Mechanical Engineering Curriculum

(For students admitted in 2017)

PROGRAM OUTCOMES

The curriculum and syllabus for B.Tech programs conform to outcome based teaching learning process. In general, ELEVEN PROGRAM OUTCOMES (a-k) have been identified and the curriculum and syllabus have been structured in such a way that each of the courses meets one or more of these outcomes. Student outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program. Further each course in the program spells out clear instructional objectives which are mapped to the student outcomes.

The program outcomes are:

- **(a)** an ability to apply knowledge of mathematics, science, and engineering
- **(b)** an ability to design and conduct experiments, as well as to analyze and interpret data
- **(c)** an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- **(d)** an ability to function on multidisciplinary teams
- **(e)** an ability to identify, formulate, and solve engineering problems
- **(f)** an understanding of professional and ethical responsibility
- **(g)** an ability to communicate effectively
- **(h)** the broad education necessary to understand the impact of engineering solutions in global, economic, environmental, and societal context
- **(i)** a recognition of the need for, and an ability to engage in life-long learning
- **(j)** a knowledge of contemporary issues
- **(k)** an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

C-D-I-O INITIATIVE

The CDIO Initiative (CDIO is a trademarked initialism for **Conceive** — **Design — Implement — Operate**) is an innovative educational framework for producing the next generation of engineers. The framework provides students with an education stressing engineering fundamentals set in the context of Conceiving — Designing — Implementing — Operating real-world systems and products. Throughout the world, CDIO Initiative collaborators have adopted CDIO as the framework of their curricular planning and outcome-based assessment. In the syllabus, every topic has been classified under one or more of C-D-I-O so that students and faculty alike are clear about the scope of learning to take place under each one of the topics.

SYMBOLS AND ABBREVIATIONS

AR	--	**Architecture Courses**
B	--	**Courses under Basic Science and Mathematics**
BT	--	**Biotechnology Courses**
C-D-I-O	--	**Conceive-Design-Implement-Operate**
CE	--	**Civil Engineering Courses**
CS	--	**Computer Science and Engineering Courses**
CY	--	**Chemistry Courses**
Dept.	--	**Department of Mechanical Engineering**
E with course code	--	**Elective Courses**
E	--	**Courses under Engineering Sciences**
EC	--	**Electronics and Communication Engineering Courses**
EE	--	**Electrical and Electronics Engineering Courses**
G	--	**Courses under Arts and Humanities**
IOs	--	**Instructional Objectives**
L	--	**Laboratory / Project / Industrial Training Courses**
LE	--	**Language Courses**
L-T-P-C	--	**L- Lecture Hours Per Week** **T- Tutorial Hours Per Week** **P- Practical Hours Per Week** **C- Credits for a Course**
M	--	**Courses with Multi-Disciplinary Content**
MA	--	**Mathematics Courses**
ME	--	**Mechanical Engineering Courses**
NC	--	**NCC- National Cadet Corps**
NS	--	**NSS – National Service Scheme**
P	--	**Professional Core Courses**
PD	--	**Personality Development Courses**
PY	--	**Physics Courses**

B. Tech. Mechanical Engineering
Curriculum – 2017-21
(Applicable for students admitted from the Academic year 2017-18)

SEMESTER I						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
COM 101	G	COMMUNICATIVE ENGLISH	3	0	0	3
ECO 122	G	PRINCIPLES OF ECONOMICS	3	0	0	3
CHE 102	B	SOLID STATE CHEMISTRY	3	0	2	4
BIO 101	B	INTRODUCTION TO BIOLOGY	3	0	2	4
ENG 101	E	ENGINEERING FUNDAMENTALS	3	0	0	3
CSE 1002	P	INTRODUCTION TO COMPUTER SICENCE AND PROGRAMMING	3	0	4	5
	G	*NCC/NSS/NSO/YOGA	0	0	0	0
TOTAL						22

*NCC-National Cadet Corps
NSS-National Service Scheme
NSO-National Sports Organization (India)

Legend: L - Number of lecture hours per week T – Number of tutorial hours per week P - Number of practical hours per week C - Number of credits for the course

Category of courses: G – General, B - Basic Sciences, E - Engineering Sciences and Technical Arts

Electives

SEMESTER II						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
CDC 102	G	SOFT SKILLS I	1	0	0	1
EGL 101	G	ENGLSH	3	0	0	3
MAT 111	G	SINGLE VARIABLE CALCULUS	3	0	0	3
PHY 111	FC	CLASSICAL MECHANICS	3	0	2	4
ECO 221	G	ECOMMERCE AND ECONOMIC	3	0	0	3
ENG 105	P	ENGINEERIGN GRAPHICS	2	0	2	3
ENG 111	E	BASIC ELECTRONICS	3	0	2	4
ME 103	P	MECHANICAL ENGINEERING TOOLS	0	0	2	1
TOTAL						22

SEMESTER III						
Course Name	**Category**	**Course Name**	**L**	**T**	**P**	**C**
ME 211	P	ENGINEERING MECHANICS	3	0	0	3
MAT 211	B	LINEAR ALGEBRA AND DEIFFERENTIAL EQUATIONS	3	0	0	3
CDC 211	G	SOFT SKILLS	1	0	0	1
ME 212	P	THERMODYNAMICS	3	0	2	4
ME 213	P	MATERIAL SCIENCE AND METTALLURGY	2	0	2	3
PHY 211	B	ELECTRICTY AND MAGNETISM	2	0	2	3
ENV 111	B	ENVIRONMENTAL SCIENCE	2	0	2	3
TOTAL						**20**

SEMESTER IV						
Course Name	**Category**	**Course Name**	**L**	**T**	**P**	**C**
ME 221	P	ELEMENTS OF STRUCTURE/STRENGTH OF MATERIAL	3	0	2	4
MAT 121	B	MULTI VARIABLE CALCULUS	3	0	0	3
ME 225	P	3D PRINTING	0	0	2	1
CDC 212	G	SOFT SKILLS	1	0	0	1
ME 228	P	MANUFACTURING SCIENCE ME ELECTIVE	3	0	0	3
ME 227	P	UNIVERSITY RESEARCH OPPORTUNITY	0	0	6	3
ME 222	P	FLUID MECHANICS	3	0	2	4
ME 223	P	ALTERNATE ENERGY SOURCE	3	0	0	3
TOTAL						**22**

SEMESTER V						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
THEORY						
MAT 221	B	PROBABILITY AND STATISTICS	3	0	0	3
ME 226	P	MEASUREMENT AND INSTRUMENTATION	3	0	2	4
ME 224	P	MACHINE DESIGN	3	0	2	4
ME 132	P	NUMERICAL METHODS	3	0	2	4
ME 401	P	CAD-CAM ME ELECTIVE	3	0	0	3
ME 402	P	MULTI BODY DYNAMICS	3	0	0	3
CDC 301		SOFT SKILLS	1	0	0	1
		TOTAL				22

SEMESTER VI						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
THEORY						
ME 230	P	HEAT AND MASS TRANSEFR	3	0	2	4
ME 172	P	KINEMATICS AND MECHANISMS	3	0	2	4
ME 321	P	FLUID MACHINERY	3	0	2	4
	P	ME ELECTIVE	3	0	0	3
	P	OPEN ELECTIVE	3	0	0	3
ME 450		MULTI DISCIPLINARY DESIGN PROJECT	0	0	4	2
		TOTAL				20

SEMESTER VII						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
ME 272	P	DYNAMICS AND CONTROL	3	0	2	4
ME 322	P	MANUFACTURING TECHNOLOGY	3	0	2	4
		ME ELECTIVE	3	0	0	3
		ME ELECTIVE	3	0	0	3
		OPEN ELECTIVE	3	0	0	3
		OPEN ELECTIVE	3	0	0	3
TOTAL						**20**

SEMESTER VII&VIII						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
ME 601		OPTION 1 CO-OP	0	0	22	11
		OPTION 2 SR DESIGN PROJECT	0	0	22	11
TOTAL						**11**

DEPARTMENTAL AND OPEN ELECTIVES						
Course code	**Category**	**Course name**	**L**	**T**	**P**	**C**
ME 405	P	ROBOTICS	3	0	0	3
ME 406	P	INDUSTRIAL TRIBOLOGY	3	0	0	3
ME 407	P	AIRCRAFT AND ROCKET PROPULSION	3	0	0	3
ME 408	P	MECHATRONICS	3	0	0	3
ME 409	P	INTERNAL COMBUSTION ENGINES	3	0	0	3
ME 403	P	ALTERNATIVE SOURCES OF ENERGY	3	0	0	3
ME 410	P	INDUSTRIAL ENGINEERING & MANAGEMENT	3	0	0	3
ME 411	P	INTRODUCTION TO SENSORS	3	0	0	3
ME 412	P	FEEDBACK CONTROL SYSTEM	3	0	0	3
ME 413	P	VEHICLE DYNAMICS AND CONTROL	3	0	0	3

ME 402	P	MULTI BODY DYNAMICS	3	0	0	3
ME 414	P	FINITE ELEMENT ANALYSIS	3	0	0	3
MR 415	P	ADVANCED FLUID MECHANICS	3	0	0	3
ME 416	P	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3
ME 417	P	REFRIGERATION AND AIR CONDITIONING SYSTEMS	3	0	0	3
ME 418	P	ADVANCED ENGINEERING THERMODYNAMICS	3	0	0	3
ME 419	P	MECHANICS OF COMPOSITE MATERIALS	3	0	0	3
ME 420	P	VIBRATION AND NOISE	3	0	0	3
ME 421	P	GAS DYNAMICS	3	0	0	3
ME 401	P	CAD CAM	3	0	0	3
	P	ADVANCED STRENGTH OF MATERIALS	3	0	0	3
ME 422	P	NON DESTRUCTIVE TESTING	3	0	0	3
ME 423	P	ADDITIVE MANUFACTURING TECHNOLOGY	3	0	0	3
ME 424	P	PRODUCTION PLANNING AND CONTROL	3	0	0	3
ME 425	P	MEMS	3	0	0	3
ME 426	P	AUTOMOTIVE ENGINEERING	3	0	0	3
ME 427	P	FLEXIBLE MANUFACTURING SYSTEMS	3	0	0	3
ME 428	P	COMBUSTION ENGINEERING	3	0	0	3
OPEN ELECTIVES						
	P	OPERATION RESEARCH	3	0	0	3
	P	DIGITAL SIGNAL PROCESSING	3	0	0	3
	P	DATA STRUCTURES	3	0	0	3
	P	ARTIFICAL INTELLIGENCE	3	0	0	3
	P	MACHINE LEARNING	3	0	0	3
	P	ELECTRIC DRIVES	3	0	0	3
	P	ELECTRICAL MACHINES	3	0	0	3
	P	POWER ELECTRONICS	3	0	0	3
	P	VLSI DESIGN	3	0	0	3
	P	DIGITAL COMMUNICATION	3	0	0	3
	P	PROJECT MANAGEMENT	3	0	0	3
	P	BUSINESS ETHICS	3	0	0	3
	P	BIOMECHANICS	3	0	0	3
	P	BIOINFORMATICS	3	0	0	3
	P	FUEL CELL AND BATTERY TECH	3	0	0	3
	P		3	0	0	3
	P		3	0	0	3

COURSES OFFERED TO OTHER DEPARTMENTS

Course Code	Category	Course Name	L	T	P	C
	P	THERMODYNAMICS	3	0	2	4
	P	FLUID MECHANICS	3	0	2	4
	P	ENGINEERING GRAPHICS	2	0	2	3

Summary of credits						
Category	**I& II**	**III & IV**	**V & VI**	**VII & VIII**	**Total**	**%**
G					**17**	**11**
B					**30**	**19**
E					**15**	**11**
P					**65**	**41**
Elective					**29**	**18**
Total	**44**	**42**	**42**	**31**	**156**	**100**

ENV 101	**ENVIRONMENTAL SCIENCE**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	F FOUNDATION CORE	ENVIRONMENTAL SCIENCE			
Course designed by	Department of Environmental Science				
Approval	--				

PURPOSE	The course aims to provide integrated, quantitative and interdisciplinary approach for understanding environmental issues and finding lasting solutions. Environmental disasters/issues faced by humanity in the past and present were used to illustrate the possible, sustainable solution.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand what sustainability is and the importance of sustainable solutions to environmental problems							
2.	Know the components of an ecosystem and how they play an important role in matter cycling.							
3.	Feel the importance of biodiversity and the consequences of declining biodiversity							
4.	Inculcate the concepts of environmental ethics while trying to resolve environmental issues and understand the policies that help in it.							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: ENVIRONMENTAL EDUCATION & SUSTAINABILITY	**3**			1

1.	What is environmental education (EE)? The evolution of EE	1		1-4	1
2.	Principles of Sustainability	1		1	1,2
3.	Sustainable technologies	1		1	2
	UNIT II: ECOLOGICAL SYSTEM	**10**			
4.	Earth Systems - atmosphere	2		2,3	1
5.	Earth Systems - Hydrosphere	1		2,3	1
6.	Earth Systems - Lithosphere	1		1,2,3	1
7.	Earth Systems - Biosphere	1		2,3	1
8.	Ecosystems - Structure and Function	1		1,2	1
9.	Major Biomes	2		2	1
10.	Water, nutrients (phosphorous, nitrogen) and Carbon cycles	2		2	1
	UNIT III: ENVIRONMENTAL POLLUTION- its role on global climate change and human health	**9**			
11.	Air pollution – composition of air, sources of pollution and their classification	2		3	2
12.	Air pollutants – classifications	2		3	2
13.	Air Quality Index (AQI)	1		3	2
14.	Air pollution control devices	1		3	2
15.	Water pollution - Water sources, use and classifications	1		3	2
16.	Water pollutants	1		3	2
17.	Water pollution control devices	1		3	2
	UNIT IV: BIODIVERSITY & ITS CONSERVATION	**9**			
18.	Biodiversity – definition and types	1		2	2,3
19.	Concepts of species richness, evenness, and their regulation. Species diversity cline	1		2	3
20.	Island biogeography – equilibrium model Vulnerability of island species	1		3	3

21.	Conservation Biology – Historical perspective of extinction Difference between past extinction and present	1		3	1
22.	Biodiversity Hotspots – global distribution	1		3	1
23.	Values of Biodiversity – Why do we care?	1		3	2
24.	World's Biodiversity is in serious trouble – frogs as global "canaries of mines"	1		3	2
25.	Human impacts on biodiversity – Habitat destruction, Pollution, Ecosystem disruption, Habitat fragmentation , over exploitation, and introduction of invasive species	1		3	2
26.	Preservation of endangered species	1		3	2
	UNIT V: ENVIRONMENTAL ETHICS, ECONOMICS, AND POLICY	**9**			
27.	Concepts of Sustainable ethics – Frontierism, Leopold's Land Ethics, and transition to Sustainable ethics	1		4	2
28.	Principles of Sustainable ethics, Frontier ethics vs sustainable ethics	1		4	2
29.	Developing and implementing sustainable ethics and overcoming the obstacles of sustainable ethics, utilitarianism and natural rights	1		4	2
30.	Fundamentals of Environmental Economics – concepts of resources, Capital, Supply, Demand, and Market equilibrium , Classical Economics, Neoclassical economics, Ecological Economics and Externalization of costs	1		4	2,4
31.	Ecosystem Services – Can we internalize all costs?	1		4	2,4
32.	Resource depletion, Hubbert Curve, and Carbon bubble, Scarcity and innovation, Economic models for growth	1		4	2,4
33.	Measuring growth – GNP, GDP, GPI, Cost-Benefit Analysis. Can market reduce pollution ?– Carbon credit	1		4	2,4
34.	Environmental Policies – international laws and polices	1		4	1
35.	Environmental Laws and Policies of India	1		4	1
	Total contact hours	40			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Basu. M, Xavier. S. "*Fundamentals of Environmental Studies*", 1st edition, Cambridge University Press, 2016

2	Danial. D. C. "*Environmental Science*", 8th edition, Jones and Barlett Publishers, MA, 2010.
3	Raven P. Biology – 11th Edition, McGraw hill
4	Cunningham and Cunningham. Environmental Science – A global concern Tata McGraw-Hill Education India

Course nature				**Theory + Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Midterm Exam I	Midterm Exam II	Quiz	Internal Practical	**Total**
	Weightage	**12%**	**12%**	**11%**	**15%**	**50%**
End semester examinationWeightage (Theory = 35%; Practical = 15%)						**50%**

Environmental Science Laboratory- ENV 111 lab

List of Experiments

1. Water parameters- Test for alkalinity and turbidity of water
2. Determination of dissolved oxygen in water
3. Test for total suspended solids and total dissolved solids
4. Determination of total hardness of water by EDTA titration
5. Determination of biological oxygen demand of wastewater
6. Test for iron content in river water

/15NT403	Principles of Economics	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category		PRINCIPLES OF ECONOMICS			
Course designed by	Department of Economics				
Approval					

PURPOSE	This course will provide you with a basic understanding of the principles of microeconomics. At its core, the study of economics deals with the choices and decisions we make to manage the scarce resources available to us. Microeconomics is the branch of economics that pertains to decisions made at the individual level, such as the choices individual consumers and companies make after evaluating resources, costs, and tradeoffs

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
5.	Analyse relevant economic concepts and economic models which inform the study of microeconomics.	D						
6.	Apply the principles of microeconomics associated with supply and demand in determining market equilibrium and the effects of price controls and elasticity.	D	I	J	A			
7.	Apply the principles of microeconomics associated with production and consumption in determining the behavior of individuals and producers in successful markets and situations where markets fail or contribute to income inequality.	D	A	I	J			
8.	Analyze market structures and apply theoretical concepts of perfect competition to identify the behavior of monopolies and imperfect competition.	D	I	A	J			
9.	Analyze resource markets to understand the decision-making of resource allocation and interrelationships among key markets in the economy	D	I	A	J			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO ECONOMICS	**5**			
36.	Why study economics? Scope and method of economics; the economic problem: scarcity and choice; the question of what to produce, how to produce and how to distribute output;	1	C		1
37.	ience of economics; the basic competitive model; prices,	1	C		1,2

38.	ience of economics; the basic competitive model; prices,	1	C		2
39.	pperty rights and profits; incentives and information; rationing;	1	C	1	1
40.	portunity sets; economic systems; reading and working with graphs	1	C-D-I		
	UNIT II – DEMAND AND SUPPLY	**8**			
41.	terminants of individual demand/supply; demand/supply schedule and demand/supply curve; market versus individual demand/supply;	1	C		1
42.	fts in the demand/supply curve, demand and supply together;	1	C		1
43.	w prices allocate resources; elasticity and its application;	1	C		1
44.	w prices allocate resources; elasticity and its application;	1	C-I	2,3	1
45.	ntrols on prices; taxes and the costs of taxation;	1	C	1,2	1
46.	ntrols on prices; taxes and the costs of taxation;	1	C	2	1
47.	nsumer surplus; producer surplus and the efficiency of the markets	1	C	2	1
48.	nsumer surplus; producer surplus and the efficiency of the markets	1	C	2	1
	UNIT III- CONSUMER THEORY	**10**			
49.	The consumption decision - budget constraint,	1	C	3	2
50.	The consumption decision - budget constraint, consumption and income/price changes,	1	C	3	2
51.	mand for all other goods and price changes;	1	C	3	2
52.	lity and preferences (indifference curves); properties of indifference curves;	1	C	3	2
53.	lity and preferences (indifference curves); properties of indifference curves;	1	C	3	2
54.	nsumer ‘s optimum choice	1	C	3	2
55.	come and substitution effects;	1	C	3	2
56.	ome and substitution effects;	1	C	3	2

57.	plying consumer theory: Labour	1	C-I	3	2
58.	plying consumer theory: Labour	1	C-I		
	UNIT IV: PRODUCER THEORY	**12**			
59.	Production, short- run production function and returns to factor	1	C	2	2
60.	Production, short- run production function and returns to factor	1	C	2	2
61.	Production, short- run production function and returns to factor	1	C		
62.	Average-marginal relationship	1	C	3	1
63.	Long– run production function and laws of return to scale- role of technology.	1	C	3	1
64.	Long– run production function and laws of return to scale- role of technology.	1	C	3	1
65.	Long– run production function and laws of return to scale- role of technology.	1	C		
66.	Cost function and cost structure of a firm in the short- run,	1	C	3	2
67.	st function and cost structure of a firm in the short-run,	1	C	3	2
68.	st function and cost structure of a firm in the short-run,	1	C	3	2
69.	g run cost function and cost structure.	1	C	3	2
70.	g run cost function and cost structure.	1	C		
	UNIT V: TYPES OF MARKET	**10**			
71.	Perfect competition -features	1	C	4	1
72.	fect competition- profit maximization	1	C	4	1
73.	ut-down and break-even points.	1	C	4	1
74.	ut-down and break-even points.	1	C	4	1
75.	nopoly: marginal revenue; marginal cost; profit maximization;	1	C	4	2
76.	nopoly: marginal revenue; marginal cost; profit maximization;	1	C	4	2

77.	ıtdown rule; market power; price discrimination.	1	C	4	2
78.	ıtdown rule; market power; price discrimination.	1	C	4	2
79.	ɔnopolistic competition and product differentiation	1	C	4	2
80.	ɔnopolistic competition and product differentiation	1	C		
	Total contact hours	45			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Principles of microeconomics, N. Gregory Mankiw, Publisher: Cengage Learning fifth edition,
2	Perloff, Jeffrey M. *Microeconomics*. 5th ed. Addison Wesley, 2008. ISBN: 9780321558497.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Assignment	Class Test	Quiz	**Total**
	Weightage	**15%**	**15%**	**10%**	**5%**	**5%**	**50%**
End semester examination Weightage :						**50%**	

CDC101	**SOFT SKILLS 1**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**1**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	G GENERAL				
Course designed by	Department of Career Development				
Approval					

PURPOSE	To Enhance holistic development of students and improve their competitive skills, life skills and employability skills.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to		D	F	G	I			
10	Develop interpersonal skills and will be a good team player.							

11	Develop socializing, positive attitude and behavioral skills.							
12	Understand their barriers of Communication and will take conscious effort to improve their skill sets.							
13	Set SMART Goals for themselves and should become better in terms of Time Management							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: KNOW THEY SELF	**6**			
81.	SWOT Analysis.	1	O	1, 4	1, 2
82.	Psychometric Analysis using simple tests.	1	O	1, 4	1, 2
83.	Grooming	2	D, I, O	4	1, 2
84.	Social Etiquette	1	D, I, O	2, 3, 4	1, 2
85.	Activity	1	O	1, 3	
	UNIT II – PERSONALITY DEVELOPMENT	**6**			
86.	Personality Construct.	1	C	4	1, 2
87.	KASAB Model.	1	O	1, 3, 4	1, 2
88.	Components of perception.	1	I	1, 3	1, 2
89.	Perceptual errors.	1	I	1, 3	1, 2
90.	Perception as a precursor of attitude and behavior.	1	O	2, 4	1, 2
91.	Activity	1	O	3	
	UNIT III – COMMUNICATION	**9**			
92.	Verbal and Non Verbal Communication.	1	O, I	3, 4	3
93.	Three V's of communication.	1	I	3, 4	3
94.	Visual or Kinesics,	1	I	3, 4	3
95.	Vocal (Articulation), Verbal,	1	I	3, 4	3
96.	Active listening, Barriers to listening, GARF (Giving and Receiving Feedback)	1	C	3, 4	3

97.	Activity	4	O		
	UNIT IV: PRESENTATION SKILLS	**8**			
98.	The four Ps of presentation,	1	D, I	3	4
99.	Different types of presentations and importance.	1	D, I	3	4
100.	Handling different types of target audience	1	O	1, 3, 4	4
101.	Techniques and Tips to give an effective presentation.	1	I	1, 3, 4	4
102.	Activity	4	O		
	UNIT V: TIME MANAGEMENT & GOAL SETTINGS	**5**			
103.	Pressure Cooker (Activity based on Planning, Organizing and Prioritization),	1	O	1, 4	5
104.	Roller Coaster (Activity on setting SMARTER goals, planning & organizing, short & long term goals).	1	O	1, 4	5
105.	Activity	3	O	4	
	Total contact hours	34			

INSTRUCTIONAL OBJECTIVES	
1	To develop inter personal skills and be an effective goal oriented team player
2	To develop professionals with idealistic, practical and moral values.
3	To develop communication and problem solving skills
4	To re-engineer attitude and understand its influence on behavior

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Mitchell S. Green – 2017, Know Thyself: The Value and Limits of Self-Knowledge
2	Debbie Hindle, Marta Vaciago Smith - 2013 , Personality Development: A Psychoanalytic Perspective

3	Lani Arredondo - 2000, Communicating Effectively.
4	Patsy McCarthy, Caroline Hatcher - 2002, Presentation Skills: The Essential Guide for Students.
5	Martha Davis, Elizabeth Robbins Eshelman, Matthew McKay - 2008, Time Management and Goal Setting: The Relaxation and Stress

ASSESSMENT

1. A practical and activity oriented course which has continuous assessment for 75 marks based on class room interaction, activities etc.
2.Presentation – 25 marks.

Course nature		**Theory**				
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	UNIT III	UNIT IV	UNIT V	PRESENTATION	**Total**
	Weightage	**25%**	**25%**	**25%**	**25%**	**100%**
End semester examination Weightage :						**0%**

CDC102	**SOFT SKILLS 2**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**1**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	G GENERAL				
Course designed by	Department of Career Development				
Approval					

PURPOSE	To Enhance holistic development of students and improve their competitive skills, life skills and employability skills.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to		D	F	G	I			
14	Develop Positive attitude and Self Motivated attitude.							
15	Develop Lateral thinking skills and understand its importance.							
16	To work in a Team dynamics.							

Session	**Description of Topic**	**Contact**	**C-**	**IOs**	**Reference**

		hours	D-I-O		
	UNIT I: MOTIVATION	**7**			
106.	Maslow's theory of Motivation.	1	C	1, 3, 4	1
107.	Soldiers' Walk and The Japanese Fan (Activities on factors of motivation)	2	D	1, 4	
108.	Steps to ward off de-motivation	4	I	1, 4	1
	UNIT II – CREATIVITY AND INNOVATION	**7**			
109.	Activity on Brain Storming, Types of Creativity, Common Barriers of creativity.	3	D	1	1, 2
110.	Sources of New Idea,	1	I	1, 4	2
111.	Activity topics to enhance the power of aesthetics and precision. Aim is to create interest in research	2	O	1, 2, 4	
112.	Activity	1	O		
	UNIT III – CRITICAL AND LATERAL THINKING	**4**			
113.	Importance's of Critical and Lateral thinking.	1	I	1	2, 3
114.	Fill Me Up, Stimulating Lateral Thinking.	1	I	1, 4	2, 3
115.	Activity to enhance critical and lateral thinking	2	I, O	1, 2, 4	2, 3
	UNIT IV: TEAM DYNAMICS	**10**			
116.	Importance of Team Dynamics,	1	C	1, 2, 3, 4	3
117.	Story boarding, Frenzy,.	2	C	1, 2	-
118.	Activities Come to my Island, Striking Cars, Defend the Egg, Tallest Tower	4	O	1, 2, 3	-
119.	Activities on the different stages of team building, team communication, coordination and collaboration	3	O	1, 2, 3, 4	-
	UNIT V: MINI PROJECT	**4**			
120.	Individual projects on topics provided by faculties	4	O	1, 2, 3, 4	-
	Total contact hours	32			

INSTRUCTIONAL OBJECTIVES

1	To develop inter personal skills and be an effective goal oriented team player
2	To develop professionals with idealistic, practical and moral values.
3	To develop communication and problem solving skills
4	To re-engineer attitude and understand its influence on behavior

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Maslow, A. H. (1943) A Theory of Human motivation. In R. J. Lowry (1973) Dominance, Self-Esteem, Self-Actualization: Germinal Papers of A.H. Maslow (pp. 153-173). Belmont, California: Wadsworth Publishing Company, Inc.
2	Sparking Student Creativity, Practical ways to promote innovative and problem solving, Patti Drapeau
3	Teach yourself to think, Edward de Bono, 1995

ASSESSMENT

1. A practical and activity oriented course which has continuous assessment for 75 marks based on class room interaction, activities etc.
2. Mini Project – 25 marks.

Course nature		**Theory**				
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Activity II	Activity III	Activity IV	Mini Project	**Total**
	Weightage	**20%**	**20%**	**20%**	**40%**	**100%**
End semester examination Weightage :					**0%**	

CDC203	**SOFT SKILLS 3**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	G GENERAL				
Course designed by	Department of Career Development				
Approval					

PURPOSE	To Enhance holistic development of student's mathematical techniques and problem solving skills which are required for their carrier building.

LEARNING OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to		D	F	G	I			
17	Crack competitive exams.							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: QUANTITATIVE REASONING	**9**			
121.	Number properties,	1	I, O	5, 6	1, 2, 3
122.	Percentage,.	1	I, O	5, 6	1, 2, 3
123.	Ratio and proportion,	1	I, O	5, 6	1, 2, 3
124.	Profit and loss,	1	I, O	5, 6	1, 2, 3
125.	Simple and compound interest	1	I, O	5, 6	1, 2, 3
126.	Averages, Speed, Time and work,	1	I, O	5, 6	1, 2, 3
127.	Powers and roots,	1	I, O	5, 6	1, 2, 3
128.	Linear equations, Quadratic equations,	1	I, O	5, 6	1, 2, 3
129.	Pipes, cisterns.	1	I, O	5, 6	1, 2, 3
	UNIT II – VERBAL REASONING	**5**			
130.	Proposition,	1	I, O	1, 2	1, 2, 3
131.	Premise: Syllogism: Verbal Analogies,	1	I, O	1, 2	1, 2, 3
132.	Verification of truth of the statement,	1	I, O	1, 2	1, 2, 3
133.	Assertion and reason,	1	I, O	1, 2	1, 2, 3
134.	Situation reaction test, Decision making	1	I, O	1, 2	1, 2, 3
135.	Alpha-numerical sequence puzzle		I, O	1, 2	1, 2, 3
	UNIT III: VERBAL ABILITY	**3**			
136.	Preposition,	1	I, O	1, 2	1, 2, 3

137.	Articles, Adverbs, Adjectives,	1	I, O	1, 2	1, 2, 3
138.	Conjunctions and Parallel Structures	1	I, O	1, 2	1, 2, 3
	UNIT IV: DATA ANALYSIS AND INTERPRETATION	**2**			
139.	Statistics: Average, Median, Mode,	1	I, O	6, 7	1, 2, 3
140.	Range, Standard deviation,	1	I, O	6, 7	1, 2, 3
	Total contact hours	19			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	R.S. Agarwal, A Modern Approach to Verbal & Non Verbal Reasoning, S. Chand Publication
2	P. Anand, Quantitative Aptitude, Wiley, 2015
3	Archana Ram, Placementor, Oxoford Publication, 2018

INSTRUCTIONAL OBJECTIVES	
1	To get equipped with basic English grammar
2	Applying numerical competence to day to day communication
3	Competent to communicate idea in English
4	Achieve target audience's attention and confidence
5	To get equipped with basic numerical ability
6	Applying numerical competence to real life problems
7	Operational strategy using logic and reasoning.
8	Executing a new model integrating quantitate aptitude

Course nature	**Theory**
Assessment Method (Weightage 100%)	

In-semester	Assessment tool	Mid Exam I	Mid Exam II	Total
	Weightage	25%	25%	50%
End semester examination Weightage :				50%

CDC204	SOFT SKILLS 4			L	T	P	C
				1	0	0	1
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	H	COMPETATIVE SKILLS	Quantitative and Verbal Ability				
Course designed by	Department of Career Development						
Approval							

PURPOSE	To Enhance holistic development of student's mathematical techniques and problem solving skills which are required for their carrier building.

