Finite Element Method to solve one dimensional Structural and Eigen value problems	**a, c, e, k**	
3.0	To gain knowledge related to two dimensional scalar variable problems with heat transfer	**3.1**	The students will be able to use the FEM to solve two dimensional scalar variable structural and heat transfer problems	**a, c, e, k**	
4.0	To introduce the vector variable of the axisymmetric problems and fluid mechanics	**4.1**	The students will be able to use the FEM to solve two dimensional axisymmetric problems and fluid mechanics problem	**a, c, e, k**	
5.0	To teach Isoparametric formulation and advanced topics in FEM	**5.1**	The students will be able to solve the problems involving Isoparametric, numerical integration approach	**a, c, d, e, k, l**	

UNIT I : BASIC CONCEPTS AND 1D ELEMENTS	**(6+6)**
Basic concepts - general procedure for FEA - discretization - weak form - weighted residual method - Ritz method- applications - finite element modeling - coordinates - shape functions - stiffness matrix and assembly - boundary conditions - solution of equations - mechanical loads, stresses and thermal effects - bar and beam elements	
UNIT II : 2D ELEMENTS	**(6+6)**
Finite element modeling - Poisson equation - Laplace equation - plane stress, plane strain - CST element - element equations, load vectors and boundary conditions - truss - deflection - stresses - Pascal's triangles - assembly - application in two dimensional heat transfer problems	
UNIT III : AXISYMMETRIC PROBLEMS	**(6+6)**
Vector variable problems - elasticity equations - axisymmetric problems - formulation - element matrices - assembly - boundary conditions and solutions	
UNIT IV : ISOPARAMETRIC ELEMENTS	**(6+6)**
Isoparametric elements - four node quadrilateral element - shape functions - Jacobian matrix - element stiffness matrix and force vector - numerical integration - stiffness integration - displacement and stress calculations	
UNIT V : DYNAMIC ANALYSIS	**(6+6)**
Types of dynamic analysis - general dynamic equation of motion, point and distributed mass - lumped and consistent mass - mass matrices formulation of bar and beam element - undamped - free vibration - eigen value and eigen vectors problems	
TOTAL (L:30 + T:30) = 60 PERIODS	

TEXTBOOKS:

1. Rao, S.S., "The Finite Element Method in Engineering", 3rd ed., Butter worth Heinemann, 2004
2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., NewDelhi, 2007

REFERENCES:

1. J.N.Reddy, "An Introduction to the Finite Element Method", 3rd ed., Tata McGrawHill,2017
2. Logan, D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2012
3. Robert D. Cook,David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th ed., Wiley Student Edition, 2007
4. Chandrupatla and Belagundu, "Introduction to Finite Elements in Engineering", 4th ed., Pearson Education India, 2015
5. David Hutton, "Fundamentals of Finite Element Analysis" McGrawHill, 2005
6. Dhanaraj. R and Prabhakaran Nair. K, "Finite Element Analysis", Oxford Publications, 2015

17MEC22 - POWER PLANT TECHNOLOGY					
		L	T	P	C
		3	0	0	3
PREREQUISITE : 17MEC04		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To acquire knowledge on working principle of steam power plant	**1.1**	Summarize the working principles of steam power plant and Boilers	**a, e, g, k, l**	
2.0	To understand the working principle of gas turbine power plant	**2.1**	Describe the working of Gas Turbine power plant and their functions	**a, e, g, k, l**	
3.0	To introduce the principles and operation of nuclear power plant and its economics	**3.1**	Explain the operating principle of Nuclear Power Plant and solve the Economics problems in power plant.	**a, e, g, k, l**	
4.0	To introduce the principles and operation of power plant and its economics.	**4.1**	Classify the type of energy sources and / or describe the working principle of hydroelectric power plant	**a, e, g, k, l**	
5.0	To introduce the principles and its economics.	**5.1**	Explain the operating principle of Power Plant and solve the Economics problems in power plant	**a, e, g, k, l**	

UNIT I : STEAM POWER PLANT	**(9)**
Essentials of steam power plant equipment - coal handling - fuel burning furnaces - methods of fuel firing - pulverizing mills - ball mill, ball and race mill, shaft mill - pulverized coal firing - steam condensers - surface condensers, jet condensers - ash disposal - handling equipment - smoke and dust removal - dust collectors - fluidized bed combustion - types - boiler - classification, working principles of Cochran boiler and La Mont boiler	
UNIT II : DIESEL POWER PLANT	**(9)**
Diesel engines - heavy oil engines - duel fuel engines - high compression gas engines - general layout of diesel power plant - performance of characteristics diesel engine - fuel system - common rail injection, individual pump injection, distributor system - diesel plant operation, efficiency - heat balance of a diesel engine power plant	
UNIT III : NUCLEAR POWER PLANT	**(9)**
Nuclear energy concepts and terms - energy from nuclear fission - radioactivity - nuclear reactor - parts, nuclear fuel, moderator, moderating ratio, reflector, reactor vessel, biological shielding, coolant, nuclear reactor, classification of nuclear reactors, Pressurized Water Reactor (PWR), Boiling Water Reactor (BWR), CANDU Reactor	
UNIT IV : RENEWABLE ENERGY SOURCES	**(9)**
Classification of energy - construction and working principles of solar energy, flat plate collectors, focusing collector, solar pond technology, low temperature thermal power generation, medium temperature systems using focusing collectors, high temperature systems – solar farm and solar power plant - wind, ocean thermal and geothermal power plant	

UNIT V : HYDROELECTRIC POWER PLANT AND POWER PLANT ECONOMICS	(9)
Hydroelectric power plant - run-off - selection of site - essential features -pumped storage plants, economics - terms and factors - factors effecting power plant design - effect of power plant type - costs, rates, fixed elements, customer elements - plant selection, power generation - load curves - ideal and realized load curves	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. El.Wakil. M. M, "Power Plant Technology", McGraw-Hill Higher Education, 2017
2. Raja.A.K, Amit Prakash Srivastava, Manish Dwivedi, "Power Plant Engineering", New Age International (P) Limited, 1st ed., Reprint 2010

REFERENCES:

1. Rajput .R.K, "A Textbook of Power Plant Engineering", 5th ed., Laxmi Publications, New Delhi, 2016
2. Nag.P.K, "Power Plant Engineering", 4th ed., Tata McGraw Hill Publishing Company Ltd, 2014
3. Arora .S.C, Domkundwar, "Power Plant Engineering", 6th ed., DhanpatRai and Co, 2013
4. Manoj Kumar Gupta, "Power Plant Engineering", 1st ed., Prentice Hall India, 2010
5. Black, Veatch, "Power Plant Engineering", 1st ed., CBS Publishers, 2005

17MEP10 - CAD / CAM LABORATORY					
		L	T	P	C
		0	0	4	2
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To gain practical experience in handling 2D drafting and 3D modeling software	**1.1**	Construct Three Dimensional CAD model of the machine component with given specifications	a, c, d, e, i	
2.0	To gain practical knowledge on assembly of 3D components in a modeling software	**2.1**	Develop Three Dimensional assembly model from the generated part models	a, c, d, e, i	
3.0	To know the application of various machine tools like CNC lathe, CNC Vertical Machining Centre	**3.1**	Make use of Manual Part Programming to create the prismatic component using CNC Machining Centre	a, c, d, e, i, k	
4.0	To study the features of CNC Machine Tool and modern control systems	**4.1**	Apply Manual Part Programming to create cylindrical component using CNC Turning Centre	a, c, d, e, i, k	
5.0	To understand the post process steps using CAM packages	**5.1**	Create Cutter Location (CL) data and post process generation using CAM packages	c, d, e, i, k	

LIST OF THE EXPERIMENTS

1. 3D Modelling

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

1. Flange Coupling
2. Fuel injector
3. Universal Joint
4. Machine Vice

2. Manual Part Programming.

(i) Part Programming - CNC Machining Centre

5. Manual part programming for CNC Milling machine using linear interpolation and Circular interpolation
6. Manual part programming for CNC Milling machine using Circular pocketing, Mirroring and Subroutine
7. Manual part programming for CNC Milling machine using Canned Cycle Operations

(ii) Part Programming - CNC Turning Centre

8. Manual part programming for CNC turning centre for step turning using linear interpolation and circular interpolation
9. Manual part programming for CNC turning centre for Taper Turning and Grooving
10. Manual part programming for CNC turning centre for Thread cutting

3. Computer Aided Part Programming

11. Creation of CL Data and Post process generation using CAM packages

TOTAL (P:60) = 60 PERIODS

17MEP11 - COMPUTER AIDED ANALYSIS LABORATORY					
		L	T	P	C
		0	0	4	2
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To acquire skill in finite element simulations using commercially available software	**1.1**	Solve structural analysis problems using one dimensional and two dimensional elements	a, c, d, e, i	
2.0	To know the steps involved in discretization of the CAD model using various elements	**2.1**	Determine numerical solution of problem using axi-symmetric condition	a, c, d, e, i	
3.0	To teach the steps involved in solving structural problems with given specifications	**3.1**	Evaluate various model of failure of a machine component using Modal analysis	a, d, e, i, k	
4.0	To gain knowledge on modal and harmonic analysis	**4.1**	Apply Harmonic analysis to find the response of a structural system using simulation	b, d, e, i, k	
5.0	To understand the thermal analysis with given specifications	**5.1**	Analyse engineering heat transfer problem under given boundary conditions	c, e, f, i, k	

LIST OF THE EXPERIMENTS

1. Analysis of a plate with a circular hole.
2. Analysis of bar (Straight, Stepped, Taper bar).
3. Analysis of beams (Cantilever, Simply supported, Fixed ends).
4. Analysis of truss component.
5. Analysis of an Axi-symmetric component.
6. Modal analysis of a component.
7. Harmonic analysis of a component.
8. Thermal analysis of the components (Fin and Wall).
9. Thermal mixed boundary conditions (Conduction and Convection).
10. Contact analysis experiment of beam.

TOTAL (P : 60) = 60 PERIODS

17MED01 - PROJECT WORK - I					
		L	T	P	C
		0	0	8	4
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To practice the fundamental concepts of basic sciences and mechanical engineering	**1.1**	Perform survey and infer the data to decide on area of project work	**a, c, h, i, k**	
2.0	To improve the management skills to address a real time situation autonomously or in a team	**2.1**	Formulate a problem definition in the field of Mechanical Engineering through literature survey	**a, c, h, i, k**	
3.0	To enhance the management skills to achieve the project goal	**3.1**	Identify the objectives of the project by thorough understanding of the problem	**a, b, d, h, i, k**	
4.0	To improve technical writing skills	**4.1**	Develop methodology using appropriate tools for the problem	**a, b, e, g, i, k**	
5.0	To apply the technical skills to provide feasible solutions for real-life problems	**5.1**	Identify the appropriate tools analyze the obtained data	**b, e, g, h, k, l**	

DESCRIPTION
Project work may be allotted to a single student or to a group of students not exceeding 4 per group. The title of project work is approved by head of the department under the guidance of a faculty member and student(s) shall prepare a comprehensive project report after completing the work to the satisfaction of the guide. The Head of the department shall constitute a review committee for project work. There shall be three reviews during the semester by the committee to review the progress. Student(s) shall make presentation on the progress made by him / her / them before the committee and evaluation is done as per Rules and Regulations.
TOTAL (P:120) = 120 PERIODS

17MED02 - PROJECT WORK - II					
			L	T	P	C
			0	0	16	8
PREREQUISITE : 17MED01					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To practice the fundamental concepts of basic sciences and address a real time situation autonomously or in a team	**1.1**	Identify the objectives of the project by thorough understanding of the problem	**a, c, h, i, k**	
2.0	To enhance the management skills to achieve the project goal by working as a team and also improve technical writing skills	**2.1**	Perform the Experimental Analysis to validate the analytical results	**a, c, h, i, k**	
3.0	To gain the knowledge on experimental and/or numerical data collection	**3.1**	Improve the research and development activities	**a, b, d, h, i, k**	
4.0	To know the tools for data analysis and drawing inference from the observations	**4.1**	Conclude the results and submit the project report	**a, b, d, h, i, k**	
5.0	To apply the technical skills to provide feasible solutions for real-life problems	**4.2**	Take up any challenging practical problems and find solutions	**b, e, h, i, k, l**	

DESCRIPTION
Project work may be allotted to a single student or to a group of students not exceeding 4 per group. The title of project work (same title as in project work-I if the same project is continued in project work-II or the title will be selected based on different project) is approved by head of the department under the guidance of a faculty member and student(s) shall prepare a comprehensive project report after completing the work to the satisfaction of the guide. The Head of the department shall constitute a review committee for project work. There shall be three reviews during the semester by the committee to review the progress. Student(s) shall make presentation on the progress made by him / her / them before the committee and evaluation is done as per Rules and Regulations.
TOTAL (P:240) = 240 PERIODS

17MEX01 - COMPOSITE MATERIALS AND MECHANICS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To introduce the fundamentals and manufacturing aspects of composite materials	**1.1**	List the types reinforcing materials and their composites	**a, b, g, k, l**
2.0	To acquire knowledge on Lamina Constitutive Equations and analysis of laminated flat plates	**2.1**	Recommend a manufacturing process for a composite material	**a, b, g, k, l**
3.0	To introduce the thermal analysis of various laminates	**3.1**	Demonstrate the governing equations of composite laminates	**a, b, g, j, l**
4.0	To understand various failure criterions related to laminated plates	**4.1**	Make use of strength analysis techniques to predict the failure of laminated plates	**a, b, g, k, l**
5.0	To gain knowledge about thermal analysis of composites	**5.1**	Estimate the Coefficient of Thermal Expansion of composites by selecting a thermal analysis	**a, b, f, j, l**

UNIT I : INTRODUCTION TO COMPOSITE MATERIALS	**(9)**
Definition - matrix materials - polymers - metals - ceramics - reinforcements - particles, whiskers, inorganic fibers, metal filaments - ceramic fibers - fiber fabrication - natural composite wood, jute - advantages and drawbacks of composites over monolithic materials - mechanical properties and applications of composites, particulate reinforced composite materials, dispersion strengthened composite, fiber reinforced composites - rule of mixtures - characteristics of fiber reinforced composites, manufacturing fiber and composite	
UNIT II : MANUFACTURING OF COMPOSITES	**(9)**
Manufacturing of Polymer Matrix Composites (PMCs) - handlay up, spray technique, filament winding, pultrusion, Resin Transfer Moulding (RTM) - bag moulding, injection moulding, Sandwich Mould Composites (SMC) - manufacturing of Metal Matrix Composites (MMCs) - solid state, liquid state, vapour state processing, manufacturing of Ceramic Matrix Composites (CMCs) - hot pressing - reaction bonding process - infiltration technique, direct oxidation - interfaces	
UNIT III : INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS	**(9)**
Lamina Constitutive Equations: Lamina Assumptions - macroscopic viewpoint - generalized Hooke's Law - reduction to Homogeneous Orthotropic Lamina - Isotropic limit case, Orthotropic Stiffness matrix (Qij), definition of stress and moment resultants - strain displacement relations - basic assumptions of laminated anisotropic plates - laminate constitutive equations - coupling - Interactions, balanced laminates, symmetric laminates, angle ply laminates, cross ply laminates - laminate structural moduli - evaluation of lamina properties from laminate tests - quasi Isotropic laminates - determination of lamina stresses within Laminates	
UNIT IV : LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES	**(9)**
Introduction - maximum stress and strain criteria - Von-Misses yield criterion for isotropic materials - generalized Hill's criterion for anisotropic materials - Tsai-Hill's failure criterion for composites - tensor polynomial (Tsai-Wu) - failure criterion - prediction of laminate failure equilibrium equations of motion - energy formulations - static bending analysis - buckling analysis - free vibrations - natural frequencies	

UNIT V : THERMAL ANALYSIS	(9)
Assumption of constant Coefficient of Thermal Expansion (C.T.E.) - modification of Hooke's law - modification of laminate constitutive equations - orthotropic lamina C.T.E's - C.T.E's for special laminate configurations - unidirectional, off-axis, symmetric balanced laminates, zero C.T.E laminates, thermally quasi-isotropic laminates	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Malik, P.K., "Fiber Reinforced Composite: Materials, Manufacturing and Design", 3rd ed., CRC Press, 2007
2. Ronald F. Gibson, "Principles of Composite Material Mechanics ", 2nd ed., CRC Press, 2007

REFERENCES:

1. Michael Hyer and Scott R White, " Stress Analysis of Fibre Reinforced Composite Materials", International edition, McGraw-Hill Education, 1998
2. Issac M. Daniel and Oril Shai, "Engineering Mechanics of Composite Materials", 2nd ed., Oxford University Press, 2005
3. John C. Halpin, "Primer on Composite Materials, Analysis", 2nd ed., CRC Press, 1992
4. Bhagwan D. Agarwal, Lawrence J. Broutman and K. Chandrashekhara, "Analysis and Performance of Fiber Composites", 3rd ed., Wiley Publications, 2012
5. Mallick.P.K and Newman.S, "Composite Materials Technology: Processes and Properties", Hanser Gardner Publications, 1991
6. Madhujit Mukhopadhyay, " Mechanics of Composite Materials and Structures", Orient Blackswan Publications, 2004
7. Deborah D. L. Chung, " Composite Materials: Science and Applications", 2nd ed., Springer, 2012

17MEX02 - MICRO ELECTRO MECHANICAL SYSTEMS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the concept of Micro Electro Mechanical Systems and its applications in various fields	**1.1**	Explain the concept of MEMS with applications and/or working principles of microsensors and actuators	**a, g, j, k, l**	
2.0	To acquire knowledge on material to be used	**2.1**	Identify the materials used for MEMS and Microsystems	**a, b, g, j, k, l**	
3.0	To teach about various fabrication processes	**3.1**	Summarize the steps involved in various microsystem fabrication processes	**a, b, g, j, l**	
4.0	To know about different ways of micromanufacturing	**4.1**	Recommend a micromanufacturing process for a particular material	**a, b, g, k, l**	
5.0	To understand the packaging of microsystems	**5.1**	List the stages of Microsystem packaging	**a, b, f, j, l**	

UNIT I : FUNDAMENTALS OF MEMS	**(9)**
MEMS and Microsystems - Typical MEMS and microsystem products - microsystems and micro electronics - applications of microsystems in automotive and other industries - microsensors - acoustic wave sensors, bio medical sensors - optical sensors, pressure sensors - microactuators - microgrippers, micromotors, microvalves, micropumps	
UNIT II : MATERIALS FOR MEMS AND MICROSYSTEMS	**(9)**
Substrates and Wafers - active substrate materials - silicon as a substrate material - silicon compounds - silicon dioxide, silicon carbide, silicon nitride, polycrystalline silicon - silicon piezoresistors - gallium arsenide - quartz - polymers - polymers as industrial materials, polymers for MEMS and microsystems, conductive polymers - packaging materials	
UNIT III : MICROSYSTEM FABRICATION PROCESSES	**(9)**
Photolithography - photoresists and application, light sources, phoresist development, removal and postbacking - ion implantation - diffusion - oxidation - chemical vapor deposition - working principle, chemical reactions, rate of deposition - physical vapor deposition - sputtering	
UNIT IV : MICROMANUFACTURING	**(9)**
Bulk micromanufacturing - etching - isotropic and anisotrotpic etching, wet etching, dry etching - surface micromachining - general process, mechanical problems associated with surface micromachining - LIGA process - general process, materials for substrates and photoresists - electroplating - SLIGA process	
UNIT V : MICROSYSTEM PACKAGING	**(9)**
Mechanical packaging of microelectronics - microsystem packaging - general considerations, three levels of microsystem packaging - interfaces in microsystem packaging - essential packaging technologies - die preparation, surface bonding, wire bonding - three dimensional packaging - assembly of microsystems - selection of packaging materials	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Tai-Ran-Hsui, "MEMS and Microsystems - Design and Manufacture", 1st ed., Mcgraw Hill Education, 2002
2. Nadim Maluf, Kirt Williams, "An Introduction to Microelectromechanical Systems Engineering", 2nd ed., Artech House Print, 2004

REFERENCES:

1. Stephen R.Santuria, "Microsystem Design",1st ed., Springer, Reprint 2004
2. Minhang Bao, "Analysis and Design Principles of MEMS devices", 1st ed., Elsevier Science, 2005
3. Nitaigour Premchand Mahalik, "MEMS", McGraw Hill Education, 2007
4. Mohamed Gad-el-Hak, "MEMS: Introduction and Fundamentals", 1st ed., CRC Press, 2005
5. Chang Liu, "Foundations of MEMS", 2nd ed., Pearson Education, 2011

17MEX03 - ENGINEERING FAILURE ANALYSIS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce various aspects of failure under mechanical loading	**1.1**	Summarize the types of tools available for failure analysis and types of stresses induced under different loading conditions	**a, b, c, k, l**	
2.0	To acquire knowledge on fundamentals of fatigue loading	**2.1**	Select the operating parameters of an equipment subjected to fatigue loading conditions	**a, b, e, g, j**	
3.0	To know about the various ways of fatigue failures	**3.1**	Analyze the failure of materials under corrosion, hydrogen exposure and creep	**a, b, e, g, j, l**	
4.0	To introduce the types of failure mechanisms and mechanics of fracture	**4.1**	Outline the mechanisms of failure and the principles of fracture mechanics	**a, b, e, g, j**	
5.0	To study about the failure effect on various metals and alloys	**5.1**	Interpret the failure in various metals and alloys	**a, b, f, j, l**	

UNIT I : MECHANICAL ASPECTS	**(9)**
Tools for failure analysis - Optical microscopy, Transmission electron microscopy, Scanning electron microscopy. Systematic approach to failure analysis - Mechanical aspects - Tensile test, Principal stresses, Stress concentration, Triaxle stresses and constraint, Plane stress, Plane strain	
UNIT II : FATIGUE	**(9)**
Loading under high cycle fatigue conditions, Test methods, S-N-P curves, endurance diagrams, influence factors - Low cycle fatigue, fretting fatigue; Fatigue design for combined stress; cumulative damage and life prediction, statistical interpretation of fatigue test data	
UNIT III : ANALYSIS OF FATIGUE	**(9)**
Failures related to corrosion, hot corrosion and stress corrosion cracking; Damages due to hydrogen; Creep of metallic material	
UNIT IV : OTHER FAILURE MECHANISMS AND FRACTURE PROCESSES	**(9)**
Fracture processes, Meaning of ductile and brittle fracture, Effect of strain rate and temperature. Fracture mechanics and Failures, Linear elastic fracture mechanics, fracture mechanics principles in design practice, Elastic Plastic fracture mechanics, Examples of crack-growth Analysis for cyclic loading	
UNIT V : FRACTURE MECHANICS AND FAILURES	**(9)**
Welded constructions and screw fastenings, Environmental degradation, Embrittlement of metals and alloys	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. William T. Becker and Roch J. Shipley, "ASM Handbook - Failure Analysis and Prevention - Volume 11", 10th ed., ASM International, 2002
2. Charlie R Brooks and Ashok Choudhury, "Failure Analysis of Engineering Materials", McGraw-Hill Education, 2001

REFERENCES:

1. Arthur J. McEvily, "Metal Failures", 2nd Revised edition, John Wiley and Sons, 2013
2. A Venugopal Reddy, "Investigation of Aeronautical and Engineering Component Failures", CRC Press, 2004
3. Neville W. Sachs, "Practical plant failure analysis", CRC Press, 2007
4. Jose Luis Otegui, "Failure Analysis - Fundamentals and Applications in Mechanical Components", Springer International Publishing, 2014

17MEX04 - PRODUCT DESIGN					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the concept of product development and product planning	**1.1**	Describe the steps involved in product development process and product planning	**a, b, g, j, k, l**	
2.0	To learn the process of gathering customer needs related to products	**2.1**	Demonstrate the process of converting the customer requirements into technical requirements and methods of converting the requirement into product	**a, b, d, g, k, l**	
3.0	To know concept generation, selection, testing and product architecture	**3.1**	Examine the ideas of concept generation for a new product and the development stages	**a, b, c, g, j, l**	
4.0	To study the stages of product development followed in industries	**4.1**	Choose the architecture of the product considering various functional requirements	**a, b, g, j, k, l**	
5.0	To acquire knowledge on concepts of Design for manufacturing and prototyping	**5.1**	Identify the design and manufacturing constraints during product design and development process	**a, b, f, j, l**	

UNIT I : PRODUCT DEVELOPMENT PROCESSES AND PRODUCT PLANNING	**(9)**
Generic product development process - concept development - product development process flows - product planning process - identification of opportunities, evaluation and prioritization of projects, allocation of resources and planning, completion of pre-project planning, reflection on the results and the process	
UNIT II : CUSTOMER NEEDS AND PRODUCT SPECIFICATION	**(9)**
Identifying customer needs - gathering raw data from customers - interpretation of raw data in terms of customer needs - organizing the needs into a hierarchy - establishment of the relative importance of the needs - reflection on the results and the process - product specifications and establishment - target and final specifications	
UNIT III : CONCEPT GENERATION, SELECTION AND TESTING	**(9)**
Activity of concept generation - clarification of the problem - external and internal search - systematic exploration - reflection on the solution and the process- concept selection - structured method for choosing a concept - screening and scoring - concept testing - defining purpose, survey population and format, communication, measure customer response - interpretation and reflection on the result and the process	
UNIT IV : PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN	**(9)**
Product architecture - implications of the architecture product change - establishing the architecture - delayed differentiation - platform planning - related system level design issues - industrial design - assessing the need - impact of industrial design - management of industrial design process - assessing the quality of industrial design	
UNIT V : DESIGN FOR MANUFACTURING AND PROTOTYPING	**(9)**
Estimation of manufacturing costs - reduction of the costs of components, costs of assembly, supporting production - impact of DFM decisions on other factors - prototyping - understanding prototypes - principles of prototyping and technologies - planning for prototypes	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Karl T. Ulrich and Steven D. Eppinger, "Product Design and Development", 5th ed., Tata McGraw-Hill Publishing Company Limited, 2016
2. Kevin N.Otto and Kristin L.Wood, "Product Design", 1st ed., Pearson Education, 2003

REFERENCES:

1. Corrodo Poli, "Design for Manufacturing: A structured approach", Butterworth- Heinemann, 2001
2. Ibrahim Zeid, "Mastering CAD/CAM" Tata McGraw-Hill, 2005
3. John W. Priest and Jose M. Sanchez, "Product development and design for manufacturing", Marcel Dekker Publications, 2001
4. Richard Crowson, "Product Design and Factory Development", 2nd ed., Taylor and Francis Groups, 2005
5. Stephen C. Armstrong, "Engineering and Product development Management - The Holistic Approach" Cambridge University Press, 2001

17MEX05 - TOOL DESIGN					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To teach students the fundamentals of work holding devices.	**1.1**	Determine the dimensions of single and multipoint cutting tools based on cutting forces	**a, b, g, j, k, l**	
2.0	To enable the students design tools, dies, jigs and fixtures.	**2.1**	Identify the importance of work holding device	**a, b, g, j, k, l**	
3.0	To teach students to analyze and optimize an existing jigs	**3.1**	Design jigs and fixtures for the given work pieces	**a, b, g, j, l**	
4.0	To gain knowledge about the design of various fixtures	**4.1**	Calculate the required specifications of a press for required operations	**a, b, g, j, k, l**	
5.0	To expose students to design of dies for press work and forging	**5.1**	Design tools and dies for required operations	**a, b, f, j, l**	

UNIT I : DESIGN OF CUTTING TOOLS	**(9)**
Metal cutting process - selection of tool materials - design of single point and multipoint cutting tool - form tools, drills, milling cutters, broaches and chip breakers - problems on design of single point cutting tools only	
UNIT II : LOCATING AND CLAMPING METHODS	**(9)**
Basic principles of location - locating methods and devices - principles of clamping - mechanical, pneumatic and hydraulic actuation - clamping force analysis - design problems.	
UNIT III : DESIGN OF JIGS	**(9)**
Types of drill jigs - general considerations in the design of drill jigs - drill bushings - types, methods of construction- simple designs of plate, channel, boxes, post, angle plate, turnovers and pot jigs.	
UNIT IV : DESIGN OF FIXTURES	**(9)**
Design principles - types of fixtures - fixtures for machine tools: lathe, milling, boring, broaching and grinding - assembly fixtures - inspection and welding fixtures.	
UNIT V : DESIGN OF DIES	**(9)**
Press tools - Fundamentals of die-cutting operations - Cutting action in punch and die operations - Die clearance - Blanking and Piercing Die construction - Pilots - Strippers and Pressure Pads - Press work materials - Strip layout - Design of simple progressive and compound die sets - Forging Die - Flow lines, parting lines, open and close die forging; Materials for die block.	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Donaldson, Lecain and Goold, "Tool Design", 3rd ed., Tata McGraw Hill, 2012
2. John G. Nee, "Tool Design", 6th ed., Society of Manufacturing Engineers, 2010

REFERENCES:

1. Venkataraman. K, “Design of Jigs Fixtures and Press Tools”, Tata McGraw Hill, New Delhi, 2005
2. Joshi. P.H, “Jigs and Fixtures”, 2nd ed., Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2004
3. Elanchezhian. C, “Design of Jigs Fixtures and Press Tools”, Eswar Press,Chennai, 2004
4. Hoffman, “Jigs and Fixture Design”, Thomson Delmar Learning, Singapore, 2004
5. Vukota Boljanovic Paquin .J. R, “Die Design Fundamentals”, 3rd ed., Industrial Press, 2005

17MEX06 – TRIBOLOGY					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE – 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the concept of tribology in design of products	**1.1**	Select tribological elements based on design considerations	**a, c, j, k, l**	
2.0	To know the concepts of friction phenomena	**2.1**	Demonstrate the understanding of friction	**b, g, j, k, l**	
3.0	To know the concepts of wear phenomena	**3.1**	Demonstrate the understanding of wear	**b, g, j, k, l**	
4.0	To learn the properties of several lubricants	**4.1**	Demonstrate skills to select lubricant	**a, b, j, k, l**	
5.0	To relate the concept of tribology to various practical applications	**5.1**	Apply the knowledge of wear and lubricants for different applications	**a, b, c, f, j, l**	

UNIT I : SURFACE TOPOGRAPHY	**(9)**
Measurement methods - statistical and fractal description - non conforming surface contact geometry - stresses in non-conforming contacts - contact of rough surfaces- adhesion - solid-solid contacts- adhesion models - influencing factors - adhesion by surface tension and contact between rough surfaces	
UNIT II : FRICTION	**(9)**
Friction measurement methods - origin of friction - friction theories - other mechanisms- Hysteresis, ratchet Mechanism, Stick-Slip, Rolling Friction - friction of metals and non-metals	
UNIT III : WEAR	**(9)**
Wear - types - adhesive, abrasive, corrosive, fatigue wear - minor forms of wear - delamination theory - debris analysis and testing methods - wear of metals, ceramics and polymers	
UNIT IV : LUBRICATION AND LUBRICANTS	**(9)**
Oil lubricants - natural and synthetic organics - greases - viscosity - effect of temperature, pressure and shear rates on viscosity, measurement of viscosity - relative density, specific heat and thermal conductivity - acidity and alkalinity - oxidation stability - flash point - foaming - pour point - demulsibility - extreme pressure properties - additives	
UNIT V : APPLICATIONS OF TRIBOLOGY	**(9)**
Study on hydrostatic, hydrodynamic bearings - Reynolds equation - design of plain slider bearing - design of multiple pad bearing	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Prasanta Sahoo, “Engineering Tribology”, PHI Learning Private Limited, 2013
2. Bharat Bhushan, “Introduction to Tribology”, John Wiley and Sons, 2013.

REFERENCES:

1. Basu S. K, Sengupta S. N and Ahuja B. B, “Fundamentals of Tribology”, PHI Learning Pvt. Ltd, 2010
2. Gohar Ramsey and Rahnejat Homer , “Fundamentals of Tribology”, World Scientific Publishing Co. Pvt Ltd, 2008
3. Ian M. Hutchings, “Tribology: Friction and Wear of Engineering Materials”, Butterworth-Heinemann Ltd, 1992
4. Kumar A , “A Textbook of Tribology”, S K Kataria and Sons-New Delhi, 2014
5. Sushil Kumar Srivastava, “Tribology in Industries”, S.Chand and Company Ltd, 2012

17MEX07 - DESIGN FOR MANUFACTURING AND ASSEMBLY					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To understand the selection of materials, methods, fit and tolerance concepts to design a product	**1.1**	Describe the manufacturing processes for various engineering materials	**a, b, c, j, k, l**	
2.0	To get knowledge in basic procedure of design for assembly	**2.1**	Demonstrate the design procedure for welding and forging processes.	**a, b, g, j, k, l**	
3.0	To familiarize the basic concept of design for castings, welding and forging	**3.1**	Summarize the design rules for castings.	**a, b, c, g, j, l**	
4.0	To study the procedure related to the design for manufacturing processes	**4.1**	Contrast the design procedure for various machining processes.	**a, b, g, j, k, l**	
5.0	To gain awareness related to concept of design for environments	**5.1**	Select the guidelines to minimize environmental impacts using recyclability and remanufacture concepts	**a, b, f, j, l**	

UNIT I : FUNDAMENTALS	**(9)**
Design for Manufacture and Assembly - implementation issues - Typical DFMA case studies - selection of materials and processes - General requirements for early materials and process selection - selection of manufacturing processes - process capabilities - selection of materials - primary process/material selection - systematic selection of processes and materials	
UNIT II : DESIGN FOR MANUAL ASSEMBLY	**(9)**
Design guidelines - assembly efficiency - classification systems - effect of part symmetry, part thickness, size, weight on handling time - parts requiring two hands for manipulation - chamfer design - obstructed access - restricted vision - insertion time - manual assembly database and design data sheets - application of the DFA	
UNIT III : DESIGN FOR CASTING AND FORMING	**(9)**
Design for sand casting - sand casting alloys - basic characteristics and mold preparation - sand cores- melting and pouring - design for die casting - die casting alloys - die casting cycle - die casting machines - dies - finishing - Design for Hot forging - characteristics - flash and its removal - allowances - performing - classification of materials	
UNIT IV : DESIGN FOR MACHINING	**(9)**
Introduction - machining using single point cutting tools - multipoint tools - abrasive wheels - standardization - choice of work material - shape of work material - machining basic component shapes- assembly of components - accuracy and surface finish - design guidelines - cost estimating for machined components	
UNIT V : DESIGN FOR THE ENVIRONMENT	**(9)**
Importance of DFE - environmental objectives - global issues - regional and local issues - basic DFE methods - design guidelines - lifecycle assessment - basic method - AT&T's environmentally responsible product assessment - weighted sum assessment method - techniques to reduce environmental impact - design for minimization of material usage - design for disassembly - design for recyclability - design for remanufacture -design for energy efficiency - design to regulations and standards	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Geoffrey Boothroyd, Peter Dewhurst and Winston A.Knight, "Product Design for Manufacture and Assembly", 3rd ed., CRC Press, 2013
2. Kevin Otto and Kristin Wood, "Product Design", 1st ed., Pearson Education India, 2003

REFERENCES:

1. Chitale .A .K and Gupta.R.C, "Product Design and Manufacturing", 6th Revised edition, Prentice Hall India, 2014
2. Bralla, "Design for Manufacturability Handbook", 2nd ed., McGraw-Hill Education, 1998
3. Joseph Fiksel, "Design for the Environment", 2nd ed., McGraw-Hill Professional Publishers, 2011
4. Harry peck, "Designing for manufacture", Pitman publishing, 1973
5. Jim Lesko, "Industrial Design, Materials and Manufacture Guide", 2nd Revised edition, John Willy and Sons, Inc., 2008
6. Madhujit Mukhopadhyay, " Mechanics of Composite Materials and Structures", Orient Blackswan Publications, 2004

17MEX08 - MECHANICAL VIBRATIONS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program Outcomes**
1.0	To understand the importance of vibration in mechanical design of machine parts that operate in vibratory conditions	**1.1**	Derive the differential equation and obtain the linear mathematical model of real life Engineering systems with undamped and damped vibrations		**a, e, j, k, l**
2.0	To understand the vibration effects, which causes the reciprocating and rotating parts in engines	**2.1**	Solve numerical problems on free and forced vibrations of machines, engines and structures which have single degree of freedom		**a, c, j, k, l**
3.0	To understand the transcribe of differential equation of motion of vibratory systems	**3.1**	Determine the solution for balancing problems on static and dynamic machines, rotors having two degrees of freedom and enumerate the working principles of vibration measuring instruments		**a, b, g, j, l**
4.0	To understand the fundamentals of free and forced vibrations	**4.1**	Analyse the balancing problems numerically in multi degrees of freedom equipment		**a, b, g, j, k**
5.0	To understand the concept of vibration measurement and frequency measurement instruments	**5.1**	Apply skills in instrumentation, measurement and signal processing through vibration testing for several physical, mechanical and structural systems		**a, b, f, j, l**

UNIT I : UNDAMPED FREE VIBRATION OF SINGLE DEGREE OF FREEDOM	**(9)**
Basic Concepts - Importance and scope - definition and terminology - representation of harmonic motions - types of vibrations - undamped free vibration - derivation of differential equation of motion - solution of differential equation - simple and compound pendulum - torsional vibrations, equivalent springs - springs in series and parallel	
UNIT II : DAMPED FREE AND FORCED VIBRATIONS OF SINGLE DEGREE OF FREEDOM SYSTEM	**(9)**
Damped free vibration of single degree of freedom - types of damping - viscous damping - over critically and under damped systems - logarithmic decrement - forced vibrations of single degree of freedom - equation of motion with harmonic force - whirling of shafts - without damping	
UNIT III : TWO DEGREES OF FREEDOM SYSTEM	**(9)**
Undamped vibrations - free vibration analysis of undamped systems - mode shapes- semi definite systems - forced vibration analysis of undamped systems - torsional vibrations of two rotor systems - torsionally equivalent shaft - applications - dynamic vibration absorber, centrifugal pendulum absorber	
UNIT IV : MULTI DEGREES OF FREEDOM SYSTEM AND CONTINUOUS SYSTEMS	**(9)**
Matrix method - matrix iteration method - Stodola method - Dunkerley method - Continuous systems - transverse vibration of string - longitudinal vibration of a bar - transverse vibration of shaft - longitudinal vibration of a beam	

UNIT V : VIBRATION MEASUREMENT	(9)
vibration Measurement - vibration measuring instruments - vibrometer - accelerometer - frequency and velocity measuring device - transmissibility - vibration isolation - transducers - classification - displacement transducers - velocity transducers - active and passive transducers - accelerometer - selection of sensors	
	TOTAL (L:45) = 45 PERIODS

TEXTBOOKS:

1. Singh V.P "Mechanical Vibrations", 3rd ed., Dhanpat Rai and Co. Ltd, 2012
2. Singiresu S. Rao, "Mechanical Vibrations", 4th ed., Pearson India Publishers, 2014

REFERENCES:

1. Balakumar Balachandran, Edward B. Magrab, "Fundamentals of Vibrations", 1st ed., Cengage Learning, 2009
2. Rattan S.S, "Theory of Machines", 4th ed., McGraw Hill Education India Private Limited, 2014
3. Metha J.S and Kailey A.S, "Mechanical Vibrations", 1st ed., S.Chand and Co. Ltd, 2012
4. Sujatha.C, "Vibration and Acoustics", 1st ed., Tata McGraw Hill Education Private Limited, 2010
5. William T. Thomson, "Theory of Vibrations with Applications", 5th ed., Pearson India Publishers, 2014

17MEX31 NEW PRODUCT DEVELOPMENT					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To know about inception, strategy and marketing related to a product	**1.1**	Outline the stages in initiation of a new product	**a, b, g, j, k, l**
2.0	To understand the value proposition and property rights due to new product	**2.1**	Demonstrate the concept of value analysis and pricing strategies	**a, b, j, k, l**
3.0	To learn various managerial aspects in development of product	**3.1**	Illustrate the managerial aspects during new product development	**a, b, g, l**
4.0	To learn about various stages involved in product management	**4.1**	Interpret the manufacturing aspects during product design and development	**a, b, k, l**
5.0	To know the efforts to be taken for launching a new product	**5.1**	Summarize the steps involved in product launching in the market	**a, b, f, j, l**

UNIT I : INCEPTION, STRATEGY AND MARKETING **(9)**

Inception - product definition - origin of new products - concept of risk - strategy - analyzing the external environment - analyzing internal direction - marketing - Sales Vs Marketing, segmentation, targeting and positioning, marketing 4Ps

UNIT II : VALUE PROPOSITION, INTELLECTUAL PROPERTY AND FUNDING **(9)**

Value proposition - commodities Vs differentiated products, features, benefits and economic value, damning, strategic elements, pricing models - Intellectual property - effectiveness, brands and intellectual property, accounting, types and monetizing - funding - valuation and finance, risk, time value of money, finance for product managers and entrepreneurs

UNIT III : MANAGERIAL ASPECTS **(9)**

Organizations - product development groups, effective leadership, inspiring followship, organizational building blocks - milestones - resource triangle, cost profiles and risk reduction, Gantt charts, Go/No-Go decision, journey and destination milestones, building blocks

UNIT IV : PRODUCT MANAGEMENT **(9)**

Design - product track, business relationships in design and manufacturing, design processes, environmental stewardship, design building blocks - Fabrication, Integration and Delivery (FID) - vertically integrated companies, outsourcing, role of software, FID building blocks - robust design - need and steps involved - quantitative and qualitative economic analysis

UNIT V : PRODUCT LAUNCHING **(9)**

Launch - five M's of advertising, innovation diffusion theory, social media, launch and recalls, launch building blocks - wrap up - lessons learned, strategies for product success, product design principles, customer relationships, hints for entrepreneurs, keys to the kingdom

TOTAL (L:45) = 45 PERIODS

TEXTBOOKS:

1. Andrea Belz, "Product Development", McGraw Hill, 2011
2. Anita Goyal, Karl T Ulrich and Steven D Eppinger, "Product Design and Development", 4th ed., Tata McGraw-Hill Education, 2009

REFERENCES:

1. George E.Dieter and Linda C.Schmidt, “Engineering Design”, McGraw-Hill International Edition, 4th ed., 2009
2. Kevin Otto and Kristin Wood, “Product Design”, Indian Reprint, Pearson Education, 2004
3. Clive L.Dym and Patrick Little, “Engineering Design: A Project-based Introduction”, 3rd ed., John Wiley and Sons, 2009
4. Yousef Haik and T. M. M. Shahin, “Engineering Design Process”, Cengage Learning India, 2010
5. Beitz.W, Pahl.G, Grote.K.H and Feldhusen.J, “Engineering Design: A Systematic Approach”, 3rd ed., Springer,

17MEX36 – BIOMECHANICS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE – 3**			
COURSE OBJECTIVES AND OUTCOMES:					

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To study the application of mechanics in human body	**1.1**	The students will be able to utilize mechanics in medicine	**a, b, c, l**
2.0	To get introduced to the mechanics involved with various physiological systems.	2.1	The students will be able to explain the mechanics of physiological systems	**a, b, c, e, j, l**
3.0	To acquire knowledge about orthopaedic mechanics	3.1	The students will be able to distinguish the reason for abnormal patterns.	**a, b, c, e, j, l**
4.0	To understand concept of deriving the mathematical models related to blood vessels	4.1	The students will be able to analyze the biomechanical systems using mathematical models	**a, b, c, e, j, l**
5.0	To know about various analysis related to biomechanics in human body	5.1	The students will be able to design and develop the models specific to orthopedic applications	**a, b, c, e, j, l**

UNIT I : INTRODUCTION TO BIOMECHANICS	**(9)**
Scope of mechanics in medicine, mechanics of bone structure, determination of in-vivo elastic modulus. Bio fluid mechanics, flow properties of blood - Anthropometry.	
UNIT II : MECHANICS OFPHYSIOLOGICALSYSTEMS	**(9)**
Heart valves, power developed by the heart, prosthetic valves. Constitutive equations for soft tissues, dynamics of fluid flow in cardiovascular system and effect of vibration - shear stresses in extra-corporeal circuits.	
UNIT III : ORTHOPAEDIC MECHANICS	**(9)**
Mechanical properties of cartilage, diffusion properties of articular cartilage, mechanical properties of bone, kinetics and kinematics of joints, Lubrication of joints.	
UNIT IV : MATHEMATICAL MODELS	**(9)**
Introduction to Finite Element Analysis, Mathematical models - pulse wave velocities in arteries, determination of in-vivo elasticity of blood vessel, dynamics of fluid filled catheters.	
UNIT V : ORTHOPAEDICAPPLICATIONS	**(9)**
Dynamics and analysis of human locomotion - Gait analysis (determination of instantaneous joint reaction analysis), occupant response to vehicular vibration. Mechanics of knee joint during standing and walking.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOK:

1. Y.C.Fung, “Bio-Mechanics - Mechanical Properties of Tissues’’, Newage Publisher, 2007
2. C. Ross Ether and Craig A.Simmons, “Introductory Biomechanics from cells to organisms”, Cambridge University Press, New Delhi, 2009.

REFERENCES:

1. Krishna B. Chandran, Ajit P. Yoganathan and Stanley E. Rittgers, Biofluid Mechanics: The Human Circulation, Taylor and Francis, 2007.
2. Sheraz S. Malik and Shahbaz S. Malik, Orthopaedic Biomechanics Made Easy, Cambridge University Press, 2015.
3. Jay D. Humphrey, Sherry De Lange, An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, Springer Science Business Media, 2004.
4. Shrawan Kumar, Biomechanics in Ergonomics, Second Edition, CRC Press 2007.

17MEX37 - GEOMETRIC DIMENSIONING AND TOLERANCING				
L	T	P	C	
3	0	0	3	
PREREQUISITE : ENGINEERING GRAPHICS	**QUESTION PATTERN : TYPE – 1**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To acquire knowledge on Drawing Standards and Dimensioning	**1.1**	Communicate the drawing with standards preciously	**a, l**
2.0	To understand the modifiers and symbols used in geometric Tolerancing	2.1	Describe the cylindrical and planar feature of size	**a, b, e, f, g,h,k, l**
3.0	To realize the state of the components using the control	3.1	Able to indicate the structure of the parts using form symbols	**a, b, e, f, g,h,k, l**
4.0	To interrupt RFS and MMC in tolerance of position applications	4.1	Calculate the WCB of a FoS Controlled with TOP at RFS	**a, b, e, f, g,h,k, l**
5.0	To understand the concept and applications of forms in the industry	5.1	Able to read the Industrial drawing of various components	**a, b, e, f, g,h,k, l**

UNIT I : DRAWING STANDARDS AND DIMENSIONING	**(9)**
Code of practice for Engineering Drawing, BIS specifications – Welding symbols, riveted joints, keys, fasteners – Reference to hand book for the selection of standard components like bolts, nuts, screws, keys, Dimensioning – Standards – fundamental rules	
UNIT II: TOLERANCING SYMBOLS AND TERMS	**(9)**
Coordinate Tolerancing system – Geometric Dimensioning & Tolerancing system – Comparison between Coordinate Tolerancing system and Geometric Dimensioning & Tolerancing system, Tolerancing symbols – Definition – Material Conditions – Modifier – Radius and Controlled Radius	
UNIT III : DATUM, FORM CONTROLS AND ORIENTATION CONTROLS	**(9)**
Basic Dimensions – Virtual conditions, inner and Outer Boundary – Bonus tolerance, Datum – implied, Planar, Axis and Center plane – FOS Datum features – Application (RFS), Referenced at MMC, Applications (MMC), Form Controls – Flatness, Straightness, Circularity, Cylindricity, Orientation Controls - Perpendicularity, Angularity, Parallelism	
UNIT IV : TOLERANCE OF POSITION, CONCENTRICITY AND SYMMETRY CONTROLS	**(9)**
Tolerance of Position – application RFS, Inspecting RFS, application MMC, Inspecting MMC - Tolerance of Position – Special application and calculations - Concentricity and Symmetry Controls – Definitions, applications	
UNIT V : RUNOUT AND PROFILE CONTROLS	**(9)**
Runout Control – Circular Runout, Total Runout, Runout Calculations – Profile Controls – Profile of Surface, Profile of Line, Part Calculations – Blue print Reading - Pump Housing, Gear Box Cover - introduction to Selective Assembly, Cumulative Assembly - cost implications or effects	
TOTAL (L:45) : 45 PERIODS	

TEXTBOOKS:

1. Alex Krulikowski, "Fundamentals of Geometric Dimensioning and Tolerancing", 3rd edition, 2012

REFERENCES:

1. K. R. Gopalakrishna, "Machine Drawing", 20th Edition, 2017
2. K. L. Narayana, P. Kannaiah, K. Venketa Reddy, "Machine Drawing", 20th Edition, New Age International Pvt Ltd Publishers, 2009

17MEX09 - FUELS AND COMBUSTION					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE – 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To acquire knowledge on types of fuels and their combustion characteristics	**1.1**	List the type of fuels and their combustion characteristics	**a, g, j, k, l**
2.0	To introduce the combustion principles and the environmental impacts	**2.1**	Summarize the combustion principles of various fuels and estimation methods	**a, c, g, j, k, l**
3.0	To know the equipments for measuring the combustion properties of fuel and safety aspects	**3.1**	Identify the various types of emissions during combustion process and ways to minimizing emissions	**a, b, e, j, l**
4.0	To get exposure on measurement methods of emissions	**4.1**	Describe the working principle of measuring devises for combustion characteristics	**d, f, g, j, k, l**
5.0	To introduce the safety aspects in thermal systems	**5.1**	Select the safety equipment for a particular industrial application	**a, b, f, j, l**

UNIT I : FUELS	**(9)**
Fuels - gaseous fuels - heating values, ignition temperature and limits, laminar flame velocity, Wobbe index, methane number - liquid fuels - chemical and physical characteristics - sulfur, ash and water content, carbon residue - solid fuels - characterization, proximate and ultimate analysis, physical properties	
UNIT II : COMBUSTION PRINCIPLES	**(9)**
Determination of the quantity of normal and oxygenated air necessary for complete combustion – calculation of the volume and the composition of the flue gas – auto ignition – induced ignition – explosives – flammability limits – minimum ignition energy – ignition delay time	
UNIT III : ENVIRONMENTAL IMPACTS	**(9)**
Pollutants - formation and impact - relevant pollutants - concepts for pollutant reduction - combustion and climate change - primary energy production - combustion and global warming by sectors - mitigation of global warming in the context of combustion - carbon sequestration	
UNIT IV : MEASUREMENT METHODS	**(9)**
In situ versus ex situ measurements - fuel characterization - investigation of combustion processes - selection of non-optical methods - selection of optical techniques - particle, spray and other techniques - test beds - advanced combustion control	
UNIT V : APPLICATION AND SAFETY	**(9)**
Industrial boilers - fluidized bed combustion - dust firing - metal, ceramic and furnaces used in various industries - gasification and pyrolysis - safety issues - mechanism of fire extinguishing media - fire detectors - deflagrations and detonations - dust explosions - fire suppression by oxygen reduction - safety by process design	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Maximilan Lackner, Arpad B. Palotas and Franz winter, "Combustion", 4th ed., Wiley-VCH Verlag GmbH and Co, 2012
2. Samir Sarkar, "Fuels and Combustion", 3rd ed., Universities Press, 2009

REFERENCES:

1. Jacques Buchetti, "Fuels, Evaporation and Combustion", Nabu Press, 2010
2. Stephen Turns, "An Introduction to Combustion: Concepts and Applications", 3rd ed., McGraw Hill Eduction, 2017
3. Mukunda H.S, "Understanding Combustion", 2nd ed., Universities Press, 2009
4. Saha S.N, "Elements of Fuel Combustion and Energy Technology", Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2008
5. Sharma S.P and Mohan Chander, "Fuels and Combustion", Tata Mcgraw Hill, 1984

17MEX10 - REFRIGERATION AND AIR CONDITIONING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the refrigerants and refrigeration cycles and	**1.1**	List the types of refrigerants and refrigeration cycles	**a, b, h, g, j, k, l**	
2.0	To know the working principles of vapour compression and vapour absorption refrigeration systems	**2.1**	Analyze the performance of vapour compression and vapour absorption refrigeration systems	**a, b, g, j, k, l**	
3.0	To acquire knowledge on non conventional refrigeration systems	**3.1**	Demonstrate an understanding on working principles of non conventional refrigeration systems and psychrometric processes	**a, b, g, j, l**	
4.0	To acquire knowledge on Air conditioning systems and their components	**4.1**	Identify the equipments and working principles of Air conditioning systems	**a, b, g, j, k, l**	
5.0	To get exposure on load estimation in refrigeration and air conditioning systems	**5.1**	Estimate the loads during the design of air conditioner	**a, b, f, j, l**	

UNIT I : AIR REFRIGERATION CYCLES AND REFRIGERANTS	**(9)**
Refrigeration - systems, Coefficient of Performance - Reversed Carnot cycle - reversed Brayton cycle - Refrigerants - introduction, classification - primary refrigerants - designation - desirable properties of ideal refrigerant - properties and uses of commonly used refrigerants - secondary refrigerants - comparison and application of refrigerants - Leak detection	
UNIT II : VAPOUR COMPRESSION AND ABSORPTION REFRIGERATION SYSTEMS	**(9)**
Simple vapour compression system - functions of parts - T-s diagrams - P-h chart - factors affecting the performance - actual vapour compression cycle - volumetric efficiency - methods of improving simple saturation cycle - Simple vapour absorption system - practical vapour absorption system - COP - Lithium Bromide system	
UNIT III : NON CONVENTIONAL REFRIGERATION SYSTEMS	**(9)**
Thermoelectric refrigeration system - thermoelectric effects, comparison between thermoelectric and vapour compression refrigeration- vortex tube and pulse tube refrigeration	
UNIT IV : AIR CONDITIONING SYSTEMS AND EQUIPMENTS	**(9)**
Air conditioning cycle - classification of air conditioning systems - central system - zoned system - unitray system - unitary central system - selection of system - RSHF - GSHF - applications of air conditioning - air conditioning equipments - package units, central units - noise and noise control	
UNIT V : LOAD ESTIMATION, APPLICATIONS OF REFRIGERATION AND AIR CONDITIONING	**(9)**
Cooling and heating load estimate - solar radiation and heat gain - thermal barriers - infiltration - internal heat gains - Design of a cold storage - domestic refrigerator - electrical circuit, maintenance - year round air conditioner - year round absorption air conditioner - air conditioning of theatres - manufacture of ice	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Rajput.R.K, “A textbook of Refrigeration and Air conditioning”, S.K.Kataria and Sons, 2nd ed., Reprint 2014
2. Paul lang V, “Principles of Air conditioning”, 3rd ed., CBS Publishers and Distributors Pvt Ltd, New Delhi 2003

REFERENCES:

1. Ananthanarayanan P.N, “Basic Refrigeration and Air Conditioning”,4th ed.,McGraw Hill, New Delhi, 2013
2. Arora, C.P., "Refrigeration and Air Conditioning", 3rd ed., McGraw Hill, New Delhi, 2008
3. Khurmi.R.S and Gupta.J.K, “A Textbook of Refrigeration and Air Conditioning”, 1st ed., S. Chand Publications, 2011
4. Roy.J.Dossat, “Principles of Refrigeration”, 4th ed., Pearson education inc, New Delhi, 2012
5. Warren Marsh.R and Thomas Olivo.C, “Principles of Refrigeration”, 2nd ed., CBS Publishers and Distributors Pvt Ltd, New Delhi 2001

17MEX11 - CRYOGENIC ENGINEERING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the basics of Cryogenics Engineering	**1.1**	Describe the thermodynamic analysis of cryogenic systems and their types	**a, g, k, l**	
2.0	To acquire knowledge on cryogenic liquefaction processes	**2.1**	Classify the liquefaction processes for various gases	**a, b, j, k, l**	
3.0	To know the principles of separation and purification processes	**3.1**	Explain the fundamentals of separation and purification processes	**a, b, e, g, l**	
4.0	To know the working principles of measurement devices and propellants	**4.1**	Select a measuring instrument to measure the parameters of cryogenic systems	**a, b, d, g, k, l**	
5.0	To provide knowledge on storage and transportation equipments in cryogenic engineering	**5.1**	Identify suitable Cryogenic storage and handling system for engineering applications	**a, b, f, j, k, l**	

UNIT I : THERMODYNAMIC ANALYSIS	**(9)**
Importance - applications of cryogenics - Refrigeration - thermodynamic minimum work - Production of low temperatures - Joule Thomson expansion - adiabatic reversible turbine expansion - cooling by an external refrigerant - Philips, Solvay, Pulse tube, adiabatic magnetic and helium dilution refrigerator	
UNIT II : CRYOGENIC LIQUEFACTION PROCESSES	**(9)**
Thermodynamically ideal system for liquefaction - Liquefaction processes for nitrogen, oxygen, argon, methane, neon and hydrogen	
UNIT III : SEPARATION AND PURIFICATION PROCESSES	**(9)**
Cryogenic separation processes of air, hydrogen, helium - noncryogenic separation processes of air, hydrogen, helium - gas purification processes - sorption for hydrogen storage	
UNIT IV : MEASUREMENT DEVICES AND PROPELLANTS	**(9)**
Temperature - sub atmospheric pressure - Liquid level in a storage vessel - Propellants - nature of propellants - challenges - performance analysis of rocket propulsion - selection of propellants	
UNIT V : STORAGE AND TRANSPORTATION	**(9)**
Storage vessel, thermal shields and insulation - transportation of cryogenics fluids - transfer of cryogenics fluids - mechanical design of vessels - safety of storage and transfer of fluids	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Mamata Mukhopadhyay, "Fundamentals of Cryogenic Engineering", PHI Learning Private Limited, 1st ed., 2010.
2. Thomas M.Flynn, "Cryogenic Engineering", CRC Press, 2nd ed., 2009

REFERENCES:

1. Herold Weinstock, "Cryogenic Technology", 1st ed., Boston Tech, 1969
2. Klaus D. Timmerhaus, Richard P.Reed., "Cryogenic Engineering", Springer, 2007
3. Randall F. Barron, "Cryogenic Systems", 2nd ed., CRC Press, 2016.
4. Robert W. Vance, "Cryogenic Technology", 1st ed., John Wiley and Sons, 1966
5. Russell B. Scott., "Cryogenic Engineering", 4th ed., Met Chemical Research, 1988.