LEARNING OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to		D	F	G	I			
18	Crack competitive exams.							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: QUANTITATIVE REASONING	**7**			
141.	Speed, Time and work,	1	C, O	1, 2	1, 2, 3
142.	Powers and roots,	1	C, O	1, 2	1, 2, 3
143.	Pipes, cisterns.	1	C, O	1, 2	1, 2, 3
144.	Problems on Clock,	1	C, O	1, 2	1, 2, 3
145.	Calendar and Cubes,	1	C, O	1, 2	1, 2, 3
146.	Height and Distance,	1	C, O	1, 2	1, 2, 3
147.	Logarithms	1	C, O	1, 2	1, 2, 3

	UNIT II – NON-VERBAL REASONING	**5**			
148.	Alpha-numerical sequence puzzle,	1	C, O	2, 3	1, 2, 3
149.	Symbols and their relationships,	1	C, O	2, 3	1, 2, 3
150.	Blood Relations, Seating Arrangement,	1	C, O	2, 3	1, 2, 3
151.	Coding-Decoding, Input- Output,	1	C, O	2, 3	1, 2, 3
152.	Test Direction Sense Test	1	C, O	2, 3	1, 2, 3
	UNIT III: DATA ANALYSIS AND INTERPRETATION	**5**			
153.	Graphical and Numerical Methods for Describing Data, ,	1	C, O	2	1, 2, 3
154.	Interpretation of data in tables and graphs,	1	C, O	2	1, 2, 3
155.	Permutations	1	C, O	2, 3	1, 2, 3
156.	Venn diagrams Counting Methods,	1	C, O	2, 3	1, 2, 3
157.	Probability.	1	C, O	2, 3	1, 2, 3
	UNIT IV: VERBAL ABILITY	**2**			
158.	Conditionals, Tense Forms,	1	C, O	5	1, 2, 3
159.	Verb Forms,	1	C, O	5	1, 2, 3
	Total contact hours	19			

INSTRUCTIONAL OBJECTIVES	
1	To get equipped with basic numerical ability
2	Applying numerical competence to real life problems
3	Operational strategy using logic and reasoning.
4	Executing a new model integrating quantitate aptitude
5	To get equipped with basic English grammar

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	R.S. Agarwal, A Modern Approach to Verbal & Non Verbal Reasoning, S. Chand Publication
2	P. Anand, Quantitative Aptitude, Wiley, 2015
3	Archana Ram, Placementor, Oxoford Publication, 2018

Course nature		**Theory**		
Assessment Method (Weightage 100%)				
In-semester	**Assessment tool**	Mid Exam I	Mid Exam II	**Total**
	Weightage	**25%**	**25%**	**50%**
			End semester examination Weightage :	**50%**

PHY 221	**Introduction to Electricity and Magnetism**	**L**	**T**	**P**	**C**
		2	**0**	**2**	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	BASIC SCIENCES	SEAS			
Course designed by	Department of Physics				
Approval	-- Academic Council Meeting -- , 2018 (Regulation 2018)				

PURPOSE	The purpose of this course is to introduce students about the basics of electricity and magnetism as well as their dynamics. We also introduce the analytical methods for solving field problems and explanation of all four Maxwell's equations.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
19	To provide a comprehensive background of field and potentials for electrostatics and magneto-statics							
20	To provide a comprehensive background of electrodynamics and Maxwell's equations							

21	To discuss the various analytical techniques for finding electric and magnetic fields							
22	To experience the hands-on experience of the practical to help the students for real time understanding of the physical process							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I –Introduction to Vector Algebra	**6**			
160.	Introduction to vectors, scalar and vector product	1	C		1,2
161	Gradient of a scalar field	1	C,O		1,2
162	Divergence and Curl of vector fields and their physical significance	1	C,O		1,2
163	Gauss and Stokes theorems	1	C		1,2
164	Coordinate systems –introduction to Cartesian system	1	C		1,2
165	Spherical and Cylindrical coordinate systems	1	C		1,2
	UNIT II – Electrostatics	**6**			
166.	Coulomb's law and electric field	1	C		1,2
167.	Gauss Law	1	C.D		1,2
168.	Electric Potential	1	C		1,2
169.	Potential Energy	1	C		1,2
170.	Conductors under Electrostatic Equilibrium	1	C		1,2
171.	Capacitors	1	C		1,2
	UNIT III – Dielectrics and Polarization	**6**			
172.	Introduction to Electric Dipole and dipole Moment	1	C		1,2
173.	Potential and field due to electric dipole	1	C		1,2
174.	Polarization in dielectrics	1	C		1,2
175.	Modification of Gauss's Law in terms of electric displacement	1	C,D		1,2

176.	Electric Susceptibility and dielectric constant	1	C,D		1,2
177.	Bound charges	1	C		1,2
	UNIT IV: Magnetostatics	**6**			
178.	Magnetic force and cyclotron	1	C		1,2
179.	Biot-Savart Law for magnetic fields	1	C,D		1,2
180.	Magnetic field due to various current loops	1	C		1,2
181.	Ampere's circutal law	1	C		1,2
182.	Equation of Continuity	1	C		1,2
183.	Magnetization in Materials	1	C		1,2
	UNIT V: Introduction to Electrodynamics	**6**			
184.	Introduction to time-varying fields	1	C		1,2
185.	Faraday's law of induction	1	C		1,2
186.	Generalization of Ampere's law	1	C		1,2
187.	Maxwell's equations	1	C		1,2
188.	Derivation of wave equation	1	C		1,2
189.	Planar Waves in free space	1	C		1,2
	Total contact hours	30			

The list of experiments for practical session:

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	To find the dielectric constant of the medium using parallel plate capacitor	2	C, I, O		1,2
2.	To find the band gap energy of a semi-conductor using Four-probe method	2	C, I, O		1,2
3.	To find the band gap energy of a semi-conductor using Four-probe method	2	C, I, O		1,2

4.	Find the magnetic field due to Helmholtz coils and verify its relation by varying the distance	2	C, I, O		1,2
5.	Use Faraday's law for finding the total magnetic flux through the coil	2	C, I, O		1,2
6.	To find the type and concentration of charge carriers using hall probe	2	C, I, O		1,2
7.	Verify the Biot-Savart law for a given circular coil	2	C, I, O		1,2
8.	To find the fill factor of a given solar cell using I-V characteristics	2	C, I, O		1,2
9.	To find the type of material using the deflection in magnetic field	2	C, I, O		1,2
10.	To study the Hysteresis curve for a given magnetic material	2	C, I, O		1,2
11.	Practice session I and remedial session	2	C, I, O		1,2
12.	Practice session II and remedial session	2	C, I, O		1,2
13.	Model Exam	2	C, I, O		1,2
14.	Model Exam	2	C, I, O		1,2
15.	Model Exam	2	C, I, O		1,2
	Total contact hours	30			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Introduction to Electrodynamics –David J. Griffiths; 4th Edition, 2012, PHI Eastern Economy Editions
2	Electricity and Magnetism- A. S. Mahajan and A. A. Rangwala, 1st Revised Edition, 2007, McGraw-Hill Education

Course nature			**Theory + Practical**			
Assessment Method theory (Weightage 60%)						
In-semester	**Assessment tool**	Midterm Exam I	Midterm Exam II	Assignment	Class Test and quiz	**Total**

	Weightage	**15%**	**15%**	**10%**	**10%**	**50%**
					End semester examination Weightage :	**50%**
Assessment Method practical (Weightage 40%)						
In-semester	**Assessment tool**	Model lab exam	Lab performance	Observation book	**Total**	
	Weightage	**20%**	**20%**	**10%**	**50%**	
					End semester examination Weightage :	**50%**

CHE101	**Principles of Chemistry**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	Foundation Course	Basic Science			
Course designed by	Department of Chemistry				
Approval	-- Board of Studies -- , 2018				

PURPOSE	The course aims to provide a basic understanding of various states of matter (gas, liquid, and solids) and the chemical bonding within. Also, this course helps the students to understand various fundamental concepts when they are dealing respective core engineering subjects. Along the way, students learning focus on sustainability, where priority is given to environmentally friendly materials.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
23	Distinguish the types of bonding and also predict the structure, electronic and magnetic properties of molecules							
24	Classify the types of chemical reactions based on reaction energetics and kinetics. Also, interprets stability of materials based on the temperature, pressure and concentration variables.							
25	Gain in-depth knowledge on crystalline materials and their applications in electronic devices.							
26	Identify the types of polymers and familiar with industrial applications of common synthetic and biodegradable polymers.							
27	Know the storage mechanism of various electrochemical cells and their applications namely electronic and e-mobility.							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**

	UNIT I: Chemical Bonding	**4**			
190	Ionic, covalent, metallic bonds and hydrogen bonding	1			1
191	Theories of bonding: Hybridization: Types of hybridization, sp, sp^2, sp^3, sp^3d, d^2sp^3.	1			1
192	Shapes of molecules (VSEPR Theory): $BeCl_2$, CO_2, BF_3, H_2O, NH_3, CH_4, PCl_5, XeF_2, SF_6, XeF_4.	1			1
193	Molecular orbital theory: Linear combination of atomic orbitals (LCAO Method), bond order, homo-nuclear diatomic molecules such as H_2, O_2, N_2	1			1
	UNIT II – Phase Rule, Thermochemistry, and Kinetics	**7**			
194.	Definition of the terms used in phase rule with examples	1			1,2
195.	Application of phase rule to one component system (eg Water)	1			1,2
196.	Application of phase rule to two component system (eg Pb-Sn)	1			1
197.	Standard terms in thermochemistry and their significance	1			1,2
198.	Heat of combustion, formation and sublimation (with examples in fuels and propellants)	1			1
199.	Order and molecularity of reactions, zero order, first order rate equations,	1			1,2
200.	Problems associated with Zero & First order reactions	1			1,2
	UNIT III – Crystalline Materials	**8**			
201.	Introduction to solid state materials, difference between crystalline and amorphous systems,	1			1
202.	Properties of crystalline materials	1			1
203.	Crystal lattice, unit cells, types of crystal systems, types of unit cells (Bravais lattices)	1			1
204.	Miller indices, Bragg's law	1			1
205.	Problems associated theoretical density of crystals and Bragg's equation	1			1
206.	Introduction to Band theory, metals, insulators, and semiconductors with examples.	1			1,3
207.	Classification of semiconductors, imperfections in crystals	1			1,3
208.	Frenkel and Schottky defects, doping and devices	1			1

	UNIT IV: Materials Chemistry	**7**			
209.	Introduction to Polymers	1			4
210.	Classification of polymers, Thermoplastic and Thermosetting polymers with examples, Tacticity of polymers	1			4
211.	Properties of polymers: Glass transition temperature (Tg)	1			4
212.	Properties of polymers: Molecular weight, weight average, Problems associated with Molecular weight, weight average	1			4
213.	Degradation of polymers and biodegradable polymers, Common Polymers: Elastomer, Conducting polymer	1			4
214.	Hardness in water, demineralization of water	1			4
215.	Water treatment: Zeolite process	1			4
	UNIT V: Electrochemical Devices	**4**			
216.	Introduction to Electrochemical cells and classification of Electrochemical cells	1			2
217.	Primary and secondary cells with examples	1			2
218.	Lead-acid battery and Li^+ batteries	1			2
219.	Li^+ batteries and Fuel cells	1			2,5
	Total contact hours	30			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	A. Bahl, B.S. Bahl, G.D. Tuli, *Essentials of Physical Chemistry*, (**2016**), S Chand Publishing Company
2	B. R. Puri, L. R. Sharma & M. S. Pathania, *Principles of Physical Chemistry*, 46th Edition (**2013**), Vishal Publication Company
3	D. F. Shriver, P. W. Atkins and C. H. Langford, *Inorganic Chemistry*, 3rd Ed., Oxford University Press, London, **2001**.
4	V. R. Gowariker, N. V. Viswanathan, J. Sreedhar, *Polymer Science*, New Age International, **1986.** ISBN: 0-85226-307-4
5	Atkins, P.W.; de Paula, J. (**2006**). *Physical chemistry* (8th ed.). Oxford University Press. ISBN 0-19-870072-5

Course nature				Theory			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Midterm I	Midterm II	Class Test	Assignments	Quiz	**Total**
	Weightage	**15%**	**15%**	**5%**	**10%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ENL 101	**COMMUNICATIVE ENGLISH**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	G GENERAL				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting				

PURPOSE	To develop the ability in the engineering student, to be able to communicate in simple english.

INSTRUCTIONAL OBJECTIVES		**STUDENTOUTCOMES**						
At the end of the course, student will be able to apply concepts of								
1.	How to speak simple English/spoken	a	e					
2.	How to communicate to customers, vendors, teachers, students	a	e					
3.	How to do presentation using plain english	a	e					
4.	How to communicate on phone, skype	a	e					
5.	How to understand ascents, phonetics	a	e					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: RHETORIC AND PUBLIC SPEAKING	**12**			
1	Rhetoric	3	C,D	1	1,2
2	Critical thinking and public speaking	3	C,D	1	1,2
3	Thinking outside the box	3	C,D	1	1,2
4	How to deliver a speech	3	C,D	1	1,2
5	Fundamentals of persuasion	1	C,D	1	1,2
	UNIT II: NON VERBAL COMMUNICATION	**12**			
6	Non verbal communication	3	C,D	2	1,2
7	Spatial distance	3	C,D	2	1,2
8	Eye contact and appearances	3	C,D	2	1,2
9	How non verbal communication is important	3	C,D	2	1,2
	UNIT III: COMMUNICATION AND THE MEDIA	**12**			
10	Persuasion and the media	3	C,D	3	1,2
11	Radio, television, film	3	C,D	3	1,2
12	Social media and the internet	2	C,D	3	1,2
13	How the media sells the ideas, images, products	3	C,D	3	1,2
14	Informative/scientific speeches and research	2	C,D	3	1,2
15	Heart of the speech, powerful narratives	1	C,D	3	1,2
16	Power of narrative	1	C,D	3	1,2

	UNIT IV: SMALL GROUP COMMUNICATION	**12**			
17	Leadership, conflict and persuasion in group	2	C,D	4	1,2
18	Importance of small groups in business	2	C,D	4	1,2
19	Moment of Inertia by analytical method	2	C,D	4	1,2
20	Group problem solving	2	C,D	4	1,2
21	Learning to say no	3	C,D	4	1,2
	Total contact hours*	**48**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Communication: Principles for a Lifetime. Beebe, Beebe and Ivy, Sixth Edition, Pearson Publishing.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Qualitative Communication Research Methods (2011) Bryan C. Taylor and Thomas R. Lindlof. Sage Publications, New Delhi, India, 3rd Edition
3.	The Fundamentals of Small Group Communication (2008) Scott A. Myers and Carolyn M. Anderson. Sage Publications, New Delhi, India.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

ENG 111	**BASIC ELECTRONICS**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	EG ENGINEERING				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting				

PURPOSE	Students should be able to learn and practice basic electronic circuits and instruments

INSTRUCTIONAL OBJECTIVES		**STUDENTOUTCOMES**						
At the end of the course, student will be able to apply concepts of								
1.	Working f basic electronic/electrical instruments	a	e					
2.	Basic function of semiconductor devices	a	e					
3.	Basic understanding of AC circuits and amplifiers	a	e					
4.	Basic function of electronic filters	a	e					
5.	Digital logic fundamentals	a	e					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I:ELECTRICAL QUANTITIES AND THEIR MEASUREMENTS	**10**			
1	Ohm's law	2	C,D	1	1,2
2	Permanent magnet, ammeter, voltmeter	2	C,D	1	1,2

3	Measurement of resistance using wheatstone bridge	2	C,D	1	1,2
4	Measurement of capacitance using different methods	2	C,D	1	1,2
5	Measurement of inductance using different methods	2	C,D	1	1,2
	UNIT II: SEMICONDUCTOR DEVICES	**10**			
6	Forward and reverse bias of PN junction diode	3	C,D	2	1,2
7	Half wave, full wave bridge rectifiers	3	C,D	2	1,2
8	Bipolar junction transistors	2	C,D	2	1,2
9	Transistor as amplifier and buffer, photodiode/phototransistor	2	C,D	2	1,2
	UNIT III: AC CIRCUITS AND AMPLIFIERS	**10**			
10	Phasor analysis, impedance, reactance, resonance, RLC, characteristics of amplifiers	2	C,D	3	1,2
11	Integrator and differentiator design	2	C,D	3	1,2
12	Differential operational amplifier	2	C,D	3	1,2
13	Parallel and series reactance	2	C,D	3	1,2
14	Common mode rejection ratio	2	C,D	3	1,2
	UNIT IV: ELECTRONIC FILTERS	**10**			
15	Low and high frequency noise in electronic circuits	2	C,D	4	1,2
16	Low pass, high pass, band pass filters	2	C,D	4	1,2
17	Fourier transform, bode plot, bandwidth	2	C,D	4	1,2
18	Higher order filters	2	C,D	4	1,2
19	Applications of filters	2	C,D	4	1,2
	UNIT V DIGITAL LOGIC FUNDAMENTALS	10			
20	Different number systems	2	C,D	5	1,2
21	Logic gates AND OR NOT NOR X-OR X-NOR	2	C,D	5	1,2
22	Adders/subtractors, multiplexers	2	C,D	5	1,2
23	D'morgan laws	3	C,D	5	1,2
	Total contact hours*	**50**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Principles of electronics by V K Mehta & Rohit Mehta, 2010 edition, S Chand and Co.Publisher, ISBN: 9788121924504
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Electronic devices and circuits by David A. Bell, 2008 edition, Oxford University Press, ISBN: 9780195693409
3.	Introduction to digital logic design by John P. Hayes, 1993 edition, Pearson Edition, ISBN: 9780201154610.
4	Electronic measurements and Instrumentation by A K Sawhney, 2015 edition, Dhanpat Rai and Co., ISBN: 9788177001006.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

ENG 105	**ENGINEERING GRAPHICS**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**
Co-requisite:	Nil				
Prerequisite:	Nil				

Data Book / Codes/Standards	Nil
Course Category	EG ENGINEERING
Course designed by	Department of Mechanical Engineering
Approval	Academic Council Meeting

PURPOSE	To draw and interpret 1D, 2D and 3D objects To prepare and interpret drawings of machine components or buildings

INSTRUCTIONAL OBJECTIVES		**STUDENTOUTCOMES**						
At the end of the course, student will be able to apply concepts of								
1.	How to project points, lines and planes on 3D planes	a	e					
2.	How to project and section solids	a	e					
3.	How to draw isometric and perspective views	a	e					
4.	Geometric dimensioning and tolerances	a	e					
5.	How to use software tool to create machine drawing views	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I:PROJECTION OF POINTS, LINES, PLANES, SOLIDS	**20**			
1	Projection of points	2	C,D	1	1,2
2	Projection of lines	3	C,D	1	1,2
3	Projection of planes	5	C,D	1	1,2
4	Projection of solids	5	C,D	1	1,2
5	Use of software tool to create projections	5			
	UNIT II: SECTIONS AND DEVELOPMENTS	**10**			
6	Sections of solids	3	C,D	2	1,2
7	True shape of the section	3	C,D	2	1,2
8	Development of surfaces of sectioned solids	2	C,D	2	1,2
9	CAD exercises	2	C,D	2	1,2
	UNIT III: ISOMETRIC VIEWS	**10**			
10	Isometric projections of simple and truncated solids	2	C,D	3	1,2
11	Isometric to orthographic and vice versa	2	C,D	3	1,2
12	Perspective projection	2	C,D	3	1,2
13	CAD exercises	2	C,D	3	1,2
	UNIT IV: GEOMETRIC DIMENSIONING AND TOLERANCES	**10**			
15	GD and T rules and concepts	2	C,D	4	1,2
16	Geometric characteristics and modifiers	2	C,D	4	1,2
17	Fourier transform, bode plot, bandwidth	2	C,D	4	1,2
18	Datums and datum references	2	C,D	4	1,2
19	CAD excersizes	2	C,D	4	1,2
	UNIT V FREE HAND SKETCHING AND CAD	10			
20	Free hand sketching of real objects	2	C,D	5	1,2
21	Free hand sketching of multiple views from pictorial views	2	C,D	5	1,2
22	CAD excersizes	2	C,D	5	1,2
23	Assignments of 2D and 3D drawings	3	C,D	5	1,2
	Total contact hours*	**60**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**

1.	Bhatt, N.D, Engineering Drawing, Charotar Publishers, 2014
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Bhatt, N.D, Machine Drawing, Charotar Publishers, 2014
3.	Venugopal, K. and Prabhu Raja, V., Engineering Graphics, Eighth Edition (Revised), New Age International Publishers, Chennai, 2007
4	Narayanan, K. L. and Kannaiah, P., Engineering Graphics, Scitech Publications, Chennai, 1999.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Final Exam**	**Practical**	**Assignm**	**Total**
	Weightage	**10%**	**15%**	**35%**	**30%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

MAT - 112	**SINGLE VARIABLE CALCULUS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Fundamental	Single variable Calculus			
Course designed by	DEPARTMENT OF MATHEMATICS				
Approval	-- Academic Council Meeting -- , 2016				

PURPOSE	The objective is to equip the students with techniques of calculus and its applications							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	The objective is to equip the students with techniques of calculus and its applications							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I: Limit and Continuity	**5**			
1.	nit of a function at a point	1	C		1
2.	ne-sided limits	1	C		1

3.	ntinuity	2	C		1
4.	mits involving infinity	2	C		1
	Unit II: Differentiation	**7**			
5.	rivative at a point	1	C		1
6.	rivative as a function	1	C		1
7.	oduct rule, Quotient rule and chain rule	2	C		1
8.	plicit differentiation	1	C		1
9.	lle's Theorem	1	C		1
10.	Mean Value Theorem	1	C		1
	Unit III: Integration	**9**			
11.	Area as a limit of finite sums	1	C		1
12.	Definite and indefinite integral	2	C		1
13.	ndamental Theorem of Calculus	1	C		1
14.	egration by substitution	2	C		1
15.	egration by parts	1	C		1
16.	egration by partial fractions	2	C		1
	Unit IV: Application of Calculus	**10**			1
17.	Maxima and minima	1	C		1
18.	Concavity and curve sketching	1	C		1
19.	Optimization problems in Physics	1	C		1
20.	Economics & Mathematics	1	C		1
21.	Area between curves	2	C		1
22.	Volumes, Arc length, Moments and centres of mass	3	C		1
23.	Newton's method to find roots	1	C		1

	Unit V: Sequence and Series	**7**			
24.	Sequences, Sum of a series	1	C		1
25.	Comparison test, Root test, Ratio test	2	C		1
26.	Leibniz theorem on alternating series	1	C		1
27.	Power series, Taylor's and Maclaurin series	2	C		1
28.	Absolute and conditional convergence	1	C		1

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Thomas' Calculus, 14th Edition, Joel R. Hass, Christopher E. Heil, Maurice D. Weir, 2018
2	roduction to Real Analysis 4th Edition, Robert G. Bartle, Donald R. Sherbert, 2014
3	Calculus and Analytic Geometry, 9th Edition, George B. Thomas, Jr. Ross L. Finney. 2017

Course nature				**Theory**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Quiz	Assignment	**Total**
	Weightage	15%	15%	10%	10%	50%
End semester examination Weightage:						50%

	MULTI VARIABLE CALCULUS	**L**	**T**	**P**	**C**
		3	**0**	**0**	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P				
Course designed by	DEPARTMENT OF MATHEMATICS				
Approval	-- Academic Council Meeting -- , 2016				

PURPOSE	This is a fundamental course Student able to learn how to find double integral, triple integral& surface integral.

LEARNING OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1	This is a fundamental course							
2	Student able to learn how to find double integral, triple integral& surface integral							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I VECTORS AND MATRICES	**15**			
1.	ree-dimensional coordinate system	3	C		1
2.	ctors	3	C		1
3.	t products	3	C		1
4.	ctor products	3	C		1
5.	nes and planes	3	C		1
	UNIT-II PARTIAL DERIVATIVES	**16**			
6.	nctions of several variables	3	C		1
7.	nits and continuity for several variable functions	4	C		1
8.	tial derivatives	3	C		1
9.	e chain rule	3	C		1
10.	ectional derivatives	2	C		1
11.	adient	1	C		1
	UNIT- III DOUBLE INTEGRAL AND LINE, INTEGRAL IN PLANES	**15**	C		1
12.	Extreme values	5	C		1
13.	ddle points	5	C		1
14.	grange multipliers	5	C		1
	UNIT-IV TRIPLE INTEGRALS IN 3D	**17**			
15.	Double and integrated integrals	9	C		1
16.	Area by double integration	8	C		1
17.	**UNIT – V SURFACE INTEGRALS IN 3D**	**12**	C		1

18.	Triple integration and applications	12	C		1

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Edwards, Henry C Thomas- Calculus, 14th edition. Chapters 12 to 16 relevant sections
2	M. Apostol, Calculus - Vol.2, 2nd Edn., Wiley India, 2003

Course nature				**Theory**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Quiz	Assignment	**Total**
	Weightage	15%	15%	10%	10%	50%
End semester examination Weightage:						50%

MAT-141	**DISCRETE MATHEMATICS**			**L**	**T**	**P**	**C**
				3	**0**	**0**	3
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	Core	DISCRETE MATHEMATICS				
Course designed by	DEPARTMENT OF MATHEMATICS						
Approval	-- Academic Council Meeting -- , 2016						

PURPOSE	The objective is to equip the students with the mathematical definitions, proofs and applicable methods							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	The objective is to equip the students with the mathematical definitions, proofs and applicable methods							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**

	Unit I - The Foundations: Logic and Proofs	**10**			
1.	positional Logic, Applications of Propositional Logic,	1	C		1
2.	positional Equivalences	1	C		1
3.	edicates and Quantifiers	2	C		1
4.	sted Quantifiers, Rules of Inference	2	C		1
5.	roduction to Proofs	2	C		1
6.	Methods and Strategy.	2	C		1
	Unit II- Set Theory	**5**			
7.	ws of set theory	2	C		1
8.	Operations	3	C		1
9.	nctions	3	C		1
10.	quences and Summations	2	C		1
11.	trices	3	C		1
	Unit III – Elementary number theory, Induction and Recursion	**10**			
12.	Divisibility and Modular Arithmetic	2	C		1
13.	Integer Representations and Algorithms	2	C		1
14.	mes and Greatest Common Divisors, Solving Congruences	2	C		1
15.	thematical Induction, Strong Induction and Well-Ordering	2	C		1
16.	cursive Definitions and Structural Induction.	2	C		1
	Unit IV – Counting principles	**9**			
17.	The Basics of Counting, The Pigeonhole Principle, Permutations and Combinations	2	C		1
18.	Binomial Coefficients and Identities	2	C		1
19.	Applications of Recurrence Relations, Solving Linear Recurrence Relations	2	C		1
20.	Divide-and-Conquer Algorithms	2	C		1

21.	Recurrence Relations	1	C		1
	Unit V – Introduction to Graph Theory	**11**			
22.	Graphs and Graph Models, Graph Terminology and Special Types of Graphs	6	C		1
23.	Trees, Spanning trees, Minimal spanning trees	4	C		1
24.	Representing Graphs and Graph Isomorphism	5	C		1
25.	Connectivity, Euler and Hamilton Paths	5	C		1
26.	Shortest-Path Problems	2	C		1

LEARNING RESOURCES

	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Kenneth H. Rosen, *Discrete Mathematics and Applications,* Seventh edition, Tata McGraw-Hill, 2012.
2	J. P. Tremblay and R. P. Manohar, *Discrete Mathematics with Applications to Com Science*, Tata McGraw-Hill, 1997
3	S. Lipschutz and M. L. Lipson, *Schaum's Outline of Theory and Problems of Discrete Mathematics*, 3rd Ed., Tata McGraw-Hill, 1999.
4	M. K. Venkataraman, N. Sridharan, and N. Chandrasekaran, *Discrete Mathema* tional Publishing Company, 2003.

Course nature				**Theory**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Quiz	Assignment	**Total**
	Weightage	15%	15%	10%	10%	50%
End semester examination Weightage:						50%

MAT-211	**LINEAR ALGEBRA**	**L**	**T**	**P**	**C**
		3	**0**	**0**	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Core	Linear Algebra			
Course designed by	DEPARTMENT OF MATHEMATICS				
Approval	-- Academic Council Meeting -- , 2016				

PURPOSE	The main aim of this course is to make students understand the central ideas of linear algebra like solving linear equations performing matrix algebra, calculating determinants, finding eigenvalues and eigenvectors

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Solving systems of linear equations is a basic tool of many mathematical procedures used for solving problems in science and engineering							
2	The main aim of this course is to make students understand the central ideas of linear algebra like solving linear equations							
3	performing matrix algebra, calculating determinants, finding eigenvalues and eigenvectors							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I - Matrices and Gaussian elimination				
1.	roduction, Geometry of Linear Equations		C		1
2.	ussian Elimination		C		1
3.	atrix Notation and Matrix Multiplication		C		1
4.	iangular Factors and Row Exchanges		C		1
5.	verses and Transposes		C		1
	Unit II - Vector spaces				
6.	ctor spaces and Subspaces		C		1
7.	ving Ax = 0 and Ax = b		C		1
8.	ear Independence, Basis and Dimension		C		1
9.	e Four Fundamental Subspaces		C		1
10.	aphs and Networks, Linear Transformations		C		1

	Unit III - Orthogonality				
11.	Orthogonal Vectors and Subspaces		C		1
12.	Cosines and Projections onto Lines		C		1
13.	jections and Least Squares		C		1
14.	thogonal Bases and Gram-Schmidt		C		1
	Unit IV - Determinants				
15.	Introduction		C		1
16.	Properties of the Determinant		C		1
17.	Formulas for the Determinant		C		1
18.	Applications of Determinants		C		1
	Unit V - Eigenvalues and eigenvectors				
19.	Introduction, Diagonalization of a Matrix		C		1
20.	Difference Equations and Powers A^k		C		1
21.	Differential Equations and e^{At}		C		1
22.	Complex Matrices, Similarity Transformations.		C		1

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Gilbert Strang, Linear Algebra and Its applications, Nelson Engineering, 4th Edn., 2007
2	Axler, Linear Algebra Done Right, 2nd Edn., UTM, Springer, Indian edition, 2010.
3	K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall of India, 1996

Course nature				**Theory**		
Assessment Method (Weightage 100%)						
In-	**Assessment**	Cycle test I	Cycle test II	Quiz	Assignment	**Total**

semester	tool					
	Weightage	15%	15%	10%	10%	50%
End semester examination Weightage:						50%

MAT 131	**Differential Equations**			**L**	**T**	**P**	**C**
				3	**0**	**0**	3
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	Core	Differential equations				
Course designed by	DEPARTMENT OF MATHEMATICS						
Approval	-- Academic Council Meeting -- , 2016						

PURPOSE	This introductory course on ordinary differential equations (**ODEs**) covers the theory, solution techniques, and applications surrounding linear and non-linear first and second-order differential equations, including systems of equations.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	model some elementary physical situations by writing an appropriate differential equation.							
2	be able to solve first order simple, linear, and separable equations							
3	solve higher order differential equations using characteristic roots, undetermined coefficients, and the Laplace transform.							
4	understand the qualitative nature of the solution to the linear and non-linear systems of equations.							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT-I First Order Differential Equations	**7**			
1.	ometric meaning of $y' = f(x, y)$, Direction Fields	1	C		1
2.	ler's Method, Classification of ODEs (Linear, Non-linear, Exact, Separable	1	C		1
3.	egrating Factor, Bernoulli Equations	2	C		1
4.	tial Value Problem	1	C		1

5.	odelling (Free falling object, Radioactivity, RL-circuit).	2	C		1
	UNIT-II Second and Higher Order Linear ODEs	**8**			
6.	mogeneous Linear ODEs	1	C		1
7.	odelling of Free Oscillations of a Mass-Spring System	2	C		1
8.	ler-Cauchy Equations	1	C		1
9.	n-homogeneous ODEs	2	C		1
10.	riation of Parameters, Modelling (Forced Oscillations, Electric Circuits)	2	C		1
	UNIT-III System of ODEs	**10**			
11.	Modelling Engineering problems (Electric Network, Mixing problem in two tanks etc.) as systems of ODEs	3	C		1
12.	Wronskian, Phase-Plane Method	2	C		1
13.	tical Points & Stability, Qualitative Methods for Nonlinear Systems	3	C		1
14.	Nonhomogeneous Linear Systems of ODEs.	2	C		1
	UNIT -IV Series Solutions of ODEs	**7**			
15.	Introduction to power series method	1	C		1
16.	Legendre's equation & polynomials	2	C		1
17.	Frobenius Method	2	C		1
18.	Bessel's Equations & Functions	2	C		1
	UNIT-V Laplace Transforms	**12**			
19.	Laplace transforms of standard functions	1	C		1
20.	Shifting Theorems, Transforms of derivatives and integrals	2	C		1
21.	Unit step function, Dirac's delta function	3	C		1
22.	Inverse Laplace transforms, Convolution theorem (without proof).	3	C		1

23.	Application: Solutions of ordinary differential equations using Laplace transforms	3	C		1

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th Edition, Wiley-India.
2	Mary L. Boas, *Mathematical Methods in Physical Sciences*, 3rd Edition, Wiley-India.
3	G. F. Simmons, *Differential Equation with Applications and Historical Notes*, TATA McGraw Hill
4	S. Vaidyanathan, *Advanced Applicable Engineering Mathematics*, CBS Publishers

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Quiz	Assignment	Project	**Total**
	Weightage	15%	15%	10%	10%	10%	60%
End semester examination Weightage:							40%

MAT - 221	**Probability & Statistics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Core	Probability & Statistics			
Course designed by	DEPARTMENT OF MATHEMATICS				
Approval	-- Academic Council Meeting -- , 2016				

PURPOSE								
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1								
2								
3								

4								

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I	**9**			
1.	sic principle of counting, permutations, combinations	1	C		1
2.	ultinomial coefficients, sample space and events	2	C		1
3.	xioms of probability, sample spaces having equally likely outcomes	2	C		1
4.	onditional probability	2	C		1
5.	Bayes` theorem, independent events.	2	C		1
	UNIT-II	**9**			
6.	ndom variable, discrete random variable, expected value	1	C		1
7.	pectation of a function of a random variable, variance	2	C		1
8.	crete probability distributions- Bernoulli, Binomial, Poisson, Geometric, negative	2	C		1
9.	nomial distributions, expected value of sums of random variables	2	C		1
10.	cumulative distribution function and its properties.	2	C		1
	UNIT-III	**7**			
11.	Continuous random variables	1	C		1
12.	Expectation and variance – their properties	2	C		1
13.	ntinuous probability distributions – uniform, normal, exponential distributions	2	C		1
14.	Distribution functions.	2	C		1
	UNIT-IV	**9**			
15.	Joint distribution functions	1	C		1
16.	Independent random variables and their sums, conditional distributions	3	C		1
17.	Joint probability distribution of functions of random variables	2	C		1

18.	covariance, correlation	3	C		1
	UNIT-V	**9**			
19.	Definition of statistics, population and sample	2	C		1
20.	Representative sample	2	C		1
21.	Descriptive statistics – classification and tabulation of univariate data	3	C		1
22.	Graphical representation, frequency curves	2	C		1

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Sheldon Ross, A First course in probability (Ninth edition)
2	Michael Baron, Probability and Statistics for computer scientistst

Course nature				**Theory**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Quiz	Assignment	**Total**
	Weightage	15%	15%	10%	10%	50%
End semester examination Weightage:						50%

ENG115	**ENGINEERING MECHANICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P	PROFESSIONAL CORE	ENGINEERING MECHANICS		
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 2016				

PURPOSE	The course aims at providing the solid basis in mechanics especially statics which is very useful students of core engineering branches like mechanical and civil etc. It also gives as introduction related to dynamics to the students. The fundamental concepts could be illustrated by the recent examples along with the contemporary knowledge.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Get an overview of the various branches of mechanics							
2.	Understand the physics behind various practical phenomena in the field of mechanical engineering.							
3.	Analyze planar and spatial systems to determine the forces in members of trusses, frames.							
4.	Calculate the motion parameters for a body subjected to a given force system.							
5.	Determine the centroid and second moment of area of various objects							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: STATICS OF PARTICLES AND RIGID BODIES	**14**			
1.	forces on particles	1	C	1-3	1-4
2.	resolution of forces	1	C	1-3	1-4
3.	rams	1	C, D	2-3	1-4
4.	particles	1	C	2-3	1-4
5.	particles (Numerical Problems)	1	D, I	2-3	1-4
6.	e	1	C	2-3	1-4

7.		1	C	2-3	1-4
8.	(Numerical Problems)	1	D, I	2-3	1-4
9.	(Numerical Problems)	1	D, I	2-3	1-4
10.	force equivalence	1	C, D	2-3	1-4
11.	ce (Numerical Problems)	1	D, I	2-3	1-4
12.	ilibrium	1	C, D	2-3	1-4
13.	ilibrium (Numerical Problems)	1	D, I	2-3	1-4
14.	ilibrium (Numerical Problems)	1	D, I	2-3	1-4
	I: FRICTION	**5**			
15.	, dry friction	1	C, D, I	2-3	1-4
16.	rolling friction	1	C, D, I	2-3	1-4
17.		1	C, D, I	2-3	1-4
18.	Ladder friction	1	C, D, I	2-3	1-4
19.		1	C, D, I	2-3	1-4
	UNIT III: ANALYSIS OF TRUSSES AND CENTROIDS	**10**			
20.	, type of supports, reaction	1	C, D	2-3	1-4
21.	method of joints	1	C, D	2-3	1-4
22.	nts	1	C, D	2-3	1-4
23.	tions (Numerical Problems)	1	D, I	2-3	1-4
24.	nts (Numerical Problems)	1	D, I	2-3	1-4
25.	nts (Numerical Problems)	1	D, I	2-3	1-4
26.	ity-lines, areas	1	C	5	1-4
27.	Volumes	1	C	5	1-4

28.	of centroid-integration method	1	C	5	1-4
29.	Determination of centroid-integration method (Numerical Problems)	1	D	5	1-4
	UNIT IV: MOMENT OF INERTIAS OF SURFACE AND VOLUMES	**6**			
30.	Determination of moment of inertia using area integration method,	1	C, D	5	1-4
31.	Determination of moment of inertia using area integration method,	1	C, D	5	1-4
32.	Determination of moment of inertia using area integration method,	1	C, D	5	1-4
33.	od, radius of gyration	1	C, D	5	1-4
34.	Polar moment of inertia,	1	C, D	5	1-4
35.	tia of different sections	1	D, I	5	1-4
	UNIT V: DYNAMICS	**10**			
36.	Rectilinear motion	1	C	4	1-4
37.	Projectile motion, Newtons second law of motion,	1	C	4	1-4
38.	Projectile motion, Newtons second law of motion,	1	D, I	4	1-4
39.	D'Alemberts principle	1	C	4	1-4
40.	Work, energy	1	C	4	1-4
41.	Impulse momentum	1	C	4	1-4
42.	Impact/collision of elastic bodies	1	C	4	1-4
43.	oblique impact	1	C	4	1-4
44.	on	2	C	4	1-4
		45			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Ferdinand. P. Beer. E, Russell Johnston Jr., David Mazurek, Philip J Cornwell, Vector Mechanics for Engineers: Statics and Dynamics, McGraw - Hill, New Delhi, 10th Edition, 2013.