17MEX12 - INTERNAL COMBUSTION ENGINES					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce students to the working of spark ignition engines	**1.1**	Determine performance and combustion characteristics of SI engines	**a, g, j, k, l**	
2.0	To introduce students to the working of compression ignition engines	**2.1**	Summarize the combustion characteristics of CI engines	**a, b, g, j, k, l**	
3.0	To enhance the understanding of students in engine emissions, pollution and their control	**3.1**	Estimate emissions from SI and CI engines using quantitative methods	**a, b, g, j, l**	
4.0	To know the usage of alternate fuels in IC engines	**4.1**	Demonstrate the performance of IC engines using alternative fuels	**a, b, g, j, k, l**	
5.0	To introduce students to the recent trends in IC Engines like stratification, multi point injection, plasma ignition etc.,	**5.1**	Explain the recent trends in Internal combustion engines with applications	**a, b, f, j, l**	

UNIT I : SPARK IGNITION ENGINES	**(9)**
Mixture requirements - fuel injection systems - monopoint, multipoint and direct injection - stages of combustion - normal and abnormal combustion, spark knock, factors affecting knock, combustion chambers	
UNIT II : COMPRESSION IGNITION ENGINES	**(9)**
Diesel fuel injection systems - stages of combustion - knocking - factors affecting knock - direct and indirect injection systems - combustion chambers - fuel spray behaviour - spray structure and spray penetration - air motion - introduction to turbo charging	
UNIT III : POLLUTANT FORMATION AND CONTROL	**(9)**
Pollutant - sources - formation of carbon monoxide, unburnt hydrocarbon, oxides of nitrogen, smoke and particulate matter - methods of controlling emissions - catalytic converters, selective catalytic reduction and particulate traps	
UNIT IV : STUDY OF FUELS	**(9)**
Alcohol, hydrogen, compressed natural gas, liquefied petroleum gas and bio diesel - properties, suitability, merits and demerits	
UNIT V : RECENT TRENDS IN IC ENGINES	**(9)**
Air assisted combustion, homogeneous charge compression ignition engines - variable geometry turbochargers - common rail direct injection systems - hybrid electric vehicles - onboard diagnostics	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Ganesan V, “Internal Combustion Engines”, 4th ed., Tata McGraw Hill, 2012
2. Mathur R. B and Sharma R. P, “Internal Combustion Engines”, Dhanpat Rai and Sons, 2002

REFERENCES:

1. John B. Heywood, “Internal Combustion Engine Fundamentals”, McGraw Hill, 2000
2. Colin R.Feriguson and Allan.T.Kirkpatrik, “IC Engines : Applied Thermo sciences”, 3rd Revised edition, Wiley- Blackwell, 2015
3. Gupta H.N, “Fundamentals of Internal Combustion Engines”, 2nd ed., Prentice Hall India, 2012
4. Rajput R. K, “A Textbook of Internal Combustion Engines”, 3rd ed., Laxmi Publications, 2016
5. Richard L Bechfold, “Alternative Fuels Guide Book”, SAE International Warrendale,1997

17MEX13 - GAS DYNAMICS AND JET PROPULSION					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To understand fundamentals of compressible flows	**1.1**	Evaluate the Mach number and describe compressibility effects, typical flow properties and wave propagation	**a, c, f, j, k, l**	
2.0	To get exposure on isentropic flow through variable area ducts	**2.1**	Demonstrate the behavior of flow through variable area ducts	**a, g, j, k, l**	
3.0	To acquire knowledge on flow through constant area ducts	**3.1**	Solve numerical problems on Rayleigh and Fanno flow	**a, b, c, f, j, l**	
4.0	To understand the phenomenon of shock waves and its effect on flow	**4.1**	Describe the concept of normal and oblique shock in compressible fluid flow	**a, b, g, j, k, l**	
5.0	To know the gas dynamics principles in the Jet and Space Propulsion	**5.1**	Explain the working principle of the rocket propulsion and various propellants	**a, b, f, j, l**	

UNIT I : FUNDAMENTALS OF COMPRESSIBLE FLOW	**(9)**
Energy and momentum equations for compressible fluid flow - various regions of flow - reference velocities - stagnation state - velocity of sound - critical states - Mach number, critical Mach number - types of waves - Mach cone, Mach angle - effect of Mach number on compressibility	
UNIT II : ISENTROPIC FLOW THROUGH VARIABLE AREA DUCTS	**(9)**
Isentropic flow through variable area ducts - T-s and h-s diagrams for nozzle and diffuser flows - area ratio as a function of Mach number - mass flow rate through nozzles and diffusers - effect of friction in flow through nozzles	
UNIT III : FLOW THROUGH CONSTANT AREA DUCTS	**(9)**
Flow in constant area ducts with friction (Fanno flow) - Fanno curves and Fanno flow equation - variation of flow properties - variation of Mach number with duct length - flow in constant area ducts with heat transfer (Rayleigh flow) - Rayleigh line and Rayleigh flow equation - variation of flow properties - maximum heat transfer	
UNIT IV : NORMAL AND OBLIQUE SHOCKS	**(9)**
Normal shock in nozzle - expression for change in entropy across the normal shock - impossibility of rare function shock - supersonic wind tunnels - determination of Mach number (velocity) of supersonic flow - oblique shocks - Prandtl Meyer relations - Applications	
UNIT V : PROPULSION	**(9)**
Jet Propulsion - operating principle of ram jet, turbojet, turbofan and turbo prop engines - rocket propulsion - types of rocket engines - propellants - feeding systems - ignition and combustion - theory of rocket propulsion - applications	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Yahya, S.M. "Fundamentals of Compressible Flow",5th Multi color ed., New Age International (P) Limited, New Delhi, 2014
2. Anderson, J.D., "Modern Compressible flow", 3rd ed., McGraw Hill, 2012

REFERENCES:

1. Patrich.H. Oosthvizen and William E.Carscallen, “Introduction to Compressible fluid flow”, 2nd ed., McGraw-Hill, 2013
2. Ganesan. V., “Gas Turbines”, 3rd ed., Tata McGraw-Hill, New Delhi, 2017
3. Rathakrishnan.E, “Gas Dynamics”, 6th ed., PHI Learning, 2017
4. Balachandran P, “Fundamentals of Compressible Fluid Dynamics”, Prentice Hall India Learning, 2006
5. Saravanamutto HIH, Cohen. H. and Rogers.G.F.C, "Gas Turbine Theory", 7th ed., Pearson Education, 2017

17MEX14 - COMPUTATIONAL FLUID DYNAMICS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To introduce the concept of computational fluid dynamics and governing equations	**1.1**	Demonstrate the governing equations for various problems	**a, b, c, g, k, l**
2.0	To acquire knowledge on numerical methods in computational fluid dynamics	**2.1**	Select a numerical method to solve CFD problems	**a, b, g, k, l**
3.0	To teach the application of computational fluid dynamics in heat conduction	**3.1**	Apply CFD concepts to solve heat conduction problems	**a, b, g, j, l**
4.0	To teach the application of computational fluid dynamics in heat convection	**4.1**	Apply CFD concepts to solve heat convection problems	**a, b, g, k, l**
5.0	To introduce the application of finite volume method in computational fluid dynamics	**5.1**	Analyze the heat transfer and fluid flow cases using finite volume method	**a, b, f, j, l**

UNIT I : FOUNDATIONS OF CFD	**(9)**
Basic concepts of fluid flow - derivation of the governing equations, conservation of mass, momentum and energy, turbulent – kinetic energy equations – mathematical behavior of PDEs on CFD - elliptic, parabolic and hyperbolic equations	
UNIT II : NUMERICAL METHODS FOR CFD	**(9)**
Finite difference method: a differential to algebraic formulation for governing PDE and BCs - iterative solution of system of LAEs for a flow property - numerical differentiation for local engineering-parameters - numerical integration for the total value of engineering-parameters	
UNIT III : HEAT CONDUCTION	**(9)**
Physical law based finite volume method - finite difference method for boundary - flux based solution methodology on a uniform grid: explicit method	
UNIT IV : HEAT CONVECTION	**(9)**
Physical law based finite volume method - flux based solution methodology on a uniform grid: explicit method	
UNIT V : FINITE VOLUME METHOD	**(9)**
Generalized variables for the combined heat and fluid flow - conservation laws for a control volume - algebraic formulation – approximations - approximated algebraic formulation - a staggered grid to avoid pressure-velocity decoupling - physical law based FVM for a staggered grid - introduction to CFD software packages	
TOTAL (L: 45): 45 PERIODS	

TEXTBOOKS:

1. John D Anderson Jr, "Computational Fluid Dynamics - The Basics with Applications", 1st ed., McGraw Hill Education (India) Private Limited, 2012
2. Versteeg.H and Malalasekara.W, "An Introduction to Computational Fluid Dynamics - The Finite Volume Method", 2nd ed., Pearson India, 2009

REFERENCES:

1. Dale Anderson, John C. Tannehill and Richard H. Pletcher, "Computational Fluid Mechanics and Heat Transfer", 3rd ed., CRC Press, 2012
2. Oleg Zikanov, "Essential Computational Fluid Dynamics", Wiley India Pvt Ltd, 2012
3. Gautam Biswas and Somenath Mukherjee, Computational Fluid Dynamics, Narosa Oublishing House Pvt. Ltd, New Delhi, 2014
4. Chung.T.J, "Computational Fluid Dynamics", 2nd Revised edition, Scholastic Press, 2010
5. Suhas V Patankar, "Numerical Heat Transfer and Fluid Flow", CRC Press, 1980

17MEX15 - SOLAR THERMAL SYSTEMS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To enable the students understand solar radiation received on the earth and fundamentals of solar thermal engineering	**1.1**	Estimate solar radiation received on a surface using solar radiation measuring devices	**a, b, g, j, k, l**	
2.0	To enable students know about solar thermal utilities like cookers, pumps, ponds etc	**2.1**	Identify the solar thermal utilities for heating and drying applications	**a, b, g, j, k, l**	
3.0	To introduce students to solar flat plates and solar concentrators	**3.1**	Predict and analyse the performance of solar utilities under varying operating conditions	**a, b, g, j, l**	
4.0	To teach students about solar power generation	**4.1**	Design a solar thermal utility working on active and passive modes	**a, b, g, j, k, l**	
5.0	To teach students about solar power generation	**5.1**	Demonstrate the solar power generation principles, design and performance	**a, b, f, j, l**	

UNIT I : SOLAR RADIATION	**(9)**
Solar radiation on the earth surface - extraterrestrial radiation characteristics, terrestrial radiation, solar insolation, Solar radiation measuring devices - Pyrheliometer and Pyranometer - spectral energy distribution of solar radiation - depletion of solar radiation - absorption, scattering	
UNIT II : SOLAR THERMAL COLLECTORS	**(9)**
Theory of flat plate collectors, evacuated tube collectors and heat pipe based collectors - performance evaluation - collector testing - natural and forced circulation - system configurations - applications	
UNIT III : SOLAR THERMAL UTILITIES – I	**(9)**
Solar air heaters - theory and applications - solar drying - theory, design, performance analysis and types - solar desalination - solar still - types - theory and performance analysis	
UNIT IV : SOLAR THERMAL UTILITIES - II	**(9)**
Solar cooking devices - solar cooling - absorption, adsorption and passive systems - solar thermal pumps - energy storage - solar ponds - solar chimney	
UNIT V : SOLAR CONCENTRATORS AND POWER GENERATION	**(9)**
Solar concentrator types - optics - performance analysis - design considerations - tracking - solar electric power generation systems - economics of solar thermal utilities	
TOTAL (L: 45): 45 PERIODS	

TEXTBOOKS:

1. Goswami Y, Kreith F and Kreider J. F, "Principles of Solar Engineering", 3rd ed., CRC Press, 2015
2. Sukhatme. S. P, "Solar Energy : Principles of Thermal Collection and Storage", Tata McGraw Hill, 3rd ed., 2008

REFERENCES:

1. John A Duffie and William A Beckman, “Solar Engineering of Thermal Processes”, 4th ed., John Wiley and Sons, 2013
2. Prakash J and Garg H, “Solar Energy : Fundamentals and Applications”, 1st ed., McGraw Hill Education, 2000
3. Solanki C.S, “Solar Photovoltaics - Fundamentals, Technologies and Applications”, 3rd Revised edition, Prentice Hall India, 2015
4. Tiwari G. N, “Solar Energy : Fundamentals, Design, Modelling and Application”, Narosa Publishing House Pvt. Ltd., 2012
5. Neville R. C, “Solar Energy Conversion : The solar cell”, 2nd ed., Elsevier Science, 1995

17MEX16 - AUTOMOBILE ENGINEERING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the types of automobiles, structure and construction details	**1.1**	List the components of an automobile and/or demonstrate the working principles of cooling and lubrication systems	**a, b, d, f, k, l**	
2.0	To acquire knowledge on engine auxiliary system and ignition systems	**2.1**	Identify the components of fuel supply and ignition systems of an automobile	**a, c, f, k, l**	
3.0	To know about the engine transmission systems	**3.1**	Classify the types of clutches, gear boxes and other transmission systems	**a, c, e, f, k, l**	
4.0	To learn the working principle of steering, brakes and suspension systems	**4.1**	Describe the working principles of steering, braking and suspension systems	**a, c, e, f, k, l**	
5.0	To introduce the types of emissions in automobiles, emission control techniques and advanced technologies	**5.1**	Summarize the emission levels of the automobiles and the types of advanced technologies	**a, b, c, f, h, j, l**	

UNIT I : VEHICLE STRUCTURE AND ENGINE COMPONENTS	**(9)**
Types of automobiles - vehicle construction - chassis - frame and body - aerodynamics, resistances and moments - component of IC engines - their forms, function and materials - cooling system - lubrication system	
UNIT II : ENGINE AUXILIARY SYSTEM	**(9)**
Fuel supply system, Simple and Solex carburetor - Electronically controlled gasoline injection system for SI engines - Mono point and multi point fuel injection system - electronically controlled diesel injection system rotary distributor type, CRDI, Unit injector system - Ignition system - battery coil ignition system, magneto coil ignition system, electronic coil ignition system - Turbo charger - super charger - electronic engine management system	
UNIT III : TRANSMISSION SYSTEMS	**(9)**
Clutch - Types and construction - single plate, multi plate, diaphragm clutch - types of gear boxes - sliding mesh, constant mesh, synchromesh - gear shifting mechanism - overdrive - fluid flywheel - torque converter – propeller shaft - slip joint - universal joint - differential - Hotchkiss drive and torque tube drive	
UNIT IV : STEERING, BRAKES AND SUSPENSION SYSTEM	**(9)**
Principle of steering - steering geometry - steering linkages - steering gear box - power steering - brakes – types and construction - drum brake, disc brake, pneumatic braking system, hydraulic braking system and antilock braking system (ABS) - types of front and rear axle - suspension system - types and construction - coil spring, leaf spring, stabilizer bars - air suspension - shock absorber	
UNIT V : EMISSION CONTROLS AND SAFETY SYSTEMS	**(9)**
Automobile emissions - standards - control techniques - exhaust gas recirculation, 3 way catalytic converter - Seat belts - air bags - Electronic Brake Distribution (EBD) - Electronic Stability Program (ESP) - Traction Control System (TCS) - Global Positioning System (GPS) - Collision avoiding system, low tire pressure warning system, driver information system	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Babu.A.K and Ajit Pal Singh, "Automobile Engineering", 1st ed., S.Chand Publications, 2013
2. Kirpal Singh, "Automobile Engineering Vol.1 and 2", Standard Publishers, New Delhi, 2011

REFERENCES:

1. William H. Crouse and Donald L Anglin, "Automotive Mechanics", 10th ed., McGraw Hill Education (India) Private Limited, 2006
2. Rajput.R.K, "A textbook Automobile Engineering" Laxmi Publishers, 2nd ed., New Delhi, 2014
3. Ramakrishna K, "Automobile Engineering", Prentice Hall India Learning Private Limited, 2012
4. Srinivasan.S, "Automotive Mechanics", 2nd ed., McGraw Hill Education (India) Private Limited, 2003
5. Jain K.K and Asthana.R.B, "Automobile Engineering", 1st ed., McGraw Hill Education Pvt. Ltd., 2002
6. Kenneth Newton, Steeds.W and Garrett.T.K, "The Motor Vehicle", 13th ed., Butterworth-Heinemann, 2000

17MEX32 RENEWABLE SOURCES OF ENERGY					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To provide students an overview of global energy resources	**1.1**	Possess the knowledge of global energy resources	**a, b, g, j, k, l**	
2.0	To introduce students to bio-fuels, hydrogen energy and solar energy	**2.1**	Use the renewable technologies like solar, biomass, wind, hydrogen etc. to produce energy	**a, b, g, j, k, l**	
3.0	To enable the students understand the importance of energy efficiency	**3.1**	Evaluate and select proper solar utilities	**a, b, g, j, l**	
4.0	To understand the need of conservation in the context of future energy supply	**4.1**	Select the appropriate energy conversion system	**a, b, g, j, k, l**	
5.0	To expose students to future energy systems and energy use scenarios	**5.1**	Involve in optimizing and selecting an alternate source of energy	**a, b, f, j, l**	

UNIT I : BIOFUELS	**(9)**
Biofuels classification – biomass production for energy forming – energy through fermentation - pyrolysis – gasification and combustion - biogas - aerobic and anaerobic bio conversion process - feed stock - properties of bio-gas composition - biogas plant design and operation - alcoholic fermentation	
UNIT II : HYDROGEN ENERGY	**(9)**
Electrolytic and thermo chemical hydrogen production – metal hydrides and storage of hydrogen – hydrogen energy conversion systems hybrid systems – economics and technical feasibility	
UNIT III : SOLAR ENERGY	**(9)**
Solar radiation - availability- measurement and estimation- isotropic and an isotropic models - introduction to solar collectors (liquid flat- plate collector - air heater and concentrating collector) and thermal storage - steady state transient analysis - photovoltaic solar cell – hybrid systems - thermal storage- solar array and their characteristics evaluation – solar distillation – solar drying	
UNIT IV : WIND ENERGY	**(9)**
Wind energy - general considerations - wind power plant design – horizontal axis wind turbine - vertical axis wind turbine - rotor selection - design considerations - number of blades – blade profile - power regulation - yaw system - choice of power plant - wind mapping and selection of location - cost analysis and economics of systems utilizing renewable sources of energy	
UNIT V : TIDAL AND GEOTHERMAL ENERGY	**(9)**
Geothermal - wave and tidal energy - availability - geographical distribution – power generation using otec - wave and tidal energy - scope and economics - geothermal energy - availability - limitations	
TOTAL (L: 45): 45 PERIODS	

TEXTBOOKS:

1. David Merick, Richard Marshall, (2001), Energy, Present and Future Options, Vol. I and II, John Wiley and sons
2. Koteswara Rao, M. V. R., (2006), Energy Resources-Conventional and Non Conventional, Second Edition, BS Publications

REFERENCES:

1. Gerald W. Koeppl, (2002), Patnam's power from wind, Van Nostrand Reinhold Co.
2. Ritchie J.D., (1999), Source Book for Farm Energy Alternative, McGraw Hill.
3. Twidell, J.W. and Weir, A.D., (1999), Renewable Energy Resources, ELBS.
4. Khan, B. H., (2009), Non-Conventional Energy Resources, Second Edition, Tata McGraw Hill.
5. Chetan Singh Solanki, (2009), Renewable Energy Technologies: A Practical Guide for Beginners, Second Printing, PHI Learning Private Limited.
6. Mukherjee, D. and Chakrabarti, S., (2005), Fundamentals of Renewable Energy Systems

17MEX38 - FUEL CELLS AND APPLICATIONS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	Impart knowledge on fuel cell technology and applications	**1.1**	The students will be able to Understand the basics of fuel cell technology	**a, c, d, i**
2.0	Know the concept of electrochemistry in fuel cells	2.1	The students will be able to Infer the concepts of fuel cell electrochemistry	**a, b, d, e**
3.0	Distinguish different types of fuel cells and operations	3.1	The students will be able to Classify the major types of fuel cells and their modes of operation	**a, b, c, g**
4.0	Inferring different hydrogen production techniques	4.1	The students will be able to Categorize the methods of production, storage and utilization of hydrogen as a fuel	**a, b, c, j**
5.0	Identify the application of fuel cells in power generation	5.1	The students will be able to Gain knowledge on application of fuel cells in power cogeneration	**a, f, k, l**

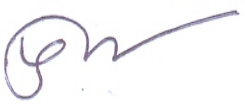
UNIT I : INTRODUCTION TO FUEL CELLS	**(9)**
Introduction and overview of fuel cell technology- Basics of fuel cell, fuel cell advantages and disadvantages - fuel cell operation - Layout of a Real Fuel Cell - Difference between fuel cell and batteries - Basic Parameters of Fuel Cells	
UNIT II : FUEL CELL ELECTROCHEMISTRY	**(9)**
Electrode kinetics - concepts - Fuel cell reaction kinetics - Conversion of chemical energy to electricity in a fuel cell - Reaction rate of fuel cell - Butler -Volmer equation	
UNIT III : TYPES OF FUEL CELLS	**(9)**
Classification of fuel cells - Polymer electrolyte membrane fuel cell (PEMFC) - Electrodes and Electrode Structure in PEMFC - Water Management in the PEMFC - Direct methanol fuel cells (DMFC) - Alkaline fuel cell (PAFC) - Molten Carbonate fuel cell (MCFC) - Solid oxide fuel cell (SOFC)	
UNIT IV : HYDROGEN PRODUCTION, STORAGE AND UTILIZATION	**(9)**
Hydrogen - Production methods: from fossil fuels, electrolysis, thermal decomposition, photochemical, photocatalytic - Hybrid methods of hydrogen production - Hydrogen storage methods	
UNIT V : APPLICATION OF FUEL CELLS IN POWER COGENERATION	**(9)**
Balance of fuel cell power plant - Fuel cell power plant structure – Cogeneration - Fuel cell electric vehicles - Case study - Safety issues and cost expectation	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOK:

1. Viswanathan. B, AuliceScibioh, M, “Fuel Cells – Principles and Applications”, Universities Press Pvt., Ltd., 2009.
2. Matthew M. Mench, Fuel Cell Engines, John Wiley & Sons, Inc. 2008

REFERENCES :

1. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, “Fuel Cell Fundamentals”, Wiley, 3rd edition 2016
2. Bagotsky .V.S, “Fuel Cells”,Wiley, 2009.
3. DetlefStolten, “Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications”, 2011
4. Frano Barbir, PEM Fuel Cells: Theory and Practice, Elsevier Academic Press, 2005.



17MEX17 - NANOTECHNOLOGY					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the science of nanotechnology, nanomaterials and their synthesis routes	**1.1**	Summarize the concept of nanotechnology, classification and metallurgical aspects	**a, b, g, j, k, l**	
2.0	To get exposure on nanomaterials and their synthesis routes	**2.1**	Identify the synthesis routes of various nanomaterials	**a, b, g, j, k, l**	
3.0	To acquire knowledge on the characterization methods of nanomaterials	**3.1**	Select a characterization method for different type of nanomaterials	**a, b, g, j, l**	
4.0	To know the types of nanostructured materials	**4.1**	Describe the type of nanostructured materials and applications	**a, b, g, j, k, l**	
5.0	To teach students the applications of nanomaterials	**5.1**	Identify the engineering applications of various nanomaterials	**a, b, f, j, l**	

UNIT I : INTRODUCTION TO NANOMATERIALS	**(9)**
Science of small things - classification of nanostructured materials - fascinating nanostructures - applications of nanomaterials - nanotechnology and nature - challenges and future prospects - unique properties of nanomaterials - microstructure and defects in nanocrystalline materials - effect of nano-dimensions on materials behaviors	
UNIT II : SYNTHESIS ROUTES	**(9)**
Bottom Up Approaches - PVD, CVD, Spray conversion processing, Sol-gel process, wet chemical synthesis, self assembly - top down approaches - mechanical alloying , equal channel angular extrusion, high pressure torsion, accumulative roll bonding, nanolithography - consolidation of nano powders	
UNIT III : TOOLS TO CHARACTERIZE NANOMATERIALS	**(9)**
X-ray Diffraction - Small Angle X-ray Scattering - scanning electron microscopy - transmission electron microscopy - atomic force microscopy - scanning tunnelling microscope - field ion microscope - three-dimensional atom probe - nanoindentation	
UNIT IV : NANOSTRUCTURED MATERIALS	**(9)**
Quantum Dots - fabrication and application - carbon nanotubes - types, chirality, synthesis, characterization techniques, physical sensors - GaN nanowires and applications – nanocrystalline ZnO - crystal structure and properties, synthesis, applications - nanocrystalline titanium oxide - titania-nanopowders, nanotubes - multilayered films - concerns and challenges	
UNIT V : APPLICATIONS OF NANOMATERIALS	**(9)**
Nano-electronics - micro and nano-electromechanical systems - nanosensors - nanocatalysts - food and agriculture industry - cosmetics and consumer goods - structure and engineering - automotive industry - water treatment and the environment - nano-medical - textiles - paints - energy - defense, space and structural applications	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Murty.B.S, Shankar.P, Baldev Raj, Rath. B.B and James Murday, "Textbook of and Nanoscience Nanotechnology", 1st ed., Orient Blackswan Private Limited, New Delhi, 2012
2. Ben Rogers, Jesse Adams and Sumita Pennathur, "Nanotechnology: Understanding Small Systems", 3rd ed., CRC Press, 2014

REFERENCES:

1. Charles P Poole Jr. and Frank J Owens, "Introduction to Nanotechnology", Wiley India Publications, 2007
2. Chattopadhyay K.K and Banerjee.A.N, "Introduction to Nanoscience and Nanotechnology", Prentice Hall India, 2009
3. Lynn E. Foster, "Nanotechnology : Science, Innovations and Opportunity", 1st ed., Pearson Education, 2007
4. Pradeep.T, "Nano: The Essentials Understanding Nanoscience and Nanotechnology", 1st ed., McGraw Hill Education (India) Private Limited, 2007
5. Suhas Bhattacharya, "A Textbook of Nanoscience and Nanotechnology", Wisdom Press, 2013

17MEX18 - METAL CASTING TECHNOLOGY					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the concept of foundry technology, molding processes and melting furnaces	**1.1**	Explain the principles of foundry technology and steps involved in sand molding process	**a, b, g, j, k, l**	
2.0	To teach students about metal molding processes and melting furnaces	**2.1**	Describe the types of metal molding processes and working principle of melting furnaces	**a, b, g, j, k, l**	
3.0	To acquire knowledge on casting design and finishing operations	**3.1**	Select the design parameters in casting and finishing operation for a casting process	**a, b, g, j, l**	
4.0	To know the quality control, mechanization and management aspects in foundries	**4.1**	Identify the inspection procedure and scope for mechanization	**a, b, g, j, k, l**	
5.0	To get exposure on planning, management and new developments in foundry	**5.1**	Summarize the steps involved management aspects and new developments in foundry	**a, b, f, j, l**	

UNIT I : FOUNDRY TECHNOLOGY AND SAND MOLDING PROCESSES	**(9)**
Metal casting - classification of foundries - challenges in foundry - industrial sectors - sand molding processes - function of molding sand, classification, ingredients, core sands, testing and control, pattern equipment, types of molding, practical aspects, mold coatings, casting defects due to sand, molding and pattern	
UNIT II : METAL MOLDING PROCESSES AND MELTING FURNACES	**(9)**
Die casting - centrifugal, continuous casting - selection of molding processes - furnaces - classification, common melting furnaces - melting procedure, practical aspects - refractories, pouring ladles - selection of melting furnace - casting defects due to improper melting	
UNIT III : CASTING DESIGN AND FINISHING OPERATIONS	**(9)**
Solidification process - running and gating system - risering / feeding systems - design of castings - finishing operations - fetling and cleaning - heat treatment of castings - salvaging of defective castings	
UNIT IV : INSPECTION, QUALITY CONTROL AND MECHANIZATION	**(9)**
Specification and inspection of castings - analysis of casting defects - quality control and assurance - foundry mechanization - mechanical equipments in foundry - plant site location, layouts - plant engineering, maintenance and services - practical aspects	
UNIT V : PLANNING, MANAGEMENT AND NEW DEVELOPMENTS IN FOUNDRY	**(9)**
Planning a new foundry project - organization, management information system - production planning control - practical aspects and case studies - new materials, processes and inspection methods - computer and IT applications - energy conservation - environmental pollution control	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Ramana Rao.T.V, "Metal Casting - Principles and Practice", 1st ed., New Age International Publishers, Reprint 2010
2. Richard W Heine, Carl L Loper and Philip C Resenthal, "Principles of Metal Casting", 2nd ed., McGrawhill education, 2011

REFERENCES:

1. Alexandre Reikher and Michael R Barkhudarov, "Casting: An Analytical Approach", 1st ed., Springer-Verlag London, 2007
2. Jain, P.L, "Principles of Springer-Verlag London", 5th ed., Tata McGraw Hill Pub., Co. Ltd., 2009
3. Khanna.O.P, "Foundry Technology", Dhanpat Rai Publications", 17th ed., 2011
4. Mahi Sahoo and Sam Sahu, "Principles of Metal Casting", 3rd ed., McGraw hill education, 2014
5. Ravi. B, "Metal Casting : Computer-Aided Design and Analysis", 1st ed., Phi Learning Pvt. Ltd., 2010

17MEX19 - METAL FORMING TECHNOLOGY					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the theory of metal forming and its fundamentals	**1.1**	Discuss the principles of metal forming, mechanical behaviour of materials and grain structure of materials during forming processes	**a, b, g, j, k, l**	
2.0	To study about the techniques of forging and extrusion	**2.1**	Identify the components and explain the working principles of forging and extrusion equipments	**a, b, g, j, k, l**	
3.0	To acquire knowledge on operation sequence of rolling and drawing processes	**3.1**	Recommend the process parameters of rolling or drawing for a particular engineering product	**a, b, g, j, l**	
4.0	To know the techniques of sheet metal forming	**4.1**	Illustrate the steps involved in sheet metal forming processes considering stress strain relations	**a, b, g, j, k, l**	
5.0	To get introduced to advances in forming processes	**5.1**	Classify the newer forming processes and describe the working principles of various equipments	**a, b, f, j, l**	

UNIT I : FUNDAMENTALS OF METAL FORMING	**(9)**
Classification and methods in forming - tensile test and metallurgy - theory of plasticity - effect of temperature, strain rate, metallurgical microstructure, chemical elements and mechanical properties - friction and lubrication - deformation zone geometry - workability - mechanics of metal forming - flow stress determination	
UNIT II : FORGING AND EXTRUSION	**(9)**
Classification of forging - forging equipment - plane strain forging with coulomb friction - residual stresses in forgings - forging defects - open and closed die forging - forging die design - extrusion - principal variables - calculation of extrusion load - defects in extrusion - deformation and flow pattern- extrusion of tubing	
UNIT III : ROLLING AND DRAWING	**(9)**
Classification - rolling mills - rolling of bars and shapes - forces and geometrical relationship - cold rolling - frictional forces in the arc of contact - rolling - process variables - defects - cold rolling theory - roll flattening - roll camber - theory of strip - drawing - rod and wire drawing - lubrication - patenting heat treatment - defects - variables in wire drawing.	
UNIT IV : SHEET METAL FORMING	**(9)**
Metal spinning - manual spinning - power spinning - spinnability of metals - blanking - rubber pad forming -Marform process - deep drawing process - stress pattern - drawability - defects - stretch forming operation - plastic stress strain relation - deep drawing tools design	
UNIT V : NEWER FORMING PROCESSES	**(9)**
Explosive Forming - electro hydraulic forming - magnetic pulse forming - petro forge hammer - drop hammer and dynapak - forming by laser beam - die-less forming	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Fritz Klocke, “Manufacturing Processes 4 - Forming", 1st ed., Springer-Verlag Berlin Heidelberg, 2013.
2. Narayanasamy.R, “Metal Forming Technology”, 1st ed., Ahuja Book Publishers and Distributors, 1997

REFERENCES:

1. George E. Dieter, “Mechanical Metallurgy”, 3rd ed., Tata McGraw Hill India, 2013.
2. Juneja.B.L, “Fundamentals of Metal Forming Processes”, 2nd ed., New Age International Publishers, 2010.
3. Rao.P N, “Manufacturing Technology : Foundry, Forming and Welding”,4th ed., Tata McGraw-Hill Education, 2013.
4. Surender Kumar, “Technology of Metal Forming Processes”, Prentice Hall India Publications, 2008.
5. William F. Hosford, Robert M. Caddell, “Metal Forming: Mechanics and Metallurgy”, 4th ed., Cambridge university press, 2014.

17MEX20 - WELDING ENGINEERING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To acquire basic knowledge in the discipline of materials science and engineering	**1.1**	Demonstrate the knowledge on welding technology for various materials	**a, b, g, j, k, l**
2.0	To introduce the basics of welding and types of welding processes	**2.1**	Describe the welding metallurgy and/or mathematical analysis of heat affected zone	**a, b, g, j, k, l**
3.0	To acquire knowledge on welding metallurgy	**3.1**	Identify a welding method for joining materials and pipelines	**a, b, g, j, l**
4.0	To introduce the welding methodology for various materials, pipelines and underwater welding	**4.1**	Explain the procedures in welding, steps in process planning and inspection methods	**a, b, g, j, k, l**
5.0	To introduce the steps involved in process planning and inspection methods for welding processes	**5.1**	Summarize the steps involved in underwater welding processes	**a, b, f, j, l**

UNIT I : FUNDAMENTALS OF WELDING TECHNOLOGY	**(9)**
Definition and classification - conditions for obtaining satisfactory welds - importance of welding and its applications - welding quality and performance - Characteristics of welding power sources - arc welding power supply equipments - selection criteria - energy input - energy sources - arc characteristics - metal transfer and melting rates - welding parameters and their effects	
UNIT II : WELDING METALLURGY AND METAL SURFACING	**(9)**
General and welding metallurgy - thermal and mechanical treatment of welds - residual stress and distortion in welds - surfacing - types of surfacing - cladding - hard facing - build - up - buttering -selection of a surface material - surface procedure - preparation and preheating of substrate - quality of deposited materials - post - Process cooling of deposits- finishing surface deposit - quality control - surfacing applications	
UNIT III : WELDING OF MATERIALS AND PIPELINES	**(9)**
Welding of cast irons - aluminium and its alloys - stainless steels - welding of dissimilar metals - welding of plastics - hot air welding of PVC plastics - welding action - equipments - testing of joints - welding of pipelines - piping - joint design - backing rings- heat treatment - offshore pipe work - pipeline welding	
UNIT IV : WELDING PROCEDURE, PROCESS PLANNING AND QUALITY	**(9)**
Welding symbols - welding procedure and sheets - joint preparations in fusion welding - welding positions - summary chart - submerged arc welding procedure sheets - welding procedure of MIG/CO_2 welding - Welding quality - undercuts - cracks - porosity - slag inclusion - lack of fusion - lack of penetration - faulty weld size and profile - corrosion testing of welded joints	
UNIT V : UNDERWATER WELDING	**(9)**
Comparison of underwater welding and normal air welding - welding procedure - types of underwater welding - underwater welding process development - developments in underwater welding - characteristics desired in electrodes for MMA wet welding - polarity - salinity of sea water - weld shape characteristics - microstructure of underwater welds	
TOTAL (L: 45): 45 PERIODS	

TEXTBOOKS:

1. Edward R. Bohnart, "Welding Principles and Practices", 4th ed., McGraw Hill Education, 2014
2. Ibrahim Khan, “Welding Science and Technology”, New Age International (P) Limited, 2007

REFERENCES:

1. Bruce Stirling, “Text Book of Welding Technology”, Dhanpat Rai Publishing Company (P) Ltd, 2013
2. Garg.G.D, “A textbook of Welding Technology”, S. K. Kataria and Sons, 2011
3. Khanna.O.P, “A textbook of Welding Technology”, 22nd ed., Dhanpat Rai Publications, 2008
4. Little R.L., “Welding and welding Technology”, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2001
5. Parmer.R.S., “Welding Engineering and Technology”, 1st ed., Khanna Publishers, New Delhi, 2008

17MEX21 - NON DESTRUCTIVE TESTING AND EVALUATION					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To study and understand the various Non-Destructive Testing and Evaluation methods	**1.1**	Differentiate various defect types and select the appropriate NDT methods for better evaluation.	**a, b, g, j, k, l**	
2.0	To know the various applications of Non Destructive testing methods	**2.1**	Complete theoretical understanding of the penetrants, penetrant testing and safety precautions.	**a, b, g, j, k, l**	
3.0	To study the concept of magnetic particle testing process	**3.1**	Demonstrate the fundamentals of magnetization methods and magnetic testing techniques.	**a, b, g, j, l**	
4.0	To gain knowledge on radiographic inspection	**4.1**	Apply radiation property for inspecting materials.	**a, b, g, j, k, l**	
5.0	To provide a basic understanding with case studies on different surface NDE techniques	**5.1**	Implement various ultrasonic and eddy current inspection methods to find material imperfections.	**a, b, f, j, l**	

UNIT I : INTRODUCTION TO NDT AND VISUAL INSPECTION	**(9)**
Non destructive testing - scope, advantages, destructive methods of testing - comparison between destructive and non destructive testing - common NDT methods, flows and defects, applications - visual inspection - basic terms, equipments used - machine vision - Ringing test	
UNIT II : PENETRANT TESTING	**(9)**
Principle of penetrant testing - test stations - accessories - applications - types of penetrants - characteristics of good penetrants - developer and its types - quality and process control - health and safety precautions in Liquid penetrant Inspection - Leak test - Zyglo Fluorescent Penetrant Test	
UNIT III : MAGNETIC PARTICLE TESTING	**(9)**
Principle of Magnetic particle testing - scope - basic terms associated with magnetic materials, classification of magnetic materials - magnetic field orientation - direct magnetization, indirect magnetization - DC and AC magnetization - skin effect - equipments - lights - magnetic field indicator - testing techniques - dry particle inspection, wet suspension inspection - advantages and limitations of magnetic particle testing - applications	
UNIT IV: RADIOGRAPHIC INSPECTION	**(9)**
Types of radiations - X-Ray radiography principle - X ray tube generator - gamma radiation sources - advantages of gamma rays over X ray radiography - X-Ray film and accessories - film interpretation - digital radiography - applications - precautions against radiation hazards and health - case study- X ray of human body	
UNIT V : ULTRASONIC AND EDDY CURRENT TESTING	**(9)**
Principle of ultrasonic testing - equipments used in ultrasonic testing -Ultrasonic inspection techniques – transmission method, pulse echo method, immersion technique, angle beam technique- applications – cathode ray oscilloscope – case study, ultrasonography of human body - Eddy current testing - working principle - basic terms -factors affecting eddy currents - eddy current flow characteristics - applications	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Osama Lari, Rajeev Kumar, "Basics of Non-Destructive testing", 1st ed., S.K.Kataria and Sons, 2013
2. Don E Bray and Roderick K Stanley, 1st ed., "Nondestructive Evaluation: A Tool in Design, Manufacturing and Service", CRC Press, 1996

REFERENCES:

1. ASM International, "ASM Handbook: Nondestructive Evaluation and Quality Control - Volume 17", 9th Revised edition, 1989
2. Baldev Raj, Jayakumar.T and Thavasimuthu.M, "Practical Non-Destructive Testing", Narosa Publishing house, 2nd ed., Eight Reprint 2013
3. Ravi Prakash, "Non-Destructive Testing Techniques", First Revised edition, New Age International (P) Limited, 2010
4. Prasad.J and Nair.C.G.K, "Non-Destructive Test and Evaluation of Materials", 2nd ed., Tata McGraw-Hill Publishing company Limited, 2011
5. Yoshida Kenichi and Laodeno Rem N, "Non-Destructive Testing Technique", LAP Lambert Academic Publishing, 2013

17MEX22 - ADDITIVE MANUFACTURING PROCESSES					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the fundamentals of Rapid Prototyping technology	**1.1**	Describe the fundamentals of rapid prototyping techniques	**a, b, g, j, k, l**	
2.0	To acquire knowledge rapid prototyping systems, virtual prototyping, materials selection and prototyping procedures	**2.1**	Demonstrate the concept of virtual prototyping, material selection and reverse engineering	**a, b, g, j, k, l**	
3.0	To introduce the types of rapid manufacturing process	**3.1**	Illustrate the types of rapid prototyping systems for various materials	**a, b, g, j, l**	
4.0	To learn the rapid prototyping process and their applications	**4.1**	Summarize the applications of Rapid Prototyping in casting and tooling	**a, b, g, j, k, l**	
5.0	To study about the rapid manufacturing process and the material properties	**5.1**	Explain the steps involved in Rapid Manufacturing and applications	**a, b, f, j, l**	

UNIT I : FUNDAMENTALS OF RAPID PROTOTYPING	**(9)**
Process requirements for Rapid Prototyping - product prototyping and product development - prototyping - need for prototyping - issues in prototyping - conducting prototyping - design procedure - prototype planning and management - product and prototype cost estimation - fundamentals of cost concepts - prototype cost estimation - cost complexities - prototype design methods - prototype design tools - morphological analysis - functional efficiency technique - paper prototyping - selecting a prototype - learning from nature	
UNIT II : VIRTUAL PROTOTYPING, MATERIALS SELECTION AND PROCEDURE FOR PROTOTYPING	**(9)**
Commercial software for virtual prototyping - prototyping materials - material selection methods - Rapid Prototyping overview - Rapid Prototyping cycle - Rapid Prototyping procedure - stl files - converting stl file from various cad files - controlling part accuracy in stl format - slicing the stl file - case studies in design for assembly Digitization techniques - model reconstruction - data processing for rapid prototyping - Reverse Engineering (RE) methodologies and techniques - selection of re systems - RE software, RE hardware, RE in product development	
UNIT III : TYPES OF RAPID PROTOTYPING SYSTEMS	**(9)**
Types of RP Process - Stereolithography - Fused Deposition Modelling - Selective Laser Sintering - 3D Printing process - Laminated Object Manufacturing - Electron Beam Melting Process - history - operation - advantages and disadvantages - applications - relation to other RP technologies (applies to all the process) - Direct Laser Deposition - Multi jet modeling system - Laser Engineered Net Shaping - Electron Beam Melting - processes, materials, products, advantages, applications and limitations	
UNIT IV : APPLICATIONS OF RAPID PROTOTYPING	**(9)**
Investment casting - sand casting - permanent mould casting - direct RP tooling - silicone rubber tooling -investment cast tooling - powder metallurgy tooling - desktop machining - case Studies on current applications of RP- novel application of RP systems - future trends of RP systems - conventional tooling Vs rapid tooling - classification of rapid tooling - direct and indirect tooling methods - soft and hard tooling methods - application in design - analysis and planning - application in manufacturing and tooling - aerospace industry - automotive industry	

UNIT V : RAPID MANUFACTURING	(9)
Rapid Manufacturing - potential of RM on design - geometrical freedom - material combinations - customer input - RM of prototypes - reverse engineering - interactive CAD models - role of materials in RM - materials for RM process - product customisation and case studies - future developments serving RM - production economics of RM - cost of manufacture - application of RM in medical, automotive, aeronautical, space and construction industries	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Chua.C.K, Leong.K.F and Lim.C.S, "Rapid Prototyping Principles and Applications", 3rd ed., Cambridge University Press India Pvt Ltd 2010.
2. Pham D.T and Dimov S.S, "Rapid manufacturing: the technologies and applications of rapid prototyping and rapid tooling", Springer, London, 2001

REFERENCES:

1. Andreas Gebhardt, "Rapid prototyping", Hanser Gardener Publications, 2003
2. Hari Prasad Ks Badarinarayan, "Rapid Prototyping and Tooling", Page turners, 2015
3. Ian Gibson, David Rosen and Brent Stucker, "Additive Manufacturing Technologies", 2nd ed., springer, 2011
4. Liou W.Liou and Frank W.Liou, "Rapid Prototyping and Engineering applications : A tool box for prototype Development", CRC Press, 2007.
5. Ramesh S, "Textbook of Rapid Prototyping", Ane book Publications, 2016

17MEX23 - SURFACE ENGINEERING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		QUESTION PATTERN : TYPE - 3			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To teach students the basic concepts of surface engineering and its development	1.1	Explain various properties of a surface and its importance during design of components	a, b, g, j, k, l
2.0	To provide students the knowledge of coatings and the formation of technological surface layers	2.1	Identify a coating method for a product to improve surface characteristics	a, b, g, j, k, l
3.0	To enable the students understand the basic principles of Plasma Coating Technology	3.1	Demonstrate the concept of plasma coating technology and its application	a, b, g, j, l
4.0	To study the characteristics of coating and their strength	4.1	Select a type of characterization method for a particular coating	a, b, g, j, k, l
5.0	To make the students learning the types of coatings and laser technology	5.1	List the types of coatings under hard and soft coatings	a, b, f, j, l

UNIT I : INTRODUCTION TO SURFACE ENGINEERING	**(9)**
Differences between surface and bulk, properties of surfaces-wear, corrosion, optical, roughness, electrical and thermal properties, wetability.	
UNIT II : CONCEPTS OF COATING	**(9)**
Coatings - concepts of coatings - electroplating - metallic and non metallic coatings - galvanizing - thermal spray, types of thermals spray and their advantages and disadvantages - conventional verses nanocoatings	
UNIT III : PLASMA COATING TECHNOLOGY	**(9)**
Process parameters, thermal and kinetic history of inflight particle, microstructural features of plasma sprayed coatings, single splat studies, process-structure property relationship, challenges in preparation, plasma spraying of nano powders - its microstructure - properties - Liquid precurser plasma spray- applications	
UNIT IV : CHARACTERIZATION OF COATINGS	**(9)**
Coatings - thickness-porosity-hardness, fracture toughness- elastic modulus - adhesion bending strength-fracture strength- tensile strength- wear and corrosion measurement phase analysis	
UNIT V : HARD AND SOFT COATINGS	**(9)**
Caser cladding- laser alloying, Electron beam hardening-ion beam implantation - sol-gel coatings - electrophoretic deposition - DLC and diamond coatings, antifriction and anti scratch coatings	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Tadeusz Burakowski, Padeusg and Weirzxhon, “Surface Engineering of Metals, Principles, equipments and Technologies”, CRC press,1998
2. BG Miller, “Surface coatings for protection against wear”, Woodhead publishing, 2006

REFERENCES:

1. P. Fauchais, A. Vardelle, and B. Dussoubs, "Quo Vadis Thermal Spraying?", Journal of Thermal Spray Technology, Volume 10(1) March 2001
2. Kenneth B. Tator, “ASM Handbook: Volume 5b: Protective Organic Coatings”, 1st ed., ASM International, 2015

17MEX24 - PROCESS PLANNING AND COST ESTIMATION					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the steps involved in Process Planning and computer aided process planning	**1.1**	Summarize the steps involved in process planning and/or computer aided process planning	**a, b, g, j, k, l**	
2.0	To acquire knowledge on elements of cost and estimation of cost	**2.1**	Identify the elements of cost during manufacture of a product and/or apply the methods to estimate the cost	**a, b, g, j, k, l**	
3.0	To know about the procedure for material cost estimation and weight estimation	**3.1**	Estimate the material cost weight for a particular part	**a, b, g, j, l**	
4.0	To know about the techniques in estimation of time and cost of machining and forging	**4.1**	Determine the machining time of material removal processes in lathe, milling, shaping, planning and grinding	**a, b, g, j, k, l**	
5.0	To introduce the techniques in estimation of time and cost of welding	**5.1**	Adopt the methods of estimation in forging and welding processes to find cost of the process	**a, b, f, j, l**	

UNIT I : PROCESS PLANNING	**(9)**
Product design and analysis - process selection, planning, steps involved, responsibilities of process planning engineer - steps involved in product design - process design - process research, pilot development, capacity consideration, commercial plan transfer - variant and generative process planning	
UNIT II : ELEMENTS OF COST AND COST ESTIMATION	**(9)**
Classification of costs - Cost estimation - functions of cost estimate - costing - types of estimates - methods of cost estimation - variations in cost estimates - data needed and data sources - estimating procedure - functions of estimator - elements of job estimate - selling price - indirect cost allocation	
UNIT III : MATERIAL COST AND WEIGHT ESTIMATION	**(9)**
Steps of estimating material cost - mensuration - area and perimeter, areas of irregular shapes, volume and surface area of solids, centroid, surface areas using centroid, volume of solid of revolution - material weight and cost estimation - steps involved	
UNIT IV : ESTIMATION OF MACHINING TIME	**(9)**
Machining operations - turning, tapping, screw cutting, chamfering , taper turning, relief turning, knurling, facing, drilling in lathe , counter boring, counter sinking, reaming in a lathe, centre drilling, planning in a shape, planning in a planning machine, milling, grinding	
UNIT V : ESTIMATION OF FORGING AND WELDING COST	**(9)**
Types of forging - forging operations - losses in forging - forging cost - Welding - terminologies - filler material, flux- types of welding - fusion and pressure welding - types of welded joints - techniques of welding - leftward and rightward welding, estimation of welding cost	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Gideon Halevi, “Process and operation planning”, 2nd ed., Springer-Verlag New York, 2003
2. Panneerselvam R, “Process Planning and Cost Estimation”, Prentice-Hall of India Pvt.Ltd, 2016

REFERENCES:

1. Adithan.M, “Process Planning and Cost Estimation”, New Age International Publishers, 2015
2. Peter Scallan, “Process planning, The Design/Manufacture interface”, Butterworth-Heinemann, 2003
3. Robert Creese, M. Adithan, B.S Pabla, “Estimating and Costing for the Metal Manufacturing Industries”, Marcel Dekker, 1992
4. Chitale, A, K., and Gupta, R. C, “Product Design and manufacturing”, Prentice Hall of India, New Delhi , 1997
5. G.B.S. Narang, V. Kumar, “Production and Costing”, Khanna Publishers, 2000

17MEX25 - INDUSTRIAL ENGINEERING AND MANAGEMENT					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the concepts of industrial engineering and value chain	**1.1**	Demonstrate an understanding of the concept of industrial engineering, production systems and productivity	**a, b, g, j, k, l**	
2.0	To learn about the work study and work measurement	**2.1**	Describe the steps involved in work study and work measurement	**a, b, g, j, k, l**	
3.0	To acquire knowledge on facility layouts, line balancing and inventory control	**3.1**	Recommend a facility layout for the manufacturing operations and/or solve numerical problems on line balancing and inventory control	**a, b, g, j, l**	
4.0	To introduce the principles of management, human resource management and marketing management	**4.1**	Summarize the principles of management, human resource management and marketing management	**a, b, g, j, k, l**	
5.0	To introduce the concept of project management using CPM/PERT	**5.1**	Estimate the duration of a project using Critical Path Method and/or Program Evaluation and Review Technique	**a, b, f, j, l**	

UNIT I : INDUSTRIAL ENGINEERING AND PRODUCTION SYSTEM	**(9)**
Industrial Engineering - historical development - role of industrial engineer - applications - types of production system - life cycle approach - supply chain management - value chain - productivity - introduction, definition, difference between productivity and production - productivity, efficiency and effectiveness - productivity measurement - base period - productivity index - productivity improvement	
UNIT II : WORK STUDY AND WORK MEASUREMENT	**(9)**
Work study - objectives, steps in work study, purpose and procedure of method study - recording methods and facts - process chart symbol - examine, develop and define, install and maintain - motion economy - working area - work measurement - purpose and organizational suitability - stop watch time study - ILO definitions - performance rating - standard time - work sampling - PMTS - MTM - comparison, job evaluation and merit rating	
UNIT III : FACILITY LAYOUT, LINE BALANCING AND INVENTORY CONTROL	**(9)**
Objective of facility layout - principles - types of common layouts - part machine incidence matrix - comparison of layouts - objectives and constraints in Line Balancing problem - methods of line balancing - Largest Candidate Rule, Kilbridge-Wester Heuristic, Ranked Positional Weight - Inventory control - inventory costs - deterministic models - other observations of basic EOQ model - gradual replacement model - ABC analysis	
UNIT IV : ESSENTIALS OF MANAGEMENT	**(9)**
Principles of management - approaches of management thoughts - role of management - functions of management - levels of management - organization - principles and organization structure and types - organization design - human resource management - organizational behavior - human resource planning - introduction to marketing management - pricing - marketing research	

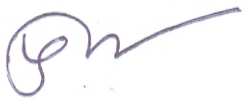
UNIT V : PROJECT MANAGEMENT AND CPM/PERT	(9)
Critical Path Method - methodology of critical path analysis - terminology in project management - symbols used in network planning - common flaws in network - Dummy activity and dummy nodes - rules for constructing network diagram - numbering of events in network - AON Vs AOA approaches for diagramming - float or slack - illustration for floats - Program Evaluation and Review Technique	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Kjell B Zandin and Harold B Maynard, "Maynard's Industrial Engineering Handbook", 5th ed., McGraw-Hill Education, 2001
2. Ravishankar, "Industrial Engineering and Management ", 2nd ed., Galgotia Publications, 2009

REFERENCES:

1. Khanna.O.P, "Industrial Engineering and Management", 17th ed., Dhanpat Rai Publications,2010
2. ILO, "Introduction to work study", 4th ed., Universal Publishing Corporation, 2010
3. M.I. Khan, "Industrial Engineering", New Age International Publications, 2007
4. Pravin Kumar, "Industrial Engineering and Management", 1st ed., Pearson Education India, 2015
5. Ravi. V, "Industrial Engineering and Management", 1st ed., PHI Learning Pvt Ltd., 2015



17GEA05 - ENGINEERING ECONOMICS AND COST ANALYSIS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To understand the basics of Economics	**1.1**	Apply the basics of economics and cost analysis to engineering applications	**a, b, g, j, k, l**	
2.0	To enable students to understand the fundamental economic concepts and value engineering	**2.1**	Summarize the steps involved in decision making with economic feasibility	**a, b, g, j, k, l**	
3.0	To understand the methods by which Cost Analysis, Pricing and Financial Accounting done in the industry	**3.1**	Evaluate an alternative by considering the economic factors	**a, b, g, j, l**	
4.0	To know about the maintenance analysis performed in industries	**4.1**	Conclude the replacement and maintenance policies of industrial equipment	**a, b, g, j, k, l**	
5.0	To learn the techniques of incorporating inflation factor in economic decision making.	**5.1**	Determine the depreciation of industrial equipment over the operating periods using appropriate method	**a, b, f, j, l**	

UNIT I : FUNDAMENTALS OF TO ECONOMICS	**(9)**
Economics - Flow in an economy, Law of supply and demand - Concept of Engineering Economics - types of efficiency, Scope of engineering economics - Element of costs - other costs/revenues - Break even analysis - profit/volume ratio - Make or buy decision, Elementary economic Analysis	
UNIT II : VALUE ENGINEERING AND INTEREST FORMULAS	**(9)**
Value analysis / value engineering - Interest formulae and their applications - Time value of money, Single payment compound and present worth amount, Equal payment series - compound amount, sinking fund, Present worth and capital recovery amount - Uniform gradient series annual equivalent amount, Effective interest rate	
UNIT III : CASH FLOW	**(9)**
Present worth method - Revenue dominated cash flow diagram, cost dominated cash flow diagram - Future worth method - Revenue dominated cash flow diagram, cost dominated cash flow diagram - Annual equivalent method - Revenue dominated cash flow diagram, cost dominated cash flow diagrams - rate of return method	
UNIT IV : REPLACEMENT AND MAINTENANCE ANALYSIS	**(9)**
Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset - capital recovery with return, concept of challenger and defender - Simple probabilistic model for items which fail completely	
UNIT V : DEPRECIATION	**(9)**
Straight line method, declining balance method, Sum of the years-digits method, sinking fund method, service output method - Evaluation of public alternatives - Inflation adjusted decisions - procedure to adjust inflation - Inflation adjusted economic life of machine	
TOTAL (L: 45): 45 PERIODS	

TEXTBOOKS:

1. Panneer Selvam, R, “Engineering Economics”, 2nd ed., PHI learning Pvt. Ltd, New Delhi, 2014
2. James L Riggs, David D Bedworth, Sabah U Randhawa, “Engineering Economics”, 4th ed., McGraw Hill Education, 2004

REFERENCES:

1. Leland Blank, Anthony Tarquin, “Engineering Economy”, 7th ed., McGraw Hill Education, 2012
2. Chan S.Park, “Contemporary Engineering Economics”, 5th ed., Prentice Hall of India, 2011
3. Donald.G. Newman, Jerome.P.Lavelle, “Engineering Economics and analysis”, 10th ed., Oxford University Press, 2010
4. Degarmo, E.P., Sullivan, W.G and Canada, J.R, “Engineering Economy”, 14th ed., Pearson India, 2010.
5. Zahid A Khan, "Engineering Economy", 1st ed., Pearson Education, 2012

17MEX26 - NEW VENTURE PLANNING AND MANAGEMENT					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the concept, theories of entrepreneurship and functions of entrepreneur	**1.1**	Explain the concept of entrepreneurship and functions of an entrepreneur	**a, b, g, j, k, l**	
2.0	To know the steps involved in new venture promotion and fund management	**2.1**	Describe various theories of entrepreneurship	**a, b, g, j, k, l**	
3.0	To acquire knowledge on entrepreneurial behavior, development programme roles of entrepreneur	**3.1**	Identify the steps involved during new venture establishment and fund requirements	**a, b, g, j, l**	
4.0	To get exposure on entrepreneurial behaviour and development programme	**4.1**	Summarize the entrepreneurial behavioural aspects and types entrepreneurship development programmes	**a, b, g, j, k, l**	
5.0	To introduce the role and responsibilities of entrepreneur	**5.1**	Demonstrate the idea of Women and Rural entrepreneurship roles of entrepreneur	**a, b, f, j, l**	

UNIT I : FUNCTIONS OF ENTREPRENEUR	**(9)**
Entrepreneur - definition and concept - characteristics of entrepreneur - entrepreneurship - definition and characteristics - emergence of entrepreneurial class - comparison of entrepreneur with entrepreneurship - enterprise and manager - Danhofis classifications, other classifications - intrapreneurs - ultrapreneurs - functions of entrepreneurs	
UNIT II : THEORIES OF ENTREPRENEURSHIP	**(9)**
Sociological theories - economic theories - cultural theories - psychological theories - specialistsi views on entrepreneurship - walker on entrepreneurship - Harbison Entrepreneurship - Drucker on entrepreneurship - Peter kilby on entrepreneurship - models on entrepreneurship	
UNIT III : PROMOTION OF A VENTURE	**(9)**
Opportunity analysis - environment and entrepreneurship - technological environment - competitive factors - small scale industrial undertakings - steps in setting up a small scale industrial enterprise - legal requirements - important acts - policies of government - raising of funds - internal and external sources of finance - capital structure - capitalization - export finance - venture capital - concept, aims, features of venture capital and financing steps - sources of venture capital and criteria to provide venture capital finance	
UNIT IV : ENTREPRENEURIAL BEHAVIOUR AND DEVELOPMENT PROGRAMME	**(9)**
Innovation and entrepreneur - Schumpeteris and Druckeris theories - entrepreneurial behaviour and psychological theories - social responsibility - entrepreneurship development programmes - meaning and objectives - Indian EDP model - phase of EDPs - EDP Curriculum - Common denominators of success of EDPs - Role, Relevance and Achievements of EDPs - Role of government in organizing EDPs	