2	R.K.Bansal, Engineering Mechanics, Laxmi Publications Ltd, 2005
3	Meriam J.L and Kraige L.G., Engineering Mechanics, Volume I - statics, Volume II - dynamics, John Wiley & Sons, New York,7th Edition, 2012
4	Timoshenko, Young, Engineering Mechanics, Tata Mc-Graw Hill Book Company, 5th Edition, New Delhi

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME 401	**Computer Aided Design and Manufacturing**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	Engineering Graphics						
Data Book / Codes/Standards	NIL						
Course Category	P	CORE ELECTIVE	Manufacturing				
Course designed by	Department of Mechanical Engineering						
Approval							

PURPOSE	

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
28	Understand the basic tools of computer-aided design (CAD) and computer-aided manufacturing (CAM).							
29	Obtain a hands-on experience in computer-aided design and manufacturing through individual and group projects. Become familiar with the cosmetically available cad packages.							
30	Prepare the student to be an effective user of a CAD/CAM system							
31	Expose the student to contemporary computer design tools for aerospace and mechanical engineers.							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I:	**9**			
220.	What is CAD. What is CAM. Applications of CAD/CAM in Engineering.	1			1,2
221	Specific applications of CAD/CAM in Mechanical engineering. What is Geometric Modelling and its applications in Mechanical engineering.	1			1,2

222	Introduction to computer graphics and it application in Mechanical engineering. Computer Graphics Software's useful for Mechanical engineers.	1			1
223	Introduction, representation of points, transformations and matrices, transformation of points, Transformation of straight lines, midpoint transformation, Transformation of parallel lines, transformation of intersecting lines.	1			1
224	Rotation, Reflection and Scaling	1			1
225	Combined transformations and Transformation of The unit square	1			1
226	Rigid body transformations and Translations and Homogeneous Coordinates	1			1
227	Rotation About an Arbitrary Point	1			1
228	Homogeneous Coordinate system and Overall Scaling	1			1
	UNIT II –	**9**			
229.	Introduction about 3D Transformations.	1			1
230.	Three-Dimensional Scaling,	1			1
231.	Three-Dimensional Shearing, Reflection,	1			1
232.	Three-Dimensional Rotation, Translation,	1			1
233.	Three-Dimensional Combined transformations	1			1
234.	Three-Dimensional rotations about an axis parallel to a coordinate axis,	1			1
235.	Three-Dimensional rotation about an arbitrary axis in space	1			1
236.	Three-Dimensional reflection through an arbitrary plane, affine and perspective geometry	1			1
237.	Introduction to orthographic projections, axonometric projections, oblique projections, perspective transformations.	1			1
	UNIT III –	**9**			
238.	Introduction about plane and space curves.	1			1
239.	Curve Representation, Implicit and Explicit representation of curves.	1			1
240.	Parametric and Non-parametric curves General and parametric representation for conic sections (Circle, Ellipse, Parabola, Hyperbola)	1			1

241.	Representation of space curves, Cubic Splines and Hermite cubic curve, normalized cubic splines	1			1
242.	Representation of Bezier Curves	1			1
243.	B-spline Curves and end conditions for periodic B-spline curves	1			1
244.	B-spline Curve Fit B-spline Curve Subdivision	1			1
245.	Rational B-spline Curves NURBS and Introduction about surfaces.	1			1
246.	Coons Bi-cubic surface, Bezier surfaces, B-spline surfaces, B-spline surface Fitting and subdivision and Rational B-spline surfaces	1			1
	UNIT IV:	**9**			
247.	Introduction to conventional Manufacturing Processes	1			2
248.	Removing, Forming, Deforming and joining	1			2
249.	Introduction to CAD, CAM and CAD-CAM	1			1,2
250.	Integration equipment's.	1			2
251.	Integrating CAD, NC and CAM	1			2
252.	Machine tools. Role of process planning in CAD/CAM Integration	1			2
253.	Computer Aided Process Planning	1			2
254.	Development, Benefits, Model and Architecture	1			2
255.	CAPP Approaches	1			2
	UNIT V:	**9**			
256.	Introduction to CAM	1			2
257.	Point to point and continuous path machining	1			2
258.	Introduction to NC, CNC and DNC – NC Programming	1			2
259.	Basics, Languages, G Code, M Code, APT – Tool path generation and verification	1			2
260.	NC Programming for Rectangular and circular pockets	1			2
261.	NC Programming for drilling, peck drilling and boring	1			2

262.	NC Programming for circular and rectangular array	1			2
263.	NC Programming for turning , facing, threading and knurling	1			2
264.	Production Control – Cellular Manufacturing	1			2
	Total contact hours	45			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Mathematical Elements for Computer Graphics by David Rogers (Author), J. Alan Adams(Author) NewYork: London, McGraw-Hill, c1990, ISBN 10: 0070535302.
2	CAD/CAM: Principles and Applications by P N Rao.

Course nature				**Theory**	
Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Surprise Test	**Total**
	Weightage	**20%**	**20%**	**10%**	**50%**
End semester examination Weightage :					**50%**

ME 103	**WORKSHOP PRACTICE**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	NIL				
Course Category	E ENGINEERING SCIENCES				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To provide the students with hands on experience on different trades of engineering like fitting, carpentry, smithy, welding and sheet metal.							
INSTRUCTIONAL OBJECTIVES		**STUDENTOUTCOMES**						
At the end of the course, student will be able to								
1.	To familiarize with the basics of tools and equipments used in fitting, carpentry, sheet metal, welding and smithy	b	c	g				
2.	To familiarize with the production of simple models in the above trades	b	c	g				

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Step fitting of two metal plates using fitting tools.	3	I	1,2	1

2.	Drilling & Tapping for generating hole and internal thread on a metal plate.	3	I	1,2	1
3.	Simple turning of cylindrical surface on MS rod using lathe machine tool.	3	I	1,2	1
4.	Plumbing of bathroom/kitchen fitting using various plumbing components and tools	3	I	1,2	1
5.	Butt joint of two metal plates using arc welding process.	3	I	1,2	1
6.	Lap joint of two metal plates overlapping on one another using arc welding process.	3	I	1,2	1
7.	T-joint of a metal plate at perpendicular direction over another plate using arc welding process.	3	I	1,2	1
8.	MIG welding of metal plates	3	I	1,2	1
9.	Cross halving joint of two wooden pieces at perpendicular direction.	3	I	1,2	1
10.	Dovetail halving joint of two wooden pieces in the shape of dovetail.	3	I	1,2	1
11.	To make circular shapes, grooving in wood piece using wood turning lathe.	3	I	1,2	1
12.	To make duster from wooden piece using carpentry tools.	3	I	1,2	1
13.	To make rectangular shaped tray using GI sheet.	3	I	1,2	1
14.	To make geometrical shape like frustum, cone and prisms using GI sheet.	3	I	1,2	1
15.	To make bigger size scoop using GI sheet.	3	I	1,2	1
16.	To forge chisel from MS rod using black smithy	3	I	1,2	1
	Total contact hours*	**45 60**			

*Any 10 experiments will be offered

Sl. No.	**REFERENCES**
1.	Lab Manual
2.	Kannaiah.P and Narayanan.K.C, "*Manual on Workshop Practice*", Scitech Publications, Chennai, 1999.
3.	Gopal.T.V, Kumar.T, and Murali.G, "*A first course on workshop practice – Theory, Practice and Work Book*", Suma Publications, Chennai, 2005.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	**Experiments**	**Record**	**MCQ/Quiz/Viva Voce**	**Model examination**	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

ME 212	**INTRODUCTION TO THERMODYNAMICS**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Co-requisite:	NIL		
Prerequisite:			
Data Book / Codes/Standards	Approved Steam tables		
Course Category	E	ENGINEERING SCIENCES	
Course designed by	Department of Mechanical Engineering		
Approval	-- Academic Council Meeting -- ,		

PURPOSE	This course provides the basic knowledge about thermodynamic laws and relations, and their application to various processes.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to understand								
1.	Thermodynamic laws and their applications.	a	e					
2.	Concept of entropy and availability.	a	e					
3.	Properties of steam.	a	e					
4.	Fuels and combustion	a	e					
5.	Thermodynamic relations.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS	**12**			
1.	Basic concepts, Microscopic and macroscopic approach. Thermodynamic system and surrounding.	1	C	1	1,2
2.	Properties of a system, Intensive and extensive, Specific and total quantities, Path and point functions.	1	C	1	1,2
3.	Thermodynamic process, cycle and equilibrium, Quasi-static, Reversible and Irreversible processes.	1	C	1	1,2
4.	Heat and work transfer, displacement work, flow work and other modes of work, p-V diagram.	2	C,D	1	1,2
5.	Zeroth law of thermodynamics, concept of temperature.	1	C	1	1,2
6.	First law of thermodynamics, energy, enthalpy, specific heats, Application of first law, Tutorials.	3	C,D	1	1,2
7.	Control volume analysis, steady flow energy equation and its applications.	1	C,D	1	1,2
8.	Tutorials on steady flow energy equation.	2	D	1	1,2
	UNIT II: SECOND LAW OF THERMODYNAMICS AND ENTROPY	**12**			
9.	Limitations of first law, cyclic heat engine, energy reservoirs, refrigerator and heat pump.	1	C,D	2	1,2
10.	Statements of second law and their equivalence.	1	C	2	1,2
11.	Reversibility and Irreversibility, Causes of irreversibility, Carnot cycle, Reversed Carnot cycle, Carnot theorem.	2	C,D	2	1,2
12.	Tutorials based on second law of thermodynamics.	3	D	2	1,2
13.	Clausius theorem, Clausius inequality	1	C,D	2	1,2
14.	Concept of entropy, T-s diagram, principle of increase of entropy	1	C	2	1,2
15.	Entropy change of ideal gases and its evaluation.	2	C,D	2	1,2
16.	Introduction to exergy.	1	C	2	1,2
	UNIT III: PROPERTIES OF STEAM AND VAPOUR POWER CYCLE	**12**			
17.	Steam formation, properties of steam.	1	C	3	1,2
18.	Calculation of steam properties using steam tables and Mollier chart.	2	C,D	3	1,2
19.	Simple Rankine cycle. Flow diagram, p-v, T-s and h-s diagrams. Tutorials	3	C,D	3	1,2
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
20.	Reheat cycle. Flow diagram, T-s and h-s diagrams. Tutorials	2	C,D	3	1,2
21.	Regenerative cycle. Flow diagram, T-s and h-s diagrams. Tutorials	3	C,D	3	1,2
22.	Dryness fraction measurements.	1	C	3	1,2
	UNIT IV: FUELS AND COMBUSTION	**12**			
23.	Classification of fuels.	1	C	4	1,2

24.	Combustion equations: Theoretical and excess air, Stoichiometric air fuel ratio.	1	C,D	4	1,2
25.	Tutorials on combustion.	3	D	4	1,2
26.	Volumetric analysis and gravimetric analysis	1	C,D	4	1,2
27.	Tutorials on air-fuel ratio and analysis of products of combustion.	3	D	4	1,2
28.	Analysis of exhaust gas.	1	C	4	1,2
29.	Calorific value of fuels, Determination of calorific values.	2	C	4	1,2
	UNIT V: THERMODYNAMIC RELATIONS	**12**			
30.	Maxwell equations.	1	C,D	5	1,2
31.	Tds equations. Equations for dH and dU.	1	C,D	5	1,2
32.	Difference in heat capacities.	2	C,D	5	1,2
33.	Joule-Thomson Co-efficient.	2	C,D	5	1,2
34.	Clausius-Clapeyron equation	1	C,D	5	1,2
35.	Properties of Gas mixtures , Dalton's law of partial pressures	2	C,D	5	1,2
36.	Properties of Gas mixtures- Tutorials	3	D	5	1,2
	Total contact hours*	**60**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Kenneth A. Kroos, and Merle C. Potter, "*Thermodynamics for Engineers*", SI Edition, 1st Edition, Cengage Learning India Pvt. Ltd., Delhi, 2015.
2.	Mahesh M. Rathore, "*Thermal Engineering"*, Tata McGraw Hill Education Private Ltd., New Delhi, Reprint 2012.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Yunus. A Cengel and Michael A Boles, "*Thermodynamics – An Engineering Approach, 8th Edition"*, Tata McGraw Hill- Education, New Delhi, 2015.
4.	Rayner Joel, "*Basic Engineering Thermodynamics*", 5th Edition, Addison Wesley Longman Limited, First ISE reprint 1999.
5.	William Z. Black, James G. Hartley, "*Thermodynamics"*, Pearson,3rdEdition, 2010.
6.	Michael J Moran, and Howard N Shapiro, "*Fundamentals of Engineering Thermodynamics"*, John Wiley & Sons, New York, 8th Edition, 2015
7.	Nag.P.K, "*Engineering Thermodynamics"*, Tata McGraw Hill Education, New Delhi, 5th Edition, 2013.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME 321	**PRODUCTION TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE	MANUFACTURING ENGINEERING			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- ,				

PURPOSE	To make the students aware of different manufacturing processes like casting, metal forming, metal cutting and gear manufacturing.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to learn								
1.	Concepts of casting Technology	a	c					
2.	Mechanical working of metals	a	c					
3.	Theory of metal cutting.	a	c					
4.	Gear manufacturing and Surface finishing processes.	a	c					
5.	Milling machine and other machine tools	a	c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT –I CASTING	**8**			
1.	Introduction to Casting , Patterns and its types and Materials	1	C	1	1,2
2.	Pattern Allowances, Moulding and its types,	1	C	1	1,2
3.	Moulding sand, Gates and Risers	1	C	1	1,2
4.	Numerical problems on pouring time and Caine's rule	1	C,D	1	1,2
5.	Cores, Core making	1	C	1	1,2
6.	Shell casting, Investment Casting	1	C	1	1,2
7.	Die casting, Centrifugal Casting.	1	C	1	1,2
8.	Casting defects and remedies.	1	C	1	1,2
	UNIT II: - MECHANICAL WORKING OF METALS	**9**			
9.	Introduction to Hot and Cold Working	1	C	2	1,2
10.	Hot and Cold Rolling, Types of rolling viz. Two, three, four, multi and Universal rolling	1	C	2	1,2
11.	Open die and Closed die forging, Wire drawing	1	C	2	1,2
12.	Hot, Cold ,Forward ,backward and tube extrusion	1	C	2	1,2
13.	Shearing, Piercing, Trimming and Stretch forming	1	C	2	1,2
14.	Theory of Bending, Bending length and Bending force calculations	1	C,D	2	1,2
15.	Drawing, Blank size and drawing force calculations	1	C,D	2	1,2
16.	Tube forming, Embossing and coining	1	C	2	1,2
17.	Progressive, Compound and Combination dies and defects in forming.	1	C	2	1,2
	UNIT III: THEORY OF METAL CUTTING	**9**			
18.	Orthogonal and oblique cutting	1	C	3	1,2
19.	Classification of cutting tools namely single point, and multipoint	1	C	3	1,2
20.	Tool signature for single point cutting tool	1	C	3	1,2
21.	Mechanics of orthogonal cutting and Force relationship	1	C	3	1,2
22.	Merchant Circle and Determination of shear angle	1	C,D	3	1,2
23.	Chip formation	1	C	3	1,2
24.	Cutting tool materials	1	C	3	1,2
25.	Tool wear and Taylor's tool life calculation	1	C,D	3	1,2
26.	Machinability and Cutting Fluids	1	C	3	1,2
	UNIT IV: GEAR MANUFACTURING AND SURFACE FINISHING PROCESS	**9**			
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
27.	Gear Manufacturing viz Extrusion, Stamping and Powder Metallurgy	1	C	4	1,2
28.	Gear Machining, Forming, Spur and Helical in milling Machine	1	C	4	1,2
29.	Gear Generating : Gear shaping, Gear hobbing	1	C	4	1,2
30.	Grinding process, Types of Grinding machines viz. Surface, Cylindrical and Centreless	1	C	4	1,2

31.	Grinding Wheel and its types	1	C	4	1,2
32.	Grinding specifications and type of abrasive bonds	1	C	4	1,2
33.	Selection of Cutting speed and work speed, dressing and truing	1	C	4	1,2
34.	Lapping, Buffing	1	C	4	1,2
35.	Honing, and Super finishing	1	C	4	1,2
	UNIT V: MACHINE TOOLS	**10**			
36.	Classification of Milling Machines and its basic construction	1	C	5	1,2
37.	Types of cutters in Milling machines	1	C	5	1,2
38.	Types of milling operations(up and down, peripheral, face milling)	1	C	5	1,2
39.	Simple and differential Indexing methods and its calculations	1	C,D	5	1,2
40.	Shaping and slotting Machine, Its description and Operations,	1	C	5	1,2
41.	Planers: Double house and open side, Quick return mechanism	1	C	5	1,2
42.	Work and tool holding Devices	1	C	5	1,2
43.	Boring machine and its Specification, operations, Jig boring machine	1	C	5	1,2
44.	Specification of Broaching machine, its types and operations (internal, surface)	1	C	5	1,2
45.	Tool nomenclature of broaching tool	1	C	5	1,2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Mikell P. Groover, *"Fundamentals of Modern Manufacturing Materials, Processes, and Systems",* 4th Edition, John Wiley & Sons, Inc., 2010
2.	E.PaulDeGarmo, Black J.T and Ronald A. Kosher, **"***Materials and Processes, in Manufacturing*", 8th Edition, Prentice – Hall of India, 1997
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Roy A. Lindberg, "*Processes and materials of manufacture*" Prentice Hall,1998
4.	John A. Schey, *"Introduction to manufacturing processes*",McGraw-Hill, 3rd Edition, 2000
5.	James S Campbell, "*Principles of manufacturing materials and processes*" New Delhi : Tata McGraw-Hill ,1983
6.	SeropeKalpakjian ,Steven R Schmid "*Manufacturing Engineering and Technology*" Pearson India, 4th Edition, 2002

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

ME 321	**MANUFACTURING TECHNOLOGY LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**
Co-requisite:					
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	MANUFACTURING ENGINEERING			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- ,				

PURPOSE	To expose hands-on training to the students on various machines like lathe, Shaper, Slotter, Milling, Gear hobbing, grinding machines.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to perform								
1.	Various types of lathe operations	a	b					
2.	Production of flat surface and contour shapes on the given component	a	b					
3.	Gear making processes.	a	b					
4.	Surface finishing process	a	b					
5.	Preparation of Sand Mould	a	b					

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Performing plain turning, step turning and chamfering in Lathe	3	O	1	1,2,3
2.	Performing taper turning by compound rest/offset method and drilling in Lathe	3	O	1	1,2,3
3.	Performing External threading, Internal thread cutting and eccentric turning in Lathe.	3	O	1	1,2,3
4.	Performing Taper boring and knurling in Lathe	3	O	1	1,2,3
5.	Performing V block shaping in shaper machine	3	O	2	1,2,3
6.	Performing Polygon milling in milling machine	3	D,I,O	3	1,2,3
7.	Spur Gear cutting in milling machine	3	D,I,O	3	1,2,3
8.	Helical Gear cutting in Hobbing machine	3	D,I,O	3	1,2,3
9.	Performing surface grinding in Grinding machine	3	O	4	1,2,3
10.	Performing cylindrical grinding in Grinding machine	3	O	4	1,2,3
11.	Grinding of single point cutting tool in Tool and Cutter grinding machine	3	O	4	1,2,3
12.	Preparation of Sand mold using solid/split pattern with loose-piece pattern	3	O	5	1,2,3
	Total contact hours*	**30**			

*Any 10 experiments will be offered

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Chapman.W.A.J, "*Workshop Technology",* Vol. I and II, Arnold Publisher, 2001.
3.	James Madison, "*CNC Machining Hand Boo*k", Industrial Press Inc., New York, 1996.
4.	HajraChoudhary.S.K and HajraChoudhary.A.K, "*Elements of Manufacturing Technology Vol II",* Media Publishers, 2007.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	**Experiments**	**Record**	**MCQ/Quiz/Viva Voce**	**Model examination**	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

ME 221	**STRENGTH OF MATERIALS**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Co-requisite:	Nil		
Prerequisite:			
Data Book / Codes/Standards	Nil		
Course Category	P	PROFESSIONAL CORE	DESIGN ENGINEERING
Course designed by	Department of Mechanical Engineering		
Approval	-- Academic Council Meeting --		

PURPOSE	To familiarize the students with the fundamentals of deformation, stresses, strains in structural elements.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know the concepts of stress and strain	a	e					
2.	Analyze the beam of different cross sections for shear stress, bending stress, slope and deflection.	a	e					
3.	Understand the concepts necessary to design the structural elements and pressure vessels.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT 1: CONCEPT OF STRESSES AND STRAINS	**12**			
1.	Concept of stress and strain, Hooke's law, Tensile, compressive and shear stresses, Poisson's ratio.	1	C, D	1	1
2.	Elastic constants and their relationship, volumetric strain, bars of uniform and varying sections subjected to single load and varying loads.	1	C, D	1	1
3.	Tutorial on stress, stress, Hooke's law, elastic constants and volumetric strain, bars of uniform and varying sections subjected to single load and varying loads.	2	C, D	1	1
4.	Analysis of bars of composite sections& Tutorial.	2	C, D	1	1
5.	Concept of Thermal stresses in simple and composite bars & Tutorial.	2	C, D	1	1
6.	Principal plane, principal stress, Analytical method: Direct stress in two mutually perpendicular directions accompanied by a simple shear stress& Tutorial.	2	C, D	1	1
7.	Mohr's circle: direct stress in two mutually perpendicular directions with and without shear stress & Tutorial.	2	C, D	1	1
	UNIT II: - ANALYSIS OF BEAMS	**12**			
8.	Introduction to types of beams and loads, Shear force and bending moment diagrams for cantilever beam due to pure point load, pure Uniformly Distributed Load (UDL), pure Uniformly Varying Load (UVL) & Tutorial.	2	C, D	2	1
9.	Shear force and bending moment diagrams for simply supported beam due to pure point load, pure UDL, pure UVL& Tutorial.	2	C, D	2	1
10.	Shear force and bending moment diagrams for overhanging beam due to pure point load, pure UDL, pure UVL & Tutorial.	2	C, D	2	1
11.	Theory of pure bending derivation and bending stress in simple beams of sections having at-least one axis of symmetry& Tutorial	2	C, D	2	1
12.	Tutorial on bending stress in simple beams sections having at-least one axis of symmetry & Tutorial.	2	C, D	2	1
13.	Derivation of shear stress distribution in beams of different sections (rectangular, circular), having at-least one axis of symmetry& Tutorial.	2	C, D	2	1
	UNIT III: TORSION OF SHAFTS	**12**			
14.	Theory of pure torsion, derivation of shear stress produced in terms of torque in a circular shaft. Strength, stiffness of shaft and Torsional rigidity & power transmitted.	1	C, D	3	1
15.	Tutorial on solid shaft, finding the dimensions.	1	C, D	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
16.	Expression for torque in terms of polar moment of inertia in a circular shaft subjected to torsion.	1	C, D	3	1
17.	Tutorial on hollow shaft, finding dimensions, percentage of material savings.	1	C, D	3	1
18.	Circular shafts in series and parallel& Tutorial.	2	C, D	3	1
19.	Concepts on Strain energy due to torsion& Tutorial.	2	C, D	3	1
20.	Circular shaft subjected to combined bending and torsion& Tutorial.	2	C, D	3	1
21.	Composite Shaft & Tutorial.	2	C, D	3	1
	UNIT IV: DEFLECTION OF BEAMS	**12**			
22.	Relationship between deflection, slope, radius of curvature, shear force and bending moment& Tutorial.	2	C, D	2	1
23.	Slope and deflection of cantilever beam with a point load, UDL by Double integration method& tutorial.	2	C, D	2	1
24.	Slope and deflection of simply supported beam with a point load, UDL by Double integration method& tutorial.	2	C, D	2	1
25.	Slope and deflection of simply supported beam with an eccentric point load, UDL by Macaulay's method& tutorial.	2	C, D	2	1
26.	Slope and deflection of cantilever beam and simply supported beam with point load and UDL by Moment area method& tutorial.	2	C, D	2	1
27.	Castigliano's theorem & tutorial.	2	C, D	2	1
	UNIT V: COLUMNS AND CYLINDERS	**12**			
28.	Columns and struts, Members subjected to combined bending and axial loads, Expression for crippling load with different end conditions based on Euler's theory & tutorial.	2	C, D	3	1
29.	Rankine's theory & tutorial.	2	C, D	3	1
30.	Thin cylindrical shells subjected to internal pressure, change in dimensions of thin cylindrical shells due to internal pressure & tutorial.	2	C, D	3	1
31.	Thin spherical shells subjected internal pressure, change in dimensions of thin spherical shells due to internal pressure & tutorial.	2	C, D	3	1
32.	Lame's theory on stresses in Thick cylinders & tutorial.	2	C, D	3	1
33.	Stresses in compound thick cylinder and Shrink fit & tutorial.	2	C, D	3	1
	Total contact hours*	**75**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, David F. Mazurek, "*Mechanics of Materials*", 7th Edition, McGraw Hill, 2014.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	William A. Nash, "*Theory and Problems of Strength of Materials*", Schaum's Outline Series, McGraw Hill International Edition, 3rd Edition, 2007.
3.	Egor P. Popov, "*Engineering Mechanics of Solids*", 2nd edition, Prentice Hall of India Private Limited, New Delhi, 2009.
4.	James M. Gere,"*Mechanics of Materials*", Eighth Edition, Brooks/Cole, USA, 2013.
5.	Shigley. J. E, "*Applied Mechanics of Materials*", International Student Edition, McGraw Hill KoyakushaLimited, 2000.

Course nature			**Theory**			
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Practical (int+end sem)**	**assignmt**	**End sem exam**	**Total**
	Weightage	**15%**	**15%**	**15%+15%**	**5%**	**35%**	**100%**

ME 221	STRENGTH OF MATERIALS LABORATORY				
Co-requisite:	ME				
Prerequisite:	Nil				
Data Book / Codes/Standards	NIL				
Course Category	P	PROFESSIONAL CORE	DESIGN ENGINEERING		
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To familiarize the students on conducting various destructive tests for determining the strength of various materials under externally applied loads from the theoretical knowledge gained from Mechanics of Solids.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the procedures for conducting various destructive testing methods like impact, compression test etc.	a	b	e	k			
2.	Learn how to measure hardness of materials and to interpret the same after heat treatment.	a	b	e	k			
3.	Determine the Young's modulus using deflection test on beams and tensile test on rods & springs.	a	b	e	k			
4.	Compare the fatigue behavior of a notched and un-notched specimen.	a	b	e	k			

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1	Tensile test on Mild steel rod.	2	C,D	1,3	1,2,3
2	Compression test of Concrete cubes and cylinders.	2	C,D	1	1,2,3
3	Test on open coil and closed coil Helicalsprings.	2	C,D	1,3	1,2,3
4	Izod&charpy impact test.	2	C,D	1	1,2,3
5	Torsion test on Graded steels.	2	C,D	1	1,2,3
6	Deflection test on beams of different materials using Maxwell reciprocal theorem.	2	C,D	1,3	1,2,3
7	Double shear test on metallic materials.	2	C,D	1	1,2,3
8	Rockwell &Brinell hardness test of metallic materials.	2	C	1,2	1,2,3
9	Bend test of metallic rods.	2	C,D	1	1,2,3
10	Fatigue testing of materials under notched and unnotched conditions.	2	C,D	1,4	1,2,3
11	Comparison of mechanical properties of Unhardened, Quenched and tempered specimen.	2	C,D	1,2	1,2,3
12	Strain measurement on rods and beams.	2	C,D	1	1,2,3
13	Study on photo elasticity	2	C,D	1	1,2,3
14	Buckling analysis	2	C,D	1	1,2,3
15	Creep Test	2	C,D	1	1,2,3
	Total contact hours*	**30**			

*Any 10 experiments will be offered

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Kazimi.S.M.A, "*Solid Mechanics*", second revised Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2001.
3.	Ferdinand Beer, E. Russell Johnston, Jr., John DeWolf, David Mazurek, "*Mechanics of Materials*" McGraw - Hill, New Delhi, 7th Edition, 2013.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	**Experiments**	**Record**	**MCQ/Quiz/Viva Voce**	**Model examination**	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

ME 172	KINEMATICS AND MECHANISMS			L	T	P	C
				3	0	2	4
Co-requisite:	Nil						
Prerequisite:							
Data Book / Codes/Standards	Nil						
Course Category	**P**	PROFESSIONAL CORE	DESIGN ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting --, 23rd						

PURPOSE	To expose the students to learn the fundamentals of various laws governing rigid bodies and its motions.			
INSTRUCTIONAL OBJECTIVES		**STUDENTOUTCOMES**		
At the end of the course, student will be able to				
1.	Know the basics of mechanism and perform kinematic analysis.	a	c	e
2.	Calculate the gas forces developed in an engine and use the excess energy for different applications.	a	c	e
3.	Balance rotating and reciprocating masses in engines.	a	c	e
4.	Construct various cam profiles based on follower motion and perform kinematic analysis.	a	c	e
5.	Deduce the number of teeth in gears and torque transmitted in epicyclic gear trains. Apply gyroscopic couple in different transportation vehicles.	a	c	e

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: MECHANISMS	**14**			
1	Introduction to mechanism and its elements. Degrees of freedom, its application in different mechanism	2	C, D	1	1,2
2	Four Bar Chain, Grashof's law, Kutzback's and Gruebler's criterion	1	C, D	1	1,2
3	Inversion of kinematic chain: Four bar chain, Single and double slider crank chain	2	C, D	1	1,2
4	Velocity analysis of Four bar mechanism by relative velocity (RV) method	1	C, D	1	1,2
5	Tutorial on velocity analysis of single slider crank mechanism	2	C, D	1	1,2
6	Tutorial on velocity analysis of six bar linkages	1	C, D	1	1,2
7	Acceleration analysis of Four bar mechanism by relative velocity method	1	C, D	1	1,2
8	Tutorial on acceleration analysis of single slider crank and six bar linkages	2	C, D	1	1,2
9	Instantaneous centre (IC) method, Kennedy's theorem	1	C, D	1	1,2
10	Tutorial on velocity analysis for different mechanisms by IC method	1	C, D	1	1,2
	UNIT II: FORCE ANALYSIS AND FLYWHEELS	**12**			
11	Inertia forces, D-Alembert's principle	1	C, D	2	1,2
12	Velocity and acceleration of the reciprocating parts in engines	1	C, D	2	1,2
13	Tutorial on derivation and calculation of gas forces	2	C, D	2	1,2
14	Dynamically equivalent systems	1	C, D	2	1,2
15	Tutorial on determination of equivalent system for connecting rod	1	C, D	2	1,2
16	Turning moment diagram (TMD) for different engines	1	C, D	2	1,2
17	Fluctuation of energy(ΔE), coefficient of fluctuation of energy	1	C, D	2	1,2
18	Tutorial on calculation of ΔE using TMD and torque equations	2	C, D	2	1,2
19	Tutorial on flywheel applications	2	C, D	2	1,2

	UNIT III: BALANCING	**12**			
20	Need for balancing, Static and dynamic balancing of rotating masses	1	C, D	3	1,2
21	Tutorial on balancing of several masses rotating in same plane by analytical and graphical methods	1	C, D	3	1,2
22	Construction of force and couple polygon	1	C, D	3	1,2
23	Tutorial on balancing of several masses rotating in different planes using couple and force polygon	2	C, D	3	1,2
24	Partial balancing of reciprocating masses	1	C, D	3	1,2
25	Tutorial on effects of partial balancing in locomotives	2	C, D	3	1,2
26	Balancing of in-line engines	2	C, D	3	1,2
27	Balancing of V engines	1	C, D	3	1,2
28	Balancing of radial engines	1	C, D	3	1,2
	UNIT IV: CAMS	**10**			
29	Cam terminology, types of cams and followers	1	C, D	4	1,2
30	Types of follower motion and its derivatives, under cutting	1	C, D	4	1,2
31	Displacement, velocity and acceleration for different follower motion	1	C, D	4	1,2
32	Tutorial on construction of cam profile for radial follower with different motion	2	C, D	4	1,2
33	Tutorial on construction of cam profile for offset follower with different motion	2	C, D	4	1,2
34	Cams with special contours	1	C, D	4	1,2
35	Tutorial on velocity and acceleration for cams with specified contours	2	C, D	4	1,2
	UNIT V: GEAR, GEAR TRAINS AND GYROSCOPES	**12**			
36	Gear terminology, types, law of gearing	1	C, D	5	1,2
37	Tutorial on path of contact, arc of contact, sliding velocity	2	C, D	5	1,2
38	Minimum number of teeth, Interference and under cutting	1	C, D	5	1,2
39	Gear train, types and applications	1	C, D	5	1,2
40	Tutorial on velocity ratio, torque calculations in epicyclic gear train	2	C, D	5	1,2
41	Introduction to automobile differential	1	C, D	5	1,2
42	Gyroscopic forces, couple, precessional angular motion	1	C, D	5	1,2
43	Gyroscopic effects on aeroplane and ship	1	C, D	5	1,2
44	Tutorial on gyroscopic effect on two and four wheelers	2	C, D	5	1,2
TOTAL CONTACT HOURS*		**60**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Rattan, S. S, "*Theory of Machines*",McGrawHill Education, 4th edition, 2015.
2.	John J Uicker, Gordon R Pennock, Joseph E Shigley, "*Theory of Machines and Mechanisms*", Oxford University Press, 4thEdition, 2014.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Thomas Bevan, "*The Theory of Machines*", Pearson India Education Services Pvt. Ltd., 3rd Edition, 2010.
4.	Robert L Norton, "*Design of machinery - An introduction to the synthesis and analysis of mechanisms and machines"*, McGrawHill Education, 5th edition, 2011.
5.	William Cleghorn, Nikolai Dechev, "*Mechanics of Machines*", Oxford University Press, 2nd Edition, 2014.
6.	George H Martin, "*Kinematics and Dynamics of Machines*", Waveland Press, Inc., 2nd Edition, 2002.
7.	G H Ryder, MDBennett, "*Mechanics of Machines*", Macmillan Education Ltd., 2nd Edition,1990.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**05%**	**05%**	**50%**
End semester examination Weightage :							**50%**

ME 223	Manufacturing Science	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P CORE ELECTIVE	Manufacturing			
Course designed by	Department of Mechanical Engineering				
Approval					