UNIT V : ENTREPRENEURSHIP AND ROLE OF ENTREPRENEUR	(9)
Role of entrepreneur - as an innovator in economic growth - generation of employment opportunities -complementing and supplementing economic growth - bringing about social stability and balanced regional development of industries - export promotion and import substitution - foreign exchange earnings and augmenting and meeting local demand - rural entrepreneur - major challenges in the way of development of rural industries - women entrepreneurship	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Shangram Keshari Mohanty, "Fundamentals of Entrepreneurship", Prentice Hall India Pvt ltd, 2005
2. Robert D Hisrich, Mathew J Manimala, Michael P Peters and Dean A Shepherd, "Entrepreneurship", 6th ed., Tata Mcgraw Hill Education Private Limited, 2013

REFERENCES:

1. Bruce R. Barringer and Duane Ireland.R, "Entrepreneurship: Successfully Launching New Ventures", 3rd ed., Pearson Education, 2011
2. Jain.P.C, "Handbook of New Entrepreneur", Oxford University Press, 2003
3. Khanka.S.S, "Entrepreneurial Development", 4th ed., S.Chand and Company Limited, New Delhi, 2007.
4. Rao.T.V and Donald F. Kuratko, "Entrepreneurship : A South-Asian Perspective", 1st ed., Cengage Learning India publications, 2012
5. Srinivasan.N.P and Gupta, C.B, "Entrepreneurial Development", Sultan Chand and Sons Publications, 2015

17GEA03 - TOTAL QUALITY MANAGEMENT					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PAPER TYPE : 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To acquire various concepts of quality management	**1.1**	Students can acquire various concepts of quality management	**b, c, f**
2.0	To implement various principles of quality management	**2.1**	Students can implement various principles of quality management	**b, c, f**
3.0	To impart quality using statistical process	**3.1**	Students will be able to impart quality using statistical process	**b, c, e**
4.0	To use the various tools to maintain quality	**4.1**	Students can learn to use the various tools to maintain quality	**b, c, e**
5.0	To implement the quality system for ISO certification	**5.1**	Students can implement the quality system for ISO certification	**b, c, f, h**

UNIT I : INTRODUCTION	**(9)**
Definitions-Basic approach - Gurus of TQM - TQM Framework - Defining Quality - Dimensions of quality - Benefits of TQM - Leadership: Leadership Concepts - The Deming philosophy - Quality council - Quality statements - Strategic planning - Customer satisfaction: Customer perception of quality - Using customer complaints - service quality - Customer retention	
UNIT II : TQM PRINCIPLES	**(9)**
Employee involvement: Motivation - Empowerment - Teams- Recognition and Reward - Performance appraisal - Continuous process improvement: The Juran Trilogy - PDSA cycle- Kaizen - Six sigma - Supplier Partnership: Partnering, Supplier selection - Supplier Rating	
UNIT III : TQM TOOLS AND TECHNIQUES - I	**(9)**
Bench marking - Reason to bench mark, process - Quality Function Development (QFD) - Failure mode and effect analysis - Stages of FMEA - Other types of FMEA-Management tools: Tree diagram- Matrix diagram- Process decision program chart - Activity network diagram	
UNIT IV : TQM TOOLS AND TECHNIQUES - II	**(9)**
Statistical process control: Pareto diagram - Process flow diagram - Cause and effect diagram - Histogram - Charts - Variable control chart - Control chart for attributes - Scatter diagrams - Process Capability - Total productive maintenance: Learning the new philosophy - Training - Improvement needs	
UNIT V ; QUALITY MANAGEMENT SYSTEMS	**(9)**
Benefits of ISO registration - ISO 9000 series of standards - ISO 9001 Requirements - implementation, Documentation, Internal Audits - Environmental Management system - ISO 14000 series standards - Concepts of ISO 14001 - Requirements of ISO 14001 - Benefits of EMS	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Dale H. Besterfiled, et at., "Total quality Management", Pearson Education Asia, 3rd ed., Indian Reprint, 2011

REFERENCES:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th ed., First Indian Edition, Cengage Learning, 2012.
2. Subburaj Ramasamy , “Total Quality Management”, Tata McGrawHill, First reprint 2009.
3. Suganthi. L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
4. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

17MEX27 - LEAN AND AGILE MANUFACTURING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the principles of lean manufacturing	**1.1**	Demonstrate the lean manufacturing principles to find and eliminate wastes	**a, b, g, j, k, l**	
2.0	To acquire knowledge on tools of lean manufacturing	**2.1**	Identify the lean manufacturing tools and their potential applications	**a, b, g, j, k, l**	
3.0	To explore various visual management techniques, TPM and Lean practices	**3.1**	Summarize the usage of visual management, TPM and lean practices	**a, b, g, j, l**	
4.0	To get knowledge on management and technology drivers of agile manufacturing	**4.1**	Compare the technology drivers of agile manufacturing	**a, b, g, j, k, l**	
5.0	To know the fundamentals of manufacturing strategy and competitive drivers of agile manufacturing	**5.1**	Explain the technology drivers of agile manufacturing	**a, b, f, j, l**	

UNIT I : LEAN MANUFACTURING PRINCIPLES	**(9)**
Lean and Agile manufacturing paradigms - lean manufacturing - origin - Toyota Production System - types of wastes - tools and techniques to eliminate wastes - value stream mapping (VSM) - primary icons - secondary icons - developing the VSM	
UNIT II : LEAN MANUFACTURING TOOLS	**(9)**
5S concepts - stages of 5S and waste elimination - Kaizen - steps of Kaizen - lean manufacturing through Kaizen - Single Minute Exchange of Die - theory of SMED - design for SMED - strategic SMED and waste elimination - pull production through Kanban - one piece flow production	
UNIT III : VISUAL MANAGEMENT, TPM AND LEAN IMPLEMENTATION	**(9)**
Visual management - tools for eliminating wastes - overproduction, inventory, delay, transportation, processing, unnecessary motion, defective parts, underutilization of people - implementation - total productive maintenance - implementation of lean practices	
UNIT IV : MANAGEMENT AND TECHNOLOGY DRIVERS OF AGILE MANUFACTURING	**(9)**
Agile manufacturing - twenty criteria model - management driver - organizational structure - devolution of authority - employee status and involvement - nature of management - business and technical processes - time management - agility through technology driver	
UNIT V : MANUFACTURING STRATEGY AND COMPETITIVE DRIVERS OF AGILE MANUFACTURING	**(9)**
Quick manufacturing setups - quick response - product life cycle management - product service elimination - automation - competitive driver - status of quality and productivity - compatible cost accounting system - outsourcing - implementation of agile manufacturing	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Devadasan.S.R, Mohan Sivakumar.V, Murugesh.R and Shalij.P.R, "Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities", PHI Learning Private Limited, 2012
2. Pascal Dennis, "Lean Production Simplified", 2nd ed., Productivity Press, 2007

REFERENCES:

1. Bill Carreira, "Lean Manufacturing That Works", 1st ed., PHI Learning Private Limited, 2007
2. Dennis P. Hobbs, "LEAN Manufacturing Implementation", 1st ed., Cengage Learning, 2009
3. Charles Grantham, James Ware and Cory Williamson, "Corporate Agility.: A Revolutionary New Model for Competing in a Flat World", PHI Learning Private Limited, 2007
4. Gopalakrishnan.N, "Simplified Lean Manufacture : Elements, rules, tools and implementation", PHI Learning Private Limited, 2010
5. Steven L Goldman, Roger N Nagel and Kenneth Preiss, "Agile Competitors and Virtual Organizations", John Wiley and Sons, 1994

17MEX28 - INDUSTRIAL ROBOTICS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To introduce the constructional features and other basic information on robotics	**1.1**	Explain the basics of robots, types and work volumes	**a, b, g, j, k, l**	
2.0	To get knowledge on various actuators and end effectors	**2.1**	Summarize the methodology of manipulator path control and types of end effectors	**a, b, g, j, k, l**	
3.0	To introduce various sensors used in robotics	**3.1**	Categorize the types sensors with applications and/or describe the use of machine vision in robots	**a, b, g, j, l**	
4.0	To teach robot programming of a typical robot	**4.1**	Develop robot programming for various industrial applications	**a, b, g, j, k, l**	
5.0	To get knowledge on robot work cell design in shop floor and/or economic aspects	**5.1**	Demonstrate the types of robotic work cells and/or apply economic measures to select a robot for an application	**a, b, f, j, l**	

UNIT I : FUNDAMENTALS OF ROBOTICS AND CONTROL SYSTEMS	**(9)**
Robot anatomy - work volume - robot drive systems - control systems and dynamic performance - precision movement - basic control systems concepts and models - controllers - control system analysis- robot activation and feedback components - position and velocity sensors - power transmission - robot joint control design	
UNIT II : MOTION ANALYSIS AND END EFFECTORS	**(9)**
Manipulator kinematics - homogeneous transformations - robot kinematics - manipulator path control - robot dynamics - configuration of robot controller - End effectors - types - mechanical grippers - other types of grippers - tools as end effectors - robot end effectors interface - considerations in gripper selection and design	
UNIT III : SENSORS AND MACHINE VISION	**(9)**
Transducers and sensors - sensors in robotics - tactile sensors - proximity and range sensors -miscellaneous sensors - sensor based systems - uses of sensors in robotics - machine vision - sensing and digitizing - image processing and analysis - training and vision system - robotic applications	
UNIT IV: ROBOT PROGRAMMING AND LANGUAGES	**(9)**
Programming methods - lead through programming - methods, capabilities, limitations - program as a path in space - motion interpolation - WAIT, SIGNAL, DELAY commands - branching - Textual languages - structure - constants, variables, other data objects - motion commands - computations and operations - program control and subroutines - communications and data processing - monitor mode commands	
UNIT V : ROBOT CELL DESIGN AND ECONOMIC ANALYSIS	**(9)**
Robot cell layouts - multiple robots - machine interference - other considerations - work cell control - interlocks - work cell control - interlocks - error detection and recovery - work cell controller - cycle time analysis - graphical simulation - economic analysis - methods - differences in production rates - other factors - project analysis form	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Mikell P Groover, "Industrial Robotics: Technology, Programming, and Applications", 2nd ed., McGraw Hill Education (India) Private Limited, 2012
2. Mittal R K and Nagrath I J, "Robotics and Control",1st ed., McGraw Hill Education (India) Private Limited, 2012

REFERENCES:

1. Deb.S.R, "Robotics Technology and Flexible Automation", 2nd ed., McGraw Hill Education (India) Private Limited, 2009
2. Fu.K.S. Gonzalz.R.C., and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", 1st ed., McGraw Hill Book Co., 2008
3. Rajput. R. K "Robotics and Industrial Automation" 1st ed., S. Chand Group, 2010
4. Richard D.Klafter, Thomas A.Chmielewski and Micheal Negin, "Robotic engineering - An Integrated Approach", Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 2005
5. Yoram Koren, "Robotics for Engineers", McGraw-Hill Book Co., 1992

17MEX29 - OPERATIONS RESEARCH					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To introduce the concept of operations research and linear programming	**1.1**	Apply the concept of linear programming in formulation and solution of industrial problems	**a, e, k, l**
2.0	To acquire knowledge on transportation and assignment models	**2.1**	Determine the optimal transportation and/or assignment cost in manufacturing company	**a, d, e, k, l**
3.0	To know the network techniques and problem solving methodology	**3.1**	Recommend a suitable network model to solve the real time problems	**a, e, k**
4.0	To teach the types of queuing models	**4.1**	Select a suitable waiting line model in production scheduling and/or decision under various risk levels	**a, d, k**
5.0	To understand the concept of production scheduling	**5.1**	Predict the production time needed for the parts considering the schedule	**a, d, e, k, l**

UNIT I : LINEAR MODELS	**(9)**
Concept of a model - scope and optimization techniques in operation research - productivity improvement - concept of linear programming model - development of LP models - man power scheduling, product mix planning - graphical method - simplex method - special cases of linear programming	
UNIT II : TRANSPORTATION AND ASSIGNMENT MODELS	**(9)**
Transportation - mathematical model - types of transportation problem - methods to solve transportation problem - assignment model - zero one programming model - types of assignment problem - Hungerian method	
UNIT III : NETWORK TECHNIQUES	**(9)**
Shortest path model - systematic method, Dijkstra's algorithm, Floyd's algorithm - minimal spanning tree problem - PRIM algorithm, Kruskal's algorithm - maximum flow problem algorithm	
UNIT IV: QUEUING AND DECISION THEORY	**(9)**
Queuing system - terminologies - empirical queuing models - (M/M/1) : (GD/∞/∞) model, (M/M/C) : (GD/∞/∞) model, (M/M/1) : (GD/N/∞) model, (M/M/C) : (GD/N/∞) model - decision theory - decision under certainty, decision under risk, decision under uncertainty	
UNIT V : PRODUCTION SCHEDULING	**(9)**
Single machine scheduling - measures of performance, SPT, WSPT, EDD rules, minimization of total tardiness - flow shop scheduling - Johnson's algorithm - 'n' jobs '2' machines, 'n' jobs '3' - job shop scheduling - '2' jobs 'm' machines	
	TOTAL (L:45) = 45 PERIODS

TEXTBOOKS:

1. Panneerselvam. R, "Operations Research", 2nd ed., PHI Learning Pvt. Ltd., 2009
2. Khanna.O.P, "Industrial Engineering and Management", Dhanpat Rai Publications, 2018

REFERENCES:

1. Hamdy A. Taha, "Operations Research: An Introduction", 10th ed., Pearson Education, 2019
2. Frederick S. Hillier, Gerald J. Lieberman, "Introduction to Operations Research", 10th ed., McGraw Hill Education, 2017
3. Gupta. P. K, Man Mohan, Kanti Swarup, "Operations Research", 7th ed., S. Chand Publishing, 2017
4. Wayne L. Winston, "Operations Research: Applications and Algorithms", 4th ed., Brooks/Cole, 2003
5. Ravindran, Phillips, Solberg. "Operations Research: Principles and Practice", 2nd ed., Wiley India, 2007
6. Yadav. S. R, Malik .A. K, "Operations Research", 1st ed., Oxford University Press, 2014

17MEX30 - ENTREPRENEURSHIP DEVELOPMENT					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program Outcomes**	
1.0	To understand the scope of an entrepreneur and the key areas	**1.1**	Able to gain Knowledge about entrepreneurship	**a, b, g, k, l**	
2.0	To acquire knowledge about entrepreneurial motivation	**2.1**	Able to achieve the benefits of entrepreneurial motivation	**a, b, g, j, k, l**	
3.0	To know about the types and procedures followed in business	**3.1**	Able to derive a business plan with the available sources	**a, b, j, l**	
4.0	To learn the business areas and financing details	**4.1**	Able to explain the financing and accounting details of business	**a, b, j, l**	
5.0	To gain awareness about various supports for entrepreneurship	**5.1**	Increased awareness and confidence about the entrepreneurship development for engineering decisions	**a, b, g, j, k, l**	

UNIT I : ENTREPRENEURSHIP	**(9)**
Entrepreneur – characteristics – types of entrepreneurs – difference between entrepreneur and intrapreneur – role of entrepreneurship in economic development – factors affecting entrepreneurial growth – economic, non-economic, government actions.	
UNIT II : MOTIVATION	**(9)**
Entrepreneurial motivation: theories and factors, achievement motivation –entrepreneurial competencies – entrepreneurship development programs – need, objectives – business game, thematic apperception test, self rating, stress management	
UNIT III : BUSINESS	**(9)**
Small enterprises – definition, characteristics, project identification and selection – project formulation: significance, content, formulation of project report – project appraisal: concept and method – ownership structures: selection and pattern	
UNIT IV: FINANCING AND ACCOUNTING	**(9)**
Finance: need, sources, capital structure, term loans – accounting: need, objectives, process, journal, ledger, trial balance, final accounts – working capital management: significance, assessment, factors, sources, management	
UNIT V : SUPPORT TO ENTREPRENEURS	**(9)**
Sickness in small business: concept, signals, symptoms, magnitude, causes and consequences, corrective measures – government policy for small scale enterprises: growth policy, support. institutional support to entrepreneurs: need and support – taxation benefits to small scale industry: need, depreciation, rehabilitation, investment	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. S.S.Khanka, “Entrepreneurial Development”, S.Chand and Co. Ltd. New Delhi, 1999
2. Kurahko and Hodgetts, “Entrepreneurship - Theory, process and practices”, 10th ed., Thomson learning, 2016

REFERENCES:

1. Hisrich R D and Peters M P, “Entrepreneurship” 5th Ed., Tata McGraw-Hill, 2002
2. Mathew J Manimala,” Entrepreneurship theory at cross roads: paradigms and praxis” Dream tech, 2nd ed., 2006
3. Rabindra N. Kanungo, “Entrepreneurship and innovation”, Sage Publications, New Delhi, 1998

17MEX33 – ARTIFICIAL INTELLIGENCE AND NEURO-FUZZY THEORY					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE - 3**			

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To illustrate the basic concepts of artificial neural networks	**1.1**	Demonstrate the types of Artificial Neural Networks and various learning algorithms	**a, b, k, l**
2.0	To introduce the concept of fuzzy logic and its applications	**2.1**	Apply fuzzy logic model for solving engineering problems	**a, b, j, k, l**
3.0	To acquire knowledge on genetic algorithm and its methodology	**3.1**	Determine the optimum values of process variables for particular process using Genetic Algorithm	**a, b, d, i, j**
4.0	To introduce simulated annealing and particle swarm algorithms	**4.1**	Make use of simulated annealing and particle swarm algorithms to locate the optimum point in search space	**a, c, i, k**
5.0	To provide an overview of artificial intelligence techniques	**5.1**	Utilize various AI techniques for real world applications	**a, b, e, k, l**

UNIT I : ARTIFICIAL NEURAL NETWORKS	**(9)**
Introduction to neural networks - perception learning rule - Hebbian learning - Widrow-Hoff learning - back propagation - associative learning - competitive networks - Grossberg networks and adaptive resonance theory - Hopfield networks - case study	
UNIT II : FUZZY SET THEORY	**(9)**
Introduction to fuzzy set with properties - fuzzy relations - fuzzy arithmetic - fuzzy logic - applications and fuzzy control - case study	
UNIT III : GENETIC ALGORITHM	**(9)**
Introduction to genetic algorithm - GA operations - standard method - rank method - rank space method	
UNIT IV: SIMULATED ANNEALING AND PARTICLE SWARM OPTIMIZATION	**(9)**
Simulated annealing: introduction to annealing process - simulated annealing optimization - particle swarm optimization: introduction to swarm behavior - particle swarm optimization	
UNIT V : ARTIFICIAL INTELLIGENCE	**(9)**
Introduction to artificial intelligence - semantic nets and description matching - generate and test - means-ends analysis and problem reduction - nets, basic search and optimal search - trees and adversarial search - rules and rule chaining - planning - case study - introduction to condition monitoring	
TOTAL (L:45) = 45 PERIODS	

TEXTBOOKS:

1. Russell S., and Norvig P, Artificial Intelligence: A Modern Approach, 3rd ed., Pearson Education, 2009
2. Thrun S., Probabilistic Robotics, Intelligent Robotics and Autonomous Agents Series, MIT Press.

REFERENCES:

1. Michael Negnevitsky and Addison Wesley, "Artificial Intelligence: A Guide to Intelligent Systems", 2nd ed., 2005
2. Jyh-Shing Roger Jang, Chuen-Tsai Sun and Eiji Mizutani, "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine", Prentice Hall
3. Nils J. Nilsson and Morgan Kaufmann, "Artificial Intelligence: A New Synthesis", Elsevier Publishers, 1998
4. David Poole, Alan Mackworth and Randy Goebel, "Computational Intelligence: a logical approach, Oxford University Press, 2004
5. Luger.G, "Artificial Intelligence: Structures and Strategies for complex problem solving", 4th ed., Pearson Education, 2002

17MEX34 - INDUSTRIAL INTERNET OF THINGS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL	**QUESTION PATTERN : TYPE - 1**				

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To make the students to know about basics of Electrical and Electronic devices	**1.1**	The students will be able to understand basics of Electrical circuits and Electronic devices	**a, c, d, i**
2.0	To make the students to know about basics and block diagram of IoT	2.1	The students will be able to understand IOT characteristics and its essential components	**a, b, d, e**
3.0	To make the students to know about Arduino processor and working of Analog and Digital I/O pins	3.1	The students will be able to describe Arduino processor and working of Analog and Digital I/O pins	**a, b, c, g**
4.0	To make the students to know about Raspberry pi and its interface with other devices	4.1	The students will be able to understand Raspberry pi and its interface with other devices	**a, b, c, j**
5.0	To motivate the students to implement the IoT using Arduino / Raspberry Pi	5.1	The students will be able to implement a IoT system using Arduino / Raspberry Pi in Mechanical Engineering stream	**a, f, k, l**

UNIT I : CONCEPTS OF ELECTRICAL AND ELECTRONICS FOR IOT	**(9)**
Introduction - current, voltage and resistance - analog and digital signal - conductors Vs insulators - KCL- KVL - basic electronics components - calculating equivalent resistance for series and parallel circuits - Ohm's law - color coding for a resistor - LED - LCD - LDR	
UNIT II : FUNDAMENTALS OF INTERNET OF THINGS	**(9)**
Introduction - definition and characteristics of Internet of Things - general block diagram and essential components of IOT - role of microprocessor and micro controller - communication of things - IOT connection with internet	
UNIT III : ARDUINO PROCESSOR	**(9)**
Introduction to Arduino processor - general block diagram - working of analog and digital I/O pins - Serial (UART), I2C Communications and SPI communication - Arduino Boards: Mega, Due, Zero and 101 - prototyping basics - technical description - setting up Arduino IDE - Introduction to Arduino programming.	
UNIT IV : RASPBERRY PI	**(9)**
Technical description of Raspberry Pi - comparison of Raspberry Pi Vs Arduino - operating systems for RPi - preparing SD card for Pi - connecting Raspberry Pi as PC - exploring Raspberry Pi environment - logical design using Python.	
UNIT V : MECHANICAL APPLICATIONS OF IOT	**(9)**
Cyber physical systems in machine tools and production systems - automobile applications - biometric car door opening system, accident monitoring system, engine oil and coolant level monitoring system	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOK:

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things - A hands-on approach", Universities Press, 2015.
2. Sabina Jeschke, Christian Brecher, Houbing Song and Danda B. Rawat, "Industrial Internet of Things - Cybermanufacturing Systems", Springer International Publishing Switzerland, 2017
3. Rajesh Singh, Anita Gehlot, Raghuveer Chimata, Bhupendra Singh and P. S. Ranjit, "Internet of things in automotive industries and road safety", River Publishers, 2018

REFERENCES :

1. Muthusubramanian. R, Salivahanan. S and Muraleedharan. K. A, “Basic Electrical, Electronics and Computer Engineering”, Tata McGraw Hill, 2nd edition, 2006.
2. Olivier Hersent, David Boswarthick and Omar Elloumi, “The Internet of Things: Key applications and Protocols”, Wiley Publications 2nd edition, 2013.
3. Marco Schwartz, “Internet of Things with the Arduino Yun”, Packt Publishing, 2014.
4. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, Wiley Publications, 2012.

17MEX39 - 3D PRINTING TECHNOLOGY					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE – 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To introduce the concept of open source 3D printers and rapid tooling	**1.1**	The students will be able to apply 3D printing tools for component design	**a, b, c, e, l**
2.0	To learn the contemporary technology available for 3D printing	2.1	The students will be able to choose the contemporary technology available for 3D design and printing	**a, b, c, e, l**
3.0	To understand the 3D printer design criteria	3.1	The students will be able to design their own 3D printer based on application.	**a, b, c, d**
4.0	To make the students to Understand various post processing methods involved in 3D printing technology	4.1	The students will be able to Apply various post processing methods involved in 3D printing technology	**b, c, e, l**
5.0	To gain knowledge about the materials used in 3D printing	5.1	The students will be able to find the utility of various materials in 3D printing applications	**a, b, c, e, l**

UNIT I : INTRODUCTIONS TO 3D DESIGN TOOLS	**(9)**
Object creation workflow, Constructing object primitives to scale and with accuracy - Duplication and arrayed duplication - Grid and point/vertex snapping - Understanding 3D geometry - Modeling workflows for Polygons - Additive vs Subtractive Tools - Mesh editing - Best Practices for constructing printable polygon meshes - Fundamental Structure - Combining, merging, and sewing up polygon meshes - Problems with the STL File Format	
UNIT II : DESIGN AND CALIBRATION OF A 3D PRINTER	**(9)**
Necessary Parts of 3D Printer - Functional Description and Design Analysis - Build Process - Future Improvements - Types of 3D Printing Software - Printer Software Configuration - Testing the 3D Printer Movement - The First Print - Creating or Downloading a Part - Configuring the Software - Final Print Configuration – Accuracy – Fill - Skirt - Speed and Temperature - Support Structure – Filament – Printing	
UNIT III : POST PROCESSING - PRODUCT VISUALIZATION AND PRINT CLEANING	**(9)**
Workflows for printing - Software and Drivers - Formats for Printing - Post and Export Print Lab setup - Cleanup and airtight modeling - Loading models and arranging print stage - Printing - Removing support material	
UNIT IV : MATERIALS FOR 3D PRINTING.	**(9)**
Types of Materials – Polymers - Thermoplastic Polymers, Thermosetting Polymers and Elastomers – Metals – Ceramics – Composites - Liquid-Based Materials - Solid-Based Materials - Powder-Based Materials - Common Materials Used in 3D Printers – PLA, ABS, PC and Polymides - Materials Selection Considerations	
UNIT V : APPLICATIONS OF 3D PRINTING AND DESIGN FOR ADDITIVE MANUFACTURING	**(9)**
Medical and dental applications of 3D Printing - Bioprinting tissues and organs - dental implants - prosthetics - orthotics - introduction to design for additive manufacturing - seven rules of design of additive manufacturing - tutorial with laboratory demonstration	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOK:

1. Rafiq Noorani, “3D Printing Technology, Applications and Selection”, CRC Press, 2018
2. Olaf Diegel, Axel Nordin and Damien Motte, “A Practical Guide to Design for Additive Manufacturing”, Springer

REFERENCES :

1. Hod Lipson, Melba Kurman, Fabricated: The New World of 3D Printing, Wiley, 2013
2. 3D Anatomy Models: http://lifesciencedb.jp/bp3d/?lng=en
3. AutoDesk Fusion360 HomePage: http://fusion360.autodesk.com
4. International Journal of Rapid Manufacturing
5. Matthew Griffin, Design and Modeling for 3D Printing, Maker Media, Inc., 2013.

17CSX31- PROBLEM SOLVING AND PROGRAMMING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : 17CSC01 / 17CSC02		**QUESTION PATTERN : TYPE 1**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To gain knowledge about the basics of programming	**1.1**	The students will be able to understand the basics of Python Programming constructs.	**a,c,l**
2.0	To gain exposure about selection structure	**2.1**	The students will be able to design programs involving selection structure	**a,b,c,d,l**
3.0	To get knowledge about repetition structure, function and modules	**3.1**	The students will be able to design programs involving function, modules and loops.	**a,b,c,d,k,l**
4.0	To gain exposure about string	**4.1**	The students will be able to realize the need of strings.	**a,b,c,d,k,l**
5.0	To get knowledge about mutable and Immutable types	**5.1**	The students will be able to realize the need of list, tuples and dictionary.	**a,b,c,d,k,l**

UNIT I - INTRODUCTION TO BASICS OF PROGRAMMING	**(9)**
Basics - Variables and Assignment - Basic Data Types- Comments - Operators - print() - Floats	
UNIT II - SELECTION STRUCTURE	**(9)**
Introduction to Selection Structure - if statements, else statements, nested elif statements, truthy and falsey values, Control Structure	
UNIT III - VALUE – REPETITION AND RETURNING STRUCTURE	**(9)**
Loops - while loops, for loops - Nested Loops - Functions - modules - variable scope	
UNIT IV - DATA AND STRING PROCESSING	**(9)**
Strings - Accessing the Strings - Traversing the Strings - Working with Strings - Formatting Strings	
UNIT V - MUTABLE AND IMMUTABLE TYPES AND METHODS	**(9)**
Introduction to lists, indexing and slicing of list, del and list methods, Tuples, Dictionary and its methods.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. Dr. R. Nageswara Rao, - Core Python Programming, Dreamtech Press, 2017 Edition.
2. Reema Thareja - Problem Solving and Programming – Python, Oxford University Press, 2nd Edition.

REFERENCES:

1. Wesley J. Chun, —Core Python Programming, Pearson Education, 2nd edition, 2010.

17ITX26- PROBLEM SOLVING AND ALGORITHMIC SKILLS					
		L	T	P	C
		3	0	0	3
PREREQUISITE: NIL		**QUESTION PATTERN : TYPE – 1**			

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		Course Outcomes		Related Program Outcomes
1.0	To impart fundamental concepts of OOP using python	**1.1**	The students will be able to understand the basics of object oriented concepts in python.	**a,c,l**
2.0	To gain exposure about inheritance and polymorphism	**2.1**	The students will be able to develop applications using inheritance and polymorphism	**a,b,c,d,e,k,l**
3.0	To understand the abstract data types and tree data structures	**3.1**	The students will be able to implement the ADTs and trees	**a,b,c,d,e,k,l**
4.0	To see how graphs and heaps can be used to solve a wide variety of problems	**4.1**	The students will be able to design graph abstract data type and heap	**a,b,c,d,e,k,l**
5.0	To understand the sorting techniques and shortest path algorithms.	**5.1**	The students will be able to implement the sorting techniques and shortest path algorithms.	**a,b,c,d,e,k,l**

UNIT I - MOTIVATION OF FUNDAMENTAL CONCEPT IN PROGRAMMING	**(9)**
Implementation of Classes and Objects in Python - Class Attributes and Instance Attributes - 'self ' parameter - Static Methods and Instance Methods - init() method	
UNIT II - ADVANCED FEATURES IN CONCEPT OF PROGRAMMING	**(9)**
Performing Abstraction and Encapsulation in Python - Single Inheritance - Multiple Inheritance - Multilevel Inheritance - Public, Protected and Private - Naming Conventions. Polymorphism- Overriding and the super() method - Diamond Shape Problem in Multiple Inheritance - Overloading an Operator - Implementing an Abstract Base Class (ABC)	
UNIT III - INTRODUCTION TO ALGORITHMIC THINKING AND PEAK FINDING	**(9)**
Array data structure - Linked List Data Structure and Its Implementation - Stacks and Queues - Binary Search Trees - Balanced Trees: AVL Trees and Red-Black Trees	
UNIT IV - MAPPING VALUES AND PRINCIPLE OF OPTIMALITY	**(9)**
Heaps - Heapsort Algorithm - Associative Arrays and Dictionaries - Ternary Search Trees as Associative Arrays - Basic Graph Algorithms - Breadth - First And Depth - First Search - Spanning Trees	
UNIT V - ANALYZING NUMBER OF EXCHANGES IN CRAZY-SORT	**(9)**
Shortest Path Algorithms, Dijkstra's Algorithm - Bellman-Ford Algorithm - Kruskal Algorithm - Sorting Algorithms- Bubble Sort, Selection Sort and Insertion Sort - Quicksort and Merge Sort, Non-Comparison Based Sorting Algorithms, Counting Sort and Radix Sort	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. Dusty Phillips, Python 3 Object-oriented Programming, Packt Publishing, Second Edition.
2. Bradley N. Miller, David L. Ranum,- Problem Solving with Algorithms and Data Structures Using Python, Franklin, Beedle & Associates, 2011.

REFERENCES:

1. Mark Summerfield - Programming in Python 3, Pearson Education, 2nd Edition
2. Michael T. Goodrich, Irvine Roberto Tamassia, Michael H. Goldwasser, - Data Structures and Algorithms in PythonII, 2013 edition.

17MEX40 - FLEXIBLE MANUFACTURING SYSTEMS			
L	T	P	C
3	0	0	3

PREREQUISITE : NIL | **QUESTION PATTERN : TYPE – 3**

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	Be familiar with the basic types of production systems	**1.1**	Explain the various products in the production system and interpret the scheduling system	**a,c,d,e,g,l,j,k**
2.0	Understand the group technology, methods and FMS	**2.1**	Apply the various production systems, group technology coding and FMS, FMC systems.	**a,d,e,l,j,k**
3.0	Be familiar with the fundamentals and need of FMS planning	**3.1**	Describe the tool management technology and processing stations of Production system.	**a,c,d,e,a,l,j,k**
4.0	Detailed study of flexible manufacturing cells and systems	**4.1**	Apply the various simulation techniques to FMS and use data base techniques.	**a,c,d,e,l,k**
5.0	Familiar with production systems, grouping of parts and FMS, FMC and different software's, hard ware components involving	**5.1**	Select appropriate type of computer control and software for the production system	**a,c,d,e,l,j,k**

UNIT I : PRODUCTION SYSTEMS **(9)**

Types of production systems job, batch and mass production system with example - Different manufacturing functions, Manufacturing support - Organization and information processing in manufacturing - Different types of plant layouts and advantages of each layout - Plant location selection methods with examples - Work in progress inventory models - Scheduling and its types and advantages - Simple problems in selection of plant location - Design the different layouts like automobile plant and supermarket and hospitals and airport etc.

UNIT II : GROUP TECHNOLOGY AND FMS **(9)**

Introduction to GT, Formation of part families - Part classification methods and different coding systems with examples - Production flow analysis methods, Machine cell design, Clustering algorithm - Bond Energy algorithm method with example - Scheduling and control in cellular manufacturing - System planning guide lines and sizing and human resources - Industrial case study for total parts moving to machine cell and machine cell formation, Manufacturing cell - Introduction to FMS, components of FMS - FMS need and types of FMS systems

UNIT III : FLEXIBLE PLANNING **(9)**

Physical planning for FMS, Objective, guide line - Need for flexibility and FMS in industries - User supplier responsibilities in planning, user-supplier role in site preparation - Machine tool selection and layout of FMS - Computer control system and different Data files, Reports and planning the FMS system - Human resources for FMS, Objective, staffing, supervisor role - Quantitative Analysis methods for FMS, Simple problems for FMS System analysis - Benefits and limitations for FMS system - Simple example of FMS planning for Automobile plant

UNIT IV : FLEXIBLE MANUFACTURING CELLS **(9)**

Introduction of cell description and its classifications - Definition of unattended machining, Requirement and features - Component handling and storage systems - Difference between Cellular system and FMS system - FMC hardware configuration and controllers - PLC and computer controllers, Different FMC Communication networks - A case study for modular control design method for a flexible manufacturing cell - Lean manufacturing with example - Agile manufacturing and example case study

UNIT V : FMS SOFTWARE **(9)**

Introduction to Different FMS software's and advantages - General structure and Requirements for FMS software - Functional descriptions and operational overview - FMS installation - Acceptance testing, Performance goals - FMS application in machining, sheet metal fabrication - Prismatic component production - FMS development towards factories of the future - Example case study for FMS

TOTAL (L: 45) = 45 PERIODS

TEXT BOOK:

1. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 4th edition, Pearson Education India Pvt. Ltd., Noida, India, 2015.
2. Radhakrishnan P. and Subramanyan S., "CAD/CAM/CIM", 4th edition, New Age International (P) Ltd., New Delhi, 2016.

REFERENCES :

1. Kalpakjian S and Steven R Schmid, "Manufacturing engineering and technology", 7th Edition, Pearson Education India Pvt. Ltd., Noida, India, 2014.
2. Jain K C., and Sanjay Jain, "Principles of Automation and Advanced Manufacturing Systems" 1st Edition, Khanna Publishers, New Delhi, 2004.

17MEX41 - ADVANCED WELDING PROCESSES				
	L	T	P	C
	3	0	0	3
PREREQUISITE : NIL	**QUESTION PATTERN : TYPE – 3**			

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To describe principles, types, advantages, limitations and application of gas and arc welding processes.	**1.1**	Select appropriate type of gas or arc welding for various Fabrication processes.	**a,c,e,j,k**
2.0	To understand principles, types, advantages, limitations and application of resistance welding processes.	**2.1**	Select appropriate type of resistance welding for an application	**a,c,e,j,k**
3.0	To explain principles, types, advantages, limitations and application of solid state welding processes.	**3.1**	Choose suitable Solid State Welding Process for the various Fabrication processes.	**a,c,e,j,k**
4.0	To understand welding processes for the automation in aerospace, nuclear and surface transport vehicles.	**4.1**	Use the modern welding processes like thermit, electron beam, atomic hydrogen welding and its automation in industries.	**a,c,e,j,k**
5.0	To be familiar with design of weld joints, weldability of various materials and testing of weldments.	**5.1**	Design the weld joint and understand the weldability of Al, Cu & stainless steels and testing of weldments	**a,b,c,e,j,k**

UNIT I : GAS AND ARC WELDING PROCESSES	**(9)**
Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, Gas tungsten arc welding, Gas metal arc welding, Plasma arc welding and Electroslag welding processes - Welding Defects - advantages, limitations and applications.	
UNIT II : RESISTANCE WELDING PROCESSES	**(9)**
Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes - advantages, limitations and applications.	
UNIT III : SOLID STATE WELDING PROCESS	**(9)**
Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Friction stir welding, Forge welding, Roll welding and Hot pressure welding processes - advantages, limitations and applications.	
UNIT IV : OTHER WELDING PROCESS	**(9)**
Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Under Water welding, welding automation in aerospace, nuclear and surface transport vehicles, Welding of plastics.	
UNIT V : DESIGN OF WELD JOINTS, WELDABILITY AND TESTING OF WELDMENTS	**(9)**
Various weld joint designs – Weldability of Aluminium, Copper, and Stainless steels. Destructive (Tensile, Bend, Impact and Nick break test) and nondestructive testing (Liquid penetrate testing, Magnetic particle testing, radiographic testing, Ultrasonic inspection and Eddy current testing) of weldments.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOK:

1. Parmer R.S., "Welding Processes and Technology", Khanna Publishers, New Delhi, 1992.
2. Little R.L., "Welding and welding Technology", Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th reprint, 2008.
3. Parmer R.S., "Welding Engineering and Technology", 1st edition, Khanna Publishers, New Delhi, 2008.

REFERENCES :

1. Schwartz M.M., "Metals Joining Manual", McGraw Hill Books, 1979.
2. Tylecote R.F., "The Solid Phase Welding of Metals", Edward Arnold Publishers Ltd. London, 1968.
3. AWS- Welding Hand Book. 8th Edition.Vol - 2, "Welding Process".
4. Nadkarni S.V., "Modern Arc Welding Technology", 1st edition, Oxford IBH Publishers, 2005.
5. Christopher Davis. "Laser Welding- Practical Guide", Jaico Publishing House, 1994.
6. Davis A.C., "The Science and Practice of Welding", Cambridge University Press, Cambridge, 1993
7. P.N.Rao – Manufacturing Tech – Tata McGraw Hill Publishing Company 2003

17MEX39 - 3D PRINTING TECHNOLOGY				
L	T	P	C	
3	0	0	3	
PREREQUISITE : NIL				

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To introduce the concept of open source 3D printers and rapid tooling	1.1	The students will be able to apply 3D printing tools for component design	a,b,c,e,l
2.0	To learn the contemporary technology available for 3D printing	2.1	The students will be able to choose the contemporary technology available for 3D design and printing	a,b,c,e,l
3.0	To understand the 3D printer design criteria	3.1	The students will be able to design their own 3D printer based on application.	a,b,c,d
4.0	To make the students to Understand various post processing methods involved in 3D printing technology	4.1	The students will be able to Apply various post processing methods involved in 3D printing technology	b,c,e,l
5.0	To gain knowledge about the materials used in 3D printing	5.1	The students will be able to find the utility of various materials in 3D printing applications	a,b,c,e,l

UNIT I - 3D DESIGN TOOLS	(9)
Object creation workflow, Constructing object primitives to scale and with accuracy - Duplication and arrayed duplication - Grid and point/vertex snapping - Understanding 3D geometry - Modeling workflows for Polygons - Additive vs Subtractive Tools - Mesh editing - Best Practices for constructing printable polygon meshes - Fundamental Structure - Combining, merging, and sewing up polygon meshes - Problems with the STL File Format	
UNIT II -DESIGN AND CALIBRATION OF A 3D PRINTER	(9)
Necessary Parts of 3D Printer - Functional Description and Design Analysis - Build Process - Future Improvements - Types of 3D Printing Software - Printer Software Configuration - Testing the 3D Printer Movement - The First Print - Creating or Downloading a Part - Configuring the Software - Final Print Configuration – Accuracy – Fill - Skirt - Speed and Temperature - Support Structure – Filament – Printing	
UNIT III - POST PROCESSING - PRODUCT VISUALIZATION AND PRINT CLEANING	(9)
Workflows for printing - Software and Drivers - Formats for Printing - Post and Export Print Lab setup - Cleanup and airtight modeling - Loading models and arranging print stage - Printing - Removing support material.	

UNIT IV - MATERIALS FOR 3D PRINTING.	(9)
Types of Materials – Polymers - Thermoplastic Polymers, Thermosetting Polymers and Elastomers – Metals – Ceramics – Composites - Liquid-Based Materials - Solid-Based Materials - Powder-Based Materials - Common Materials Used in 3D Printers – PLA, ABS, PC and Polymides - Materials Selection Considerations	
UNIT V -APPLICATIONS OF 3D PRINTING AND DESIGN FOR ADDITIVE MANUFACTURING	(9)
Medical and dental applications of 3D Printing - Bioprinting tissues and organs - dental implants - prosthetics - orthotics - introduction to design for additive manufacturing - seven rules of design of additive manufacturing - tutorial with laboratory demonstration	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOK:

1. RafiqNoorani, "3D Printing Technology, Applications and Selection", CRC Press, 2018
2. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010

REFERENCES:

1. Hod Lipson, Melba Kurman, Fabricated: The New World of 3D Printing, Wiley, 2013
2. 3D Anatomy Models: http://lifesciencedb.jp/bp3d/?lng=en
3. AutoDesk Fusion360 HomePage: http://fusion360.autodesk.com
4. International Journal of Rapid Manufacturing
5. Matthew Griffin, Design and Modeling for 3D Printing, Maker Media, Inc., 2013.
6. Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles & Applications", World Scientific, 2003
7. Ali K. Kamrani, EmandAbouel Nasr, "Rapid Prototyping: Theory & Practice", Springer, 2006.
8. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001

17MEX42 DIGITAL MANUFACTURING AND IoT			
L	T	P	C
3	0	0	3

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To study the various aspects of digital manufacturing.	1.1	Impart knowledge to use various elements in the digital manufacturing.	a,c,d,e,f,h,l,j
2.0	To inculcate the importance of DM in Product Lifecycle Management and Supply chain Management.	2.1	Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment.	a,c,d,e,f,h,l,j
3.0	To formulate of smart manufacturing systems in the digital work environment.	3.1	Select the proper procedure of validating practical work through digital validation in Factories.	a,c,d,e,f,h,l,j
4.0	To interpret IoT to support the digital manufacturing.	4.1	Implementation the concepts of IoT and its role in digital manufacturing.	a,c,d,e,f,h,l,j
5.0	To elaborate the significance of digital twin.	5.1	Analyse and optimize various practical manufacturing process through digital twin.	a,c,d,e,f,h,l,j

UNIT I – INTRODUCTION TO DIGITAL MANUFACTURING AND IoT	(9)
Introduction – Need – Overview of Digital Manufacturing and the Past – Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management – Practical Benefits of Digital Manufacturing – The Future of Digital Manufacturing.	
UNIT II - DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT	**(9)**
Collaborative Product Development, Mapping Requirements to specifications – Part Numbering, Engineering Vaulting, and Product reuse – Engineering Change Management, Bill of Material and Process Consistency – Digital Mock up and Prototype development – Virtual testing and collateral. Overview of Digital Supply Chain - Scope& Challenges in Digital SC - Effective Digital Transformation - Future Practices in SCM	
UNIT III - SMART FACTORY	**(9)**
Smart Factory – Levels of Smart Factories – Benefits – Technologies used in Smart Factory – Smart Factory in IoT- Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cybersecurity	
UNIT IV - INDUSTRY 4.0	**(9)**
Introduction – Industry 4.0 –Internet of Things – Industrial Internet of Things – Framework: Connectivity devices and services – Intelligent networks of manufacturing – Cloud computing – Data analytics – Cyber physical systems –Machine to Machine communication – Case Studies.	
UNIT V - STUDY OF DIGITAL TWIN	**(9)**
Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow-Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:
1. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012. 2. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, A press, 2016.
REFERENCES:
1. Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009. 2. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, “Digital Twin Driven Smart Manufacturing”, Elsevier Science., United States, 2019. 3. Alp Ustundag and EmreCevikcan, “Industry 4.0: Managing The Digital Transformation”, Springer Series in Advanced Manufacturing., Switzerland, 2017 4. Ronald R. Yager and Jordan PascualEspada, “New Advances in the Internet of Things”, Springer., Switzerland, 2018. 5. Ronald R. Yager and Jordan PascualEspada, “New Advances in the Internet of Things”, Springer., Switzerland, 2018.

17MEX43 LEAN MANUFACTURING				
L	T	P	C	
3	0	0	3	
PREREQUISITE : NIL				

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To introduce the basics of 6 SIGMA	1.1	Discuss the basics of 6 SIGMA	a,b,c,d,e,l,k,l
2.0	To learning about the lean manufacturing tools.	2.1	Elaborate the lean manufacturing tools.	a,b,c,d,e,l,k,l
3.0	To study about the deeper understanding methodologies of Lean manufacturing.	3.1	Illustrate about the deeper understanding methodologies of Lean manufacturing.	a,b,c,d,e,l,k,l
4.0	To study the lean concepts and its elements.	4.1	Discuss lean concepts and its elements.	a,b,c,d,e,l,k,l
5.0	To learn implementation and challenges of lean manufacturing.	5.1	Describe the implementation and challenges of lean manufacturing.	a,b,c,d,e,l,k,l

UNIT I – BASICS OF 6 SIGMA	(9)
Introduction to 6 Sigma, basic tools of six sigma like problem solving approach, standard deviation, normal distribution, various sigma levels with some examples, value for the enterprise, Variation, and sources of variation, Mean and moving the mean, Various quality costs, cost of poor quality.	
UNIT II - INTRODUCTION TO LEAN MANUFACTURING TOOLS	(9)
Process Capability Indices, Cause and Effect diagram, Control Charts, Introduction to FMEA, APQP, PPAP. 3 foundational 6 Sigma methodologies: DMAIC, DMEDI, and Process Management DMEDI for process creation, DMAIC for process improvement and PDCA for sustaining improvements.	
UNIT III - DEEPER UNDERSTADING METHODOLOGIES	(9)
What is a process, Why Process management, Keys to process management, Difference between process management and 6 Sigma, Introduction to Deming cycle, PDCA, DMAIC and continuous improvement, DMEDI for creation process, DMAIC Vs DMEDI with examples, Introduction to Toyota Production System, Six Sigma and Production System integration.	
UNIT IV - LEAN ELEMENTS	(9)
Introduction to Lean Concepts like In-Built Quality, Concept of Right Part at the Right Time, Lead Time reduction, Optimum utilization of Capital, Optimum utilization of People. Understanding the Zero-defect concept and Metrics, Focus on Human Resources, Quality, Delivery, Cost. Building Zero defect capabilities, Cultural and Organizational aspects	
UNIT V - IMPLEMENTATION AND CHALLENGES	(9)
Implementing Checks and Balances in the process, Robust Information Systems, Dashboard, follow up and robust corrective and preventive mechanism. Concept of Audits, and continuous improvement from gap analysis, risk assessments etc.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:
1. Quality Planning and Analysis- JM Juran& FM Gryna. Tata McGraw Hill 2. Lean Manufacturing: Principles to Practice by Akhilesh N. Singh, Bibliophile SouthAsia 3. The Toyota Way: 14 Management Principles 4. Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy,Masaki Imai
REFERENCES:
1. Quality Council of India https://qcin.org/ & its library. https://qcin.org/nbqp/knowledge_bank/ 2. International Society of Six Sigma Professionals: https://isssp.org/about-us/ 3. NPTEL / SWAYAM: https://nptel.ac.in/courses/110105123 : Six Sigma, Prof. Jitesh J Thakkar, IIT Kharagpur, Certification course. (Self- Learning). 4. Older / Previous editions of AIAG manuals on APQP, FMEA and PPAP. These are great sources of information on Quality Planning and has basics of Project Management and required skills. 5. Quality Management for Organizations Using Lean Six Sigma Techniques- Erick C Jones

17MEX44 MODERN ROBOTICS				
L	T	P	C	
3	0	0	3	
PREREQUISITE : NIL				

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To introduce definition, history of robotics and robot anatomy.	1.0	Discuss the definition, history of robotics and robot anatomy.	a,b,c,d,e,l
2.0	To learn the simulation of robot kinematics	2.0	Develop the simulation of robot kinematics	a,b,c,d,e,l
3.0	To study the grasping and manipulation of robots.	3.0	Describe the grasping and manipulation of robots.	a,b,c,d,e,l
4.0	To study about mobile robot and manipulation.	4.0	Explain about mobile robot and manipulation.	a,b,c,d,e,l
5.0	To study the applications of industrial, service, domestic robots.	5.0	Discuss the applications of industrial, service, domestic robots.	a,b,c,d,e,l

UNIT I – INTRODUCTION	(9)
Robot: Definition, History of Robotics, Robot Anatomy, Co-ordinate systems, types and classification, Configuration space and degrees of freedom of rigid bodies and robots, Configuration space topology and representation; configuration and velocity constraints; task space and workspace, Rigid-body motions, rotation matrices, angular velocities, and exponential coordinates of rotation, Homogeneous transformation matrices.	
UNIT II - SIMULATION OF ROBOT KINEMATICS	(9)
Robot kinematics, Forward and inverse kinematics (two three four degrees of freedom), Forward and inverse kinematics of velocity, Homogeneous transformation matrices, translation and rotation matrices Dennavit and Hartenberg (D-H) transformation, Dynamics of Open Chains, Trajectory Generation, motion planning, robot control: First- and second-order linear error dynamics, stability of a feedback control system.	
UNIT III - GRASPING AND MANIPULATION OF ROBOTS	(9)
Kinematics of contact, contact types (rolling, sliding, and breaking), graphical methods for representing kinematic constraints in the plane, and form-closure grasping, Coulomb friction, friction cones, graphical methods for representing forces and torques in the plane, End effectors, grippers, types of gripper, gripper force analysis, and examples of manipulation and grasping.	
UNIT IV - MOBILE ROBOTS	(9)
Mobile robot, Wheeled Mobile Robots: Kinematic models of omnidirectional and non-holonomic wheeled mobile robots, Controllability, motion planning, feedback control of non-holonomic wheeled mobile robots; odometry for wheeled mobile robots; and mobile manipulation. Reference Trajectory generation, feed forward control	

UNIT V - APPLICATIONS OF ROBOTS	(9)
Application of robotic: industrial robots, Service robots, domestic and house hold robots, Medical robots, military robots, agricultural robots, space robots, Aerial robotics Role of robots in inspection, assembly, material handling, underwater, space and healthcare.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Modern Robotics: Mechanics, Planning, and Control, by Kevin M. Lynch , Frank C. Park , Cambridge University Press; 1st edition (25 May 2017), ISBN-10 : 110715
2. Modern Robotics: Mechanics, Systems and Control, by Julian Evans, Larsen and Keller Education (27 June 2019), ISBN-10 : 1641720751

REFERENCES:

1. Modern Robotics: Designs, Systems and Control, by Jared Kroff, Willford Press (18 June 2019)ISBN-10 : 1682856763
2. Advanced Technologies in Modern Robotic Applications, by ChenguangYang, Hongbin Ma, Mengyin Fu, Springer; Softcover reprint of the original 1st ed. 2016 edition (30 May 2018), ISBN - 10 : 981109263X
3. Modern Robotics: Building Versatile Machines, by Harry Henderson, Facts On File Inc; Illustrated edition (1 August 2006), ISBN-10 : 0816057451
4. Artificial Intelligence for Robotics, by Francis X. Govers, Packt Publishing Limited; Standard Edition (30 August 2018), ISBN-10 : 1788835441
5. Modern Robotics Hardcover by Lauren Barrett (Editor), Murphy & Moore Publishing (1 March 2022), ISBN-10 : 1639873732

17MEX45 GREEN MANUFACTURING DESIGN AND PRACTICES					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To introduce the concept of environmental design and industrial ecology.	1.0	Explain the environmental design and selection of eco-friendly materials.	a,b,c,d,g,l,l
2.0	To impart knowledge about air pollution and its effects on the environment.	2.0	Analyse manufacturing processes towards minimization or prevention of air pollution.	a,b,c,d,g,l,l
3.0	To enlighten the students with knowledge about noise and its effects on the environment.	3.0	Analyse manufacturing processes towards minimization or prevention of noise pollution.	a,b,c,d,g,l,l
4.0	To enlighten the students with knowledge about water pollution and its effects on the environment.	4.0	Analyse manufacturing processes towards minimization or prevention of water pollution.	a,b,c,d,g,l,l
5.0	To introduce the concept of green co-rating and its need	5.0	Evaluate green co-rating and its benefits.	a,b,c,d,g,l,l

UNIT I – DESIGN FOR ENVIRONMENT AND LIFE CYCLE ASSESSMENT	(9)
Environmental effects of design -selection of natural friendly material - Eco design - Environmental damage Material flow and cycles – Material recycling – Emission less manufacturing- Industrial Ecology – Pollution prevention – Reduction of toxic emission – design for recycle.	
UNIT II - AIR POLLUTION SAMPLING AND MEASUREMENT	**(9)**
Primary and Secondary Pollutants, Automobile Pollutants, Industrial Pollution, Ambient air quality Standards, Metrological aspects of air Pollution, Temperature lapse Rates and Stability-wind velocity and turbulence-Pump behavior dispersion of air Pollutants-solution to the atmosphere dispersion equation-the Gaussian Plume Model, Air pollution sampling-collection of gaseous air pollutants-collection of particulate pollutants-stock sampling, analysis of air pollutants-sulfur dioxide-nitrogen dioxide, carbon monoxide, oxidants and ozone.	
UNIT III - NOISE POLLUTION AND CONTROL	**(9)**
Frequency and Sound Levels, Units of Noise based power radio, contours of Loudness. Effect of human, Environment and properties, Natural and Anthrogenic Noise Sources, Measuring Instruments for frequency and Noise levels, Masking of sound, Types, Kinetics, Selection of different reactors used for waste treatment, Treatment of noise at source, Path and Reception, Sources of noise, Effects of noise- Occupational Health hazards, thermal Comforts, Heat Island Effects, Radiation Effects.	
UNIT IV - WATER DEMAND AND WATER QUALITY	**(9)**
Factors affecting consumption, Variation, Contaminants in water, Nitrates, Fluorides, Detergents, taste and odour, Radio activity in water, Criteria, for different impurities in water for portable and non-portable use, Point and non-point Source of pollution, Major pollutants of Water, Water Quality Requirement for different uses, Global water crisis issues.	

UNIT V - GREEN CO-RATING	(9)
Ecological Footprint - Need For Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage- Assessment Process – Types Of Rating – Green Co-Benefits – Case Studies Of Green Co- Rating	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
2. Rao M.N. and Dutta A.K. "Wastewater treatment", Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006

REFERENCES:

1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
2. Frances Cairncross- Costing the Earth: The Challenge for Governments, the Opportunities for Business – Harvard Business School Press – 1993.
3. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
4. Rao M.N. and Dutta A.K. "Wastewater treatment", Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006
5. Rao CS Environmental Pollution Control Engineering-, Wiley Eastern Ltd., New Delhi, 2006.
6. Lewis H Bell and Douglas H Bell, Industrial noise control, Fundamentals and applications, Marcel Decker, 1994.

17MEX46 ENVIRONMENT SUSTAINABILITY AND IMPACT ASSESSMENT					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		Course Outcomes		Related Program outcomes	
1.0	To make the students to understand the concepts of Environmental Sustainability & Impact Assessment	1.0	Explain the concepts of Environment Sustainability and trained to make decision related to Environment.	a,c,g,l,l	
2.0	To familiarize the students in environmental decision making procedure.	2.0	Make decision that has an effect on our environment	a,c,g,l,l	
3.0	Make the students to identify, predict and evaluate the economic, environmental, and social impact of development activities	3.0	Evaluate the basics of environmental policy, planning and various legislation Get valuable information for exploring decisions in each life stage of materials, buildings, services and infrastructure.	a,c,g,l,l	
4.0	To provide information on the environmental consequences for decision making	4.0	Explain the Life cycle assessment of Environmental sustainability.	a,c,g,l,l	
5.0	To promote environmentally sound and sustainable development through the identification of appropriate alternatives and mitigation measures.	5.0	Explain sustainable urban economic development.	a,c,g,l,l	

UNIT I – ENVIRONMENTAL IMPACT ASSESMENT	(9)
Environmental impact assessment objectives – rationale and historical development of EIA - Conceptual frameworks for EIA Legislative development – European community directive – Hungarian directive.	
UNIT II - ENVIRONMENTAL DECISION MAKING	(9)
Strategic environmental assessment and sustainability appraisal – Mitigation, monitoring and management of environmental impacts- Socio economic impact assessment.	
UNIT III - ENVIRONMENTAL POLICY, PLANNING AND LEGISLATION	(9)
Regional spatial planning and policy – Cumulative effects assessment – Planning for climate change, uncertainty and risk.	

UNIT IV - LIFE CYCLE ASSESSMENT	(9)
Life cycle assessment; Triple bottom line approach; Industrial Ecology. Ecological foot printing, Design for Environment, Future role of LCA, Product stewardship, design, durability and justifiability, measurement techniques and reporting	
UNIT V - SUSTAINABLE URBAN ECONOMIC DEVELOPMENT	**(9)**
Spatial economics – Knowledge economy and urban regions.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. The Application of Science in Environmental Impact Assessment, by Aaron J. MacKinnon, Peter N. Duinker , Tony R. Walker , Routledge; 1st edition (14 May 2019), ISBN-10 : 0367340194
2. Routledge Handbook of Environmental Impact Assessment, by Kevin Hanna, Routledge; 1st edition (11 April 2022), ISBN-10 : 0367244470

REFERENCES:

1. Clive George, C. Collin, H. Kirkpolarice – Impact Assessment and sustainable development – Edward Elgar Publishing, 2007
2. Robort B Gibsan, Sustainability Assessment, Earth Scan publishers, 2005
3. Simon Dresner, The principle of sustainability – Earth Scan publishers, 2008
4. Canter, R.L., "Environmental Impact Assessment", McGraw Hill Inc., New Delhi, 1996.
5. Shukla, S.K. And Srivastava, P.R., "Concepts In Environmental Impact Analysis", Common Wealth Publishers, New Delhi, 1992.
6. John G. Rau And David C Hooten "Environmental Impact Analysis Handbook", McGraw Hill Book Company, 1990.