PURPOSE	The course introduces principles and basics of manufacturing processes. This course imparts knowledge to students in the technological topics on various production and manufacturing engineering and to provide them with opportunities in taking up advanced topics in the field of study.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
32	Acquire fundamental knowledge and understanding of Manufacturing processes							
33	Formulate relevant research problems, conduct experimental and/or analytical work and analyze results using modern mathematical and scientific methods							
34	Design and validate technological solutions to defined problems and write clearly and effectively, for the practical utilization of their work							
35	Review and document the knowledge developed by scholarly predecessors and critically assess the relevant technological issues							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I:	**9**			
265.	Introduction to conventional manufacturing processes and broad classification.	1			1
266	Introduction to Metal Casting operations	1			1
267	Solidification of Metals	1			1
268	Characteristics of sand casting	1			1
269	Characteristics of Patterns	1			1
270	Pattern allowances, Pattern materials and example problems	1			1
271	Types of patterns, Molding materials, Molding sand properties	1			1

272	Types of sand molds, Cores, Gating system, Casting Defects, Special casting processes, example problems	1			1
273	Cast structures, Melting furnaces, Methods of Sand testing	1			1
	UNIT II –	**9**			
274.	Classification of joining processes and Welding technique	1			1
275.	Terms used in welding techniques	1			1
276.	Energy density and example problems	1			1
277.	Introduction to different welding processes and Gas Welding	1			1
278.	Electric Arc Welding, Tungsten Inert-gas Welding (TIG) and example problems	1			1
279.	Gas Metal-Arc Welding (GMAW), Plasma Arc Welding (PAW)	1			1
280.	Submerged Arc Welding (SAW), Resistance Welding and example problems	1			1
281.	Friction Stir Welding (FSW), Thermite welding	1			1
282.	Electron Beam Welding (EBW), Laser Beam Welding (LBW), Weld Defects	1			1
	UNIT III –	**9**			
283.	Introduction to bulk deformation processes	1			1
284.	Hot and cold working, Forging	1			1
285.	Types of forging and Forging defects	1			1
286.	Rolling, Defects in rolled products and example problems	1			1
287.	Extrusion, Metal flow in extrusion and example problems	1			1
288.	Rod drawing, Wire and Tube drawing	1			1
289.	Example problems solving	1			1
290.	Swaging and introduction to severe plastic deformation processes	1			1
291.	Friction stir processing, Equal channel angular extrusion and high pressure torsion.	1			1

	UNIT IV:	**13**			
292.	Mechanism of metal cutting and types of tools	1			1
293.	Tool Geometry, Tool Signature	1			1
294.	Orthogonal and Oblique cutting, Mechanics of chip formation	1			1
295.	Chip morphology, Tool wear and failure, Machinability	1			1
296.	Cutting-tool materials, Cutting fluids	1			1
297.	Brief description of metal removal processes	1			1
298.	Turning, drilling, boring and Milling	1			1
299.	Example problems solving	1			1
300.	Material removal rate and machining time example problems solving	1			1
301.	Example problems solving on merchant circle	1			1
302.	Example problems solving on merchant circle	1			1
303.	Derivation of chip thickness ratio	1			1
304.	Example problems solving on chip thickness ratio	1			1
	UNIT V:	**5**			
305.	Production of metal powders	1			1
306.	Particle size and shape, Blending of metal powders	1			1
307.	Compaction of metal powders	1			1
308.	Shaping processes, Sintering, Finishing operations	1			1
309.	Design considerations for powder metallurgy	1			1
	Total contact hours	45			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL

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

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Presentation	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**10%**	**10%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

ME223	**HEAT AND MASS TRANSFER**		**L**	**T**	**P**	**C**
			3	**0**	**2**	**4**
Co-requisite:	NIL					
Prerequisite:	Thermodynamics, Fluid Mechanics, Differential calculus					
Data Book / Codes/Standards	Heat and Mass Transfer data book					
Course Category	P	PROFESSIONAL CORE	Thermal and Fluids Engineering			
Course designed by	Department of Mechanical Engineering					
Approval	Academic Council Meeting					

PURPOSE	This course gives an introduction of heat transfer and different mechanisms of heat transfer such as conduction, convection, radiation along with fundamentals of mass transfer. Firstly, 1D conduction, steady state and transient analysis of heat transfer situations are studied. Concepts of convective mode of heat transfer including both forced and free modes of convection are discussed. The radiation heat transfer between any two bodies is discussed. The principles of heat transfer are used in analyses directed towards understanding the performances of engineering systems such as Heat exchangers and phenomena of condensation and boiling. Finally, a brief introduction to mass transfer is discussed. Although, Heat Transfer may appear to be just differential equations and empirical correlations but the real-world importance of this subject is immense. This course is a foundation course offered in thermal and fluids engineering.
LEARNING OBJECTIVES	**STUDENT OUTCOMES**

At the end of the course, student will be able to								
1.	Understand the heat transfer laws, modes of heat transfer and applications of these modes to real life engineering systems	a	e					
2.	Understand the conduction mode of heat transfer	a	b	e				
3.	Understand the convection and radiation mode of heat transfer	a	b	e				
4.	Know about utility of heat transfer data book for identifying properties of solids and fluids used in engineering systems, data charts for heat exchangers *etc.* Understand phenomena of phase change (boiling and condensation) and mass transfer.	a	e					
5.	Learners should be able to analyze the heat transfer situations	a	e	k				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION	**02**			
1.	Definitions of heat and heat transfer. Difference between heat transfer and thermodynamics. Basic Modes and Laws of Heat Transfer.	01	C	1	1, 3, 4
2.	Examples of Heat and Mass Transfer. Engineering Applications of Heat Transfer	01	C	1	1, 3, 4
	UNIT II – CONDUCTION	**14**			
3.	Fourier's law of heat conduction for homogeneous, isotropic media in Cartesian coordinates and its extension to heterogeneous, isotropic media (differential form).	02	C	2,4	1, 2, 3, 4,5
4.	Vectorial form of Fourier's law for heterogeneous, isotropic continua. Fourier's law in cylindrical and spherical coordinates.	01	C	2,4	1, 2, 3, 4,5
5.	Derivation of heat conduction equation in Cartesian coordinates for heterogeneous, isotropic materials.	02	C	2,4	1, 2, 3, 4,5

	Heat conduction equation in Cartesian coordinates for (Case of constant thermal conductivity).				
6.	Significance of thermal diffusivity. Heat conduction equations in cylindrical and spherical coordinates for constant thermal conductivity.	02	C	2,4	1, 2, 3, 4.5
7.	Simple One-dimensional (1D) Steady Heat Conduction Problems: Plane Wall, Cylinder, and Sphere, Hollow (cylinder and sphere). Temperature distribution and heat transfer.	02	C-D	2,4, 5	1, 2, 3, 4, 5, 8
8.	Concepts of conductive and convective resistances. Conductive and Convective Resistances in Series.	01	C-D	2,4	1, 2, 3, 4
9.	Special one dimensional steady state situations – Heat generation, pin fins, Other fin configurations, Two dimensional steady state situations (brief).	02	C-D-I	2,4,5	1, 2, 3, 4, 8
10.	Transient conduction: Lumped capacitance model, One dimensional transient problems analytical solutions, One dimensional Heisler charts, Product solutions.	02	C-D-I	2,4,5	1, 2, 3, 4, 8
	UNIT III – CONVECTION	**10**			
11.	Forced Convection: Review of fluid mechanics (brief) fundamentals, order of magnitude analysis of momentum and energy equations	01	C	3,4	1, 2, 3, 4, 7
12.	Laminar flow heat transfer in circular pipe – constant heat flux and constant wall temperature, thermal entrance region	02	C-D	3,4,5	1, 2, 3, 4, 7
13.	Turbulent flow heat transfer in circular pipe, pipes of other cross sections.	02	C-D	3,4,5	1, 3, 4, 7, 8
14.	Heat transfer in laminar flow and turbulent flow over a flat plate, Reynolds analogy	01	C-D	3,4,5	1, 3, 4, 7, 8
15.	Flow across a cylinder and sphere, flow across banks of tubes.	01	C-D-I	3,4,5	1, 3, 4, 7, 8
16.	Natural Convection: Introduction, governing equations	01	C-D-I	3,4	1, 3, 4, 7
17.	Natural Convection: Vertical plate, horizontal cylinder, horizontal plate, enclosed spaces.	02	C-D	3,4,5	1, 3, 4, 7, 8
	UNIT IV: RADIATION	**08**			
18.	Basic ideas, spectrum, basic definitions, Laws of radiation.	01	C	3,4	1,2,3,6
19.	Black body radiation, Planck's law, Stefan Boltzman law, Wien's Displacement law, Lambert cosine law	03	C	3,4	1,2,3,6

20.	Radiation exchange between black surfaces, shape factor	02	C	3,4	1,2,3,6,8
21.	Radiation exchange between gray surfaces – Radiosity-Irradiation method Parallel plates, Enclosures (non-participating gas), Gas radiation.	02	C-D	3,4,5	1,2,3,6,8
	UNIT V: HEAT EXCHANGERS, CONDENSATION AND BOILING	**08**			
22.	Heat Exchangers: Types of heat exchangers, LMTD approach – parallel, counter-flow,	02	C	4	1,3,4,7
23.	Heat Exchangers: Multi-pass and cross flow heat exchanger, NTU approach – parallel and counterflow, shell and tube, cross flow heat exchanger.	02	C-D-I	3,4,5	1,3,7,8
24.	Condensation and Boiling: Dimensionless parameters, boiling modes	01	C	4	1,3,4,7
25.	Condensation and Boiling: Correlations Forced convection boiling, laminar film condensation on a vertical plate, turbulent film condensation.	03	C-D-I	3,4,5	1,3,7,8
	UNIT VI: MASS TRANSFER	**03**			
26.	Analogy between heat and mass transfer, mass diffusion, Fick's law of diffusion, boundary conditions	01	C	4	1,3,4,7
27.	Steady mass diffusion through a wall, transient mass diffusion, mass convection, limitations of heat and mass transfer analogy.	02	C-D	4	1,3,4,7
	Total contact hours	**45**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	F. P. Incropera, D. P. Dewitt, T. L. Bergman and A. S. Lavine, "Fundamentals of Heat and Mass Transfer", 7th Ed., John Wiley and Sons, 2011.
2.	J. P. Holman, "Heat Transfer", 10th Ed., McGraw Hill, 2009
3.	Yunus A. Çengel, Afshin J. Ghajar, "Heat and mass transfer: fundamentals and applications", McGraw-Hill Education, 2015

4.	P. K. Nag, "Heat and Mass Transfer", 3rd Ed., McGraw Hill
5.	M. N. Ozisik, Heat Transfer-A Basic Approach, McGraw Hill, 1985
6.	Frank Kreith, Raj M. Manglik and Mark S. Bohn, "Principles of Heat Transfer", 7th Ed., Cengage Learning, 2011
7.	A. Bejan, Convective Heat Transfer, 3rd Ed., John Wiley and Sons, 2004
8.	C. P. Kothandaraman and S. Subramanyan, "Heat and Mass transfer data book 6th Ed. (Multi-color, edition)",, New Age International Publishers, 2018

Course nature			**Theory**		
Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Midterm I	Midterm II	Assignment	**Total**
	Weightage	**20%**	**20%**	**10%**	**50%**
End semester examination Weightage :					**50%**

ME 132	**NUMERICAL METHODS**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:							
Data Book / Codes/Standards	Approved Steam Tables, Refrigeration Tables and Psychrometric Chart.						
Course Category	P	PROFESSIONAL CORE	THERMAL ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting -- , 23rd						

PURPOSE	To acquire analytical ability in solving mathematical problems numerially							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to understand								
1.	To familiarize with numerical solutions of equations	a	e					
2.	Learn abt numerical differentiations and integration	a	e					
3.	Learn about numerical solution to ordinary differential equations	a	e					
4.	Learn about numerical solution to partial differential equations	a	e					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: CURVE FITTING/ NUMERICALSOLUTIONS	**10**			
1.	Curve fitting, straight line, parabola	2	C	1	1,2
2.	Newton Raphson method	2	C,D	1	1,2
3.	Bisection method	2	C,D	1	1,2
4.	Iterative methods	2	C,D	1	1,2
5.	Power methods	2	C	1	1,2

	UNIT II: - FINITE DIFFERENES AND INTEGATION	**10**			
6	Forward difference and backword difference	2	C	2	1,2
. 7	Central difference	2	C	2	1,2
8.	interpolation	2	C,D	2	1,2
9.	Divided differences	2	C	2	1,2
10.	Inverse interpolation	2	C,D	2	1,2
	UNIT III: NUMERICAL DIFFERENTIAION AND INTEGRATION	**8**			
11.	Numerical differentiation, applications	2	C	3	1,2
12.	Numerical integration, applications	2	C	3	1,2
13.	Simpsons rule	2	C,D	3	1,2
14.	Trapezoidal rule	2	C,D	3	1,2
	UNIT IV:NUMERICAL SOLUTIONS OF FIST ORDER ODE	**9**			
15	Taylor series method	2	C	4	1,2
16.	Eulers methods and applications	2	C	4	1,2
17.	Runge kutta method	3	C,D	4	1,2
18.	Predictor corrector method	2	C	4	1,2
	UNIT V: NUMERICAL SOLUTION OF PDE	**7**			
19.	Solution of elliptic equations	1	C	4	1,2
20.	Solution of laplace equations	2	C	4	1,2
21.	Solution of parabolic equations	2	C,D	4	1,2
22.	Solutions of hyperbolic equations	2	C,D	4	1,2
	Total contact hours *	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	B.S.Grewal, Numerical methods in engineering and science, Khanna publisher, 2012
2.	M.K.Venkatraman, Numerical methods in engineering, National publishing, 2005
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	S.S.Sastri, Numerical methods analysis, 2005

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Assignment**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**15%**	**15%**	**10%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME 222	**FLUID MECHANICS**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**
Co-requisite:	Nil				
Prerequisite:					

Data Book / Codes/Standards	Nil		
Course Category	P	PROFESSIONAL CORE	THERMAL ENGINEERING
Course designed by	Department of Mechanical Engineering		
Approval	-- Academic Council Meeting -- , 23rd		

PURPOSE	To familiarize with the concepts of fluid mechanics and hydraulic machines.							
INSTRUCTIONAL OBJECTIVES On the completion of the course, the students are able to		**STUDENT OUTCOMES**						
1.	Understand the properties of the fluid.	a	e					
2.	Understand and solve the fluid flow problems.	a	e					
3.	Understand the mathematical techniques of practical flow problems.	a	e					
4.	Understand the energy exchange process in fluid machines.	a	e					
5.	Understand the boundary layer theory	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: PROPERTIES OF FLUIDS AND FLUID STATICS	**12**			
1.	Properties of fluids: density, specific weight, specific volume, specific gravity, vapour pressure.	1	C	1	1,2
2.	Viscosity: Dynamic and Kinematic viscosity, Newton's law of viscosity, factors affecting viscosity.	1	C	1	1,2
3.	Types of fluids, Tutorial-Problems on fluid properties	2	C,D	1	1,2
4.	Surface tension, compressibility and bulk modulus concepts.	1	C,D	1	1,2
5.	Fluid statics- Pascal's law, Hydrostatic law.	2	C,D	1	1,2
6.	Manometry: Types of manometers, Piezometer, U-tube Manometer	3	C,D	1	1,2
7.	Tutorials on manometers.	2	C,D		1,2
	UNIT II: - FLUID KINEMATICS AND DYNAMICS	**12**			
8.	Types of flow, Lagrangian and Eulerian approach, Velocity and Acceleration of fluid particle.	2	C	2	1,2
9.	Tutorial problems on Velocity and Acceleration of fluid particle	2	D	2	1,2
10.	Fluid flow pattern: Stream line, streak line, path line	1	C	2	1,2
11.	Continuity equation	2	C,D	2	1,2
12.	Fluid dynamics: Euler's equation of motion, Bernoulli's Equation	1	C	2	1,2
13.	Applications of Bernoulli's equation in flow measurementDevices: Venturimeter.	3	C, D	2	1,2
14.	Orifice meter, Pitot tube, nozzle flow meter	1	C,D	2	1,2
15.	Impulse momentum equation.	2	C,D	2	1,2
	UNIT III: DIMENSIONAL ANALYSIS AND FLOW THROUGH PIPES	**15**			
16.	Dimensional analysis: Dimensions, Dimensional homogeneity.	1	C	3	1,2
17.	Rayleigh method, Buckingham's Pi-theorem, non-dimensional analysis.	3	C,D	3	1,2
18.	Model analysis: Advantages and applications of model testing, Similitude. Dimensionless number: Reynold's number, Froude's number, Euler's number, Weber number, Mach number.	1	C,D	3	1,2
19.	Reynold's model law – Problems	1	C,D	3	1,2
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
20.	Froude's model law – Problems	1	C,D	3	1,2
21.	Euler's model law, Weber model law and Mach model law	1	C	3	1,2

22.	Laminar and Turbulent flow, Reynold's experiment, Flow through circular pipes –Hagen Poiseuille law.	2	C,D	3	1,2
23.	Turbulent flow – Derivation of Darcy Weisbach equation, Tutorial – Problems on Darcy Weisbach equation.	1	C,D	3	1,2
24.	Minor loss due to sudden enlargement, sudden contraction, inlet and exit of pipes, problems.	2	C,D	3	1,2
25.	Flow through pipes in series and parallel – problems.	2	C,D	3	1,2
	UNIT IV: HYDRAULIC MACHINES	**12**			
26.	Hydraulic turbines- classification, Impulse and reaction turbine.	1	C	4	1,2
27.	Design parameters and performance of Pelton turbine.	2	C,D	4	1,2
28.	Design parameters and performance of Francis turbine.	2	C,D	4	1,2
29.	Design parameters and performance of Kaplan turbine	2	C,D	4	1,2
30.	Classification of pumps; Positive-displacement and non-positive pumps.	2	C,D	4	1,2
31.	Centrifugal pump, Performance curves and velocity triangles	2	C,D	4	1,2
32.	Cavitations in pumps, Thoma's cavitation number.	1	C	4	1,2
	UNIT V: BOUNDARY LAYER THEORY	**9**			
33.	Boundary layer theory: laminar and turbulent boundary layer over a flat plate.	1	C	3	1,2
34.	Displacement, Momentum, Energy thickness: derivations and problems.	2	C,D	3	1,2
35.	Momentum integral equation derivation	2	C	3	1,2
36.	Separation of flow over bodies: stream lined and bluff bodies, Flow over cylinders.	2	C, D	3	1,2
37.	Aerofoil description, definition of parameters involved in aerofoil, velocity and pressure acting over the aerofoil	2	C, D	3	1,2
	Total contact hours*	**60**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, "*Introduction to Fluid Mechanics"*, Wiley , 8th Edition, 2013.
2.	Frank M.White, "*Fluid Mechanics"*, McGraw-Hill, 7th Edition, New Delhi, 2011.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Irving H.Shames, "*Mechanics of Fluids*", McGraw Hill, 3rd Edition, 2014.
4.	Yunus A Cengel& John M. Cimbala, *Fluid Mechanics*, Tata McGraw Hill Edition, New Delhi, 3rd Edition, 2015.
5.	Modi P.N, & Seth S.M, "*Hydraulics and Fluid Mechanics"*, Standard Book House, New Delhi, 20**th** Edition, 2015.
6.	Streeter.V.L, and Wylie.E.B, "*Fluid Mechanics"*, McGraw Hill, 9th Edition 2010.

Course nature			**Theory**				
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME 222	**FLUID DYNAMICS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**
Co-requisite:	15ME205				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				

Course Category	P	PROFESSIONAL CORE	THERMAL ENGINEERING
Course designed by	Department of Mechanical Engineering		
Approval	-- Academic Council Meeting -- , 23rd		

PURPOSE	To enable the students to acquire knowledge of fluid flow concepts, working principles of flow meters, performance of pumps and turbines.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to understand the								
1.	Working of flow meters.	a	b	e				
2.	Different forms of energy of fluid flow.	a	b	e				
3.	Various losses in pipes.	a	b	e				
4.	Performance of pumps and turbines.	a	b	e				

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Flow measurement using Venturimeter	2	O	1	1,2
2.	Flow measurement using Pitot tube	2	O	1	1,2
3.	Flow measurement using Orificemeter	2	O	1	1,2
4.	Flow visualization using Reynolds apparatus	2	O	2	1,2
5.	Verification of Bernoulli's theorem	2	O	2	1,2
6.	Free and forced vortex flow visualization experiment	2	O	2	1,2
7.	Impact of jet of water on vanes	2	O	2	1,2
8.	Determination of major loss in pipe	2	O	3	1,2
9.	Determination of minor losses in pipe fittings	2	O	3	1,2
10.	Performance test on Centrifugal pump	2	O	4	1,2
11.	Performance test on Submersible pump	2	O	4	1,2
12.	Performance test on Gear pump	2	O	4	1,2
13.	Performance test on Reciprocating pump	2	O	4	1,2
14.	Performance test on Jet pump	2	O	4	1,2
15.	Visualization of cavitation in pipe flow	2	O	4	1,2
16.	Performance test on Pelton turbine	2	O	4	1,2,3
17.	Performance test on Kaplan turbine	2	O	4	1,2,3
18.	Performance test on Francis turbine	2	O	4	1,2,3
	Total Contact Hours*	**20**			

*Any 10 experiments will be offered

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, "*Introduction to Fluid Mechanics"*, Wiley, 8th Edition, 2013.
3.	Frank M.White, "*Fluid Mechanics"*, McGraw-Hill, 7th Edition, New Delhi, 2011.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	**Experiments**	**Record**	**MCQ/Quiz/Viva Voce**	**Model examination**	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

ME Elective	ADVANCEED THERMODYNAMICS			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:							
Data Book / Codes/Standards	Approved Steam Tables, Refrigeration Tables and Psychrometric Chart.						
Course Category	P	PROFESSIONAL CORE	THERMAL ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting -- , 23rd						

PURPOSE	To expose the students to learn the fundamental concepts of gas and vapour power cycles, IC engines, air compressors, refrigeration and air conditioning systems.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to understand								
1.	Various gas power cycles.	a	e					
2.	Engine testing and performance.	a	e					
3.	The performance of air compressors.	a	e					
4.	Refrigeration and air conditioning systems.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: GAS POWER CYCLES	**12**			
1.	Introduction to air standard cycles. Air standard efficiency. Assumptions	1	C	1	1,2
2.	Otto cycle: Air standard efficiency, mean effective pressure, Power developed. Tutorials	3	C,D	1	1,2
3.	Diesel cycle: Air standard efficiency, mean effective pressure and power developed .Tutorials	3	C,D	1	1,2
4.	Dual cycle: Air standard efficiency, Mean Effective pressure and power developed. Tutorials	3	C,D	1	1,2
5.	Comparison of Otto, Diesel and Dual cycles.	1	C	1	1,2
6.	Brayton cycle, Concept of reheat and regeneration in brayton cycle.	1	C	1	1,2
	UNIT II: - INTERNAL COMBUSTIONENGINES	**12**			
7.	Classification of IC engines. Basic operations	2	C	2	1,2
8.	Actual P-V diagram of four stroke otto cycle engine and four stroke diesel cycle engine.	1	C	2	1,2
9.	Engine performance parameters.	2	C,D	2	1,2
10.	Measurements of fuel and air consumption, brake power and in-cylinder pressure.	1	C	2	1,2
11.	Tutorials on engine performance parameters.	3	C,D	2	1,2
12.	Heat balance sheet.	2	C,D	2	1,2
13.	Engine performance curves.	1	C	2	1,2
	UNIT III: AIR COMPRESSORS	**12**			
14.	Reciprocating air compressors, Construction and working.	1	C	3	1,2
15.	Compression with and without clearance, Equation for work. Volumetric efficiency.	1	C	3	1,2
16.	Tutorials on single stage compressor with and without clearance. Free air delivered.	3	C,D	3	1,2
17.	Multistage compression, Conditions for minimum work.	2	C,D	3	1,2
18.	Compressor efficiencies.	1	C,D	3	1,2
19.	Tutorials on multistage compressor with and without clearance.	3	C,D	3	1,2
20.	Rotary compressors, vane compressor, roots blower - Comparison between reciprocating compressors and rotary compressors	1	C	3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT IV:REFRIGERATION SYSTEMS	**12**			
21.	Vapor compression refrigeration system and its working principle	1	C	4	1,2
22.	Classifications of refrigerants, properties, eco- friendly refrigerants	1	C	4	1,2
23.	Analysis of vapor compression refrigeration cycle, P-h chart	2	C,D	4	1,2
24.	Factors affecting the performance of VCR system.	1	C	4	1,2
25.	Tutorials on performance of simple VCR cycle	2	C,D	4	1,2
26.	Sub-cooling and superheating phenomena in VCR cycle	1	C	4	1,2
27.	Tutorials on VCR system with sub-cooling and superheating	2	C,D	4	1,2
28.	Simple and practical vapor absorption refrigeration system	1	C	4	1,2
29.	Comparison between vapor compression refrigeration and vapour absorption refrigeration systems.	1	C	4	1,2
	UNIT V: PSYCHROMETRY AND AIR CONDITIONING	**12**			
30.	Properties of atmospheric air and Psychrometric chart.	1	C	4	1,2
31.	Psychrometric processes.	2	C	4	1,2
32.	Tutorials on sensible heating and cooling.	2	C,D	4	1,2
33.	Tutorials on cooling and dehumidification, heating and humidification.	3	C,D	4	1,2
34.	Adiabatic mixing of two air streams and property calculations.	1	C,D	4	1,2
35.	Summer, Winter and Year round air conditioning systems. Window, Split and Centralized AC systems.	2	C	4	1,2
36.	Introduction to heat load calculations.	1	C,D	4	1,2
	Total contact hours *	**60**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Eastop.T.D, Mcconkey.A, "*Applied Thermodynamics for Engineering Technologists*", 5th Edition, Pearson Edition Publications, 2009.
2.	Mahesh Rathore , "*Thermal Engineering*",Tata McGraw Hill, New Delhi-Reprint 2012.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Yunus A Cengel; Michael A Boles,"*Thermodynamics: An Engineering Approach*",8th edition Tata McGraw Hill, New Delhi-2015.
4.	Kothandaraman.C.P, Domkundwar.S, AnandDomkundwar, "*A Course in Thermal Engineering*", DhanpatRai& Co. (P) Ltd., 2010.
5.	Rajput.R.K, "*Thermal Engineering*", Laxmi Publications, 10th Edition, New Delhi, 2015.
6.	Sarkar.B.K, "*Thermal Engineering*", 3rd Edition, Tata McGraw Hill, New Delhi, 2009.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME 121	METALLURGY AND MATERIAL SCIENCE	L	T	P	C
		2	0	2	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards					
Course Category	C	CORE			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 2019				

PURPOSE	Engineering problem, at certain point in time, will involve issues related to material selection. Understanding material behavior, their structures, and property will help in the process of identification of suitable material. The objective of this course is to impart such understanding to Mechanical Engineering Students.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To make the learner familiarize with the structure and properties of materials	a	b					
2.	Familiarize them with various heat treatment method and implications on improving materials properties	a	b	c	e			
3.	Develop a deep knowledge on traditional material, advanced material and composites.	a	c					
4.	Familiarize them with various method used in powder processing	a						
5.	Expose to the concept of additive manufacturing	a	c					

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: Metal Structure	**6**			
1.	Crystal structures.	1	C	1-4	1,2
2.	Elastic-plastic behavior.	1	C	1	1,2
3.	Deformation mechanisms , Slip, twinning Imperfections.	1	C	1	1,2
4.	Types of fracture	1	C	1	1,2
5.	Three Stages in creep.	1	C		1,2
6.	Fatigue mechanism.	1	C		1,2
	UNIT II: Material properties	**6**			

7.	Testing of metals,	1	C	2	1,2,3,4
8.	Properties, strength, plasticity, stiffness	1	C	2	1,2,3,4
9.	Properties, toughness, brittleness, ductility	1	C		1,2,3,4
10.	Hardness	1	C	2	1,2,3,4,
11.	Creep and fatigue tests	2	C		1,2,3,4
	UNIT III: Heat Treatment	**6**			
12.	Solidification, crystal growth, rule,	1	C,D	4	1,2,3,4
13.	Phase diagram, Gibbs Phase rule, Equilibrium diagrams, lever rule	1	C,D		1,2,3,4
14.	Iron Carbon diagram, solidification of steel and cast irons.	1	C,D		1,2,3,4
15.	Heat treatment, TTT curves, annealing, normalising, hardening, tempering, inductin harening, age hardening	1	C,D		1,2,3,4
16.	Martempering, austempering, carburising, cyaniding, nitriding, flame and induction harening, age hardening	1	C,D,	4	1,2,3,4
17.	Ferrous, Non-ferrous metals, Cast Iron, Steel, Copper, Aluminium alloys	1	C,D		1,2,3,4
	UNIT IV: Composite materials	**6**			
18.	Composites	1	C	4	1,2,3,4
19.	Fibre reinforced composites	1	C	4	1,2,3,4
20.	Manufacturing methods	2	C	4	1,2,3,4
21.	Metal matrix composites	2	C		1,2,3,4
	UNIT V: Powder Metallurgy	**6**			
22.	Powder metallurgy: Powder characterization, size analysis, compaction and sintering	2	C	4	5
23.	Manufacturing methods: Mechanical, chemical and physical	2	C	4	5
24.	Additive manufacturing	2	C	4	5
	Total contact hours	30			

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	**Introduction**	**2**	**C**		
2.	Polish the samples until one can see the microscopic phases clearly	4	C, I	1-4	1,2
3.	To determine the hardness of the given Specimen using Vicker‟s hardness test.	2	C, I		1,2
4.	To find the Brinell Hardness number for the given metal specimen	2	C, I	1	1,2
5.	To determine the Rockwell hardness number of the given specimen.	2	C, I	1	1,2
6.	Heat treat given materials at different levels	4	C, I		1,2
7.	Study micrographs of differently heat treated materials and compare them	4	C, I		1,2
8.	Measure the hardness of given materials using End Quench hardness tester	4	C,I		1,2
9.	Mini project-Design of heat cycle to improve properties of given alloy.	6	D,I,O		
	Total contact hours	30			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Willium D Callister, “ Material Science and Engineering” John Wiley and Sons, 2014 edition
2.	U.C.Jindal , “Material Science and Metallurgy “ U.C.Jindal, Pearson Publication, 2011 edition
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Allen Cottrell “Introduction to Metallurgy” University Press, 2000 editio
4.	R. Srinivasan “Engineering materials and metallurgy”, McGraw Hill, 2009 edition.
5.	Anish Upadhya and G S Upadhaya, “Powder Metallurgy: Science, Technology and Materials, Universities Press, 2011

Course nature				**Theory + Practical**	
Assessment Method – Theory Component (Weightage 50%)					
In-semester	**Assessment tool**	Mid Term-I	Mid Term II	Surprise test/Assignment	**Total**

	Weightage	**20%**	**20%**	**10%**	**50%**
End semester examination Weightage :					**50%**
Assessment Method – Practical Component (Weightage 50%)					
In-semester	**Assessment tool**	Experiments	Record /report/Quiz/Viva		**Total**
	Weightage	**30%**	**20%**		**50%**
End semester examination Weightage :					**50%**

ME Elective	**FUNDAMENTALS OF VIBRATION AND NOISE**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	Nil						
Prerequisite:							
Data Book / Codes/Standards	Nil						
Course Category	P	PROFESSIONAL CORE	DESIGN ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting -- , 23rd						

PURPOSE	To familiarize the students with the sources of vibration and noise in machines and make design modifications to reduce the vibration and noise and improve the life of the components							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know the concepts of vibration and noise	a						
2.	Analyze the Single Degree, Two Degree and Multi degree of Freedom Systems	a	e					
3.	Study the numerical methods for vibration analysis	a	e					
4.	Identify the sources of noises and the ways to control it.	a	e					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: FREE VIBRATION	**12**			
1.	Introduction to vibration terminologies and types of vibration	1	C,D	1	1,2
2.	Equation of motion for free undamped single Degree of Freedom system by Newton's and energy method	1	C,D	1	1,2,3
3.	Tutorials on single Degree of Freedom undamped free vibration systems	2	C,D	1	1,2
4.	Equation of motion for free damped single Degree of Freedom systems	2	C,D	1	1,2
5.	Tutorials on free damped single Degree of Freedom systems	2	C,D	1	1,2
6.	Torsional Vibration of Two Rotor and three rotor Systems	1	C,D	1	1,2
7.	Tutorials on Torsional Vibration of Two Rotor and three rotor Systems	2	C,D	1	1,2
8.	Torsional Vibration of Geared Systems with Two and Three rotor System	1	C,D	1	1,2
	UNIT II: FORCED VIBRATION	12	C,D		
9.	Equation of motion for harmonically excited single Degree of Freedom system	2	C,D	2	
10.	Tutorials on harmonically excited single Degree of Freedom system	2	C,D	2	1,2
11.	Forced vibration due to unbalanced rotating and reciprocating systems	1	C,D	2	1,2

12.	Tutorials on Forced vibration due to unbalanced rotating and reciprocating systems	1	C,D	2	1,2
13.	Forced vibration due to Base excitation by Absolute and Relative amplitude Method	2	C,D	2	1,2
14.	Tutorials on Forced vibration due to Base excitation by Absolute and Relative amplitude Method	1	C,D	2	
15.	Force Transmissibility and Vibration isolation	1	C,D	2	1,2
16.	Tutorials on Force Transmissibility and Vibration isolation	1	C,D	2	1,2
17.	Whirling of shaft and tutorials	1	C,D	2	1,2
	UNIT III: MULTI DEGREE OF FREEDOM	**12**			
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	SYSTEMS				
18.	Equation of motion for free undamped two and three degrees of Freedom systems and tutorials	3	C,D	2	1,2
19.	Equation of motion for Two and three DOF using Lagrangian energy method for Un-damped free vibration	1	C,D	2	1,2
20.	Tutorials on Lagrangian energy method for Un-damped free vibration	2	C,D	2	1,2
21.	Co-ordinate Coupling and tutorials	2	C,D	2	1,2
22.	Concept of Linear and torsional undamped Vibration Absorber	2	C,D	2	1,2
23.	Tutorials on Linear and torsional undamped Vibration Absorber	2	C,D	2	1,2
	UNIT IV: **NUMERICAL METHODS**	12	C,D		
24.	Stiffness and Flexibility Influence Coefficients and tutorials	2	C,D	2,3	1,2
25.	Eigenvalue, Eigenvector and orthogonal Properties and tutorials	2	C,D	2,3	
26.	Concept of Dunkerlay's and Rayleigh's method	**1**	C,D	3	1,2
27.	Tutorials on Dunkerley's and Rayleigh's method	2	C,D	3	1,2
28.	Concept of Holzer's method for far coupled and tutorials	2	C,D	3	1,2
29.	Concept of Holzer's method for close coupled system and tutorials	1	C,D	3	1,2
30.	Concept of Matrix iteration method and tutorials	**2**	C,D	3	1,2
	UNIT V: VIBRATION AND NOISE MESUREMENT	12			
31.	Vibration measuring devices and Vibration exciters	3	C	3	1,8
32.	Free and Forced vibration Tests	1	C	3	1,8
33.	Balancing Machines, single plane and two plane balancing	2	C	3	1,8
34.	Condition monitoring techniques and signal analysis	2	C	3	1,8
35.	Basics of Noise terminologies and their relations	2	C	3	1,8
36.	Noise Control Methods at source, along Path and at receiver	2	C	3	1,8
	Total contact hours*	**60**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Rao.S.S, "*Mechanical Vibrations*", 5th Edition, Pearson Education Inc. Delhi 2009.
	REFERENCE BOOKS/OTHER READING MATERIAL
2	Ambekar.A.G, "*Mechanical Vibrations and Noise engineering*", PHI New Delhi, 2015.
3	Thomson.W.T, "*Theory of Vibration and its Applications*",5th Edition, Prentice Hall, New Delhi, 2001.
4.	Meirovitch, L., "*Elements of Vibration Analysis*", Mc Graw – Hill Book Co., New York, 1986.
5.	Rao.J.S and Gupta.K, "*Introductory course on theory and practice of mechanical vibrations*", 2nd Edition,New Age International, New Delhi, 2014.