17MEX47 ENERGY SAVING MACHINERY AND COMPONENTS				
L	T	P	C	
3	0	0	3	
PREREQUISITE : NIL				

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To introduce the various energy saving machineries and components to the students for the purpose of conserving energy.	1.0	Explain the various energy saving machinery and components.	a,b,c,d,g,l,l
2.0	To study the basics and principles of transforms, Pumps and motors.	2.0	Evaluate the various methods of conservation of energy.	a,b,c,d,g,l,l
3.0	To impart the knowledge about the methods of energy conservation.	3.0	Evaluate the performance and energy conservation of fans, pumps and compressors.	a,b,c,d,g,l,l
4.0	To introduce the energy efficiency devices and concepts of ENCON.	4.0	Discuss the various energy efficiency devices.	a,b,c,d,g,l,l
5.0	To impart the knowledge about CO2 mitigation.	5.0	Explain the co2 mitigation and cost factor.	a,b,c,d,g,l,l

UNIT I – BASICS OF ELECTRICAL ENERGY USAGE	(9)
Fuel to Power : Cascade Efficiency – Electricity Billing : Components and Costs – kVA – Need and Control – Determination of kVA demand and Consumption – Time of Day Tariff – Power Factor Basics – Penalty Concept for PF – PF Correction – Demand Side Management (a brief) - energy monitoring, measurement and analysis.	
UNIT II - TRANSFORMERS AND MOTORS	**(9)**
Transformer – Basics and Types – AVR and OLTC Concepts – Selection of Transformers – Performance Prediction - Energy Efficient Transformers - Motors : Specification and Selection – Efficiency / Load Curve – Load Estimation – Assessment of Motor Efficiency under operating conditions – Factors affecting performance – ill effects of Rewinding and Over sizing - Energy Efficient Motors – ENCON Scope. Transmission Line Parameters – Transmission Line Losses- Kelvin's Law Performance Calculation and Analysis	
UNIT III - FANS, PUMPS AND COMPRESSORS	**(9)**
Basics – Selection – Performance Evaluation – Cause for inefficient operation – scope for energy conservation – methods adopted for effecting ENCON – Economics of ENCON adoption.	
UNIT IV - STUDY OF ILLUMINATION AND ENERGY EFFICIENT DEVICES	**(9)**
Specification of luminaries - Types - Efficacy - Selection and Application - ENCON Avenues and Economic Proposition - New Generation Luminaries (LED - Induction Lighting) - Soft Starters- Auto Star - Delta - Star Starters- APFC - Variable Speed and Frequency Drives - Time Sensors - Occupancy Sensors.	

UNIT V – CO2 MITIGATION AND CASE STUDIES	(9)
Evaluation for 3 / 4 Typical Sectors – PAT Scheme (an introduction) – CO_2 Mitigation - Energy Conservation - Cost Factor. Case Studies on Industrial Energy Audit.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Energy-Efficient Shutdown of Circuit Components and Computing Systems, by EhsanPakbaznia, Proquest, Umi Dissertation Publishing (1 September 2011) ,ISBN-10 : 1243819898
2. Handbook on Energy Efficiency, TERI, New Delhi, 2001

REFERENCES:

1. Hamies, Energy Auditing and Conservation ; Methods Measurements, management and Case Study, Hemisphere, Washington, 1980
2. Trivedi, PR and Jolka KR, Energy Management, Commonwealth Publication, New Delhi, 1997
3. Handbook on Energy Efficiency, TERI, New Delhi, 2001
4. Peters, Kraushaar and Ristenen, Sustainable Energy, beta – test – draft, Energy and Problems of a Technical Society, 1993
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors (www.energymanagertraining.com)
6. Nagrath IJ and Kothari DP, Power system engineering, TMH, 2007

17MEX48 GREEN SUPPLY MANAGEMENT					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		Course Outcomes		Related Program outcomes	
1.0	To familiar the various standards and legislation of modern electronic manufacturing.	1.1	Get concise awareness of standards and legislation of modern electronic manufacturing for green environment.	a,b,c,g,l,k,l	
2.0	To know the conventional electronic processing and lead-free electronic manufacturing techniques.	2.1	Explain the conventional electronic processing and lead free electronic manufacturing techniques.	a,b,c,g,l,k,l	
3.0	To recognize the steps involved in assembly process and understand the need of recycle the electronics	3.1	Realize the assembly process and the need of recycle of electronics	a,b,c,g,l,k,l	
4.0	To implement reliability and product life cycle estimation tools in green electronic manufacturing.	4.1	Use reliability and product life cycle estimation tools for electronic manufacturing.	a,b,c,g,l,k,l	
5.0	To demonstrate the green electronic manufacturing procedure in applications.	5.1	Validate the green electronic manufacturing procedures in applications.	a,b,c,g,l,k,l	

UNIT I – INTRODUCTION TO GREEN ELECTRONICS	(9)
Environmental concerns of the modern society- Overview of electronics industry and their relevant regulations in China, European Union and other key countries- global and regional strategy and policy on green electronics industry. Restriction of Hazardous substances (RoHS) - Waste Electrical and electronic equipment (WEEE - Energy using Product (EuP) and Registration - Evaluation, Authorization and Restriction of Chemical substances (REACH).	
UNIT II - GREEN ELECTRONICS MATERIALS AND PRODUCTS	(9)
Basics of IC manufacturing and its process – Electronics with Lead (Pb) -free solder pastes, conductive adhesives, Introduction to green electronic materials and products - halogen-free substrates and components. Substitution of non-recyclable thermosetting polymer based composites with recyclable materials X-Ray Fluorescence (XRF) for identifying hazardous substances in electronic products	
UNIT III - GREEN ELECTRONICS ASSEMBLY AND RECYCLING	(9)
Various processes in assembling electronics components - the life-cycle environmental impacts of the materials used in the processes - substrate interconnects. Components and process equipments - Technology and management on e-waste recycle system construction, global collaboration, and product disassembles technology.	

UNIT IV - PRODUCT DESIGN AND SUSTAINABLE ECO-DESIGN	(9)
Stages of product development process in green design: Materials- Manufacturing - Packaging and use - End of Life and disposal - Design for recycling - Life Cycle Assessment (LCA), and Eco-design tools - Environmental management systems, and International standards - Eco-design in electronics industry.	
UNIT V - CASE STUDIES	(9)
Reliability of green electronics systems , Reuse and recycle of End-of-Life(EOL) electrical and electronic equipment for effective waste management – Introduction of Green Supply Chain, and Modeling green products from Supply Chain point of view - A life-cycle assessment for eco-design of Cathode Ray Tube Recycling.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Green Supply Chain Management, by CharisiosAchillas , Dionysis D. Bochtis , DimitriosAidonis, Routledge; 1st edition (16 November 2018), ISBN-10 : 1138644617
2. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.

REFERENCES:

1. David Austen, Green Electronic Morning, Ingleby Gallery, 2006.
2. John Hu. Mohammed Ismail, CMOS High Efficiency on – Chip Power Management, Springer Publications 4th edition, 2011.
3. Yuhang yang and Maode Ma, Green Communications and Networks, Springer Publication., 2014.
4. SankaGanesan, Michael Pecht, Lead free Electronics, John Wiley & Sons, 2006.
5. Charles A. Harper, Electronic Materials and Processes Hand book, McGraw-Hill, 2010.
6. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.

17MEX49 AUTOMOTIVE MATERIALS, COMPONENTS, DESIGN AND TESTING				
	L	T	P	C
	3	0	0	3
PREREQUISITE : NIL				

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To describe the functional requirements of engine components and suitable materials	1.1	Demonstrate the requirements of engine components and select suitable materials.	a,b,c,d,l
2.0	To design cylinder and piston components	2.1	Apply the concept of design to cylinder and piston components and solve problems.	a,b,c,d,l
3.0	To design connecting rod and crank shaft	3.1	Apply the concept of design to Connecting rod and crank shaft and solve problems.	a,b,c,d,l
4.0	To design of flywheel and valve train	4.1	Apply the concept of design to flywheel and valve train and solve problems.	a,b,c,d,l
5.0	To describe the Engine Testing cycles, Emission measurement technologies	5.1	Demonstrate engine teste cycles, dynamometer and emission measurement technologies and instruments	a,b,c,d,l

UNIT – I FUNCTIONAL REQUIREMENTS OF ENGINE COMPONENTS AND SUITABLE MATERIALS	6
Functional requirements of engine components – Piston, piston pin, cylinder liner, connecting rod, crank shaft, valves, spring, engine block, cylinder head, and flywheel. Suitable materials for engine components.	
UNIT – II DESIGN OF CYLINDER AND PISTON COMPONENTS	6
Design of cylinder, cylinder head, piston, piston rings and piston pin	
UNIT – III DESIGN OF CONNECTING ROD AND CRANK SHAFT	6
Design of connecting rod – Shank design – small end design – big end design – bolts design. Design of overhang crank shaft under bending and twisting – Crank pin design – Crank web design – Shaft design.	
UNIT – IV DESIGN OF FLYWHEEL AND VALVE TRAIN	6
Design of valve – inlet valve – exhaust valve - Valve springs – tappet – rocker arm. Determination of mass of flywheel for a given coefficient of fluctuation of speed. Design of flywheel - rim - hub - arm.	
UNIT – V ENGINE TESTING	6
Engine test cycles – Worldwide harmonized Light-duty vehicles Test Cycles ((WLTC) – World Harmonized Stationary Cycle (WHSC) – World Harmonized Vehicle Cycle (WHVC) – Nonroad Transient Cycle (NRTC) – ISO 8178. Dynamometer - Chassis dynamometer - transient dynamometer. Emission measurement technologies and instruments - NO_X – Smoke – Particulate matter – CO – CO_2 - HC.-Particle counter	
TOTAL (L:30 + P:30) = 60 PERIODS	

EXPERIMENTS

1. Design and animate Piston Cylinder assembly and motion study using CAD software.
2. Design and simulate Connecting rod and crank shaft
3. Design flywheel and valve
4. Design and simulate Two Cylinder Engine assembly using CAD software.
5. Conduct the engine performance test
6. Conduct the emission test

TEXT BOOK:

1. Khurmi. R.S. & Gupta. J.K., "A text book of Machine Design", Eurasia Publishing House (Pvt) Ltd, 2001.
2. The Automotive Chassis: Volume 1: Components Design (Mechanical Engineering Series) by Giancarlo Genta and Lorenzo Morello | 24 December 2019

REFERENCES:

1. Hiroshima Yamagata, “The science and technology of materials in automotive engines”, Woodhead Publishing Limited, Cambridge, England.
2. Jain.R.K, “Machine Design”, Khanna Publishers, New Delhi, 2005
3. Manufacturing Automotive Components from Sustainable Natural Fiber Composites (SpringerBriefs in Materials) by Lobna A. Elseify, MohamadMidani, et al. | 9 August 2021
4. Mechanical and Materials Engineering of Modern Structure and Component Design (Advanced Structured Materials Book 70) by Andreas Öchsner and Holm Altenbach | 6 June 2015
5. Advanced Technology for Design and Fabrication of Composite Materials and Structures: Applications to the Automotive, Marine, Aerospace and ... Applications of Fracture Mechanics) by George C. Sih, Alberto Carpinteri, et al. | 15 December 2010

WEB RESOURCES

https://tinyurl.com/mrwpjtbz
https://tinyurl.com/464ndbeh
https://tinyurl.com/4t4ukv6m

17MEX50 CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY			
L	T	P	C
3	0	0	3

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To learn various advanced combustion technologies and its benefits	1.1	Demonstrate the need of advanced combustion technologies and its impact on reducing carbon foot-print on the environment.	a,b,l
2.0	To learn the methods of using low carbon fuels and its significance	2.1	Analyse the basic characteristics of low carbon fuels, its impact over conventional fuels and in achieving sustainable development goals.	a,b,l
3.0	To describe the advanced engine technologies	3.1	Demonstrate the latest trends in engine technology	a,b,l
4.0	To learn and understand the hybrid and electric vehicle configurations	4.1	describe the working and energy flow in various hybrid and electric configurations.	a,b,l
5.0	To study the application of fuel cell technology in automotives	5.1	Analyse the need for fuel cell technology in automotive applications.	a,b,l

UNIT – I COMBUSTION TECHNOLOGY	9
Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low Temperature Combustion Concepts- Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.	
UNIT – II LOW CARBON FUEL TECHNOLOGY	**9**
Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward	
UNIT – III ADVANCED ENGINE TECHNOLOGY	**9**
Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder De-activation, After Treatment Technologies, Electric EGR, Current EMS architecture	
UNIT – IV HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED)	**9**
Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward	
UNIT – V FUEL CELL TECHNOLOGY	**9**
Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:
1. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004 2. Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines. ISBN 978-3-319-68507-6, SPRINGER
REFERENCES:
1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003. 2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003 3. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998 4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003. 5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

17MEX51 RENEWABLE POWERED OFF HIGHWAY VEHICLES AND EMISSION CONTROL TECHNOLOGY				
	L	T	P	C
	3	0	0	3
PREREQUISITE : NIL				

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To study the low and zero carbon fuels suitability and methods of use in off-road vehicles	1.1	Select suitable low and zero carbon fuels for off-highway vehicles.	a,b,c,d,e,l,l
2.0	To learn and understand the green energy production methodologies and its use in off-road vehicle categories	2.1	Demonstrate green energy technologies and its applications in off road vehicles.	a,b,c,d,e,l,l
3.0	To learn various fuel cell types and its suitability in off-highway vehicles applications	3.1	Select the suitable fuel cell for Off-Highway vehicles	a,b,c,d,e,l,l
4.0	To illustrate the impact of in-cylinder technologies on engine out emissions control	4.1	Demonstrate in-cylinder low temperature combustion technologies and its key role in controlling the engine-out emissions.	a,b,c,d,e,l,l
5.0	To study the existing after-treatment technologies used in off-highway vehicle applications	5.1	Demonstrate the working of various after treatment systems in controlling the engine out emissions.	a,b,c,d,e,l,l

UNIT – I LOW AND ZERO CARBON FUELS POWERED OFF-HIGHWAY VEHICLES	9
Ethanol, Methanol, Butanol, Biodiesel, Compressed natural gas,liquefied natural gas, Dimethyl ether, Polyoxymethylene Dimethyl Ether, Ammonia and Hydrogen Fuels suitability, methods, and technologies for powering off-road vehicles.	
UNIT – II GREEN ENERGY POWERED OFF-HIGHWAY VEHICLES	9
Solar Technology for Green Electricity, Green Electricity for Hydrogen Production, Hydrogen Smart Grid Technologies, Hydrogen to ICE powered vehicles, Hydrogen to Fuel Cell Powered Vehicles.	
UNIT – III FUEL CELL POWERED OFF-HIGHWAY VEHICLES	9
Fuel Cell, Types, Applications, Fuel Cell Requirement, Sizing and Design for Off-Highway applications, Merits and Demerits, Pathway to overcome the limitations. Scope of the fuel cell research on Off-road vehicle applications.	
UNIT – IV IN-CYLINDER TREATMENT TECHNOLOGIES	9
Low temperature Combustion Modes - Homogeneous Charge Compression Ignition, Premixed-Charge Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition, Water Injection Technologies.	
UNIT – V AFTER TREATMENT TECHNOLOGIES	9
Diesel Oxidation Catalyst, Diesel Particulate Filter, Selective Catalytic Reduction, Ammonia slip / clean up catalyst. CO_2 absorption techniques, Waste Heat Recovery and Organic Rankine Cycle.	
TOTAL 45 PERIODS	

TEXT BOOKS:
1. John Twidell, and Tony Weir. Renewable Energy Sources – 3rd Edition 2015 2. Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines.
REFERENCES:
1. Daniel J Holt. Fuel Cell Powered Vehicles: Automotive Technology of the Future. Society of Automotive Engineers, 2001 - Technology & Engineering, 2. W. AddyMajewski, Magdi K. Khair. Diesel Emissions and Their Control. 3. Toward Zero Carbon: The Chicago Central Area DeCarbonization Plan by Adrian Smith and Gordon Gill | 1 June 2011 4. Transportation in a Net Zero World: Transitioning Towards Low Carbon Public Transport (Green Energy and Technology) by Kathryn G. Logan, Astley Hastings, et al. | 7 April 2022 5. The Political Economy of Low Carbon Transformation: Breaking the habits of capitalism (Routledge Studies in Low Carbon Development) by Harold Wilhite | 21 December 2017

17MEX52 VEHICLE HEALTH MONITORING, MAINTENANCE AND SAFETY				
L	T	P	C	
3	0	0	3	

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To enable the student to understand the principles, functions and practices adapted in maintenance activities of vehicles	1.1	Demonstrate the general maintenance and monitoring of vehicle	a,b,c,d,e,l,l
2.0	To study the power train maintenance, fault diagnosis, maintenance of Batteries	2.1	Demonstrate powertrain tests and its maintenance.	a,b,c,d,e,l,l
3.0	To develop vehicle system maintenance and service of clutch, brake	3.1	Demonstrate the maintenance of braking systems, steering and wheels	a,b,c,d,e,l,l
4.0	To study the concepts of vehicle safety and regulations.	4.1	Demonstrate various vehicle safety features.	a,b,c,d,e,l,l
5.0	To study and understand the simulation of safety concepts	5.1	Demonstrate the simulation of safety concepts.	a,b,c,d,e,l,l

UNIT – I GENERAL MAINTENANCE OF VEHICLE	9
Need for Maintenance – importance, classification of maintenance work-basic problem diagnosis. Maintenance of vehicle systems – power pack, tyres, safety systems. Scheduled maintenance services – service intervals – On-board diagnostics(OBD), Computerized engine analyzer study and practice- OBD I & II and scan tools;	
UNIT – II POWERTRAIN MAINTENANCE	**9**
Exhaust emission test of petrol and diesel engine; - Electronic fuel injection and engine management service - fault diagnosis- OBD-III and scan tool, identifying Diagnostic Trouble Code(DTC) and servicing emission controls, Maintenance of Batteries, Starting System, Charging System and Body Electrical -Fault Diagnosis Using Scan Tools.	
UNIT – III VEHICLE SYSTEM MAINTENANCE	**9**
Clutch- adjustment and service, Maintenance and Service of Hydraulic brake, Bleeding of brakes, Checking Anti-lock Braking System(ABS) and components. Maintenance and Service of McPherson strut, coil spring. tyre wear, measurement of read depth and tyre rotation, Computerized wheel balancing & wheel alignment, Maintenance and Service of steering linkage, steering column, Rack and pinion steering	
UNIT – IV VEHICLE SAFETY	**9**
Concepts of vehicle safety -Seat belt, regulations, automatic seat belt tightener system, collapsible steering column, air bags, electronic system for activating air bags, bumper design for safety, Active Safety - ABS, Electronic Brake-force Distribution(EBD), Cornering Stability Control (CSC), Traction control system, Modern electronic features in vehicles like tyre pressure monitoring, Automatic headlamp ON, Rain sensing wipers.	

UNIT – V SIMULATION OF SAFETY CONCEPTS	9
Active safety: driving safety, conditional safety, perceptibility safety, operating safety passive safety: exterior safety, interior safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact. Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system Interactions.	
TOTAL 45 PERIODS	

TEXT BOOKS:

1. 5th Edition, “Advanced Automotive Fault Diagnosis Automotive Technology: Vehicle Maintenance and Repair” By Tom Denton
2. Safety Management System and Documentation Training Programme Handbook by S. V. Paul ISBN: 9788123923444

REFERENCES:

1. Ed May, "Automotive Mechanics Volume One" and Two, McGraw Hill Publications, Tenth edition, 2018
2. Bosch Automotive Handbook, Tenth Edition, 2018
3. Jack Erjavek, “A systems approach to Automotive Technology”, Cengage Learning, 5th Edition, 2012
4. William H. Crouse and Donald L. Anglin, “Automotive Mechanics”, Tata McGraw Hill, 10thEdition, 2004.
5. Vehicle Service Manuals of Reputed Indian Manufacturers

17MEX53 CAE AND CFD APPROACH IN FUTURE MOBILITY			
L	T	P	C
3	0	0	3

PREREQUISITE:NIL

COURSE OBJECTIVES AND OUTCOMES:

	Course Objectives		Course Outcomes	Related Program outcomes
1.0	To study the use of computer in mobility software or mobility.	1.1	Demonstrate the basic concept of the CAE /CFD	a,b,c,d,e,g,l,l
2.0	To study the concepts computer aided design and rapid prototyping	2.1	Develop the computer aided design and rapid prototyping.	a,b,c,d,e,g,l,l
3.0	To introduce the basic concepts of the finite elements methods.	3.1	Demonstrate the basic concept of Finite Element methods.	a,b,c,d,e,g,l,l
4.0	To introduce basics and fundamental of the computational fluid dynamics	4.1	Demonstrate the concepts of computational fluid dynamics	a,b,c,d,e,g,l,l
5.0	To introduce Turbulence Modeling and various simulation techniques	5.1	Solve the problem and simulate using computational fluid dynamics.	a,b,c,d,e,g,l,l

UNIT I : COMPUTER AIDED ENGINEERING AND COMPUTATIONAL FLUID DYNAMICS	(9)
Introduction to use of computer in Mobility Product Life Cycle, Software for mobility. Introduction to designprocess and role of computers in the design process, use of modern computational tools used for design and analysis, Concept of modeling and simulation. CFD as a design and research tool, Applications of CFD in mobility engineering	
UNIT II : CAD AND RAPID PROTOTYPING	**(9)**
Curves and Surfaces: Geometric modeling curves and surfaces, Wire frame models, Parametric representations, Parametric curves and surfaces, Mechanism design and assembly. CAD/CAM Data Exchange Formats: Types of file formats & their exchange, Graphics standards. CAD Data and Programming Techniques for RP: Transformations, Solid modeling for RP, Surface modeling, STL file generation, Defects in STL files and repairing algorithms, Interface formats	
UNIT III : FINITE ELEMENT ANALYSIS	**(9)**
Basic Concept of Finite Element Method, Ritz and Rayleigh Ritz methods, Method of weighed residuals, Galerkin method. Governing differential equations of one- and two dimensional problems, One Dimensional Second Order Equations – Discretization – Linear and Higher order Elements – Interpolation and shape functions, Derivation of Shape functions and Stiffness matrices and force vectors-Assembly ofMatrices - Solution of static problems and case studies in stress analysis of mechanical components using2D and 3D elements	
UNIT IV : COMPUTATIONAL FLUID DYNAMICS	**(9)**
CFD vs. experimentation; continuity, Navier-stokes and energy equations; modeling and discretization techniques; basic steps in CFD computation Various simplifications, Dimensionless equations and parameters, Incompressible inviscid flows, Source panel method, and Vortex panel method. Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching. 3-D structured and unstructured grid generation, mesh smoothing and sensitivity checks	

UNIT V : PROBLEM SOLVING USING CFD	(9)
Turbulence Modeling, different turbulent modeling scheme. Incompressible Viscous Flows, Applications to internal flows and boundary layer flows. Eddy viscosity and non-eddy viscosity models; Vehicle Aerodynamic Simulation Wind tunnel and on-road simulation of vehicles; Simulation of Ahmed and Windsor bodies; Vorticity based grid-free simulation technique; simulation in climatic and acoustic wind tunnels; velocity vector and pressure contour simulation	
TOTAL = 45 PERIODS	

TEXT BOOKS:

1. Versteeg, H.K., and Malalasekera, W.,"An Introduction to Computational Fluid Dynamics": The finite volume Method, Pearson Education, 2014
2. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill, 1998.

REFERENCES:

1. Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill Publishing Co.2007
2. Groover, M. P., CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education, 2008
3. TirupathiR.Chandrupatla and Ashok D.Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014.
4. Dhanaraj. R and Prabhakaran Nair. K, "Finite Element Analysis", Oxford Publications, 2015.

17MEX54 HYBRID AND ELECTRIC VEHICLE TECHNOLOGY				
	L	T	P	C
	3	0	0	3
PREREQUISITE : NIL				

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To introduce the concept of hybrid and electric drive trains.	1.1	Demonstrate hybrid and electric drive trains.	a,b,c,d,e,g,l
2.0	To elaborate on the types and utilization of hybrid and electric drive trains.	2.1	Design and apply appropriate hybrid and electric drive trains in a vehicle	a,b,c,d,e,g,l
3.0	To expose on different types of AC and DC drives for electric vehicles.	3.1	Design and install suitable AC and DC drives for electric vehicles.	a,b,c,d,e,g,l
4.0	To learn and utilize different types of energy storage systems	4.1	Demonstrate suitable energy storage system for a hybrid / electric vehicle	a,b,c,d,e,g,l
5.0	To introduce concept of energy management strategies and drive sizing	5.1	Apply energy management strategies to ensure better economy and efficiency	a,b,c,d,e,g,l

UNIT I : INTRODUCTION TO HYBRID AND ELECTRIC VEHICLES	(9)
Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.	
UNIT II : HYBRID ELECTRIC DRIVE TRAINS	(9)
Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.	
UNIT III : CONTROL OF AC & DC DRIVES	(9)
Introduction to electric components used in hybrid and electric vehicles, Configuration, and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency.	
UNIT IV : ENERGY STORAGE	(9)
Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy storage and its analysis - Battery based, Fuel Cell based, and Super Capacitor based, Hybridization of different energy storage devices	

UNIT V : DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES	(9)
Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification, and comparison of energy management strategies, Implementation issues.	
TOTAL = 45 PERIODS	

TEXT BOOK:

1. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals,ThirdEdition,2021
2. James Larminie, John Lowry, Electric VehicleTechnologyExplained,Wiley,2003

REFERENCES:

1. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley &Sons,1998
3. Hybrid, Electric and Fuel-Cell Vehicles, International Edition by Jack Erjavec June2012
4. Energy Management in Hybrid Electric Vehicles using Co-Simulation by Christian Paar |11February2011

17MEX55 THERMAL MANAGEMENT OF BATTERIES AND FUEL CELLS				
	L	T	P	C
	3	0	0	3

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To study the working principle of Li-ion Batteries and Battery Packs.	1.1	Demonstrate the different Li-ion Batteries and their applications.	a,b,c,d,e,l
2.0	To learn the thermal management system in Battery modules.	2.1	Analyze the impact of Phase change Materials in thermal management	a,b,c,d,e,l
3.0	To develop the different case studies in Battery Thermal Management System.	3.1	Design and Simulate EV batteries for optimized thermal management system	a,b,c,d,e,l
4.0	To learn the working principle of Fuel Cells and cooling methods.	4.1	Demonstrate the working and applications of different types of fuel cell.	a,b,c,d,e,l
5.0	To learn the inside components of Thermal Management Systems in various famous Electric and Fuel Cell Electric Vehicles.	5.1	Employ different Thermal Management System approaches for usage of fuel cell Electric Vehicles.	a,b,c,d,e,l

UNIT I: ADVANCED BATTERIES	(9)
Li-ion Batteries- chemistry, different formats, operating areas, efficiency, aging. Battery Management System- Configuration, Characteristics. Tesla Model S-18650 Cell specifications, P85 Battery Pack mechanical structure, Texas Instruments BMS. Super capacitors Vs batteries. Diamond battery concepts.	
UNIT II: THERMAL MANAGEMENT IN BATTERIES	**(9)**
Thermal Management Systems- impact, Types- Air, Liquid, Direct refrigerant, Heat pipe, Thermo Electric, Phase Change Material (PCM) Cooling methods. Solid-liquid PCM Types- Organic, Inorganic, Eutectics. PCM Thermal properties and applications. Tesla Model-S Battery Module- bonding techniques, thermal management.	
UNIT III: BATTERY THERMAL MANAGEMENT CASE STUDIES	**(9)**
EV Battery Cooling- challenges and solutions. Heat Exchanger Design and Optimization Model for EV Batteries using PCMs- system set up, selection of PCMs. Chevrolet Volt Model Battery Thermal Management System- Case study. Modeling Liquid Cooling of a Li-Ion Battery Pack with COMSOL Multi physics- simulation concepts.	
UNIT IV: PROPERTIESOFPURESUBSTANCES AND THERMODYNAMIC RELATIONS	**(9)**
Fuel Cells- operating principle, hydrogen-air fuel cell system characteristics, other fuel cell technologies, polarization curves, applications. Fuel cell thermal management- basic model, energy balance, governing equations, characteristic curve, sizing, cooling methods, advantages, restrictions.	
UNIT V: FUEL CELL THERMAL MANAGEMENT CASE STUDIES	**(9)**
Fuel cell system- balance of plant- components required. Fuel cell power plant sizing problems- Fuel Cell Electric Vehicle Fuel economy calculations-Battery EVs Vs Fuel Cell EVs. Toyota Mirai FCV- Operating principle, High pressure hydrogen tank, Boost convertor, NiMH Battery, Internal circulation system, Hydrogen refueling- Case studies.	
	TOTAL=45 PERIODS

TEXTBOOKS:

1. Ibrahim Dinçer, Halil S. Hamut, and Nader Javani, "Thermal Management of Electric Vehicle Battery Systems'', Wiley, 2017.
2. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles'', Wiley, 2015.

REFERENCES:

1. Nag.P.K, "Engineering Thermodynamics", 5th Edition, Tata McGraw Hill Education, New Delhi, 2013.
2. "Vehicle thermal Management Systems Conference Proceedings", 1st Edition; 2013, Coventry Techno centre, UK
3. YounesShabany," Heat Transfer: Thermal Management of Electronics Hardcover" 2010, CRC Press.
4. T. YomiObidi, "Thermal Management in Automotive applications", 2015, SAE International.
5. Jerry Sergent, Al Krum, "Thermal Management Handbook: For Electronic Assemblies Hardcover", 1998, McGraw-Hi

17MEX56 SMART MOBILITY AND INTELLIGENT VEHICLES				
	L	T	P	C
	3	0	0	3
PREREQUISITE : NIL				

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To introduce the various technologies and systems used to implement smart mobility and intelligent vehicles.	1.1	Demonstrate the Automated, Connected, and Intelligent Vehicles	a, b, c, d, f, l
2.0	To learn Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, LIDAR Sensor Technology and Systems and other sensors for automobile vision system.	2.1	Demonstrate the various sensor technologies needed to implement in autonomous vehicles.	a, b, c, d, f, l
3.0	To learn Basic Control System Theory applied to Autonomous Automobiles.	3.1	Apply the cyber-physical control systems for autonomous vehicles.	a, b, c, d, f, l
4.0	To produce overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task.	4.1	Demonstrate the basic concepts of wireless communications, wireless data networks and their contribution in autonomous vehicles.	a, b, c, d, f, l
5.0	To allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car & autonomous vehicle technology.	5.1	Analyze the concept of the connected car, autonomous vehicle technology and its role in developing safe and secure automated vehicles.	a, b, c, d, f, l

UNIT I: INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES	(9)
Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Power train Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicles.	
UNIT II: SENSOR TECHNOLOGY FOR SMART MOBILITY	**(9)**
Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems	
UNIT III :CONNECTED AUTONOMOUS VEHICLE	**(9)**
Basic Control System Theory applied to Automobiles, Overview of the Operation of electronic control units (ECUs), Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy	
UNIT IV: VEHICLE WIRELESS TECHNOLOGY & NETWORKING	**(9)**
Wireless System Block Diagram and Overview of Components, Transmission Systems - Modulation/Encoding, Receiver System Concepts- Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking - the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks	

UNIT V: CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY	(9)
Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues	
TOTAL= 45 PERIODS	

TEXTBOOKS:

1. "Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board.
2. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019, Springer

REFERENCES:

1. Tom Denton, "Automobile Electrical and Electronic systems, Roultedge", Taylor & Francis, Group,5th Edition,2018.

17MEM01 BASICS OF ELECTRIC VEHICLES					
		L	T	P	C
		3	0	0	3
PREREQUISITE: NIL					
COURSE OBJECTIVES AND OUTCOMES :					
Course Objectives		Course Outcomes		Related Program outcomes	
1.0	To introduce learner about EV and its fundamentals.	1.1	Explain the importance and different configurations of electric vehicles.	a, b, c, e, l	
2.0	To infer knowledge on electric propulsion technology.	2.1	Distinguish the characteristics of various motor drives for EVs.	a, b, c, e, l	
3.0	To acquire the knowledge on power sources and energy storages.	3.1	Interpret the various energy storage systems in EVs.	a, b, c, d	
4.0	To gain knowledge on hybrid electric vehicle.	4.1	Describe the concept of hybrid electric drive trains.	b, c, e, l	
5.0	To understand the principles of fuel cell hybrid electric drive train	5.1	Demonstrate the concept of fuel cell drive train in Hybrid EVs.	a, b, c, e, l	

UNIT I : INTRODUCTION TO ELECTRIC VEHICLES	(9)
Importance of different transportation development strategies to future oil supply - History of EVs - General description of Vehicle movement - Configurations of EVs - Performance of EVs: Traction motor characteristics - Tractive effort and transmission. Requirement - Vehicle performance - Tractive effort in normal driving - Energy consumption, Indian standards for EV	
UNIT II : ELECTRIC PROPULSION SYSTEMS	**(9)**
Induction motor drives: Basic operation principles of induction motors - Motor Torque characteristics, Power electronic control - Field orientation control - Voltage source inverter for FOC - Permanent magnetic BLDC motor drives: Basic principles of BLDC motor drives - BLDC machine. Construction and classification - SRM drives: Basic magnetic structure - Modes of operation - Sensor less control, EESM technology and applications	
UNIT III : ENERGY STORAGES	**(9)**
Electrochemical batteries: Electrochemical reactions - Thermodynamic voltage - Specific energy - Specific power - Energy efficiency. Battery technologies - Lead-acid battery - Nickel-based batteries - Lithium-based batteries - Ultra capacitors - Ultra-high-speed flywheels - Hybridization of energy storage.	
UNIT IV : HYBRID ELECTRIC VEHICLES	**(9)**
Concept of hybrid electric drive trains - Architectures of hybrid electric drive trains: Series hybrid electric drive trains (Electrical coupling) - Parallel hybrid electric drive trains (Mechanical coupling) - Hybrid drive trains with both torque and speed coupling, Comparison of operating cost of EV and ICE vehicles	
UNIT V : FUEL CELL HYBRID ELECTRIC DRIVE TRAIN	**(9)**
Operating principles of fuel cells - Fuel cell system characteristics - Fuel cell technologies - Fuel supply - Fuel cell hybrid Electric drive train design: Configuration - Control strategy - Parametric design.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOK:

1. Mehrded Ehsani, YiminGao & Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design", 2nd ed., CRC Press, USA, 2010.

REFERENCES:

1. IqbalHussain, "Electric and Hybrid Vehicles: Design Fundamentals", 2nd ed., CRC Press, USA, 2011.
2. Chris Mi, AbulMasrur M & David WenzhongGao, "Hybrid Electric Vehicles Principles And Applications With PracticalPerspectives", 1st ed., Wiley Publication, UK, 2011.
3. Akash Kumar Bhoi, Jens Bo Holm-Nielsen, Nil Patel, SanjeevikumarPadmanaban, “Electric Vehicles: Modern Technologies and Trends (Green Energy and Technology)”, Springer, 2020

17MEM02 ELECTRIC VEHICLE ARCHITECTURE AND CONTROL SYSTEM					
		L	T	P	C
		3	0	0	3
PREREQUISITE: NIL					
COURSE OBJECTIVES AND OUTCOMES :					
Course Objectives		Course Outcomes		Related Program outcomes	
1.0	To teach the basics of vehicle architecture	1.1	Describe the various vehicle architectures with specifications	a, c, l	
2.0	To introduce the working of fuel cells and their types	2.1	Explain the vehicle mechanics like kinetics and dynamics of vehicle motions	a, c, l	
3.0	To provide knowledge on transmission systems and brakes.	3.1	Analyze the various transmissions systems and braking systems on EV	a, c, l	
4.0	To impart the knowledge of plug-in HEV	4.1	Illustrate the components and working of plug-in HEV	a, c, l	
5.0	To introduce the control systems in EV and HEV	5.1	Demonstrate the various control systems on EV and HEV	a, c, l	

UNIT I : VEHICLE ARCHITECTURE AND SIZING	(9)
Electric Vehicle History and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. - Details and Specifications. Fundamentals - Diode, Bi polar switch, Transistors, Capacitors	
UNIT II : VEHICLE MECHANICS	(9)
Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire - Road mechanics, Propulsion System Design.	
UNIT III : POWER COMPONENTS AND BRAKES	(9)
Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example.Modelling of the components in MATLAB, SIMULINK	
UNIT IV : PLUG-IN HYBRID ELECTRIC VEHICLE	(9)
Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components - Charging mechanisms-Advantages of PHEVs.	
UNIT V : CONTROL PRELIMINARIES AND HYBRID VEHICLE CONTROL STRATEGY	(9)
Control Design Preliminaries - Introduction - Transfer Functions - Bode plot analysis, Control of AC machines, Vehicle supervisory control, Mode selection strategy in Hybrid vehicle, Thermal aspects of Electronic components	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. MehrdadEhsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
2. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First ed., 2017.

REFERENCES:

1. Build Your Own Electric Vehicle, Seth Leitman , Bob Brant, McGraw Hill, Third ed., 2013.
2. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011.
3. Heavy-duty Electric Vehicles from Concept to Reality, ShashankArora, AlirezaTashakoriAbkenar, ShanthaGaminiJayasinghe, Kari Tammi, Elsevier Science, 2021
4. Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, SanjeevikumarPadmanaban, Jens Bo Holm-Nielsen Springer, 2020
5. Giancarlo Genta, Lorenzo Morello, “The Automotive Chassis: Volume 1: Components Design (Mechanical Engineering Series), Springer, 2nd ed., 2019

17MEM03 MATERIALS FOR ELECTRIC VEHICLES				
L	T	P	C
3	0	0	3

PREREQUISITE: NIL

COURSE OBJECTIVES AND OUTCOMES:

	Course Objectives		Course Outcomes	Related Program outcomes
1.0	To provide the knowledge about the chassis types and materials of the vehicle.	1.1	Able to understand the different chassis and materials used in EV	a, b, l, k, i
2.0	To acquire the knowledge of battery types and materials	2.1	Know the battery types and materials	a, b, l, k, i
3.0	To learn the basic concept of motor, brake and semiconductor materials	3.1	Select the materials for motor, brake and semiconductor.	a, b, l, k, i
4.0	To study the manufacturing process in the batteries.	4.1	Explain the manufacturing process of the batteries.	a, b, l, k, i
5.0	To understand the basis of materials and testing	5.1	Acquire the concept of basis of materials and testing	a, b, l, k, i

UNIT I : CHASSIS TYPES AND MATERIALS	(9)
Overview of materials, Introduction to chassis, types- Conventional chassis, Non-conventional chassis, Full forward chassis, Semi-forward chassis, Bus chassis, Engine at front chassis, Rear chassis and Center chassis. Chassis materials	
UNIT II : BATTERIES TYPES AND MATERIALS	**(9)**
Types of Batteries, materials- Batteries-Lithium-ion battery & Lead acid battery basics, Special characteristics of lead acid batteries, Battery life and maintenance, Battery charging, Summary, Nickel-based Batteries-Introduction, Nickel cadmium, Nickel metal hydride batteries, battery packaging materials, Battery pack encapsulation materials, fire retardant grade materials.	
UNIT III : MATERIALS FOR MOTORS, BRAKES & SEMICONDUCTORS	**(9)**
Introduction of motor, types, materials for rotor, stator, body, armature, shaft, bearings, Introduction to brake, types, selection of brake materials. Neodymium permanent magnets, Hydrogen compatible Materials – Metals and Polymers, Semiconductor materials	
UNIT IV : MANUFACTURING OF BATTERIES	**(9)**
Introduction to manufacturing of batteries, battery production process-electrode manufacturing, mixing, coating & drying, calendaring, slitting, cell assembly-notching, stacking, pouch assembly - Forming, aging and validation.	
UNIT V : MATERIALS AND TESTING	**(9)**
Classification of material testing, Purpose of testing, Selection of material, Development of testing, Testing organizations and its committee, Testing standards, Result Analysis, Advantages of testing.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:
1. Vladimir Kobelev, “Design and Analysis of Composite Structures for Automotive Applications Chassis and Drivetrain”Wiley, 2019. 2. Austin Hughes, William Drury, “Electric Motors and Drives: Fundamentals, Types and Applications”, 4th ed., Newnes, 2013.
REFERENCES:
1. Metals Handbook: Mechanical testing, (Volume 8) ASM Handbook Committee, 9th Edition, American Society for Metals, 1978. 2. Guangjin Zhao, “Reuse and Recycling of Lithium-Ion Power Batteries”, John Wiley & Sons. 2017. 3. Keisuke Fujisaki, “Magnetic material for motor drive system: fusion technology of electromagnetic fields”, Springer, 1st ed., 2019. 4. Brian Cantor, P. Grant, C. Johnston, “Automotive engineering: lightweight functional and novel materials”, Taylor & Francis, 2008

17MEM04 POWERTRAIN DESIGN FOR ELECTRIC VEHICLES				
	L	T	P	C
	3	0	0	3
PREREQUISITE: NIL				

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To introduce the types of structure, construction details and working principle of EV	1.1	Know the structure, components of an electric vehicles and it types	a, b, c, d, e, f, l, k, i
2.0	To learn about the design of different electric motor for drives	2.1	Describe the working principles of electric motors and functions	a, b, c, d, e, f, l, k, i
3.0	To learn about the various types of transmission systems	3.1	Classify the types of transmission systems	a, b, c, d, e, f, l, k, i
4.0	To acquire knowledge on auxiliary system, steering, brakes and suspension	4.1	Explain the working principles of steering, braking and suspension systems	a, b, c, d, e, f, l, k, i
5.0	To know the electric vehicles safety and types of advanced technologies	5.1	Summarize the safety and types of advanced technologies	a, b, c, d, e, f, l, k, i

UNIT I : COMPONENTS OF EV	(9)
Vehicle construction - chassis - frame and body - aerodynamics, resistances and Moments – battery – power converter – Electric motor – generator, inverter – Rectifier – coupler – controller – Pure Electric vehicles – Hybrid electric vehicles – Plug in Hybrid Electric vehicle	
UNITII : ELECTRIC DRIVE SYSTEM	**(9)**
Introduction-Transfer function for DC motor / load and converter – Closed loop control with Current and speed feedback-Armature voltage control and field weakening mode - DC Series Motor - Induction motors - Brushless DC Motor - Permanent Magnet Synchronous Motor (PMSM) - Three Phase AC Induction Motors - Switched Reluctance Motors (SRM)	
UNIT III :TRANSMISSION SYSTEM	**(9)**
E pedal - Electric power converter -Electric booster - power train controller - Drive power - Torque converter - Reduction gear-Power split device- driveshaft - differential – axles - Drive wheels	
UNIT IV : STEERING, BRAKES AND SUSPENSION SYSTEM	**(9)**
Principle of steering - steering geometry - steering linkages - steering gear box - power steering - brakes – types and construction - drum brake, disc brake, pneumatic braking system, hydraulic braking system and antilock braking system (ABS) - types of front and rear axle - suspension system - types and construction - coil spring, leaf spring, stabilizer bars - air suspension - shock absorber	
UNIT V :SAFETY SYSTEMS & ADVANCED TECHNOLOGY	**(9)**
Air bags - Electronic Brake Distribution (EBD) - Electronic Stability Program (ESP) - Traction Control System (TCS) - Global Positioning System (GPS) - Collision avoiding system, - Tyre pressure monitoring system (TPMS), Cruise controller - driver information system - Advanced driver assistance systems (ADAS), Autonomous vehicles - IoT, Connected cars, Cyber Physical System (CPS)	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:
1. William H. Crouse and Donald L Anglin, “Automotive Mechanics”, 10th ed., McGraw Hill Education (India) Private Limited, 2006. 2. Babu.A.K and Ajit Pal Singh, “Automobile Engineering”, 1st ed., S.Chand Publications, 2013.
REFERENCES:
1. Ronald K Jurgen, “Automotive Electronics Handbook”, McGraw Hill, Inc, 1999. 2. Tom Denton, “Automobile Electrical and Electronic Systems”, Edward Arnold publications, 1995 3. Don Knowles, Don Knowles, Prentice Hall, Englewood Cliffs, “Automotive Electronic and Computer controlled Ignition Systems”, New Jersey 1988. 4. William, T.M., “Automotive Electronic Systems”, Heiemann Ltd., London, 1978. 5. Kirpal Singh, “Automobile Engineering Vol.1 & 2”, Standard Publishers, New Delhi, 2011 6. VijayakumarGali, LucianeNevesCanha, Mariana Resener, BibianaFerraz, Madisa V.G. Varaprasad “Advanced Technologies in Electric Vehicles Challenges and Future Research Developments” Academic Press, 1st ed., 2023 7. Marco Mileti, Patrick Strobl, Hermann Pflaum, Karsten Stahl, “Design of a Hyper-High-Speed Powertrain for EV to Achieve Maximum Ranges”, Springer Berlin Heidelberg, 2023

17MEM05 BATTERY MANAGEMENT					
		L	T	P	C
		3	0	0	3
PREREQUISITE: NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		Course Outcomes		Related Program outcomes	
1.0	To introduce learner about batteries and its parameters.	1.1	Calculate the various parameters of battery and battery pack.	a,b,c,d,e,k	
2.0	To infer knowledge on operational factors of battery technology.	2.1	Interpret the operational factors associated with battery systems.	a,b,c,d,e,k	
3.0	To acquire the knowledge on lead acid batteries.	3.1	Formulate the design procedure for lead acid batteries.	a,b,c,d,e,k	
4.0	To understand the battery management system and life prediction of batteries.	4.1	Identify the requirements of Battery Management System.	a,b,c,d,e,k	
5.0	To gain knowledge on traction batteries and miscellaneous applications of batteries.	5.1	Familiarize different kinds of traction batteries.	a,b,c,d,e,k	

UNIT I : INTRODUCTION TO BATTERIES	(9)
Types of Batteries - Energy conversion in batteries - Battery components - Principle of operation - Electrode selection -Calculating battery cell voltage - Battery cell voltage and Nernst equation – Cell balancing - Electrolyte for batteries - Gibbs free energy and battery voltage - Theoretical battery capacity - Practical energy of a battery - Specific energy and power.	
UNIT II : OPERATIONAL FACTORS OF BATTERY SYSTEMS	(9)
Performance parameters - Battery voltage -Secondary battery systems - Battery limiting factors - Battery current modes of discharge - Discharge current effect on voltage - Discharge current effect on capacity - The effect of temperature on battery performance - Self discharge - Calendar and Cycle Life - Internal resistance - safety - Battery selection – Battery testing.	
UNIT III : LEAD ACID BATTERIES & LITHIUM-ION BATTERIES	(9)
Introduction - Principle of operation-Types of lead acid & Lithium-Ion batteries - Cell components and fabrication - Failure modes -Charge process - Discharge process – Electrolyte - State of charge (SOC) - Capacity - Cycle life – Self discharge. Applications: Telecommunications and UPS, solar and wind energy storage.	
UNIT IV : IV BATTERY MANAGEMENT AND LIFE PREDICTION	(9)
Definitions: Battery management and battery life prediction - Monitoring & measuring, SOH - Battery management functions: Charge management, discharge management, safety management and smart battery system – Thermal run away - Life Prediction, Recycling of EV Battery	
UNIT V:TRACTION BATTERIES	(9)
Introduction to electric vehicles and hybrid electric vehicles - Battery technology for traction: Lead Acid , Nickel Cadmium, Nickel Metal Hydride, Lithium Ion, Lithium Polymer Batteries, Sodium Nickel Chloride Battery.Miscellaneous applications of batteries: Tracking Systems, Toll Collection, Oil Drilling, Car Accessories, Oceanography.	
TOTAL (L:45) : 45 PERIODS	

Text Books :
1. DavideAndrea , Battery Management Systems for Large Lithium-Ion Battery Packs, Artech House Publishers, London, First ed., 2010. 2. M. Broussely, G. Pistoia, Industrial Applications of Batteries From Cars to Aerospace and Energy Storage, Elsevier Publishers, The Netherlands, First ed., 2007.
References :
1. Vladimir S. Bagotsky, Alexander M. Skundin, Yurij M. Volfkovich, Electrochemical power sources: batteries, fuel cells, and super capacitors, John Wiley & Sons, Inc., Hoboken, New Jersey, First ed., 2015. 2. Slobodan Petrovic, Battery Technology Crash Course A Concise Introduction, Springer Nature Switzerland AG, First ed., 2021. 3. Kiehne, H.A. Battery Technology Handbook, Dekker Publishers, New York, Second Revised ed., 2007. 4. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, Kindle ed., 2015. 5. Valer Pop , Henk Jan Bergveld , Dmitry Danilov , Paul P. L. Regtien , Peter H. L. Notten, “Battery Management Systems”, Springer, 2008

17MEM06 AI AND IOT FOR ELECTRIC VEHICLES				
	L	T	P	C
	3	0	0	3
PREREQUISITE: NIL				

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To introduce the fundamentals of IoT	1.1	Understand the concepts of IoT.	a,e
2.0	To introduce learner about AI and its fundamentals.	2.1	Familiarize the fundamentals of AI.	a,e
3.0	To impart the knowledge on AI and IoT applications in battery.	3.1	Explain the applications of AI and IoT in battery.	a,b,c,d,e,f
4.0	To gain knowledge on AI in EV design.	4.1	Demonstrate the applications of AI in EV design and power supply.	a,b,c,d,e,f
5.0	To infer knowledge on recent case studies.	5.1	Gain knowledge on real time applications of AI on EV.	a,b,c,d,e,f

UNIT I : INTRODUCTION TO INTERNET OF THINGS	(9)
Characteristics of IoT, Physical and logical design of IoT - IoT enabling technologies - Wireless sensor networks - Cloud computing - Big data analytics - Communication protocols - Embedded systems - Functional blocks - Communication models and APIS - IoT levels and deployment templates - Overview of microcontroller, sensors and actuators	
UNIT II : BASICS OF ARTIFICIAL INTELLIGENCE	**(9)**
Introduction to AI – Agents and Environments – Concept of rationality – Nature of environments – Structure of agents – Problem solving agents – Search algorithms – Uninformed search strategies – Data management and Data Munging	
UNIT III : AI AND IoT APPLICATIONS IN BATTERY	**(9)**
AI and IoT-Based Battery Management System for Electric and Hybrid Electric Vehicles- Monitoring of charging in industrial, commercial, and residential scenarios - health and temperature monitoring, monitoring of key parameters: voltage, current, temperature of battery – Monitoring of individual cells/group of cells	
UNIT IV : APPLICATIONS OF AI IN EV DESIGN AND POWER SUPPLY	**(9)**
AI in EV manufacturing, AI in electric vehicle design, modeling and optimization - Self driving EV Controlled with AI - advantages and limitations - AI in power supply management and life cycle assessment, CRISP - DM Method	
UNIT V : CASE STUDIES	**(9)**
Bosch – Google (Waymo) - Tesla - Autopilot – Audi - Jaguar - Land Rover - Toyota Guardian – FLIR.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. S. Angalaeswari, T. Deepa, L. Ashok Kumar, "Artificial Intelligence Applications in Battery Management Systems and Routing Problems in Electric Vehicles", IGS Global Publisher, 2023
2. A. Chitra, P. Sanjeevikumar, Jens Bo Holm-Nielsen, S. Himavath, "Artificial Intelligent Techniques for Electric and Hybrid Electric Vehicles", Wiley online library, 2020

REFERENCES:

1. Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", 4th ed., Pearson Education, 2020.
2. SudipMisra, Anandarup, Mukherjee, Arijit Roy, "Introduction to IoT", Cambridge University Press, 1st ed., 2022
3. Arun MR, "Fundamentals of IoT", Notion press, 2022
4. https://link.springer.com/book/10.1007/978-981-19-2184-1
5. https://www.researchgate.net/publication/361251263_AI_and_ML_Powered_IoT_Applications_for_Energy_Management_in_Electric_Vehicles

17MEM07 AUTONOMOUS VEHICLES					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To introduce the automated driving	1.1	Explain the concept of automated driving	a,b,i,l
2.0	To know about the advanced driver assistance systems	2.1	Understand the basic concept of advanced driver assistance systems	a,b,i,l
3.0	To learn and understand automated driving technologies	3.1	Develop the appropriate automated driving technology	a,b,i,l
4.0	To impart the knowledge of social and human issues	4.1	Know about the social and human issues	a,b,i,l
5.0	To learn and under the various case study	5.1	Apply the various case study	a,b,i,l

UNIT I :AUTOMATED DRIVING	(9)
Introduction to ADV - Safety - Vehicle and its occupants – IMI TechSafe, Regulation and Safety aspects of AV, Levels of automation	
UNIT II : ADVANCED DRIVER ASSISTANCE SYSTEMS	**(9)**
Introduction to ADAS - Example Systems - Adaptive Cruise control - Obstacle Avoidance Radar - Basic reversing aid – Radar -Stereo Video Camera - Rear Radar - Functional Safety and Risk.	
UNIT III : AUTOMATED DRIVING TECHNOLOGIES	**(9)**
Introduction - Road to Autonomy – Perception - Lidar Operation - Sensor Positioning - Automated Driving System – Mapping -Other technologies – Connectivity – Artificial Intelligence - Top-down and Bottom-up AI - Deep learning - End to End Machine Learning.	
UNIT IV : SOCIAL AND HUMAN ISSUES	**(9)**
Introduction - Public reaction to CAVs – Insurance - Mobility as a Service - Global Overview - UK - European union – US –Japan and china, External people and property - Service and repair	
UNIT V : CASE STUDIES	**(9)**
Nvidia – Bosch - Google (Waymo) - Tesla Autopilot – Nio, Xpeng, Arrival - Audi - Jaguar Land Rover – Toyota Guardian – FLIR - First sensor AG	
	TOTAL (L:45) : 45 PERIODS

TEXT BOOK:
1. Tom Denton “Automated Driving and Driver Assistance Systems” 1st ed., Routledge, Taylor & Francis Group, United Kingdom, 2020.
REFERENCES:
1. Maurer, Markus, J. Christian Gerdes, Barbara Lenz, and Hermann Winner., “Autonomous driving: technical, legal and social aspects” Springer Nature, 2016. 2. Coppola, Pierluigi, and DomokosEsztergár-Kiss., “Autonomous Vehicles and Future Mobility”, Elsevier, 2019. 3. Hussain T Mouftah, MelikeErol-kantarci and SameshSorour, “Connected and Autonomous Vehicles in Smart Cities” CRC Press, 1st ed., 2020. 4. Markus Maurer, J. Christian Gerdes, Barbara Lenz, Hermann Winner, “Autonomous Driving-Technical, Legal and Social Aspects”, Springer, 2016.

17MEM08 FUEL CELL TECHNOLOGY & SAFETY REGULATIONS				
L	T	P	C	
3	0	0	3	

PREREQUISITE: NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To introduce the working of fuel cells and their types	1.1	Understand the working of different types of fuel cells	a,b,e,f,g,k,l
2.0	To provide knowledge on fuel cell components and their performance	2.1	Determine the performance characteristics of various fuel cell components	a,b,e,f,g,k,l
3.0	To impart the knowledge on fuel cell and other competing technologies	3.1	Analyse the applications of fuel cell and other competing technologies	a,b,e,f,g,k,l
4.0	To impart the knowledge of fuel cell applications in automotive field	4.1	Apply the fuel cells on automotive field	a,b,e,f,g,k,l
5.0	To teach the basics of safety regulations of EV	5.1	Apply the safety regulations in the designing of EV	a,b,e,f,g,k,l

UNIT I : INTRODUCTION TO FUEL CELLS	(9)
Introduction – working and types of fuel cell – low, medium and high temperature fuel cell, liquid and methanol types, proton exchange membrane fuel cell - blue-grey-green hydrogen – thermodynamics and electrochemical kinetics of fuel cells - Battery swapping, shared mobility, connected vehicles	
UNIT II : FUEL CELL COMPONENTS AND THEIR IMPACT ON PERFORMANCE	(9)
Membrane electrode assembly components, bi-polar plate, humidifiers and cooling plates - Fuel cell performance characteristics – current/voltage, voltage efficiency and power density, ohmic resistance, kinetic performance, mass transfer effects.	
UNIT III : FUEL CELL ANALYSIS	(9)
Introduction - Modelling of FCEV - Applications to fuel cell and other competing technologies on vehicles - SI engine fueled by natural gas and hydrogen and hybrid electric vehicle.	
UNIT IV : FUEL CELLS FOR AUTOMOTIVE APPLICATIONS	(9)
Fuel cells for automotive applications – technology advances in fuel cell vehicle systems- onboard hydrogen generation –liquid and compressed hydrogen – metal hydrides, fuel cell control system- - road map to market applications.	
UNIT V : SAFETY REGULATIONS OF EV AND FCEV	(9)
Introduction - EV Policy measures – ARAI standard and Regulations for EV, Electric Power Train Vehicles-Construction and Functional Safety Requirements, Electric Vehicle Charging Safety Guidelines, Charging Infrastructure for Electric Vehicles (EV), Safety Regulations of FCEV, European regulations	
TOTAL(L:45) = 45 PERIODS	

Approved by Eleventh Academic council

TEXT BOOKS:
1. FranoBarbir, " PEM Fuel Cells : Theory and practice", Elsevier Academic Press, USA, 2005 2. Matthew M. Mench, "Fuel Cell Engines", John Wiley & Sons, 2008
REFERENCES:
1. Andrew L. Dicks, David A. J. Rand, "Fuel Cell Systems Explained" 3rd Ed., Wiley 2018 2. Pasquale Corbo, FortunatoMigliardini, OttorinoVeneri, "Hydrogen Fuel Cells for Road Vehicles - Green Energy and Technology (GREEN)", Springer, 2011 3. GregorHoogers, "Fuel Cell Technology Handbook" CRC Press, 2003 4. https://e-vehicleinfo.com/electric-vehicles-in-india-arai-standards-and-regulation/ 5. https://powermin.gov.in/en/content/electric-vehicle

Approved by Eleventh Academic council