6.	Keith Mobley.R, "*Vibration Fundamentals*", Plant Engineering Maintenance Series, Elsevier, 2007.
7.	Ramamurthi.V, "*Mechanical Vibration Practice with Basic Theory*", 1st edition, Narosa Publishing House, Chennai, 2000.
8.	Kewelpujara, "*Vibration and noise for engineers*", Dhanpatrai& Sons, 2009.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**15%**	**15%**	**15%**	**5%**	**-**	**50%**
					End semester examination Weightage :		**50%**

ME	**DYNAMICS AND CONTROL**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	Nil						
Prerequisite:							
Data Book / Codes/Standards	Nil						
Course Category	P	PROFESSIONAL CORE	DESIGN ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting -- , 23rd						

PURPOSE	To familiarize students about dynamic system modeling and introduction to control systems							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know the concepts of vibration	a						
2.	Analyze the Single Degree, Two Degree and Multi degree of Freedom Systems	a	e					
3.	Study the numerical methods for vibration analysis	a	e					
4.	Identify the sources of noises and the ways to control it.	a	e					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: FREE VIBRATION	**12**			
1.	Introduction to vibration terminologies and types of vibration	1	C,D	1	1,2
2.	Equation of motion for free undamped single Degree of Freedom system by Newton's and energy method	1	C,D	1	1,2,3
3.	Tutorials on single Degree of Freedom undamped free vibration systems	2	C,D	1	1,2
4.	Equation of motion for free damped single Degree of Freedom systems	2	C,D	1	1,2
5.	Tutorials on free damped single Degree of Freedom systems	2	C,D	1	1,2
6.	Torsional Vibration of Two Rotor and three rotor Systems	1	C,D	1	1,2
7.	Tutorials on Torsional Vibration of Two Rotor and three rotor Systems	2	C,D	1	1,2
8.	Torsional Vibration of Geared Systems with Two and Three rotor System	1	C,D	1	1,2
	UNIT II: FORCED VIBRATION	12	C,D		
9.	Equation of motion for harmonically excited single Degree of Freedom system	2	C,D	2	
10.	Tutorials on harmonically excited single Degree of Freedom system	2	C,D	2	1,2
11.	Forced vibration due to unbalanced rotating and reciprocating systems	1	C,D	2	1,2

12.	Tutorials on Forced vibration due to unbalanced rotating and reciprocating systems	1	C,D	2	1,2
13.	Forced vibration due to Base excitation by Absolute and Relative amplitude Method	2	C,D	2	1,2
14.	Tutorials on Forced vibration due to Base excitation by Absolute and Relative amplitude Method	1	C,D	2	
15.	Force Transmissibility and Vibration isolation	1	C,D	2	1,2
16.	Tutorials on Force Transmissibility and Vibration isolation	1	C,D	2	1,2
17.	Whirling of shaft and tutorials	1	C,D	2	1,2
	UNIT III: MULTI DEGREE OF FREEDOM	**12**			
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	SYSTEMS				
18.	Equation of motion for free undamped two and three degrees of Freedom systems and tutorials	3	C,D	2	1,2
19.	Equation of motion for Two and three DOF using Lagrangian energy method for Un-damped free vibration	1	C,D	2	1,2
20.	Tutorials on Lagrangian energy method for Un-damped free vibration	2	C,D	2	1,2
21.	Co-ordinate Coupling and tutorials	2	C,D	2	1,2
22.	Concept of Linear and torsional undamped Vibration Absorber	2	C,D	2	1,2
23.	Tutorials on Linear and torsional undamped Vibration Absorber	2	C,D	2	1,2
	UNIT IV LANGARANGIAN DYNAMICS	12	C,D		
24.	Virtual work, generalized forces	2	C,D	2,3	1,2
25.	Derivation of langaragian equations	2	C,D	2,3	
26.	Eigen value problems	**1**	C,D	3	1,2
27.	Equilibrium analysis	2	C,D	3	1,2
28.		2	C,D	3	1,2
	UNIT V: VIBRATION MESUREMENT	12			
31.	Vibration measuring devices and Vibration exciters	3	C	3	1,8
32.	Free and Forced vibration Tests	1	C	3	1,8
33.	Balancing Machines, single plane and two plane balancing	2	C	3	1,8
34.	Condition monitoring techniques and signal analysis	2	C	3	1,8
35.	Basics of Noise terminologies and their relations	2	C	3	1,8
36.	Noise Control Methods at source, along Path and at receiver	2	C	3	1,8
	Total contact hours*	**60**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Gian carlo genta, Vibration dynamics and control, 1993, Springer.
	REFERENCE BOOKS/OTHER READING MATERIAL
2	Leonard meirovitch , Dynamics and Control, Abe books, 1985.
3	Lazlo Kevizsky, Control Engineering, 2018
4	Gopal, Control Systems, 1997
5	Iyengar, Mechanical vibrations, 2010

Course nature	**Theory**
Assessment Method (Weightage 100%)	

In-semester	Assessment tool	Cycle Test I	Cycle Test II	Assignment	Surprise Test	Quiz	Total
	Weightage	15%	15%	15%	5%	-	50%
						End semester examination Weightage :	50%

ME 171	KINEMATIC AND MACHINERY LABORATORY	L	T	P	C
		0	0	2	1
Co-requisite:	15ME301				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	DESIGN ENGINEERING			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To study the static and dynamic behavior of machines.							
INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1.	Understand and verify the laws governing the kinematics and dynamics of Machines.	a	b					
2.	Analyze the effect of vibration and noise	a	b	k				

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Analysis of Cam and Follower	3	O	1	1
2.	Dynamic analysis of Epi-cyclic gear trains	3	O	1	1
3.	Dynamic analysis of Gyroscope	3	O	1	1
4.	Dynamic analysis of Porter Governor	3	O	1	1
5.	Dynamic analysis of ProellGovernor	3	O	1	1
6.	Dynamic Balancing of rotating masses	3	O	1	1
7.	Dynamic Balancing of reciprocating masses	3	O	1	1
8.	Measurement of cutting forces in Drilling, turning and Milling using Dynamometers	3	O	1	1
9.	Study of Free Vibration of helical springs	3	O	2	1
10.	Free damped and un-damped torsional vibration of single rotor systems	3	O	2	1
11.	Free & forced vibration of equivalent spring mass system	3	O	2	1
12.	Transmissibility Ratio in Vibrating Systems	3	O	2	1
13.	Free and forced transverse vibration analysis for beams	3	O	2	1
14.	Whirling of shaft	3	O	2	1
15.	Vibration measurement using strain gauge	3	O	2	1
16.	Free vibration analysis with Impact hammer	3	O	2	1
17.	Forced vibration analysis with exciter	3	O	2	1
18.	Transmission loss analysis using Sound level meter	3	O	2	1
	Total contact hours*	**30**			

*Any 10 experiments will be offered

LEARNING RESOURCES	
Sl. No.	REFERENCES
1.	Laboratory Manual

Course nature				Practical		
Assessment Method (Weightage 100%)						
In-semester	Assessment tool	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	Total
	Weightage	40%	5%	5%	10%	60%
					End semester examination Weightage :	40%

ME402	MULTIBODY DYNAMICS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	E PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 2016				

PURPOSE	Most of the real-world systems are made of more than one body connected by various joints which we call multibody systems. In order analyze the behavior of the systems under various real-world circumstances, the multibody system has to be reshaped to its mathematical form. Once we formulate the mathematical model of the multibody system we can perform various analysis on the system to ensure the sustainability of the system for real world applications. In this subject the students will learn how to reshape the multibody system to its mathematical form and they also gets the knowledge of various techniques that are available for this purpose. The content of course is useful in various applications like vehicle dynamics, automobiles, robotics and any field that requires systems of multibody.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Recollect the fundamentals required for studying the Multibody dynamics.							
2.	learn the fundamentals required for the kinematic analysis of multibody system.							
3.	To make students learn the fundamentals required for the dynamic analysis of multibody system.							
4.	Perform the kinematic analysis of multibody systems using the body coordinate formulation approach.							
5.	To make the students perform the dynamic analysis of multibody systems using the body coordinate formulation approach.							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I	**8**			
1.	INTROUCTION: What is MBD, Applications and scope of MBD, Objectives of MBD.	1	C	1	1,5
2.	PRELIMINARIES OF MBD: Kinematics- Position,	1	C	1-2	1,5

	velocity, acceleration				
3.	momentum, angular momentum.	1	C	1-2	1,5
4.	cs- Force, moment, torque, equations of motion.	1	C,D	1,3	1,5
5.	Methods of formulations for MBD.	1	D	2-3	1,5
6.	TICAL BACKGROUND FOR MBD: Vectors, Scalars, Arrays, Matrix operations,	1	D	2	1,5
7.	fferentiation of vectors, arrays and matrices	1	D	2-3	1,5
8.	Differential equations.	1	D	2-3	1,5
	UNIT II: FUNDAMENTALS OF KINEMATICS	**6**			
9.	Kinematics of particles	1	C	2	1,5
10.	f a rigid body- position, velocity and acceleration of a rigid body	1	C, D	2	1,5
11.	Array of coordinates, degrees of freedom	1	C	2	1,5
12.	Constraint equations	1	C	2	1,5
13.	kinematics of joints	1	C, D	2	1,5
14.	Numerical problems	1	D, I	2	1,5
	UNIT III: FUNDAMENTALS OF DYNAMICS	**8**			
15.	of motion- Dynamics of particle and system of particles.	1	C	3	1,5
16.	cs of rigid body- Centroidal equations of motion	1	C	3	1,5
17.	Numerical problems	1	D, I	3	1,5
18.	Non centroidal equations of motion	1	C	3	1,5
19.	ts, Applied forces- Gravitational forces, point to point tuator, point to point spring, point to point damper,	1	D	3	1,5
20.	Combined elements, rotational elements, viscous friction.	1	C	3	1,5
21.	ce: Method of Lagrange multipliers, Coulomb friction.	1	D	3	1,5
22.	Numerical problems.	1	D, I	3	1,5
	BODY COORDINATE FORMULATION: KINEMATICS	**10**			

23.	General procedure	1	C	4	1,5
24.	rmulation of kinematic joint constraints	1	C, D	4	1,5
25.	ute, translational, composite and rigid joints.	1	C, D	4	1,5
26.	Numerical examples.	1	D, I	4	1,5
27.	Velocity and acceleration of joint constraints.	1	C	4	1,5
28.	ocity and acceleration of joint constraints.	1	C	4	1,5
29.	Numerical examples	1	D, I	4	1,5
30.	Formation of system Jacobian.	1	D, I	4	1,5
31.	Numerical examples	1	D, I	4	1,5
32.	Numerical examples	1	D, I	4	1,5
	UNIT V- BODY COORDINATE FORMULATION: DYNAMICS	**13**			
33.	stem of un constrained bodies	1	C	5	1,5
34.	Dynamics of system of un constrained bodies	1	C	5	1,5
35.	o body system	1	D	5	1,5
36.	Dynamics of two body system	1	D	5	1,5
37.	Dynamics general unconstrained bodies	1	C	5	1,5
38.	Numerical problems.	1	D, I	5	1,5
39.	Numerical problems.	1	D, I	5	1,5
40.	Dynamics of System of constrained bodies	1	C	5	1,5
41.	Dynamics of System of constrained bodies	1	C	5	1,5
42.	Numerical problems.	1	D, I	5	1,5
43.	Analysis of MBD system	1	D, I	5	1,5

44.	Analysis of MBD system	1	D, I	5	1,5
45.	D system	1	D, I	5	1,5
		45			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	Parviz E Nikravesh, "Planar Multibody Dynamics: Formulation, programming and applications", CRC Press, 2007.
2.	Ahmed A Shabana, "Dynamics of Multibody systems", Third edition, Cambridge University Press.
3.	Farid Amiroche, "Fundamnetals of Multibody Dynamics: Theory and Applications" , Springer Science & Business Media, 2007.
4.	Ahmed A. Shabana, Railroad Vehicle Dynamics: A Computational Approach, CRC Press.
5.	Parviz E Nikravesh, "Computer Aided Analyis of Mechanical Systems", Prentice Hall Publications.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

	FLUID MACHINERY			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	Nil						
Prerequisite:	Nil						
Data Book / Codes/Standards	Nil						
Course Category	P	PROFESSIONAL CORE	MANUFACTURING ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting -- , 23rd						

PURPOSE	To understand the fluid power systems and to develop circuits for industrial applications.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the principles and characteristics of hydraulic components.		e					
2.	Familiarize the principles and characteristics of pneumatic components.		e					
3.	Design the circuit for given applications.	c	e					
4.	Analyze the maintenance and trouble shooting of fluid power systems.		e					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I - HYDRAULIC POWER GENERATING AND UTILIZING SYSTEMS	**10**			

1.	Introduction to fluid power system, Hydraulic fluids functions, types, properties, selection and application.	1	C	1	1,2
2.	POWER GENERATING ELEMENTS: Construction, operation, characteristics of External Gear pump, internal Gear pump	1	C	1	1,2
3.	Construction, operation, characteristics of Lobe, Gerotor and Screw pumps	1	C	1	1,2
4.	Construction, operation, characteristics of Un balanced and balanced vane pump	1	C	1	1,2
5.	Construction, operation, characteristics of pressure compensated vane pump	1	C	1	1,2
6.	Construction, operation, characteristics of bent axis piston pump, swash plate piston pump and Radial Piston Pump	1	C	1	1,2
7.	Construction and working of single acting, double acting hydraulic linear actuators	1	C	1	1,2
8.	Special cylinders: Tandem, Rodless, Telescopic	1	C	1	1,2
9.	Cushioning arrangement for cylinders to reduce the impact on the cylinders, Various cylinder mountings	1	C	1	1,2
10.	Construction and working of Gear, Vane, Piston motors to obtain rotary motion	1	C	1	1,2
	UNIT II - HYDRAULIC VALVES AND ACCESSORIES	**9**			
11.	construction and working of manually operated 2/2, 3/2, 4/2, 4/3, directional control valves	1	C	1	1,2
12.	construction and working of pilot and solenoid operated 2/2, 3/2, 4/2, 4/3, directional control valves	1	C	1	1,2
13.	Construction and working of pressure relief, compound pressure relief, pressure sequence valves	1	C	1	1,2
14.	Construction and working of pressure reducing, counter balance valves	1	C	1	1,2
15.	Working principle of check valve, throttle valve, one way FCV, pressure compensated FCV, and their applications	1	C	1	1,2
16.	Importance of proportional valves, Servo valves and its applications	1	C	1	1,2
17.	Need for intensifier in hydraulic systems, applications	1	C	1	1,2
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
18.	Different switches, filters, seals, fittings and other accessories used in hydraulic systems	1	C	1	1,2
19.	Functions, types and applications of accumulators in hydraulics	1	C	1	1,2
	UNIT III - PNEUMATIC SYSTEMS	**9**			
20.	Introduction, comparison with hydraulic systems and electrical systems	1	C	2	1,3
21.	Construction, operation, characteristics and symbols of reciprocating and rotary compressors	1	C	2	1,3
22.	Construction, operation, characteristics and symbols of 3/2, 5/2, 5/3 manual operated, pilot operated and solenoid operated DCVs	1	C	2	1,3
23.	Need for air treatment, Filter, Regulator, Lubricator, Muffler and Dryers	1	C	2	1,3
24.	Introduction to fluidic devices, working of Bi-stable, mono-stable devices and application circuits	2	C,D	2,3	1,3
25.	Introduction to Electro Pneumatics, logic circuits, constructing electrical ladder diagrams for various fluid power applications	2	C,D	2,3	1,3
26.	Pneumatic Sensors types and applications	1	C	2	1,3
	UNIT IV - DESIGN OF FLUID POWER SYSTEMS	**10**			
27.	Speed, force and time calculations in fluid power systems	1	C,D	3	1,2,3

28.	Calculation of pressure and pressure drop across components in fluid power circuits	1	C,D	3	1,2,3
29.	Sizing of actuators, pumps, reservoirs for specific requirement	1	C, D	3	1,2,3
30.	Finding the capacity (Sizing) of accumulators required for hydraulic systems, Calculations on Heat generation in fluid	1	C, D	3	1,2,3
31.	Design of hydraulic/pneumatic circuit for a practical application Selection of different components such as reservoir, various valves, actuators, filters, pumps based on design	1	C, D	3	1,2,3
32.	Design of hydraulic/pneumatic circuits for simple reciprocation, regenerative, speed control of actuators	1	C, D	3	1,2,3
33.	Design of hydraulic/pneumatic circuits for sequencing, synchronization and transverse	1	C, D	3	1,2,3
34.	Cascading circuits for two and three cylinders	2	C,D	3	1,2,3
35.	Fail-safe circuit, counter balance circuit, actuator locking	1	C, D	3	1,2,3
	UNIT V - APPLICATIONS, MAINTENANCE AND TROUBLE SHOOTING	**7**			
36.	Industrial hydraulic circuits for riveting machine, actuator locking	1	C, D	3	1,2,3
37.	Working of hydraulic press and pump unloading circuits	1	C, D	3	1,2,3
38.	Hydraulic / pneumatic circuits for material handling systems	1	C, D	3	1,2,3
39.	Preventive and breakdown, maintenance procedures in fluid power systems	1	C	4	1,2,3
40.	Trouble shooting of fluid power systems, fault finding process equipments / tools used, causes and remedies.	2	C	4	1,2,3
41.	Safety aspects involved fluid power systems.	1	C	4	1,2,3
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Anthony Esposito, "*Fluid Power with applications"*, Prentice Hall International, 2009
2.	Majumdar.S.R, "*Oil Hydraulic Systems: Principles and Maintenance"*, Tata McGraw Hill, 2006.
3.	Majumdar.S.R, "*Pneumatic systems – principles and maintenance"*, Tata McGraw-Hill, New Delhi, 2006
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Werner Deppert / Kurt Stoll, "*Pneumatic Application: Mechanization and Automation by Pneumatic Control"*, Vogel verlag, 1986.
5.	John Pippenger, Tyler Hicks, "*Industrial Hydraulics"*, McGraw Hill International Edition, 1987.
6.	Andrew Parr, "*Hydraulics and Pneumatics: A technician's and engineer's guide"*, Elsevier Ltd, 2011.
7.	FESTO manual, "*Fundamentals of Pneumatics"*, Vol I, II and III.
8.	Hehn Anton, H., "*Fluid Power Trouble Shooting",* Marcel Dekker Inc., NewYork, 1995.
9.	Thomson, "*Introduction to Fluid power",* Prentice Hall, 2004.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME 224	**MECHINE DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**
Co-requisite:	Nil				
Prerequisite:					
Data Book / Codes/Standards	*Approved Design Data Book*				
Course Category	P PROFESSIONAL CORE	DESIGNENGINEERING			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting --				

PURPOSE	To study the basic design principles and apply the principles to the design of various elements encountered in Mechanical machines and structures.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Determine the strength of the components.	a						
2.	Determine the failure conditions and apply them to real life problems.		b			j		
3.	Design simple joints, fasteners levers and springs.			c	e			

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: FUNDAMENTALS OF MECHANICAL DESIGN	**12**			
1.	Basic definitions, types of design	1	C	1	2
2.	Criteria for Design based on strength, fatigue, stiffness, wear resistance, vibration resistance, heat resistance and reliability	2	C,D	1	2
3.	Overview of Engineering materials, Theories of failure, Rankine theory, Guests theory, St.Venants theory, Maximum strain energy theory and Distortion energy theory	2	C	1	1
4.	Problems on Theories of failure	2	C,D	1	1
5.	Design of members subjected to combined stresses with eccentric load	1	C,D	1	2
6.	Problems on combined stresses with eccentric load	2	C,D	1	2
7.	Eccentric loading in curved beams, crane hooks,frames,clamps.	2	C,D	1	2
	UNIT II: DESIGN FOR VARIABLE STRESSES	**12**			
8.	Members subjected to variable stresses, Failure and endurance limit.	1	C	2	3
9.	Stress concentration, Methods of reducing stress concentration, Notch sensitivity.	2	C,D	2	1
10.	Combined steady and variable stresses	1	C	2	3
11.	Problems on variable stresses using Soderberg method.	2	D	2	3
12.	Problems on variable stresses using Gerber method	1	D	2	3
13.	Problems on variable stresses using Goodman method	2	D	2	3
14.	Members subjected to impact loads	1	C,D	2	1
15.	Members subjected to dynamic loads	2	C,D	2	1
	UNIT III: DESIGN OF SHAFTS AND TEMPORARY JOINTS.	**12**			
16.	Shafts: Types, Materials, Manufacturing and stresses	1	C	1	2
17.	Design for Strength based on twisting moment, bending moment and combination of axial, bending and torsional loads.	3	C,D	1	2
18.	Cotter joints: Types, design procedure and problems on Socket and spigot cotter joint	2	C,D	3	5
19.	Knuckle joints: Design procedure and problems on knuckle joint	2	C,D	3	5
20.	Bolted joints: Design procedure and problems on bolted joints with eccentric load parallel to axis of bolt	2	C,D	3	1
21.	Design procedure and problems on bolted joints with eccentric load perpendicular to axis of bolt	2	C,D	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT IV: DESIGN OF PERMANENT JOINTS.	**12**			
22.	Riveted joints: Types, materials, failures	1	C	3	2
23.	Design procedure and problems on riveted joints for pressure vessels	2	C,D	3	2
24.	Design procedure and problems on riveted joints for structural applications	1	C,D	3	2
25.	Design procedure and problems on eccentric loaded riveted joint.	2	C,D	3	2
26.	Welded joints: Types and strength	1	C,D	3	2
27.	Design procedure and problems on axially loaded welded joints	2	C,D	3	2
28.	Design procedure and problems on eccentric loaded welded joint.	3	C,D	3	2
	UNIT V : DESIGN OF GEARS AND SPRINGS	**12**			
29.	Design of spur gears	2	C	3	5
30.	Design helical gears	2	C,D	3	5
31.	Design bevel gears	2	C,D	3	5
32.	Design of work gears	1	C,D	3	5
33.	Springs: Stresses and deflections in helical springs	1	C	3	1
34.	Design procedure and problems on helical springs	1	C,D	3	1
35.	Design procedure and problems on helical springs with fatigue load	1	C,D	3	1
36.	Leaf springs: Construction, Nipping, Materials	1	C,D	3	1
37.	Design procedure and problems on leaf springs	1	C,D	3	1
	Total contact hours*	**75**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Robert C.Juvinalland Kurt M. Marshek "*Fundamentals of Machine Component Design"*, John wiley& sons, 5th Edition, 2011.
2.	Spotts.M.F, ShoupT.E, "*Design of Machine Elements"*, Prentice Hall of India Eighth Edition, 2006.
3.	Joseph Edward Shigley and Charles ,R.Mischke, *"Mechanical Engineering Design"*,McGraw-Hill International Editions, 8th edition., 2008
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	William Orthwein, "*Machine Component Design"*, Vol. I and II, JaicoPublishing house, New Edition, 2006.
5.	Khurmi, R.S. and Gupta J.K, "Machine design ", S.Chand publishing , 14th Edition, 2014.
6.	P.S.G Tech..,*"Design Data Book",* KalaikathirAchchagam, 2012
7.	Gitin M Maitra, , "*Handbook of Gear Design"*, Tata Mcgraw-Hill, 2010.

Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Practial (Int+end sem)**	**End Sem exam**	**Quiz**	**Total**
	Weightage	**15%**	**15%**	**15%+15%**	**35 %**	**5%**	**100%**

ME ELECTIVE	GAS DYNAMICS AND SPACE PROPULSION	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:					
Data Book / Codes/Standards	Approved Gas Tables				
Course Category	P PROFESSIONAL CORE	THERMAL ENGINEERING			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	On completion of this course, the students will be in a position to apply their knowledge to solve problems in basic compressible fluid flow, performance of aircraft and rocket engines.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the compressible fluid flow concepts	a	e					
2.	Solve isentropic flow problems through variable area ducts and normal shocks	a	e					
3.	Analyze flow through constant area duct with friction and heat transfer	a	e					
4.	Analyze the performance of aircraft propulsion	a	e					
5.	Analyze the performance of rocket propulsion	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: FUNDAMENTALS OF COMPRESSIBLE FLOW	**12**			
1.	Energy equation for compressible fluid flow, Stagnation state and Mach number	2	C	1	1,2
2.	Various regimes of flow, reference velocities, Critical states, second kind Mach number, Crocco number.	2	C	1	1,2
3.	Equivalent of Bernoulli's equation for compressible flow, Effect of Mach number on compressibility	2	C	1	1,2
4.	Types of waves - subsonic, sonic and supersonic waves. Mach cone, Mach angle.	2	C	1	1,2
5.	Problems in isentropic compressible flow	2	C	1	1,2,6
6.	Problems in isentropic compressible flow	2	C	1	1,2,6
	UNIT II: FLOW THROUGH VARIABLE AREA DUCTS	**12**			
7.	**Flow through variable area duct:** T-S and h-s diagrams for nozzles and diffusers, Area ratio as a function of Mach number, Impulse function	2	C	2	1,2,6
8.	Mass flow rate through nozzles and diffusers, Problems based on flow through nozzles and diffusers, Mass flow rate in terms of pressure ratio (Flienger's formula)	**2**	C	2	1,2,6
9.	Problems in variable area flow nozzles and diffusers	2	C, D	2	1,2,6
10.	**Flow with normal shock:** Development, governing equations, Variation of flow parameters -static pressure & temperature, density, stagnation pressure and entropy across the shock, Impossibility of shock in subsonic flows, strength of a shock	2	C	2	1,2,6
11.	Derivation of Prandtl – Meyer equation	2	C	2	1,2
12.	Flow through nozzles and diffusers with shock, Wind tunnels	2	C,D	2	1,2,6
	UNIT III: FLOW THROUGH CONSTANT AREA DUCTS	**12**			
13.	Flow in constant area ducts with friction (Fanno flow), Fanno curves, Fanno flow equations, Variation of flow properties.	2	C	3	1,2
14.	Variation of Mach number with duct length,	2	C	3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
15.	Problems in Fanno flow with and without normal shocks	2	C,D	3	1,2
16.	Flow in constant area ducts with heat transfer - Rayleigh curve, constant entropy lines and constant enthalpy lines, Rayleigh flow equations,	2	C		1.2
17.	Flow properties and maximum heat transfer concept	2	C	3	1,2,6
18.	Problems in Rayleigh flow	2	C, D	3	1,2,6
	UNIT IV: AIRCRAFT PROPULSION	**12**			
19.	Types of aircraft engines, Energy flow through Jet engines,	2	C	4	1,2
20.	Aircraft Propulsion Theory, Thrust augmentation methods.	2	C	4	1,2
21.	Performance of Turbojet engines, Problems in Aircraft Engine Performance	2	C,D	4	1,2
22.	Ramjet, pulse jet engines: Construction and working, problems	3	C, D	4	1,2
23.	Problems in aircraft propulsion	3	C,D	4	1,2
	UNIT V: ROCKET PROPULSION	**12**			
24.	Various types and applications of rockets	2	C	5	1,2
25.	Solid, liquid propellants: Construction and fuels-oxidizers	3	C	5	1,2
26.	Hybrid propellants, Different propulsion systems	3	C	5	1,2
27.	Rocket Propulsion theory and performance, problems.	4	C,D	5	1,2
	Total contact hours*	**60**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Robert. D. Zucker, *Oscar Biblarz,* "*Fundamentals of Gas Dynamics"*, John Wiley and Sons, 2nd Edition, 2002.
2.	John D. Anderson, "*Fundamentals of Aerodynamics*", McGraw-Hill Series in Aeronautical and Aerospace Engineering, 5th Edition, 2010.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Mattingly. J. D, "*Elements of Gas turbine Propulsion"*, McGraw Hill, 2005
4.	James John, Theo Keith, "*Gas Dynamics*", Pearson, 3rd Edition, 2006
5.	Yahya. S. M, "*Fundamentals of compressible flow with Aircraft and Rocket Propulsion"*, New Age International (P) Ltd, New Delhi, 3rd Edition, 2005
6.	**DATA BOOK**
7.	Yahya.S.M, "*Gas Tables for compressible flow calculations"*, New Age International (P) Ltd, New Delhi, 6th Edition, 2011

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle TestIII**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME 4011	MULTI-DISCIPLINARY DESIGN	L	T	P	C
		0	0	4	2
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	Students of any specialization at an undergraduate level learn courses related to various sub-domains (Multi-disciplinary) of their specialization individually. They are not exposed to understanding how the various multi-disciplinary fields interact and integrate in real life situations. It is very common that an expert in a particular domain models and designs systems or products oblivious of the impact of other subsystems. This lack of multi-disciplinary thinking is very blatantly visible when the students take up their major project during their final year. This course aims to develop appropriate skills on systemic thinking on how to identify and formulate a problem, decompose the problem into smaller elements, coneptualise the design, evaluate the conceptual design by using scientific, engineering and managerial tools, select, analyze and interpret the data, consideration of safety, socio-politico-cultural, risks and hazards, disposal, regional and national laws, costing and financial model and undertake documentation and finally presentation.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To subdivide a complex system into smaller disciplinary models, manage their interfaces and reintegrate them into an overall system model	a	c	e	f	i		
2.	To rationalize a system architecture or product design problem by selecting appropriate design variables, parameters and constraints	a	c	e	f	i		
3.	To design for value and quantitatively assess the expected lifecycle cost of a new system or product	a	c	e	f	i		
4.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.	a	c	e	f	i		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1	Introduction: Facilitating Multidisciplinary Projects		C,D, I,O	1,2, 3,4	1,2
2	Identifying and formulating a problem				
3	System Modelling				
4	Thinking perspectives: Decomposition–Composition Thinking Hierarchical Thinking, Organizational Thinking, Life-Cycle Thinking, Safety Thinking, Risk Thinking, Socio-politico-cultural thinking, Environment thinking				
5	Decomposing a system – Identifying the major sub-systems				
6	Mathematical Modeling and Governing equations for each sub systems				
7	Objectives, Constraints and Design Variables				
8	Conceptual Design				
9	Collaborative Design – Disciplinary teams satisfy the local constraints while trying to match the global constraints set by the project coordinator.				
10	Tools for modeling, designing, analysis, data interpretation, decision making etc				
11	Design Analysis, evaluation and selection				
12	Costing and Financial model				
13	Documentation, reviewing and presentation				
Total contact hours		**60**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	G. Maarten Bonnema, Karel T. Veenvliet, Jan F. Broenink, "Systems Design and Engineering: Facilitating Multidisciplinary Development Projects",CRC Press, December 15, 2015, ISBN 9781498751261
2.	Ina Wagner , Tone Bratteteig , Dagny Stuedahl**, "***Exploring Digital Design-Multi-Disciplinary Design Practices***",** , Springer-Verlag London, 2010, ISSN:1431-1496

Course nature		**Predominantly Practice complimented by theory**				
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	**Review 1**	**Review 2**	**Review 3**	**Review 4**	**Total**
	Weightage	**10%**	**25%**	**25%**	**40%**	**100%**
End semester examination Weightage :						**0%**

ME 201	**UNIVERSITY RESEARCH INITIATIVE**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To obtain a hands-on experience in converting a small novel idea / technique into a working model / prototype involving multi-disciplinary skills and / or knowledge and working in at team.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To conceptualise a novel idea / technique into a product	c						
2.	To think in terms of multi-disciplinary environment		d					
3.	To understand the management techniques of implementing a project				k			
4.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.			g				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	A Multidisciplinary project to be taken up by a team of maximum of ten students. Development of prototype product, a 3D model, simulation, blueprint for a larger project and any otherdevelopment work arepermitted. The contribution of the individuals in the project should be clearly brought out. A combined report is to be submitted. A presentation is to be made for the reviewers on the work done by the candidate.		C,D,I	1,2,3,4	
	Total contact hours				

Course nature		**Project – 100% internal continuous assessment**	
Assessment Method (Weightage 100%)			
In-semester	**Assessment tool**	Refer the table	**Total**
	Weightage	Refer the table below	**100%**
End semester examination Weightage :			**0%**

Assessment components

Assessment component	**Expected outcome**	**Evaluators**	**Criteria or basis**	**Marks**

Project proposal (Review – I)	A short presentation to be delivered on: • A brief, descriptive project title (2-4 words). This is critical! • The 3 nearest competitors (existing solutions) and price. • Team members name, phone number, email, department/degree program, and year. • A description of the product opportunity that has been identified. To include: Documentation of the market need, shortcomings of existing competitive products, and definition of the target market and its size. • Proposed supervisor / guide	Panel of reviewers	Viability / feasibility of the project Extent of preliminary work done.	**0**
Review II	• Mission Statement / Techniques • Concept Sketches, Design	Panel of reviewers	Originality, Multi-disciplinary	**20**
	Specifications / Modules & Techniques along with System architecture • Coding		component, clarity of idea and presentation, team work, handling Q&A.	
Review III	• Final Concept and Model / Algorithm/ Technique • Drawings, Plans / programme output • Financial Model / costing • Prototype / Coding • Final Presentation and Demonstration	Panel of reviewers	Originality, Multi-disciplinary component, clarity of idea and presentation, team work, handling Q&A.	**50**
Final technical Report	A good technical report	Supervisor / Guide	Regularity, systematic progress, extent of work and quality of work	**30**
			Total	**100**

ME 141	DESIGN PROJECT/INDUSTRIAL PROJECT	L	T	P	C
		0	0	2	1
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To provide short-term work experience in an Industry/ Company/ Organisation

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To get an inside view of an industry and organization/company				j			
2.	To gain valuable skills and knowledge				j			
3.	To make professional connections and enhance networking	f	g					
4.	To get experience in a field to allow the student to make a career transition			i				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	1. It is mandatory for every student to undergo this course. 2. Every student is expected to spend a minimum of 15-days in an Industry/ Company/ Organization, during the summer vacation. 3. The type of industry must be NOT below the Medium Scale category in his / her domain of the degree programme. 4. The student must submit the "Training Completion Certificate" issued by the industry / company / Organisation as well as a technical report not exceeding 15 pages, within the stipulated time to be eligible for making a presentation before the committee constituted by the department. 5. The committee will then assess the student based on the report submitted and the presentation made. 6. Marks will be awarded out of maximum 100. 7. Appropriate grades will be assigned as per the regulations. 8. Only if a student gets a minimum of pass grade, appropriate credit will be transferred towards the degree requirements, as per the regulations. 9. It is solely the responsibility of the individual student to fulfill the above conditions to earn the credits. 10. The attendance for this course, for the purpose of awarding attendance grade, will be considered 100%, if the credits are transferred, after satisfying the above (1) to (8) norms; else if the credits are not transferred or transferable, the attendance will be considered as ZERO. 11. The committee must recommend redoing the course, if it collectively concludes, based on the assessment made from the report and presentations submitted by the student, that either the level of training received or the skill and / or knowledge gained is NOT satisfactory.		D, I,O	1,2, 3,4	
	Total contact hours				

Course nature		**Training – 100% internal continuous assessment**		
Assessment Method (Weightage 100%)				
In-semester	**Assessment tool**	**Presentation**	**Report**	**Total**
	Weightage	**80%**	**20%**	**100%**
End semester examination Weightage :				**0%**

ME 225	MEASUREMENT S AND INSTRUMENTATION	L	T	P	C
		3	0	2	4
Co-requisite:	NIL				
Prerequisite:	Nil				
Data Book / Codes/Standards	Approved Metrology & Quality Control Tables and Charts				
Course Category	P PROFESSIONAL CORE	MANUFACTURING ENGINEERING			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To understand types of shop floor measurement in the industries and its role in SQC.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the types of errors , design of limit gauges and various comparative measurement	a	c					
2.	Acquire the fundamentals of the gear, thread measurements and surface finish	a						
3.	Perceive the knowledge about the optical metrology and form measurement	a						
4.	Distinguish the Coordinate and machine tool metrology				k			
5.	Choose the appropriate control charts and acceptance sampling in SQC		c	h				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: TYPES OF MEASUREMENTS,COMPARATOR AND GAUGE DESIGN	**9**			
1.	Introduction to Metrology, Need for inspection, Physical measurement	1	C	1	1
2.	Methods of measurements, Classification and characteristics of Measuring instruments	1	C	1	1,5
3.	Role of NPL, Sources of Errors	1	C	1	1,5
4.	Types of Errors, Statistical treatment of Errors, tutorial	1	D	1	1,5
5.	Standards of Measurements, Calibration , Classification of standards	1	C	1	1,5
6.	Limits, Fits, and Tolerances: Tutorial	1	C,D	1	1,5
7.	Interchangeability and Selective Assembly	1	C	1	1
8.	Inspection Gauges, Types of Gauges, Taylor's Principle, Gauge Design	1	C,D	1	1
9.	Introduction to Comparators , Mechanical(Sigma), Electrical, Pneumatic comparator	1	C	1	1,5
	UNIT II- MEASUREMENTS OF SCREW THREAD, GEAR AND SURFACE FINISH	**9**			
10.	Measurements of various elements of external and internal thread, Measurement of Major, Minor diameter	1	C	2	1
11.	Effective diameter , Two and three wire method, Best Wire Size	1	C,D	2	1
12.	Measurements of various elements of Gear, Gear tooth vernier	1	C,D	2	1
13.	Constant chord method, Derivation, tutorial	1	C,D	2	1
14.	Base tangent method, Derivation, tutorial	1	C,D	2	1
15.	Circular pitch and Composite error measurement	1	C	2	1
16.	Surface Finish: Surface topography definitions	1	C	2	1
17.	Measurement of Surface Texture parameters	1	C,D	2	1
18.	Methods for the evaluation of Surface finish	1	C,D	2	1
	UNIT III: OPTICAL METROLOGY and FORM MEASUREMENT	**9**			
19.	Principle of light wave interference, Light sources, Measurements with optical flat	1	C	3	1,5
20.	Types of Interferometers ,Michelson, Twyman Green Specialisation of Michelson	1	C	3	1
21.	NPL flatness Interferometers, The Pitter NPL gauge	1	C	3	1,5
22.	Laser interferometer, Laser micrometer, Surface Roughness measurement using Laser	2	C,D	3	1,5
23.	Measurement of straightness using Autocollimator, Tutorial	2	C,D	3	1,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
24.	Measurement of flatness using Autocollimator	1	C,D	3	1,5
25.	Measurement of squareness, parallelism, circularity, roundness and run out.	1	C,D	3	1,5
	UNIT IV: COORDINATE AND MACHINE TOOL METROLOGY	**6**			
26.	Introduction to Coordinate Metrology, difference between conventional and coordinate metrology	1	C	4	1,5,10,11
27.	components ,types and construction of CMM, Types of measuring head and probes in CMM	1	C	4	1,5,10,11
28.	Measuring accuracy, causes of error and calibration of CMM, Tutorial	1	C,D	4	1,5,10,11
29.	performance of CMM and its applications	1	C	4	1,5,10,11
30.	Alignment Tests in machine tools	2	C	4	1,10,11
	UNIT V: THEORY OF CONTROL CHARTS & ACCEPTANCE SAMPLING	**12**			
31.	Definition of Quality , Chance Causes and assignable Causes , SQC , Benefits and Limitations	1	C	5	2,7,8
32.	Theory of Control Charts , Control Charts for Variables - X bar and R charts	2	C,D	5	2,7,8
33.	Control Charts for attributes – P chart, np chart	2	C,D	5	2,7,8
34.	Control charts for Non Conformities - C and U chart.	1	C,D	5	2,7,8
35.	Basic Concepts of acceptance sampling and OC curve , AQL, LTPD ,AOQL	1	C,D	5	2,7,8
36.	Sampling Plans , Simple ,Double and Multiple , tutorial	2	C,D	5	2,7,8
37.	Sequential sampling plan, tutorial	1	C,D	5	2,7,8
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Jain.R.K, "*Engineering Metrology",* Khanna Publishers, New Delhi, 2012.
2.	Gupta.R.C, "*Statistical Quality Control",* Khanna Publishers, New Delhi, 1994 .
3.	**REFERENCES**
4.	Kevin Harding ,"*Handbook of Optical Dimensional Metrology",* CRC Press, A Taylor & Francis group, 2013.
5.	Robert. J Hocken, Paulo H. Pereira, "Coordinate *Measuring Machines And Systems",* CRC Press, Taylor & Francis Group, 2011.
6.	Connie Dotson, Roger Harlow and Richard L. Thompson, "*Fundamentals of Dimensional Metrology", Thomson Delmar Learning",* 4th edition, 2005.
7.	Toru Yoshizawa, "*Handbook of Optical Metrology: Principles And Applications*", CRC Press, 2009
8.	Grant E. L., "*Statistical Quality Control",* McGraw Hill, New York, 1972
9.	*Statistical Quality Control, M.Mahajan , Dhanpat Rai & co. Gagankapur ,2010*
10.	***Journal Publication***
11.	Heinrich Schwenke', Ulrich Neuschaefer-Rube', Tilo Pfeifer' , Horst Kunzmann ,"*Optical Methods for Dimensional Metrology in Production Engineering*", CIRP Annals- Manufacturing Technology ,Volume 51, Issue 2, 2002, Pages 685–699
12.	A. Weckenmann, T. Estler, G. Peggs, D. McMurtry ,"*Probing Systems in Dimensional Metrology*", CIRP Annals - Manufacturing Technology Volume 53, Issue 2, 2004, Pages 657–684
13.	A.M.A. Al-Ahmari, JavedAalam,"*Optimizing parameters of freeform surface reconstruction using CMM",* Measurement, 64 (2015) 17–28

Course nature	**Theory**

Assessment Method (Weightage 100%)

In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME 225	MEASUREMENT AND INSTRUMENTATION LABORATORY			L	T	P	C
				0	0	2	1
Co-requisite:							
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	MANUFACTURING ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting -- , 23rd						

PURPOSE	To understand the various measuring techniques in dimensional,optical and computer aided inspection in the industries and its role in SQC.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know the various standards of measurement (line, end and wavelength standards).	a		e				
2.	Measure gear, thread and form errors	a	b					
3.	Calibrate the various measuring instruments		b					
4.	Explore and use the Computer aided measurement techniques.				k			
5.	Understand the basics of sampling and control charts		b					

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Use of Precision Measuring Instrument (linear and angular) and Gauges	2	I,O	1	1
2.	Gear tooth measurement using Gear tooth vernier	2	O	2	1
3.	Gear parameter measurement using Parkinson Gear Tester	2	O	2	1
4.	Thread Parameter measurement using floating carriage micrometer, thread micrometer	2	O	2	1
5.	Calibration of Measuring Instruments (Micrometer, Vernier Caliper, Vernier Height gauge and Dial Gauge)	2	I,O	3	1
6.	Indirect method of measurement using standard balls and rollers	2	I,O	1	1
7.	Usage of various comparators(mechanical, electrical ,pneumatic)	2	I	1	1
8.	Circularity measurement using mechanical Comparator , CMM	2	I	4	1
9.	Attribute Control Charts using Go, No-Go gauges	2	I,O	5	1
10.	Variable Control Charts (x bar-R chart) and process capability studies	2	I,O	5	1
11.	Various parameter measurement using Computerized profile projector	2	I,O	4	1
12.	Gear and Thread measurement using Computerized profile projector	2	I,O	2,4	1
13.	Straightness, flatness measurement using autocollimator	2	I,O	1	1
14.	Engine Bore Straightness using bore dial gauge	2	O	1	1
15.	Nomenclature of single point cutting tool using tool makers microscope	2	O	4	1
16.	Surface roughness measurement	2	I	4	1
17.	Demo on Interferometers and measurements using laser	2	C	4	1
18.	Fundamental measurement using CMM, automatic probing	2	O	4	1
19.	Angle measurements using Sine bar, Sine Center	2	O	1	1
20.	Measurement using Machine Vision system	2	O	4	1
	Total contact hours*	**20**			

*Any 10 experiments will be offered

LEARNING RESOURCES

Sl. No.	REFERENCES
1.	Laboratory Manual

Course nature				Practical		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	**Experiments**	**Record**	**MCQ/Quiz/Viva Voce**	**Model examination**	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
End semester examination Weightage :						**40%**

ME ELECTIVE	DESIGN OF TRANSMISSION SYSTEMS			L	T	P	C
				3	0	0	3
Co-requisite:	Nil						
Prerequisite:	15ME305						
Data Book / Codes/Standards	*Approved Design Data Book*						
Course Category	P	PROFESSIONAL CORE	DESIGN ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting -- , 23rd						

PURPOSE	To study the design of various mechanical transmission systems.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Design the friction drives.	a	c	e				
2.	Design the gears.	a	e					
3.	Design the gear box.	a	e					
4.	Design the bearing.	a	c	e				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: DESIGN OF FLEXIBLE DRIVES	**12**			
1.	Belt drives: types, selection of belt drives, belt materials and applications	1	C	1	1
2.	Design procedure and problems on flat belt drives using fundamental equations & manufacturer's data	3	C,D	1	1
3.	Design procedure and problems on V-belt drives using fundamental equations & manufacturer's data	2	C,D	1	1
4.	Wire ropes: types, construction and designation of wire ropes, stresses in wire ropes	1	C,D	1	1
5.	Design procedure and problems on wire ropes	2	C,D	1	1
6.	Power transmission chains: types and applications	1	C	1	1
7.	Design procedure and problems on power transmission chains and sprockets	2	C,D	1	1
	UNIT II: DESIGN OF PARALLEL GEARS	**12**			
8.	Review of gear fundamentals, Forces and stresses in gear tooth	1	C	2	1
9.	Equivalent number of teeth, gear tooth failures, selection of gear materials	1	C	2	1
10.	Design procedure and problems on spur gear based on strength consideration	3	C,D	2	1
11.	Design procedure and problems on spur gear based on wear consideration	2	C,D	2	1
12.	Design procedure and problems on helical gear based on strength consideration	3	C,D	2	1
	Design procedure and problems on helical gear based on wear consideration	2	C,D	2	1
13.	**UNIT III: DESIGN OF NON-PARALLEL GEARS**	**10**			

14.	Straight bevel gear: Terminology, Forces and stresses on gear tooth	1	C	2	2
15.	Design procedure and problems on bevel gear based on strength consideration	2	C,D	2	2
16.	Design procedure and problems on bevel gear based on wear consideration	2	C,D	2	2
17.	Worm gear: Thermal capacity, efficiency, forces and stresses	1	C,D	2	2
18.	Design procedure and problems on worm gear based on strength consideration	2	C,D	2	2
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
19.	Design procedure and problems on worm gear based on wear consideration	2	C,D	2	2
	UNIT IV: DESIGN OF GEAR BOXES	**12**			
20.	Geometric progression, standard step ratio, structural and ray diagrams	1	C	3	6
21.	Number of teeth calculation, Meshing arrangement	1	C,D	3	6
22.	Design procedure and problems on sliding mesh gear box	2	C,D	3	6
23.	Design procedure and problems on constant mesh gear box	2	C,D	3	6
24.	Design of Multi speed gear box for machine tool applications	2	C,D	3	6
25.	Variable speed gear box, Fluid couplings	2	C,D	3	6
26.	Torque convertor for automotive applications	2	C,D	3	6
	UNIT V: DESIGN OF BEARINGS, CLUTCHES AND BRAKES	**14**			
27.	Sliding contact bearings: types, assumptions and terminology in hydrodynamic lubricated journal bearing	1	C	4	2
28.	Design procedure and problems on journal bearing	2	C.D	4	2
29.	Rolling contact bearings: types, static and dynamic load rating, life and reliability	1	C,D		2
30.	Selection of rolling contact bearings	2	C,D	4	2
31.	Clutches: Types, Design of plate clutches	2	C,D	4	2
32.	Design of cone clutches and internal expanding rim clutches	2	C,D	4	2
33.	Brakes: Types, Energy considerations, Temperature rise	1	C,D	4	2
34.	Design of band brakes	1	C,D		2
35.	Design of external shoe brakes and internal expanding shoe brake	2	C,D	4	2
	Total contact hours*	**60**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Robert. C. Juvinall, Kurt. M. Marshek, "*Fundamentals of Machine Component Design"*, John Wiley &sons, 5th Edition, 2011.
2.	Joseph Edward Shigley and Charles R. Mischke, "*Mechanical Engineering Design*", McGraw –Hill International Editions, New York, 6th Edition, 2003.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Spotts, M.F., Shoup, T.E., Hornberger, L.E., "*Design of Machine Elements"*, Prentice Hall of India Eighth Edition, 2004.
4.	Paul H Black and O. E. Adams, P., "*Machine Design"*, 3rd edition, Mc Graw Hill Book Company, Inc., New York, USA, 2007.
5.	Bernard Hamrock, Steven Schmid, Bo Jacobson, "*Fundamentals of Machine Elements*", 2nd Edition, Tata McGraw-Hill Book Co., 2006.
6.	Mehtha.N.K, "*Machine Tool Design and Numerical Control*", Tata Mc-Graw Hill, *Third Edition, 2012*

7.	Darle W Dudley, "*Hand Book of Practical Gear Design*", CRC Press, Florida, 2002
8.	P.S.G Tech..,*"Design Data Book",* KalaikathirAchchagam, 2012

Course nature		Theory					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME ELECTIVE	**ELEMENTS OF MECHATRONICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE	MANUFACTURING ENGINEERING			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To introduce the concept and components of mechatronics systems.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the basic key elements of mechatronics systems.	a						
2.	Have cognizance on performance of sensors and transducers.		e					
3.	Understand different actuation systems, signal processing and controllers.	a	e					
4.	Program the PLC.		e					
5.	Design mechatronics system and its applications.		e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO MECHATRONICS	**8**			
1.	Introduction to Mechatronics systems	1	C	1	1
2.	Mechatronics system components and Measurement Systems, Control Systems.	1	C	1	1
3.	Open and Closed Loops Systems temperature control	1	C	1	1
4.	Water level controller and Shaft speed control	2	C	1	1
5.	Transfer function : Laplace transform, system in series and System with feedback loop	1	C,D	1	1
6.	Sequential Controllers : Washing machine control	1	C	1	1
7.	Sequential Controllers : Digital camera	1	C	1	1
	UNIT II: - SENSORS AND TRANSDUCERS	**11**			
8.	Introduction to sensors and transducers and classifications	1	C	2	1
9.	Principle and working of Resistive, capacitive, inductive and resonant transducers	2	C	2	1
10.	Optical measurement systems for absolute and incremental encoders	1	C	2	1
11.	Photo electric sensor and vision system	1	C	2	1,2
12.	Fiber optic transducers	2	C	2	2
13.	Solid state sensors and transducers for magnetic measurements	1	C	2	1,2
14.	Temperature measurements	1	C	2	1

15.	Chemical measurements, piezoelectric sensor and accelerometers	1	C	2	1,2
16.	Ultrasonic sensors and transducers for flow and distance	1	C	2	2
	UNIT III: ELECTRICAL DRIVES AND CONTROLLERS	**10**			
17.	Introduction, Electromagnetic Principles, Solenoids and Relays	1	C	3	1
18.	Electrical drives of stepper motors, servo motors.	2	C	3	1
19.	Operational amplifier.	1	C	3	1
20.	A/D converters & D/A converters.	2	C	3	1
21.	Signal processing, Multiplexer and Introduction to Data acquisition system	1	C	3	1
22.	Proportional, Integral, Derivative and PID controller	1	C	3	1
23.	Introduction to Micro controller : M68HC11 and ATMEGA328	2	C	3	1
	UNIT IV: PROGRAMMABLE LOGIC	**8**			
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	CONTROLLERS				
24.	Basic structure, Programming units and Memory of Programmable logic controller	2	C	4	1
25.	Input and Output Modules, Mnemonics for programming	1	C	4	1
26.	Latching and Internal relays	1	C,D	4	1
27.	Timers, Counters and Shift Registers	2	C,D	4	1
28.	Master relay and Jump Controls	1	C,D	4	1
29.	Programming the PLC using Ladder diagram for Simple applications.	1	C,D	4	1
	UNIT V: MECHATRONICS SYSTEM DESIGN AND APPLICATION	**8**			
30.	Mechatronics in Engineering Design, Traditional and mechatronics design	1	C	5	1
31.	Car park barriers using PLC	1	C	5	1
32.	Pick and Place robots and Bar code reader	2	C	5	1
33.	Wind screen wiper using stepper motor control.	1	C	5	1
34.	Car Engine management systems	1	C	5	1
35.	Case studies for Coin counters, Robot walking machine, Boiler control using PID.	2	D	5	8
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Bolton.W, "*Mechatronics*", Addison Wesley, 4th Edition, New Delhi, 2010.
2.	Bradley.D.A, Dawson.DBurdN.C.and Loader A.J, "*Mechatronics*", Chapman and Hall Publications, New York, 1993.
3.	Jacob Fraden, "*Handbook of Modern Sensors Physics, Designs, and Applications*", Third Edition, Springer-Verlag New York, 2004.
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	James Harter, "*Electromechanics, Principles and Concepts and Devices*", Prentice Hall, New Delhi, 1995.
5.	David W. Pessen, "*Industrial Automation Circuit Design and Components*", John Wiley, New York, 1990.
6.	Rohner.P, "*Automation with Programmable Logic Controllers*", Macmillan / McGraw Hill, New York, 1996.
7.	Brian Morris, "*Automatic Manufacturing Systems Actuators, Controls and Sensors*", McGraw Hill, New York, 1994.
8.	Godfrey C. Onwubolu, "*Mechatronics Principles and applications*", Butterworth-Heinemann, New Delhi, 2006.

Course nature				Theory			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME 141	**MAJOR PROJECT**	**L**	**T**	**P**	**C**
		0	**0**	**22**	**11**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	The Major Project experience is the culminating academic endeavor of students who earn a degree in their Undergraduate Programs. The project provides students with the opportunity to explore a problem or issue of particular personal or professional interest and to address that problem or issue through focused study and applied research under the direction of a faculty member. The project demonstrates the student's ability to synthesize and apply the knowledge and skills acquired in his/her academic program to real-world issues and problems. This final project affirms students' ability to think critically and creatively, to solve practical problems, to make reasoned and ethical decisions, and to communicate effectively.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To provide students with the opportunity to apply the knowledge and skills acquired in their courses to a specific problem or issue.	a	c		e	f		i
2.	To allow students to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.	a	c		e	f		i
3.	To encourage students to think critically and creatively about academic, professional, or social issues and to further develop their analytical and ethical leadership skills necessary to address and help solve these issues.	a	c		e	f	h	i
4.	To provide students with the opportunity to refine research skills and demonstrate their proficiency in written and/or oral communication skills.	a	c		e	f	g	i
5.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.			d			g	

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**

	1. The Major project is a major component of our engineering curriculum: it is the culmination of the program of study enabling the students to showcase the knowledge and the skills they have acquired during the previous four years, design a product/service of significance, and solve an open-ended problem in engineering. 2. Each student must register to the project course related to his or her program 3. Major Project course consists of one semester and would be allowed to register only during the final year of study. 4. The Major Project may be initiated during the pre-final semester but will be assessed and credits transferred only during the last semester of study, upon completion of all other degree requirements. Generally the undergraduate major project is a team based one. 5. Each team in the major project course will consist of maximum of 5 students. 6. Each project will be assigned a faculty, who will act as the supervisor. 7. The project shall be driven by realistic constraints like that related to economic, environmental, social, political, ethical, health & safety, manufacturability and sustainability. 8. Each group must document and implement a management structure. Group leadership roles must be clearly identified including who has responsibility for monitoring		C,D, I,O	1,2,3, 4, 5	
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	project deliverables and group coordination.				
	9. A group project may be interdisciplinary, with students enrolled in different engineering degrees, or in Engineering plus other faculties such as Management, Medical and Health Sciences, Science and Humanities. 10. Each student team is expected to maintain a log book that would normally be used to serve as a record of the way in which the project progressed during the course of the session. 11. Salient points discussed at meetings with the supervisor (i.e., suggestions for further meetings, changes to experimental procedures) should be recorded by the student in order to provide a basis for subsequent work. 12. The logbook may be formally assessed; 13. The contribution of each individual team member will be clearly identified and the weightage of this component will be explicitly considered while assessing the work done. 14. A project report is to be submitted on the topic which will be evaluated during the final review. 15. Assessment components will be as spelt out in the regulations. 16. The department will announce a marking scheme for awarding marks for the different sections of the report. 17. The project report must possess substantial technical depth and require the students to exercise analytical, evaluation and design skills at the appropriate level.				
	Total contact hours				

Course nature	**Project – 100 % Internal continuous Assessment**
Assessment Method (Weightage 100%)	

In-semester	**Assessment tool**	**Review 1**	**Review 2**	**Review 3**	**Total**
	Weightage	**10%**	**15%**	**20%**	**45%**
End semester examination	**Assessment Tool**	**Project Report**	**Viva Voce**		
	Weightage :	**25%**	**30%**		**55%**

ME ELECTIVE	**FUNDAMENTALS OF HYDRAULICS AND PNEUMATICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting, 23rd				

PURPOSE	To understand the Hydraulic, pneumatic systems and creating circuits for given industrial applications.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the basics of fluid power systems		e					
2.	Understand principles and characteristics of hydraulic and pneumatic components		e					
3.	Design fluid power circuits for given application	c	e					
4.	Do Maintenance and troubleshooting of fluid power systems.		e					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I - BASICS OF FLUID POWER SYSTEMS	**7**			
1.	Introduction to fluid power, Advantages of fluid power, Application of fluid power system	2	C	1	1,2
2.	Types of fluid power systems	1	C	1	1,2
3.	Properties of hydraulic fluids, general types of fluids	1	C	1	1,2
4.	Fluid power symbols	1	C	1	1,2
5.	Basics of Hydraulics, Applications of Pascal's Law	1	C	1	1,2
6.	seals and fittings	1	C	1	1,2
	UNIT II HYDRAULIC SYSTEM AND COMPONENTS	**11**			
7.	Sources of Hydraulic Power: Pumping theory, Pump classification	1	C	2	1,2
8.	Gear pumps: construction and working of internal and external gear pumps	1	C	2	1,2
9.	Vane Pump: construction and working of unbalanced, balanced vane pumps	1	C	2	1,2
10.	Piston pump: construction and working of axial, radial piston pumps	1	C	2	1,2
11.	Construction of Control Components : Directional control valves, types 4/2, 4/3, check valve, flow control valve	2	C	2	1,2
12.	Pressure control valves: construction and working of relief valve, reducing, sequencing, counter balance valves	2	C	2	1,2
13.	Solenoid operated valves, Relays.	1	C	2	1,2
14.	Linear actuators: construction and working of single acting, double acting, and telescopic cylinders	1	C	2	1,2
15.	Rotary actuators: construction and working of gear, vane and piston motors	1	C	2	1,2
	UNIT III PNEUMATIC SYSTEMS AND COMPONENTS	**10**			

16.	Introduction, comparison with hydraulic systems and electrical systems, Properties of air	1	C	2	1,3
17.	Construction, operation, characteristics and symbols of reciprocating and rotary compressors	2	C	2	1,3
18.	Need for air treatment, Filter, Regulator, Lubricator, Muffler and Dryers	1	C	2	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
19.	Construction, operation of 3/2, 5/2, 5/3 manual operated, pilot operated and solenoid operated DCVs, pneumatic actuators	2	C	2	1,3
20.	Introduction to fluidic devices, working of Bi-stable, mono-stable devices	2	C,D	2,3	1,3
21.	Fluidic logic application circuits	1	C,D	2,3	1,3
22.	Pneumatic Sensors types and applications	1	C	2	1,3
	UNIT IV DESIGN OF HYDRAULIC AND PNEUMATIC CIRCUITS	**10**			
23.	Speed, force calculations, and Sizing of actuators in fluid power systems	1	C,D	3	1,2,3
24.	Design of hydraulic/pneumatic circuits for simple reciprocation, regenerative, speed control of actuators	1	C, D	3	1,2,3
25.	Design of hydraulic/pneumatic circuits: synchronizing and sequencing circuits	1	C, D	3	1,2,3
26.	Sequential circuit design for simple applications using cascade method	1	C, D	3	1,2,3
27.	Electro Hydraulic and Pneumatic logic circuits, ladder diagram design	2	C, D	3	1,2,3
28.	PLC applications in fluid power control	1	C, D	3	1,2,3
29.	Accumulators: Types, circuits, sizing of accumulators	2	C,D	3	1,2,3
30.	Intensifier: Intensifier circuit and applications	1	C, D	3	1,2,3
	UNIT V APPLICATION, MAINTENANCE AND TROUBLE SHOOTING	**7**			
31.	Industrial hydraulic circuits for riveting machine, actuator locking	1	C, D	3	1,2,3
32.	Working of hydraulic press and pump unloading circuits	1	C, D	3	1,2,3
33.	Hydraulic / pneumatic circuits for material handling systems	1	C, D	3	1,2,3
34.	Preventive and breakdown, maintenance procedures in fluid power systems	1	C	4	1,2,3
35.	Trouble shooting of fluid power systems, fault finding process equipments / tools used, causes and remedies.	2	C	4	1,2,3
36.	Safety aspects involved fluid power systems.	1	C	4	1,2,3
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Anthony Esposito, "*Fluid Power with applications"*, Prentice Hall International, 2009
2.	Majumdar.S.R, "*Oil Hydraulic Systems: Principles and Maintenance"*, Tata McGraw Hill, 2006.
3.	Majumdar.S.R, "*Pneumatic systems – principles and maintenance"*, Tata McGraw-Hill, New Delhi, 2006
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Werner Deppert , Kurt Stoll, "*Pneumatic Application:Mechanization and Automation by Pneumatic Contro"l*, Vogel verlag, 1986.
5.	John Pippenger, Tyler Hicks, "*Industrial Hydraulics"*, McGraw Hill International Edition, 1980.
6.	Andrew Parr, "*Hydraulics and Pneumatics: A technician's and engineer's guide"*, Elsevier Ltd, 2011.
7.	FESTO, "*Fundamentals of Pneumatics"*, Vol I, II and III.
8.	Hehn Anton, H., "*Fluid Power Trouble Shooting",* Marcel Dekker Inc., NewYork, 1995.

9.	Thomson, "*Introduction to Fluid power",* Prentice Hall, 2004.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

ME ELECTIVE	**ROBOTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting, 23rd				

PURPOSE	To impart knowledge about the engineering aspects of Robots and their applications							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to learn								
1.	Basic concepts of robotics	a						
2.	End effectors and Sensors	a	c					
3.	Robots cell design and programming	e						
4.	Industrial applications of robot	a	c	e	j	k		

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: INTRODUCTION	**8**			
1.	Basic concepts of robotics (Laws of robotics, robotic systems), RIA definition	1	C	1	1
2.	Robot anatomy (Robot configurations, Robot motions, Joint notation scheme) , Manipulators	1	C	1	1
3.	Precision movement (Spatial resolution, accuracy, repeatability)	1	C	1	1
4.	Work volume, robot specifications	1	C	1	1
5.	Types of Robot drives, electric drive, Hydraulic, pneumatic drives	1	C	1	1
6.	Basic robot motions, Point to point control and continuous path control.	1	C	1	1
7.	Kinematics: Forward and inverse kinematics	1	D	1	1
8.	Problems on kinematics	1	D	1	1
	UNIT II: END EFFECTORS AND TRANSFORMATIONS	**9**			
9.	End effectors-Introduction, classification.	1	C	2	1
10.	Mechanical, Magnetic grippers.	1	C	2	1
11.	Vacuum and adhesive gripper	1	C	2	1
12.	Gripper force analysis and design	1	D	2	1
13.	Problems on gripper design	1	D	2	1
14.	Problems on force calculation	1	D	2	1
15.	2D transformation (scaling, rotation, translation)	1	D	2	1
16.	3D transformation (scaling, rotation, translation)	1	D	2	1
17.	Homogeneous transformations	1	D	2	1
	UNIT III: SENSORS AND CONTROL SYSTEMS	**10**			
18.	Sensor devices	1	C	2	1
19.	Types of sensors (contact, position and displacement sensors)	1	C	2	1
20.	Force and torque sensors	1	C	2	1

21.	Proximity and range sensors, acoustic sensors.	1	C	2	1
22.	Robot vision systems, Sensing and digitizing.	2	C	2	1
23.	Image processing and analysis.	1	C	2	1
24.	Robot control system	1	C	2	1
25.	Unit control system	1	C	2	1
26.	Adaptive and Optimal control	1	C	2	3
	UNIT IV: ROBOT CELL DESIGN	**8**			
27.	Robot work cell design and control	2	C	3	1
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
28.	Safety considerations in cell design	1	C	3	1
29.	Robot cell layouts , multiple	2	C	3	1
30.	Multiple robots	1	C	3	1
31.	Machine interface	1	C	3	1
32.	Robot cycle time analysis	1	C	3	1
	UNIT V: ROBOT PROGRAMMING AND APPLICATIONS	**10**			
33.	Robot language, classification.	1	C	3	1
34.	Programming methods, off and on line programming.	1	C	3	1
35.	Lead through method, powered and Manual lead through.	1	C	3	1
36.	Teach pendent method.	1	C	3	1
37.	VAL systems and language, Simple program.	1	C	3	1
38.	Application of Robots, Material handling, Constrains, Machine loading and unloading.	1	C	4	1
39.	Assembly Robot, Assembly operation, RCC device, Benefits-Inspection robot, used in Quality control.	1	C	4	1
40.	Welding Robot, features, sensors, Advantages,-Painting Robot, Requirement, and Spray painting.	1	C	4	1
41.	Mobile and microbots, types, mobility and application.	1	C	4	1
42.	Recent developments in robotics- safety considerations.	1	C	4	1
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Mikell P. Groover, "*Industrial Robotics Technology Programming and Applications*", McGraw Hill Co., Singapore, 2008.
2.	Deb .S.R, "*Robotics technology and flexible automation*", Tata McGraw Hill publishing company limited, New Delhi, 2010.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Klafter R.D, Chmielewski T.A and Noggins, "*Robot Engineering: An Integrated Approach*", Prentice Hal of India Pvt. Ltd., New Delhi, 2010.
4.	Fu K.S, Gonzalez, R.C., & Lee, C.S.G., "*Robotics control, sensing, vision and intelligence*", McGraw Hill Book Co., Singapore, Digitized 2007.
5.	Craig.J.J, "*Introduction to Robotics mechanics and control*", Addison- Wesley, London, 2008.

Course nature			**Theory**				
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME ELECTIVE	INDUSTRIAL TRIBOLOGY	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:					
Data Book / Codes/Standards	Approved design data book, Approved tribology data sheets, ASTM standards				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting, 23rd				

PURPOSE	To present the engineering concepts of friction, its effects and different lubrication theories and types used in industries

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Identify the friction and wear in materials.	a	c	e	j			
2.	Study various types of lubricants and their properties	a	c	e				
3.	Understand the preparation of bearing materials	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I : SURFACES AND FRICTION	**9**			
1.	Introduction to the concept of tribology, Tribological problems	1	C	1	1,2,3
2.	Nature of engineering surfaces, Surface topography	1	C	1	1,2,3
3.	Surface profilometer, measurement of surface topography	1	C	1	1,2,3
4.	Contact between surfaces, Sources of sliding Friction	1	C	1	1,2,3
5.	Friction due to ploughing, Friction due to adhesion	1	C	1	1,2,3
6.	Friction characteristics of metals and non-metals	1	C	1	1,2,3
7.	Sources of rolling friction, Stick slip motion	1	C	1	1,2,3
8.	Friction of ceramic materials and polymers	1	C	1	1,2,3
9.	Measurement of friction	1	C	1	1,2,3
	UNITII: WEAR	**9**			
10.	Wear and Types of Wear	1	C	1	1,2,3
11.	Simple theory of sliding wear mechanism	1	C	1	1,2,3
12.	Abrasive wear	1	C	1	1,2,3
13.	Adhesive wear	1	C	1	1,2,3
14.	Corrosive wear	1	C	1	1,2,3
15.	Surface fatigue wear situations	1	C	1	1,2,3
16.	Wear of ceramics	1	C	1	1,2,3
17.	Wear of polymers	1	C	1	1,2,3
18.	Wear measurements	1	C	1	1,2,3
	UNIT III: FILM LUBRICATION THEORY	**9**			
19.	Coefficient of viscosity, Fluid film in simple shear	1	C,D	2	1,2,3
20.	Viscous flow between very close parallel plates: Tutorials	1	C,D	2	1,2,3
21.	Lubricant supply, Lubricant flow rate	1	C,D	2	1,2,3
22.	Cold jacking, Couette flow	1	C,D	2	1,2,3
23.	Cavitations, Film rupture, oil whirl	1	C,D	2	1,2,3
24.	Shear stress variation within the film	1	C,D	2	1,2,3
25.	Lubrication theory by Osborne Reynolds: Tutorials	1	C,D	2	1,2,3
26.	Pressure fields for full sommerfeld, Half sommerfeld	1	C,D	2	1,2,3
27.	Reynolds boundary conditions	1	C,D	2	1,2,3
	UNIT IV: LUBRICANTS AND LUBRICATION TYPES	**9**			
28.	Types of Lubricants	1	C	2	2,3,4
29.	Properties of Lubricants	1	C	2	2,3,4
30.	Testing methods	1	C	2	2,3,4
31.	Hydrodynamic Lubrication	2	C,D	2	2,3,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
32.	Elasto-hydrodynamic Lubrication	2	C,D	2	2,3,4
33.	Hydrostatic lubrication	2	C,D	2	2,3,4
	UNIT V: SURFACE ENGINEERING AND MATERIALS FOR BEARINGS	**9**			
34.	Classification of Surface modifications and Surface coatings	1	C	3	1,2,3
35.	Surface modifications, Transformation hardening	1	C	3	1,2,3
36.	Surface modifications, surface fusion	1	C	3	1,2,3
37.	Thermo chemical Processes	1	C	3	1,2,3
38.	Surface coatings	2	C	3	1,2,3
39.	Materials for rolling element bearings	1	C	3	1,2,3
40.	Materials for fluid film bearings	1	C	3	1,2,3
41.	Materials for marginally lubricated and dry bearings	1	C	3	1,2,3
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Hutchings.I.M, "*Tribology, Friction and Wear of Engineering Material,* Edward Arnold, London, 1992.
2.	Williams.J.A, "*Engineering Tribology",* Oxford University Press, 2005.
3.	GwidonStachowiak, Andrew W Batchelor., "*Engineering tribology",* Elsevier Butterworth –Heinemann, USA, 2005.
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Stolarski.T.A, "*Tribology in Machine Design*", Industrial Press Inc., 1990.
5.	Bowden.E.P. and Tabor.D, "*Friction and Lubrication*", Heinemann Educational Books Ltd, 1974.
6.	Cameron.A, "*Basic Lubrication Theory*", Longman, U.K., 1981.
7.	Neale.M.J. (Editor), "*Tribology Handbook*", Newnes Butter worth, Heinemann, U.K., 1975.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

ME ELECTIVE	**PROCESS PLANNING AND COST ESTIMATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd				

PURPOSE	To impart clear knowledge about process planning, costing, and estimation of machining time.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Acquire knowledge about Process planning.	c						
2.	Understand Different Cost and its components.	c	e					
3.	Estimate different Costs.	c	e					
4.	Calculate Machining time for different process.	c	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference

	UNIT I: PROCESS PLANNING	**8**			
1.	Production system and Types of production	1	C	1	1,2
2.	Standardization and Simplification	1	C	1	1
3.	Production design and selection	1	C	1	1,2,5,6
4.	Process planning, Selection and analysis	1	C	1	1
5.	Manual/Experience based planning	1	C	1	1,2
6.	Variant type CAPP	1	C	1	1,2,3
7.	Generative type CAPP	1	C	1	1,2,3
8.	Processes analysis, Break even analysis	1	C,D	1	1,2
	UNIT II:COSTING AND ESTIMATION	**9**			
9.	Objectives of costing and estimation : Functions and procedure	2	C	2	1
10.	Introduction to costs, Computing material cost	1	C,D	2	1
11.	Direct labor cost, Analysis of overhead costs	1	C,D	2	1
12.	Factory expenses, Administrative expenses, Selling and distributing expenses	2	C,D	2	1
13.	Cost ladder ,Cost of product	1	C,D	2	1,2
14.	Depreciation, Analysis of depreciation, Problems in depreciation method	2	C,D	2	1
	UNIT III: ESTIMATION OF COSTS IN DIFFERENT SHOPS	**9**			
15.	Estimation in foundry shop: Pattern cost, Casting cost	2	C	3	1
16.	Cost estimation in Foundry shop	2	C,D	3	1,2
17.	Forging: Types, Operations, Estimation of Losses and time in forging	2	C	3	1
18.	Estimation of Forging cost	1	C	3	1,2
19.	Cost estimation in Forging shop: Tutorials	2	C,D	3	1,2
	UNIT IV: ESTIMATION OF COSTS IN FABRICATION SHOPS	**9**			
20.	Welding, Types of weld joints, Gas welding	1	C	3	1
21.	Estimation of Gas welding cost, Gas cutting	1	C	3	1
22.	Arc welding: Equipments, Cost Estimation	1	C	3	1
23.	Cost estimation in Welding shop: Tutorials	2	C,D	3	1,2
24.	Estimation in sheet metal shop, Shearing and forming	2	C	3	1
25.	Cost estimation in Sheet metal shop	2	C,D	3	1,2
	UNIT V: ESTIMATION OF MACHINING TIMES AND COSTS	**10**			
26.	Machine shop operations, Estimation of Machining time	1	C	4	1,4
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
27.	Estimation of machining time for turning, knurling and facing operations : Tutorials	1	C,D	4	1,2
28.	Estimation of machining time for reaming, threading and tapping operations : Tutorials	1	C,D	4	1,2
29.	Estimation of machining time for drilling, boring : Tutorials	2	C,D	4	1,2
30.	Estimation of machining time for shaping, planning : Tutorials	2	C,D	4	1,2
	Estimation of machining time for milling and grinding operations : Tutorials	2	C,D	4	1,2
31.	Case studies: Estimation of cost for a product	1	C,D	4	6
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Banga.T.R and Sharma.S.C, "*Estimating and Costing*", Khanna publishers, New Delhi, 17th Edition, 2015.
2.	Adithan.M.S and Pabla, "Estimating and Costing", Konark Publishers Pvt., Ltd, 1989.

	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Nanua Singh, "*System Approach to Computer Integrated Design and Manufacturing*", John Wiley & Sons, New York, 1996.
4.	Joseph G. Monks, "*Operations Management, Theory and Problems*", McGraw Hill Book Company, New Delhi, 1982.
5.	Narang.G.B.S and Kumar.V, "*Production and Planning*" , Khanna Publishers, New Delhi, 1995.
6.	Chitale.A.K and Gupta.R.C, "*Product Design and manufacturing*", Prentice Hall of India, New Delhi, 2007.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**

ME ELECTIVE	**INTERNAL COMBUSTION ENGINES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	On completion of this course, the students are able to understand the operation, combustion, performance and emissions of internal combustion engines.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Acquire the knowledge of engine operation and performance	a	c	e				
2.	Understand the working of engine auxiliary systems	a	c					
3.	Understand the combustion aspects of SI Engines	a	c					
4.	Understand the combustion aspects of CI Engines	a	c					
5.	Know the various alternate fuels, engine emissions, measuring and control techniques		c		j			

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: COMPONENTS OF IC ENGINES AND PERFORMANCE	**9**			
1.	Classification of internal combustion engines, application of IC Engines	1	C	1	1
2.	Function and operation of two stroke and four stroke engines	1	C	1	1
3.	Comparison of SI and CI, two stroke and four stroke engines	1	C	1	1
4.	Effects, limitations, and types of supercharging and scavenging process	1	C	1	1
5.	Performance characteristics of IC engines	2	C, D	1	1
6.	Numerical problems on performance and heat balance	2	C, D	1	1
7.	Fuel air cycles and their significance	1	C	1	1
	UNIT II: ENGINE AUXILIARY SYSTEMS	**9**			
8.	Carburetion, mixture requirements at different loads and speeds, simple carburetor	2	C, D	2	1

9.	Functional requirements and classification of an injection systems, injection pump, nozzle types, MPFI and EFI systems	2	C	2	1
10.	Battery and magneto ignition systems, ignition timing and engine parameters	2	C	2	1
11.	Properties of lubricants, mist, wet and dry sump lubrication systems	2	C	2	1
12.	Liquid and air cooled cooling system, coolant and antifreeze solutions	1	C	2	1
	UNIT III: COMBUSTION IN SI ENGINES	**9**			
13.	Homogeneous and heterogeneous mixture, combustion in spark ignition engines, stages of combustion in spark ignition engines	2	C	3	1
14.	Flame front propagation, factors influencing flame speed	2	C	3	1
15.	Rate of pressure rise, abnormal combustion, phenomenon of knock in SI engines	2	C	3	1
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
16.	Effect of engine variables on knock, combustion chambers for SI engines, smooth engine operation	2	C	3	1
17.	High power output and thermal efficiency, stratified charge engine	1	C	3	1
	UNIT IV: COMBUSTION IN CI ENGINES	**9**			
18.	Combustion in CI engine, stages of combustion in CI engines	2	C	4	1
19.	Factors affecting the delay period, compression ratio, engine speed, output, atomization and duration of injection, injection timing, quality of fuel, intake temperature, intake pressure	2	C	4	1
20.	Phenomenon of knock in CI engines, comparison of knock in SI and CI engines	2	C	4	1
21.	Combustion chambers for CI engines	2	C	4	1
22.	Homogenous charge compression ignition Engine	1	C	4	1
	UNIT V: ALTERNATE FUELS AND EMISSION	**9**			
23.	Liquid fuels, alcohol, methanol, ethanol; vegetable oil, biodiesel production, properties, advantages and disadvantages	2	C	5	1, 2
24.	Gaseous fuel - Hydrogen, CNG, LPG	2	C	5	1, 2
25.	Air pollution due to IC engines, hydrocarbon and CO emission, oxides of nitrogen, aldehydes, sulphur, lead and phosphorus emissions	2	C	5	1, 2
26.	Catalytic converter, exhaust gas recirculation	1	C	5	1, 2
27.	Flame ionization detector, non dispersive infra-red detector, chemiluminescence analyzer, smoke types, Bosch smoke meter, Emission standards	2	C	5	1, 2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Ganesan.V, *"Internal Combustion Engines"*, Tata McGraw-Hill, New Delhi, 2015.
2.	Ramalingam.K.K, "*Internal Combustion Engines- Theory and practice"*, SciTech publications India Pvt. Ltd., Chennai, 2010.

	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Thipse.S.S, "*Internal Combustion Engines"*, Jaico Publication House, 2010.
4.	Thipse.S.S, "*Alternate Fuels"*, Jaico Publication House, 2010.
5.	Mathur.M.L and Sharma.R.P, "*A course in Internal Combustion Engines"*, DhanpatRai& Sons, New Delhi, 2010.
6.	Heywood.J.B, "*Internal Combustion Engine Fundamentals"*, McGraw Hill International, New York, 2008.
7.	Domkundwar.V.M, "*A course inInternal Combustion Engines"*, DhanpatRai& Sons, 2010.
8.	Shyam.K.Agrawal, "*Internal Combustion Engines*", New Age International, 2012.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME ELECTIVES	**ALTERNATIVE SOURCES OF ENERGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To familiarize the students about the utilization of various alternative sources of energy technologies for thermal and electrical needs with environmental merits.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize with the solar energy technologies	a	e					
2.	Understand the wind energy and hybrid energy systems.	a	e					
3.	Know the concepts of ocean, hydro and geothermal energy systems.	a	e					
4.	Familiarize the biomass energy conversion technologies.	a	e					
5.	Familiarize the operations of direct energy conversion systems.	a	e					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: SOLAR ENERGY	**9**			
1.	Solar radiation and its measurements.	1	C	1	1,2
2.	Types of solar thermal collectors.	1	C	1	1,2
3.	Solar thermal applications for water heaters, solar stills and solar pond.	1	C	1	1,2
4.	Solar thermal applications for refrigeration and air-conditioning system.	1	C	1	1,2
5.	Solar thermal applications for solar dryer, solar cookers and solar furnaces.	1	C	1	1,2
6.	Sensible and latent heat thermal energy storage systems	1	C	1	1,2
7.	Solar thermal power generation systems	1	C	1	1,2
8.	Solar photovoltaic systems: basic working principle and components	1	C	1	1,2
9.	Applications of solar photovoltaic systems	1	C	1	1,2
	UNIT II: WIND ENERGY	**9**			
10.	Basic principle of wind energy conversion system.	1	C	2	1,2
11.	Wind data, site selection and energy estimation	1	C,D	2	1,2

12.	Components of wind energy conversion systems	1	C	2	1,2
13.	Types of Horizontal axis and Vertical axis wind turbine.	1	C	2	1,2
14.	Design consideration of horizontal axis wind turbine.	1	C	2	1,2
15.	Aerofoil theory	1	C	2	1,2
16.	Analysis of aerodynamic forces acting on the blade	1	C	2	1,2
17.	Performance of wind turbines.	1	C	2	1,2
18.	Introduction to solar and wind hybrid energy systems, environmental issues of wind energy.	1	C	2	1,2
	UNIT III: OCEAN, HYDRO AND GEOTHERMAL ENERGY	9			
19.	Wave characteristics and wave energy	1	C	3	1,2
20.	Tidal energy and its types.	1	C	3	1,2
21.	Estimation of energy and power in single basin tidal system.	1	C	3	1,2
22.	Ocean thermal energy conversion for open system.	1	C	3	1,2
23.	Ocean thermal energy conversion for closed system.	1	C	3	1,2
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
24.	Hydro power plants for small, mini and micro system.	1	C	3	1,2
25.	Exploration of geothermal energy.	1	C	3	1,2
26.	Geothermal power plants	1	C	3	1,2
27.	Challenges, availability, geographical distribution, scope and economics for geothermal plant.	1	C	3	1,2
	UNIT IV: BIOMASS	**9**			
28.	Sources of biomass	1	C	4	1,2
29.	Pyrolysis, combustion and gasification process	1	C	4	1,2
30.	Updraft and downdraft gasifier.	1	C	4	1,2
31.	Fluidized bed gasifier.	1	C	4	1,2
32.	Fermentation and digestion process	1	C	4	1,2
33.	Fixed and floating digester biogas plants	1	C	4	1,2
34.	Design considerations of digester	1	C	4	1,2
35.	Operational parameter of biogas plants.	1	C	4	1,2
36.	Economics of biomass power generation.	1	C	4	1,2
	UNIT V: DIRECT ENERGY CONVERSION SYSTEMS	**9**			
37.	Basic principle of thermo electric and thermionic power generations.	1	C	5	1,2
38.	Fuel cell principles and its classification	1	C	5	1,2
39.	Phosphoric acid fuel cell, polymer electrolyte membrane fuel cell, molten carbonate fuel cell and solid oxide fuel cell,	1	C	5	1,2
40.	Fuel cell conversion efficiency, applications of fuel cell	1	C	5	1,2
41.	Magneto hydrodynamic power generation for open cycle.	1	C	5	1,2
42.	Magneto hydrodynamic power generation for closed cycle.	1	C	5	1,2
43.	Hydrogen energy: properties and its production methods.	1	C	5	1,2
44.	Electrolysis, thermo-chemical methods, fossil fuel methods and solar energy methods,	1	C	5	1,2
45.	Hydrogen storage, transportation and applications.	1	C	5	1,2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**

1.	Tiwari.G.N, Ghosal.M.K, "*Fundamentals of renewable energy sources"*,1st Edition, UK, Alpha Science International Ltd, 2007.
2.	Godfrey Boyle, "*Renewable energy"*, 2nd Edition, Oxford University Press, 2010.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Twidell.J.W and Weir.A.D, "*Renewable Energy Resources"*,1st Edition, UK,E.&F.N. Spon Ltd, 2006.
4.	Domkundwar.V.M, Domkundwar. A.V, "*Solar energy and Non-conventional sources of energy"*, Dhanpat rai & Co. (P) Ltd, 1st Edition, New Delhi, 2010.
5.	G.D Rai, "*Non-Conventional Energy Sources"*, Khanna Publishers, 5th Edition, New Delhi, 2011.
6.	B.H Khan, "*Non-conventional Energy Resources"*, 2nd Edition, New Delhi, Tata McGraw Hill, 2009.
7.	S.P. Sukatme, J.K. Mayak, "*Solar Energy-Principles of thermal collection and storage*", 3rd edition, New delhi, McGraw Hill,2008.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

ME ELECTIVES	**INDUSTRIAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To provide the basic features of Industrial Engineering like work study, materialhandling, production planning control, wages and incentives.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the students will be able to understand								
1.	The techniques and procedures of work study.	b	f					
2.	Plant layout and Material handling	b	f					
3.	Ergonomics of work design, production and productivity measurement	b	f					
4.	Concept of Production Planning and Control	b	f					
5.	Methods of wage payment	b	f					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I - WORK MEASUREMENT AND WORK STUDY	**9**			
1.	Introduction to Work measurement and its Techniques.	1	C	1	1,3,5
2.	Production study and Time study.	1	C	1	1,3,5
3.	Standard time, Rating factors and Work sampling.	1	C	1	1,3,5
4.	Techniques of Work study.	1	C	1	1,3,5
5.	Human factors of Workstudy.	1	C	1	1,3,5
6.	Method study, Techniques and procedures of Productivity.	1	C	1	1,3,5
7.	ChargingTechniques.	1	C	1	1,3,5
8.	Motion economy principles.	1	C	1	1,3,5
9.	SIMO chart, Ergonomics and Industrialdesign.	1	C	1	1,3,5
	UNIT II - PLANT LAYOUT AND MATERIAL HANDLING	**9**			
10.	Plant location and site selection.	1	C	2	1,4
11.	Types, need, factors influencing the plant layout.	1	C	2	1,4

12.	Tools and techniques for developing layout, process chart, flow diagram, string diagram, Template and Scale models.	2	C	2	1,4
13.	Layout Planning procedure, Assembly line balancing.	1	C	2	1,4
14.	Material Handling, scope and importance.	1	C	2	1,4
15.	Types of material handling systems.	1	C	2	1,4
16.	Factors influencing material handling.	1	C	2	1,4
17.	Methods of material handling.	1	C	2	1,4
	UNIT III - WORK DESIGN ERGONIMICS,PRODUCTION&PRODUCTIVITY	**9**			
18.	Introduction to work design, Work design for increased productivity.	1	C	3	1,3,5
19.	The work system, design Introduction to job design.	1	C	3	1,3,5
20.	Environmental factors, organizational factors & behavioural factors influencing effective job design.	2	C	3	1,3,5
21.	Ergonomics, Objectives system approach of ergonomic	2	C	3	1,3,5
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	model, Man machine system Production and Productivity.				
22.	Definition of production, function and type of production.	2	C	3	1,3,5
23.	Definition of productivity and productivity measurement.	1	C	3	1,3,5
	UNIT IV - PRODUCTION PLANNING AND CONTROL				
24.	Objectives and Functions of PPC.	1	C	4	2,5
25.	Aspects of product development and design.	1	C	4	2,5
26.	Process Planning.	1	C	4	2,5
27.	Principles of Standardization.	1	C	4	2,5
28.	Specialization and Simplification.	1	C	4	2,5
29.	Group Technology.	1	C	4	2,5
30.	Optimum Batch size.	1	C	4	2,5
31.	ABC analysis.	1	C	4	2,5
32.	Value Engineering.	1	C	4	2,5
	UNIT V - WAGES AND INCENTIVES				
33.	Wages and salary administration	1	C	5	1,3,5
34.	Meaning principles and techniques of wage fixation	2	C	5	1,3,5
35.	Job evaluation	1	C	5	1,3,5
36.	Merit rating	1	C	5	1,3,5
37.	Methods of wage payment	1	C	5	1,3,5
38.	Types, Advantages and disadvantages of Incentive scheme	1	C	5	1,3,5
39.	Productivity base incentives	1	C	5	1,3,5
40.	Case Example of Evaluation of incentive scheme	1	C	5	1,3,5
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Khanna.O.P, "*Industrial Engineering and Management*", DhanpatRai Publications Pvt Ltd, 2010
2.	Samuel Eilon, "*Elements of Production Planning and Control"*, McMillan andCo., Digitized, 2007.

	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Kumar.B, "*Industrial Engineering and Management"*, 9th edition, KhannaPublishers, New Delhi, 2005.
4.	James M. Apple, "*Principles of Layout and Material Handling"*, Ronald press,2007.
5.	Maynard.H, "*Industrial Engineering Hand Book"*, McGraw Hill Book Co., NewYork, 2010

Course nature			**Theory**				
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME ELECTIVE	**ADVANCED FLUID MECHANICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	15ME205				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To familiarize the students about the principles and flow aspects of fluid mechanics.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the fundamentals of irrotational flows	a	e					
2.	Apply Exact Solutions of the Navier-Stokes Equations	a	e					
3.	Understand thermal effects and flow stability.	a	e					
4.	Analyze turbulent flows using numerical models.	a	e					
5.	Apply computational methods for fluid flow problems.	a	e					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I : INVISCID IRROTATIONAL FLOWS	**9**			
1.	The Local Continuity Equation, Path Lines, Streamlines, and Stream Functions	1	C	1	1,2
2.	Newton's Momentum Equation, Equation for Newtonian fluid, Vorticity and Circulation, Non-Newtonian fluids, Moving coordinate systems	2	C	1	1,2
3.	Irrotational Flows and the Velocity Potential, Singularity Distribution Methods	2	C	1	1,2
4.	Forces Acting on a Translating Sphere, Added Mass and the Lagally Theorem	2	C	1	1,2
5.	Theorems for Irrotational Flow: Mean Value and Maximum Modulus Theorems, Maximum-Minimum Potential Theorem, Kelvin's Minimum Kinetic Energy Theorem	2	C	2	1,2
	UNIT II: EXACT SOLUTIONS OF THE NAVIER-STOKES EQUATIONS	**9**			
6	Solutions to the Steady-State Navier-Stokes Equations	1	CC	2	1,2
7	Two-Dimensional Flow Between Parallel Plates, Poiseuille Flow in a Rectangular Conduit, Poiseuille Flow in a Round Conduit	2	C	2	1,2
8	Couette Flow Between Concentric Circular Cylinders	1	C	2	1,2

9	Unsteady Flows: Impulsive Motion of a Plate—Stokes's First Problem, Oscillation of a Plate—Stokes's Second Problem	2	C	2	2,3
10	Plane Stagnation Line Flow	1	C	2	2,3
11	Three-Dimensional Axi-symmetric Stagnation Point Flow	1	C	2	2,3
12	Flow into Convergent or Divergent Channels	1	C	2	2,3
	UNIT III :THERMAL EFFECTS AND FLOW STABILITY	**9**			
13	Thermal Boundary Layers	1	C	3	2,4
14	Forced Convection on a Horizontal Flat Plate	1	C	3	2,4
15	The Integral Method for Thermal Convection	1	C	3	2,4
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
16	Linear Stability Theory of Fluid Flows	2	C	3	2,4
	Thermal Instability in a Viscous Fluid—Rayleigh-BénardConvection	**2**	C, D	3	2,4
18	Stability of Flow Between Rotating Circular Cylinders:Couette-Taylor Instability	**2**	C, D	3	2,4
	UNIT IV: TURBULENT FLOWS	**9**			
19	Statistical Approach—One-Point Averaging	1	C	4	1,2
20	Zero-Equation Turbulent Models, One-Equation Turbulent Models, Two-Equation Turbulent Models	2	C	4	1,2
21	Stress-Equation Models	2	C	4	1,2
22	Equations of Motion in Fourier Space	2	C	4	1,2
23	Quantum Theory Models**,** Large Eddy Models	2	C	4	1,2
	UNIT V :COMPUTATIONAL METHODS	**9**			
24	Numerical Calculus	1	C	5	1,2
25	Numerical Integration of Ordinary Differential Equations	1	C	5	1,2
26	The Finite Element Method, Linear Stability Problems—Invariant Imbedding and Riccati Methods, Errors, Accuracy, and Stiff Systems	3	C	5	1,2
27	Multi-dimensional methods: Relaxation Methods, Surface Singularities	1	C	5	1,2
28	One-Step Methods: Forward Time, Centered Space, Dufort-Frankel Method, Crank-Nicholson Method, Hybrid Method, Upwind Differencing.	3	C, D	5	1,2
	Total contact hours*	**45**			

* Excluding Assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Graebel. W.P, "*Advanced Fluid Mechancis*", 1st Edition, Academic Press, Elsevier Inc., 2007
2.	K. Muralidhar and G. Biswas, " *Advanced Engineering Fluid Mechanics*", 3rd Edition, Narosa Publishers, 2015
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Stevan A Jones, "*Advanced Methods for Practical Applications in Fluid Mechanics*", InTech Publishers, 2012.
4.	Hyoung Woo Oh, "*Advanced Fluid Mechancis*", InTech Publishers, 2012.
5.	Roger Kinsky, "*Fluid Mechanics Advanced Applications*", McGraw-Hill Education Europe, 1997

Course nature	**Theory**
Assessment Method (Weightage 100%)	

In-semester	Assessment tool	Cycle Test I	Cycle Test II	Cycle Test III	Surprise Test	Quiz	Total
	Weightage	10%	15%	15%	5%	5%	50%
End semester examination Weightage :							50%

ME ELECTIVE	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	Approved Standard Normal Distribution Table				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd				

PURPOSE	To familiarize with the components of computer aided manufacturing and production planning.							
INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to understand the								
1.	Concepts of Linear programming technique.	a	e					
2.	Applications of Transportation and Replacement models.	a						
3.	Techniques of PERT, CPM and sequencing.	a	e	h				
4.	Detailed knowledge of Inventory control and Queuing theory.	a						
5.	Decision theory and Game theory techniques.	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference/ Text Books
	UNIT I: LINEAR PROGRAMMING	**9**			
1.	Operation Research and decision making- Development, Definition, Characteristics, Necessity, Scope, Applications, Advantages, Limitations	1	C	1	1, 2
2.	Objectives, Phases, Types of mathematical models in OR and constructing the model. Linear Programming - Requirements, Assumptions, Applications	1	C	1	1, 2
3.	Formulation of linear programming problem, Advantages, Limitations, Simplex method - Graphical method of solution	1	C	1	1, 2
4.	Simplex method - Analytical - Canonical and Standard forms of LPP	1	C,D	1	1, 2
5.	Artificial Variables Techniques - Big M-method	1	C,D	1	1, 2
6.	Artificial Variables Techniques - Two Phase method	1	C,D	1	1, 2
7.	Problems in Artificial Variables Techniques	1	C,D	1	1, 2
8.	Assignment models [Balanced, Unbalanced, Maximization] -Mathematical Representation ,Comparison with Transportation models - Hungarian Method of Solution	1	C,D	1	1, 2
9.	Assignment models [Travelling Salesman Problem.] (Shortest Cyclic Route Models)	1	C,D	1	1, 2
	UNIT II: TRANSPORTATION MODELS AND REPLACEMENT MODEL	**9**			
10.	Transportation problem –Assumption , Definition, Formulation and Solution - North west corner method	1	C,D	2	1, 2
11.	Transportation problem – Least cost method	1	C,D	2	1, 2
12.	Transportation problem – Vogel's approximation method.	1	C,D	2	1, 2
13.	Transportation problem – MODI method	1	C,D	2	1, 2
14.	MODI method [Unbalance in transportation model]	1	C,D	2	1, 2

15.	MODI method [Degeneracy in transportation model]	1	C,D	2	1, 2
16.	Replacement Model, Replacement of items that deteriorate, Gradually, Fail suddenly	1	C,D	2	1, 2
17.	Group Replacement policy analysis - Problems	1	C,D	2	1, 2
18.	Group Replacement policy analysis - Problems	1	C,D	2	1, 2
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference/ Text Books**
	UNIT III: SEQUENCING AND NETWORK ANALYSIS	**9**			
19.	Problem of Sequencing, Processing 'n' jobs through two and three machines.	1	C,D	3	1, 2
20.	Problem of Sequencing, Processing 'n' jobs through two and three machines.	1	C,D	3	1, 2
21.	Project - Planning, Scheduling, Controlling - Network Analysis – Constructing a project network - Fulkerson's Rule	1	C	3	1, 2
22.	Network computations – Earliest Completion time of a project and Critical path	1	C,D	3	1, 2
23.	Programme Evaluation Review Technique	1	C,D	3	1, 2
24.	Total Slack, Free Slack,Probability of achieving completion date	1	C,D	3	1, 2
25.	Cost Analysis - Crashing the network - Resource Scheduling -Advantages, Limitations	1	C,D	3	1, 2
26.	Cost Analysis - Crashing the network - Resource Scheduling -Advantages, Limitations	1	C,D	3	1, 2
27.	Problems - Distinction between PERT and CPM - LPP Formulation	1	C,D	3	1, 2
	UNIT IV : INVENTORY CONTROL AND QUEING THEORY	**9**			
28.	Introduction – Necessity for Maintaining Inventory, Inventory Costs – Types- Variables in an inventory problem – Lead time, Reorder Level, EOQ	1	C	4	1, 2
29.	Deterministic Inventory Models – Purchasing model with no shortages , Manufacturing model with no shortages	1	C,D	4	1, 2
30.	Purchasing model with shortages , Manufacturing model with shortages	1	C,D	4	1, 2
31.	Multi item deterministic model, safety stock, storage quantity discount	1	C,D	4	1, 2
32.	Multi item deterministic model, safety stock, storage quantity discount	1	C,D	4	1, 2
33.	Queuing Models - Elements - Kendall's Notation - Poisson arrivals and exponential service times	1	C,D	4	1, 2
34.	Waiting time,Idle time cost, Single channel problem	1	C,D	4	1, 2
35.	Multi-channel problem	1	C,D	4	1, 2
36.	Poisson arrivals and service time.	1	C,D	4	1, 2
	UNIT V : DECISION THEORY AND GAME THEORY	**9**			
37.	Steps in Decision theory approach - Decision making Environments-Making under conditions of Certainty, Uncertainty, Conditions of Risk	1	C	5	1, 2
38.	Steps in Decision theory approach - Decision making Environments-Making under conditions of Certainty, Uncertainty, Conditions of Risk	1	C	5	1, 2
39.	Decision making conditions – problems	1	C,D	5	1, 2
40.	Decision trees. - Utility Theory	2	C	5	1, 2

41.	Theory of Games , Characteristics Game models - Definition - Rules - Pure Strategy	1	C	5	1, 2
42.	Optimal solution of two person zero sum games, mixed strategies	1	C	5	1, 2
43.	Graphical solution of (2xn) and (mx2) games	1	C,D	5	1, 2
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference/ Text Books**
44.	Solution of (mxn) games by linear programming	1	C,D	5	1, 2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Premkumar Gupta and Hira, "*Operation Research*", Third Edition S Chand Company Ltd., New Delhi 2003.
2.	A.C.S.Kumar, "*Operation Research*", Yes Dee Publishing Ltd., Chennai 2015.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Fredric.S.Hilleer and Gerold J. Lieberman, "*Introduction to Operation Research*", 2nd Edition, CBS, 1974.
4.	Handy, "A. Taha, "*Operations Research*", 5th Edition, Prentice Hall of India, New Delhi, 1997.
5.	Philip and Ravindran, "*Operational Research*", John Wiley, 2000.
6.	Sundaresan.V, GanapathySubramanian.K.S, "*Resource Management Techniques: Operations Research*" A.R Publications, 2003.
7.	Panneerselvam.K, "*Operation Research*", Prentice Hall of India, 2002.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME ELECTIVE	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:					
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To impart knowledge about various computational methods of fluid flow and solve simple fluid flow problems.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student should be able to understand								
1.	The formulation of governing equations for fluid flow and their mathematical behavior	a	c	e	i			
2.	Various discretization techniques.	a	c	e	i			
3.	Different techniques to solve the numerical equations..	a	c	e	i			
4.	Development of various types of grids to solve the problem..	a	c	e	i			
5.	The finite volume approach to discretize the governing equations	a	c	e	i			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: GOVERNING EQUATIONS AND MATHEMATICAL BEHAVIOR OF PARTIAL DIFFERENTIAL EQUATIONS	**9**			
1.	Introduction to computational fluid dynamics, Types of model flow, substantial derivative, Divergence of velocity.	1	C	1	1
2.	Continuity equation in conservation form ,integral and differential form	1	C	1	1
3.	Continuity equation in non-conservation form ,integral and differential form	1	C	1	1
4.	Manipulation of continuity equation , Three dimensional momentum equation	1	C	1	1
5.	Navier's Stokes equation	1	C	1	1
6.	Energy equation.	1	C	1	1
7.	Different boundary conditions ,Classification of PDE	1	C	1	1
8.	Classification of PDE	1	C	1	1
9.	Mathematical behavior of PDE, Well posed problems	1	C	1	1
	UNIT II –DISCRITIZATION TECHNIQUES	**9**			
10.	Explanation of finite difference method	1	C	2	1
11.	Discretisation of wave equation	1	C	2	1
12.	Discretisation of laplace equation	1	C	2	1
13.	Numerical error types and stability criterion	1	C	2	1
14.	One dimensional transient heat conduction equation discretisation	1	C,D	2	1
15.	Explicit ,Crank Nicholson and pure implicit method	1	C,D	2	1
16.	Numerical error and stability of One dimensional transient heat conduction equation	1	C	2	1
17.	Grid independence test	1	C	2	1
18.	Optimum step size	1	C	2	1
	UNIT III: SOLUTUION TECHNIQUES	**9**			
19.	Laxwendroff Technique	1	C	3	1
20.	Maccormmacks Technique	1	C	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
21.	Relaxation Technique and its significance	1	C	3	1
22.	TDMA Algorithm	1	C	3	1
23.	Alternative Direction Implicit method	1	C	3	1
24.	Pressure correction Technique	1	C	3	1
25.	Staggered Grid.	1	C	3	1
26.	Numerical SIMPLE Algorithm	1	C	3	1
27.	Stream function and Vorticity method	1	C	3	1
	UNIT IV: -GRID GENERATION	**9**			
28.	Grid transformation of equations	1	C	4	1
29.	Transformation of aerofoil from physical plane to Computational plane	1	C	4	1
30.	Transformation of continuity and Laplace equation	1	C	4	1
31.	Metrices and Jacobians	1	C	4	1
32.	Stretched grid	1	C	4	1
33.	Compressed grid	1	C	4	1
34.	Adaptive grids , Body fitted coordinate system	1	C	4	1
35.	Grid generation in irregular geometry	1	C	4	1
36.	Modern development in grid generation	1	C	4	1
	UNIT V: FINITE VOLUME METHOD	**9**			
37.	Finite Volume methods of discretisation-Central differencing scheme	1	C	5	2
38.	Upwind scheme ,hybrid scheme	1	C	5	2
39.	One dimensional conduction problems	1	C,D	5	2
40.	One dimensional convection problems	1	C,D	5	2
41.	One dimensional convection and diffusion problem with different boundary conditions	2	C,D	5	2
42.	Steady state heat conduction problems	1	C,D	5	2
43.	Transient heat conduction problems	2	C,D	5	2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Anderson J.D., "*Computational Fluid dynamics"*, McGraw Hill Int., New York, 2010.
2.	Versteeg H.K., and Malalasekera W., "*An introduction to computational fluid dynamics, The finite volume method"*, Longman, 2007.
3.	**REFERENCE BOOKS/OTHER READING MATERIAL**
4.	Suhas.V. Patankar, "*Numerical Heat Transfer and Fluid Fl*ow", Hemisphere Publishing Corporation, 2009.
5.	Muralidhar.K, and Sundararajan.T, "*Computational Fluid Flow and Heat Transfer"*, Narosa Publishing House, New Delhi, Second Edition, 2008.
6.	Ghoshdasdidar.P.S, "*Computer simulation of fluid flow and heat transfer"*, Tata McGraw Hill Publishing Company Ltd., 1998.
7.	Anil W. Date, "*Introduction to computational fluid dynamics",*Cambridge University Press, Cambridge ,2009.

Course nature			**Theory**				
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME ELECTIVE	REFRIGERATION AND AIR CONDITIONING SYSTEMS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:					
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd				

PURPOSE	To on completion of this course, the students are expected to gain knowledge about refrigeration and air conditioning system.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student should be able to understand								
1.	Vapour compression and vapour absorption system Operation.	a	e					
2.	The refrigeration cycles and methods for improving Performance.	a	e					
3.	The components of refrigeration systems.	a	e					
4.	Design air conditioning systems using cooling load calculations.	a	e					
5.	Application of refrigeration and air conditioning systems	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: VAPOUR COMPRESSION REFRIGERATION SYSTEMS	**9**			
1.	Review of thermodynamic principles of refrigeration	1	C	1	1,3
2.	Simple vapour compression system	1	C	1	1,3
3.	Calculation: COP of VCR system	1	C,D	1	1,3
4.	Method for improving COP in VCR system	1	C	1	1,3
5.	Multistage and multiple evaporator system	1	C,D	1	1,3
6.	Cascade system	1	C	1	1,3
7.	COP comparison with sub cooling and super heating	1	C,D	1	1,3
8.	Tutorial : problem on sub Cooling , and super heating	2	C,D	1	1,3
	UNIT II: ABSORPTION REFRIGERATION SYSTEMS	**9**			
9.	Absorption refrigeration cycle, Water lithium bromide systems	1	C	2	1,2
10.	Tutorial : LiBr COP calculation	1	C,D	2	1,2
11.	Ammonia Absorption Refrigeration system	1	C	2	1,2
12.	Tutorial : ammonia COP calculation	1	C,D	2	1,2
13.	COP calculation of single effect absorption system	1	C	2	1,2
14.	Refrigeration absorbent combinations	1	C	2	1,2
15.	Comparison of absorption system with vapourcompression systems	1	C	2	1,2
16.	Tutorial: COP comparison of vapour compression systems with vapour absorption system.	2	C,D	2	1,2
	UNIT III: REFRIGERATION EQUIPMENTS & CONTROL	**9**			
17.	Compressors –type	1	C	3	1,3
18.	Condensers type	1	C	3	1,3
19.	Cooling towers type	1	C	3	1,3
20.	Evaporators	1	C	3	1,3
21.	Expansion devices type	1	C	3	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
22.	Refrigerants: properties	1	C	3	1,3
23.	Selection of refrigerants-alternate refrigerants.	1	C	3	1,3
24.	Refrigeration plant controls	1	C	3	1,3
25.	Testing and charging of refrigeration units.	1	C	3	1,3
	UNIT IV: DESIGN OF AIR CONDITIONING SYSTEMS	**9**			
26.	Different heat sources of Conduction and radiation	1	C	4	1,3
27.	Load: occupants load, equipment load, fresh air load ,infiltration air load	1	C	4	1,3
28.	Tutorial : conduction, radiation	1	C,D	4	1,3
29.	Tutorial : load calculation, Estimation of total heat load(SHL+LHL)	2	C,D	4	1,3
30.	Bypass factor (BPF), Effective sensible heat factor (ESHF)	1	C	4	1,3
31.	Tutorial : SHF& ESHF	2	C,D	4	1,3
32.	Cooling coils and dehumidifier air washers.	1	C,D	4	1,3
	UNIT V: APPLICATIONS OF REFRIGERATION AND AIR CONDITIONING SYSTEMS	**9**			
33.	Preservation of different products	1	C	5	1,3
34.	Ice factory	1	C	5	1,3
35.	Dairy plant refrigeration systems	1	C	5	1,3
36.	Application of air conditioning in hotels	1	C	5	1,3
37.	Application of air conditioning in restaurants	1	C	5	1,3
38.	Application of air conditioning in theatres	1	C	5	1,3
39.	Application of air conditioning in auditorium	1	C	5	1,3
40.	Application of air conditioning in hospitals	1	C	5	1,3
41.	Cryogenics applications	1	C	5	1,3
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Arora.S.C and Domkundwar.S, "*A course in Refrigeration and Air conditioning*", DhanpatRai (P) Ltd., New Delhi, 2012.
2.	Ananthanarayanan.P.N, "*Basic Refrigeration and Air Conditioning*", Tata McGraw Hill, 3rd Edition, New Delhi, 2006.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Manohar Prasad, "*Refrigeration and Air conditioning*", New Age International (P) Ltd, New Delhi, 2010.
4.	Roy J. Dossat,"*Principles of Refrigeration*", Pearson Education Asia, 4th Edition, 2001.
5.	Arora, C. P., "*Refrigeration and Air Conditioning*", Tata McGraw Hill, New Delhi, 2006

Course nature			**Theory**			
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME ELECTIVE	ADVANCED ENGINEERING THERMODYNAMICS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting --, 23rd				

PURPOSE	On completion of this course, the students are expected to gain knowledge in exergy analysis, thermodynamic relations, microscopic and macroscopic approach.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize with the availability and thermodynamic properties	a	e					
2.	Understand the real gas behaviour and multicomponent systems	a	e					
3.	To studychemical thermodynamics	a	e					
4.	To study statistical and classical thermodynamics	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS	**9**			
1.	Reversible work, availability, irreversibility and second law efficiency for a closed system.	2	C,D	1	1,3
2.	Availability analysis of simple cycles, exergy analysis and Thermodynamic potentials.	2	C,D	1	1,2
3.	Maxwell relations, Generalized relations for changes inEntropy, internal energy and enthalpy.	3	C,D	1	1,3
4.	Generalized relations for Cp and C_VClausiusClayperon equation and Joule – Thomson coefficient.	2	C,D	1	1,3
	UNIT II: REAL GAS BEHAVIOUR AND MULTI – COMPONENT SYSTEMS	**9**			
5.	Different equations of state, fugacity, compressibility and principle of corresponding states.	1	C,D	1	1,6
6.	Use of generalized charts for enthalpy and entropy departure, fugacity coefficient, Lee – Kesler generalized three parameter tables.	3	C,D	1	1,6
7.	Fundamental property relations for systems of variable composition. Partial molar properties	2	C,D	1	1,6
8.	Real gas mixtures, Ideal solution of real gases and liquid, activity, equilibrium in multi-phase systems	2	C,D	1	1,3
9.	Gibbs phase rule for non – reactive components	1	C,D	1	1,3
	UNIT III: CHEMICAL THERMODYNAMICS AND EQUILIBRIUM	**9**			
10.	Thermochemistry, First law analysis of reacting systems	2	C,D	2	1,3
11.	Adiabatic flame temperature, entropy change of reacting systems	3	C,D	2	1,3
12.	Second law analysis of reacting systems, Criterion for reaction equilibrium	2	C,D	2	1,3
13.	Equilibrium constant for gaseous mixtures, evaluation of equilibrium composition.	2	C,D	2	1,3
	UNIT IV: STATISTICAL THERMODYNAMICS	**9**			
14.	Statistical thermodynamics- introduction, energy states and energy levels, macro and microscales, thermodynamic probability	2	C	3	1,3
15.	Maxwell–Boltzman, Fermi–Diarc and Bose–Einstein statistics statistics, distribution function	3	C,D	3	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
16.	Partition energy, statistical interpretation of entropy,	2	C,D	3	1,3
17.	Application of statistics to gases-mono-atomic ideal gas	2	C	3	1,3
	UNIT V: IRREVERSIBLE THERMODYNAMICS	**9**			
18.	Conjugate fluxes and forces.	3	C	3	1,5
19.	Entropy production Onsager's reciprocity relations.	3	C,D	3	1,5
20.	Thermo – electric phenomena, formulations.	3	C,D	3	1,5
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Kenneth WarkJt.m, "*Advanced Thermodynamics for Engineers*", McGrew – Hill Inc., 1995.
2.	M.J. Moran and H.N. Shapiro, "*Fundamentals of Engineering Thermodynamics*", John Wiley and Sons, 2003
3.	Yunuscengel, "*Thermodynamics an engineering approach*", McGrew – Hill Inc, 8th Edition, 2015
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Bejan, A., "*Advanced Engineering Thermodynamics*", John Wiley and Cons, 1988
5.	Holman, J.P., "*Thermodynamics*", 4th Edition, McGraw – Hill Inc., 1988.
6.	Sonntag, R.E., and Van Wylen, G, "*Introduction to Thermodynamics, Classical and Statistical Themodynamics*", John Wiley and Sons, 3rd Edition, 1991

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME ELECTIVE	**FINITE ELEMENT METHODS**	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	Nil				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd				

PURPOSE	To learn the basic concepts of finite element method (FEM) and its application in engineering							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, learner will be able to								
1.	Study the basics of Finite Element analysis, Standard truss, beam, plane triangular and quadrilateral elements.	a	b					
2.	Study its application to static analysis		b	e				
3.	Analysis of one and two-dimensional problems using software			e	j	k		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: BASIC CONCEPTS OF THE FINITE ELEMENT METHOD	**9**			
1.	Basics of FEA, Derive the stiffness matrix of Spring, bar and beam elements	1	C,D	1	1, 2, 3
2.	Tutorial Problems on spring and bar elements	1	C,D	1	1, 2, 3

3.	Derive the stiffness matrix of beam elements	1	C,D	1	1, 2, 3
4.	Tutorial Problems on spring and bar elements	1	C,D	1	1, 2, 3
5.	Local and global coordinate systems	1	C,D	1	1, 2, 3
6.	assembly of elements, calculation of element stress	1	C,D	1	1, 2, 3
7.	simple applications, trusses, Drive the stiffness matrix	1	C,D	1	1, 2, 3
8.	Tutorial Problems on Trusses-stiffness matrix calculation	1	C,D	1	1, 2, 3
9.	Tutorial Problems on Trusses, Member stress calculation	1	C,D	1	1, 2, 3
	UNIT II: VARIATIONAL AND WEIGHTED RESIDUAL APPROACHES	**8**			
10.	Variational problems, Euler's Equation	1	C,D	1,2	2, 3
11.	Example problem, solving first order differential equation using 2-node 1D element	1	C,D	1,2	2, 3
12.	Example problems, solving first order differential equation using 1D-sub-parametric elements	2	C,D	1,2	2, 3
13.	Weighted residual approaches, Galerkin formulation and Point-collocation	1	C,D	1,2	2, 3
14.	Example problems on Galerkin formulation, simple regular beam sections with different types of loads	1	C,D	1,2	2, 3
15.	Example problems on Point-collocation- simple regular beam sections with different types of loads	1	C,D	1,2	2, 3
16.	Weighted residual approaches, Sub-domain collocation, Least-square minimization	1	C,D	1,2	2, 3
17.	Example problems on Sub-domain collocation - simple regular beam sections with different types of loads	1	C,D	1,2	2, 3
18.	Example problems on Least-square minimization - simple regular beam sections with different types of loads	1	C,D	1,2	2, 3
	UNIT III :TWO DIMENSIONAL ISOPARAMETRIC ELEMENTS AND GAUSS NUMERICAL INTEGRATION	**10**			
19.	Natural coordinate systems	1	C,D	1,2	2, 3
20.	Interpolation function for Triangular Elements (CST, LST and QST)	2	C,D	1,2	2, 3
21.	Interpolation function for 4-node,8-node and 9-node	2	C,D	1,2	2, 3
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	quadrilateral Elements				
22.	Element stiffness matrix formulation for two dimensional elements	1	C,D	1,2	2, 3
23.	Gauss Numerical Integration- Derivation of one point and two point formula	2	C,D	1,2	2, 3
24.	Example Problems on Gauss Numerical Integration using one point and two point formula (1D problems)	2	C,D	1,2	2, 3
	UNIT-4: EIGEN VALUE PROBLEMS for one dimension problems (DYNAMIC CONSIDERATION)	**8**			
25.	Formulation- Hamilton's Principle-Characteristic polynomial technique	2	C,D	1,2	2, 3
26.	Element mass matrix formulation for one dimensional Elements (2-node isoparametric and 3-node sup –parametric elements)	2	C,D	1,2	2, 3
27.	Example problems for 1-D Problems to find eigenvalues and eigenvectors- using 2-node isoparametric	2	C,D	1,2	2, 3
28.	Example problems for 1-D Problems to find eigenvalues and eigenvectors- using 3-node isoparametric	2	C,D	1,2	2, 3
	UNIT-5: STEADY STATE HEAT TRANSFER ANALYSIS	**9**			
29.	Introduction, straight uniform fin analysis, Derivation 1D Element matrices	1	C,D	2,3	2, 3
30.	Example Problems, straight uniform fin analysis	1	C,D	2,3	2, 3

31.	Example Problems, Taper fin analysis, Heat Flex Boundary conditions	1	C,D	2,3	2, 3
32.	Analysis of uniform fins using 1D Quadratic Elements	1	C,D	2,3	2, 3
33.	Two Dimensional Steady state Problems,using CST Elements	1	C,D	2,3	2, 3
34.	Example Problems for 2D steady Problems using CST Elements	2	C,D	2,3	2, 3
35.	1-D and 2-D simple Problems using any commercial FEA software	2	C,D	3	3
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Hutton, D.V., "*Fundamentals of Finite Element Analysis*", McGraw Hill, International Edition, 2004.
2.	Segerlind, L.J., "*Applied Finite Element Analysis*", John Wiley & Sons, 1984.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Chandrupatla, T.R., Belegundu, A.D., "*Introduction to Finite Elements in Engineering*", Prentice Hall of India, 1997.
4.	Zienkiewicz, O.C., "*Finite Elements and Approximation*", Dover International, 2006.
5.	Cook R.D., Malkus, D.S., Plesha, M.E., Witt, R.J., "*Concepts and Applications of Finite Element Analysis*", 4th Edition, John Wiley & Sons, 2001.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**CycleTest I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME ELECTIVE	**ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To introduce the basics of Artificial Intelligence and Expert Systems							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, students should be able to								
1	Understand basic concepts of artificial intelligence	j	k					
2	Identify and use various search and matching techniques used in artificial intelligence		k					
3	Apprehend basic concepts of expert systems	j	k					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: INTRODUCTION TO AI	**8**			
1	History, Definition of AI and Emulation of human cognitive process	1	C	1	1,3
2	Agents: types	2	C	1	2
3	An abstract view of modeling and Elementary knowledge	1	C	1	1
4	Computational and Predicate logic	1	C	1	1

5	Analysis of compound statements using simple logic connectives	1	C	1	1
6	Nature of Environments	2	D	1	1,2
	UNIT II: PROBLEM SOLVING AGENTS	**10**			
7	Problem Definition, Formulating problems and Searching for solutions	1	C	2	2,3
8	Examples using production rules	1	C	2	2,3
9	Search /Strategies :Uninformed or Blinded search and Breadth first search	1	C	2	2,3
10	Uniform cost search: Depth first search, Depth limited search	1	C	2	2,3
11	Iterative deepening , Depth first search and Bi – directional search	1	C	2	2,3
12	Comparing uniformed search strategies and Informed search strategies	1	C	2	2,3
13	Heuristic information and Hill climbing methods	1	C	2	2,3
14	Best First Search; Greedy Best First Search, Branch-and-Bound Search	1	C	2	2,3
15	Optimal search algorithm A* and iterative deepening A*	2	C	2	2,3
	UNIT III: KNOWLEDGE ORGANISATION AND COMMUNICATION	**9**			
16	Knowledge organization, manipulation and acquisition	1	C	2	7
17	Indexing and Retrieval techniques and Integration of knowledge in memory organization systems	1	C	2	7
18	Matching Techniques : Need for matching and simple Matching problems	1	C,D	2	7
19	Partial matching , Fuzzy matching and RETE matching algorithm	1	C	2	7
20	Perception	1	C	2	7
21	Natural language: Overview of linguistics and Basic semantic analysis	1	C	2	7
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
22	Representation structures and Natural language generation	1	C	2	7
23	Uncertainty	1	C	2	2, 7
24	Bayesian Networks and Bayesian Inference	1	C	2	2, 7
	UNIT IV: PROGRAMMING LANGUAGE	**9**			
25	Introduction to LISP: syntax	1	C,D	3	2
26	Input output statements	2	C,D	3	2
27	Numeric functions, User defined Functions	2	C,D	3	2
28	Predicate Logic and declaration of local variables	1	C,D	3	2
29	Interaction and recursion functions	2	C,D	3	2
30	Property list and arrays	1	C,D	3	2
	UNIT V: EXPERT SYSTEMS	**9**			
31	Introduction to Expert Systems	1	C	3	4
32	Activities of an expert system	1	C	3	4
33	Interpretation ,Prediction and Diagnosis	1	C	3	4
34	Design, Planning and Monitoring	1	C	3	4
35	Debugging and Repair, Instruction and Control	1	C	3	4
36	Acquisition module frames of expert systems	1	C	3	4
37	Knowledge base	1	C	3	4
38	Production rules , Semantic nets and Inference engines	1	C,D	3	4
39	Backward chaining and forward chaining	1	C	3	4
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**

1.	Schalkoff, R.J., "*Artificial Intelligence: An Engineering Approach"*, McGraw-Hill, 1990
2.	Elaine Rich and Kelvin Knight, "*Artificial Intelligence"*, Tata McGraw Hill, New Delhi, 1991
3.	Stuart Russell and Peter Norvig, "*Artificial Intelligence: A modern approach"*. Prentice Hall, New Jersey, 1995
4.	Donald A. Waterman, *"A Guide to Expert Systems"*, Addison-Wesley Longman Publishing Co., Inc. Boston, MA, USA ©1985 ISBN:0-201-08313-2
	REFERENCE BOOKS/OTHER READING MATERIAL
5.	Nilson, N. J., "*Principles of Artificial Intelligence"*, Springer Verlag, Berlin, 1980
6.	Eugene Charniak and Drew McDermot, "*Introduction to Artificial Intelligence"*, Addison Wesley Longman Inc., 1998
7.	Patterson, "*Introduction to Artificial Intelligence and Expert systems"*, Prentice Hall of India, New Delhi, 1990

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**CycleTest I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME ELECTIVE	**MICRO CONTROLLER AND ITS APPLICATION IN ROBOTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To study the basic concepts of microcontroller and apply the knowledge in the field of robotics.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the fundamental concepts of 8051 microcontroller	a						
2.	Learn to program the microcontroller using assembly language	a	e					
3.	Program and interface the microcontroller with the external world using a high level language	a	e					
4.	Get knowledge about an open source microcontroller and its programming	a						
5.	Design a Microcontroller system and to get know its various applications.		e					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: INTRODUCTION TO 8051 MICROCONTROLLER	**9**			
1.	Data representation and Numbering system and its types are binary,decimal, hexadecimal systems	1	C	1	1,5
2.	Data conversion from hexadecimal to decimal and decimal to binary,binary addition and subtraction	1	D	1	1,5
3.	Introduction and history description about microcontrollers	1	C	1	1,4,5
4.	Specification and Internal architecture of 8051	1	C	1	1,5
5.	Pin description of 8051	1	C	1	1,5
6.	Various Addressing modes of 8051 are immediate, direct, indirect, indexed addressing modes	2	C	2	1,5
7.	Difference between microcontroller with microprocessor	1	C	1	1,5

8.	Selection criterion for choosing microcontroller	1	C	1	1,5
	UNIT II: 8051 PROGRAMMING	**9**			
9.	Introduction to Assembly language, Instruction sets with syntax	2	C	2	1,5
10.	Timers and its types,TCON,TMOD	2	C	2	1,5
11.	Delay program with and without timer	1	C,D	2	1,5
12.	Interrupts both hardware and software	2	C,D	2	1,5
13.	I/O Ports and its 3 modes of operation	1	C	2	4,5
14.	Serial communication and its modes, SCON.	1	C,D	2	1,5
	UNIT III: PERIPHERAL INTERFACE	**9**			
15.	Introduction to External world interfacing with microcontroller, Analog signals and Digital signals	1	C	3	1,5
16.	Analog to digital and Digital to Analog conversion and its types	2	C	3	1,5
17.	Analog inputs are mechanical switches ,relays	1	C	3	1,5
18.	Digital outputs are LED,7 segment display and LCD interfacing	1	C,D	3	1,5
19.	Analog outputs are DC motor, Stepper motor, Servo motor and its interfacing	3	C,D	3	4,5
20.	Digitalinputs are keypad and its interfacing	1	C,D	3	1,5
	UNIT IV: OPEN SOURCE MICROCONTROLLER AND ITS PROGRAMMING	**9**			
21.	Introduction to open source microcontroller	1	C	4	2
22.	Arduino platform basic knowledge of its hardware and its software environments	1	C	4	2
23.	Variables ,digital inputs and outputs,print and println with programs	2	C,D	4	2
24.	Reading analog signals and PWM signal generation with programs	1	C,D	4	2
25.	Conditional statements are if ,else and nested if with programs	1	C,D	4	2
26.	Looping statements are for ,while and Do while with programs	1	C,D	4	2
27.	Functions and recursive function with programs	1	C,D	4	2
28.	Continuous Serial monitoring and hardware interrupt with programs	1	C,D	4	2
	UNIT V: MICROCONTROLLER SYSTEM DESIGN AND APPLICATION	**9**			
29.	Application of Microcontroller in various fields	1	C	5	3
30.	Advancement in Microcontroller	1	C	5	3
31.	Study and Design a home security system using microcontroller	2	C,D	5	3
32.	Study and Design a Micro mouse using microcontroller	1	C,D	5	3
33.	Study and Design a Unmanned Aerial Vehicle using microcontroller	2	C,D	5	3
34.	Study and Design a Smart Card using microcontroller	1	C,D	5	3
35.	Study and Design a Soccer playing robot using microcontroller	1	C,D	5	3
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Mazidi, "*The 8051 micro controller and embedded system*", Pearsoneducation, 2007.
2.	Simon Monk, "*Programming Arduino Getting Started with Sketches*", McGraw-Hill Education, 2011.
3.	K. Uma Rao, AndhePallavi, "*The 8051 Microcontroller Architecture,Programming and Applications*",Pearson Education India, 2010.
	REFERENCE BOOKS/OTHER READING MATERIAL

4.	Han-way Huang, "*Using the MCS-51 microcontroller*", OxfordUniversity Press, 2009.
5.	Scott Mackenzie, Raphael C. W. Phan, "*The 8051 Microcontroller*",Prentice Hall, 2007.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**CycleTest I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME ELECTIVE	**MACHINERY FAULT DIAGNOSTICS AND SIGNAL PROCESSING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To impart clear knowledge about fault analysis, instrumentation, detection, and testing.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand about failures and failure analysis.		e	k				
2.	Acquire knowledge about signal analysis.	d	e	k				
3.	Learn about instrumentation, detection and testing.	d	e	k				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: FAILURE ANALYSIS	**9**			
1.	Failures and failure analysis	1	C	1	1,3
2.	Failure concepts and characteristics	1	C	1	1,3
3.	Fault detection sensors	1	C	1	1,3
4.	Data processing and signal analysis	2	C	1	1
5.	Condition based maintenance principles	1	C	1	1
6.	Fault analysis planning and system availability	1	C	1	1,3
7.	Reliability/failure concepts	1	C	1	1,3
8.	Application of diagnostic maintenance to specific industrial machinery and plants	1	C	1	1
	UNIT II:FAULT DIAGNOSTICS AND VIBRATION	**9**			
9.	Principles of Maintenance	1	C	1	1
10.	Failure Modes Effects and Criticality Analysis	2	C	1	1
11.	Fault Diagnostics and Prognostics	2	C	1	1,3
12.	Basics of Machinery Vibration	1	C	1	2
13.	Engineering Applications of Vibration	1	C	1	2
14.	Rotor dynamics	2	C	1	2
	UNIT III: SIGNAL ANALYSIS	**9**			
15.	Time Domain Signal Analysis	1	C	2	1,2
16.	Frequency Domain Signal Analysis	1	C	2	1,2
17.	Computer Aided Data Acquisition	2	C	2	1,2
18.	FFT Analysis	1	C	2	1,2
19.	Modulation and Sidebands	1	C	2	1,2
20.	Envelope Analysis	1	C	2	1,2
21.	Cepstrum Analysis	1	C	2	1,2
22.	Order Analysis	1	C	2	1,2
	UNIT IV: INSTRUMENTATION AND DETECTION	**9**			
23.	Data Recording and Transmission	1	C	3	2

24.	Vibration Transducers, Vibration Monitoring	1	C	3	2
25.	Basics of Noise and Noise Monitoring	1	C	3	2
26.	Numerical problems in Noise Vibration and Data Acquisition	2	C,D	3	2
27.	Unbalance Detection, Field Balancing	1	C	3	2,3
28.	Misalignment Detection, Cracked Shaft Detection	1	C	3	2,3
29.	Looseness and Rub Detection, Ball and Journal Bearings	1	C	3	2,3
30.	Gear Fault Detection	1	C	3	2,3
	UNIT V: EQUIPMENT TESTING AND ANALYSIS	**9**			
31.	Fans, Blowers, Compressors, Pumps and Turbines	1	C	3	3
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
32.	Contaminant Analysis	1	C	3	3
33.	Oil Analysis	1	C	3	3
34.	Fault Detection in Motors and Transformers	1	C	3	1,3
35.	Motor Current Signature Analysis	1	C	3	3
36.	Thermography and Ultrasonics	1	C	3	3,4,5
37.	Acoustic Emission and Eddy Current Testing	1	C	3	3,4,5
38.	Radiography,Dye Penetrant Test and Visual Inspection	2	C	3	3,4,5
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	E. S. Tehrani and K. Khorasani, "*Fault diagnostics of a nonlinear system using a hybrid approach*", Springer, 2009.
2.	PareshGirdhar, Cornelius Scheffer, "*Practical machinery vibration analysis and predictive maintenance*", Elsevier, 2004.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Rolf Isermann, B. Freyermuth, "*Fault Detection, Supervision and Safety for Technical Processes*", Pergamon Press, 2006.
4.	J Prasad, C G K Nair, "*Non-Destructive Testing and Evaluation of Materials*", Tata McGraw Hill Education Private Limited, 2008.
5.	American Metals Society, "*Non-Destructive Examination and Quality Control*", Metals Hand Book, Vol.17, 9th Ed, Metals Park, OH, 1989.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**CycleTest I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME ELECTIVE	**ADVANCED STRENGTH OF MATERIALS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
	NIL				
Prerequisite:					
Data Book / Codes/Standards	Approved PSG Design Data Book, Supplementary Approved Data Book				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd				

PURPOSE	To familiarize the students in the area of stress, strain and deformation for a 3D problems.						
INSTRUCTIONAL OBJECTIVES	**STUDENT OUTCOMES**						
Upon successful completion of the course the students will be able to solve practical problems involving							

1.	Stress – strain relation in 3-D	a	e					
2.	unsymmetrical bending	a	e					
3.	Curved Flexural Members	a	e					
4.	Torsion of noncircular sections	a	e					
5.	Stress in flat plates	a	e					
6.	Contact stresses	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION	**9**			
1.	Plane Stress - Plane strain relations	1	C	1	1
2.	General equations of elasticity in Cartesian, polar and spherical co-ordinates equations of equilibrium	1	C, D	1	1
3.	Representation of 3-dimentinal stress of tensor, Stress at a point - inclined plane	1	C, D	1	1
4.	3D stress at a point - Principal stress	1	C, D	1	1
5.	3D Stress transformation	1	C, D	1	1
6.	Generalized Hooke's law	1	C, D	1	1
7.	St.Venant's principle	1	C, D	1	1
8.	Compatibility and boundary conditions	1	C, D	1	1, 6
9.	Airy's stress function	1	C, D	1	6
	UNIT II: UNSYMMETRICAL BENDING AND SHEAR STRESS ON BEAMS	**9**			
10.	Stress and deflections in beams subjected to unsymmetrical loading – Double (I) symmetry sections	1	C, D	2	1
11.	Stress and deflections in beams subjected to unsymmetrical loading –Single symmetry (T) sections	1	C, D	2	1
12.	Stress and deflections in beams subjected to unsymmetrical loading –Single symmetry (C)sections	1	C, D	2	1
13.	Stress and deflections in beams subjected to unsymmetrical loading – Unsymmetrical (L) sections	2	C, D	2	1
14.	Kern of a section	1	C, D	2	1
15.	Shear Stress Distribution on beams – Thin walled sections	1	C, D	2	1
16.	Shear Center - Location of shear center for various sections	1	C, D	2	1
17.	Shear flow	1	C, D	2	1
	UNIT III: CURVED FLEXURAL MEMBERS	**9**			
18.	CURVED FLEXURAL MEMBERS: circumferential and radial stresses – Winkler Bach Theory	2	C, D	3	1
19.	Circumferential and radial stresses for curved beam with restrained ends	2	C, D	3	1
20.	Deflections in Curved Flexural Members	1	C, D	3	1
21.	Closed ring subjected to concentrated loading	1	C, D	3	1
22.	Closed ring subjected to uniform load	1	C, D	3	1
23.	Chain links	1	C, D	3	1
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
24.	Crane hooks	1	C, D	3	1
	UNIT IV: TORSION ON NON-CIRCULAR SECTIONS	**9**			
25.	Torsion of rectangular cross section	1	C, D	4	1
26.	St. Venant's theory	1	C, D	4	1
27.	Elastic membrane analogy	1	C, D	4	1
28.	Prandtl's stress function	1	C, D	4	1
29.	Torsional stress in hollow thin-walled tubes	1	C, D	4	1
30.	Stress due to Rotation:Radial and tangential stresses in solid disc of uniform and varying thickness with allowable speeds	2	C, D	4	6
31.	Radial and tangential stresses in ring of uniform and varying thickness with allowable speeds	2	C, D	4	6

	UNIT V: STRESSES IN FLAT PLATES AND CONTACT STRESSES	**9**			
32.	Stresses in circular plates due to various types of loading and end conditions	2	C, D	5	1
33.	Stresses in rectangular plates due to various types of loading and end conditions	2	C, D	5	1
34.	Buckling of plates	1	C, D	5	1
35.	Methods of computing contact stresses	1	C, D	6	1
36.	Deflection of bodies in point contact	1	C, D	6	1
37.	Deflection of bodies in line contact	1	C, D	6	1
38.	Contact stress for various applications	1	C, D	6	1
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Arthur Boresi& Omar Sidebottom, "*Advanced Mechanics of Materials*," John Wiley & Sons, 6th Edition, 2002.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Seely and Smith, "*Advanced mechanics of materials*", John Wiley International Edn, 1952.
3.	Rimoahwnko, "*Strength of Materials*", Van Nostrand., 1970.
4.	Den Hartong, "*Advanced Strength of Materials*", McGraw Hill Book Co., New York 1952.
5.	Timoshenko and Goodier, "*Theory of Elasticity*", McGraw Hill., 1994.
6.	Wang, "*Applied Elasticity*", McGraw Hill., 1979.
7.	Case, "*Strength of Materials*", Edward Arnold, London 1957.
8.	Robert D. Cook, Warren C. Young, "*Advanced Mechanics of Materials*", Macmillian Pub. Co. 1952
9.	Durelli Phillips and Tso, "*Introduction to the Theoretical and Experimental Analysis of Stress and Strain*",McGraw-Hill, 1958.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**CycleTest I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME ELECTIVE	**ADDITIVE MANUFACTURING TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P DEPARTMENT ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To familiarize with the concepts of additive manufacturing techniques and its post processing operations.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Expose themselves to the evolution and basics of additive manufacturing technologies	c	k					
2.	Familiarize withPowder based additive manufacturing technologies	c	k					
3.	Familiarize with Liquid based and Solid based additive manufacturing technologies	c	k					

4.	Expose themselves to other additive manufacturing technologies like 3D printer, Ballastic particle method,Shape deposition modeling,Reverse engineering.	c	k					
5.	Familiarize with thepost processing and tooling methods of additive manufacturing technologies	c	k					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO ADDITIVE MANUFACTURING SYSTEMS	**9**			
1.	History and Development of AM.	1	C	1	1
2.	Need of AM,Difference between AM and CNC.	1	C	1	1,2
3.	Classification of AM Processes: Based on Layering techniques, Raw materials and Energy sources.	2	C	1	1,2
4.	AM Process chain.	1	C	1	1,2
5.	Benefits of AM, Applications of AM.	1	C	1	1,2,3
6.	Representation of 3d model in STL format, Repair of STL files.	2	C	1	1,2,3
7.	RP Data formats : SLC,CLI,RPI,LEAF,IGES,CT,STEP,HP/GL.	1	C	1	1,3
	UNIT II: POWDER BASED AM SYSTEMS	**9**			
8.	Principle and process of Selective Laser Sintering (SLS).	2	C	2	1,2
9.	Advantages, Limitations and Applications of SLS.	1	C	2	1,2
10.	Principle and Process of Laser Engineered Net Shaping (LENS).	2	C	2	1,2
11.	Advantages, Limitations and Applications of LENS.	1	C	2	1,2,3
12.	Principle and Processof Electron Beam Melting (EBM).	2	C	2	1
13.	Advantages, Limitations and Applications of EBM.	1	C	2	1,2
	UNIT III: SOLID AND LIQUID BASED AM SYSTEMS	**9**			
14.	Stereolithography (SLA): Principle, Process, Materials, Advantages, Limitations, Applications.	3	C	3	1,2
15.	Solid Ground Curing (SGC): Principle, Process, Materials, Advantages, Limitations, Applications.	2	C	3	1,2
16.	Fusion Deposition Modeling (FDM): Principle, Process, Materials, Advantages, Limitations, Applications.	2	C	3	1,2
17.	Laminated Object Manufacturing (LOM): Principle,	2	C	3	1,2
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Process, Materials, Advantages, Limitations, Applications.				
	UNIT IV: OTHER ADDITIVE MANUFACTURING SYSTEMS	**9**			
18.	Three Dimensional Printing (3DP): Principle, Process, Advantages, Limitations, Applications.	2	C	4	1,2
19.	Ballastic Particle Manufacturing (BPM): Principle, Process, Advantages, Limitations, Applications.	2	C	4	1,2
20.	Shape Deposition Manufacturing (SDM): Principle, Process, Advantages, Limitations, Applications.	2	C	4	1,2,3
21.	Reverse engineering.	3	C	4	1,2
	UNIT V: TOOLING AND PRE &POST PROCESSING TECHNIQUES IN AM SYSTEMS	**9**			
22.	Rapid tooling: Classification of Tooling, Direct and Indirect tooling methods, Soft and Hard tooling methods.	3	C	5	1
23.	Design for AM: Part orientation, Removal of supports, Hollowing out parts, Interlocking features, Reduction of part count in an assembly.	3	C,D	5	1

24.	Post processing: Support material removal, Surface texture Improvements, Accuracy Improvements, Machining Strategy, Aesthetic Improvements, Property enhancements.	3	C,D	5	1
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Ian Gibson, David Rosan, Brent Stucker, "*Additive Manufacturing Technologies*", Springer, 2010.
2.	Chua C.K.,Leong K.F., and Lim C.S., "*Rapid Prototyping: Principles and Applications*", SecondEdition,World scientific Publishers, 2003
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	LiouW. Liou, Frank W. Liou, "*Rapid Prototyping and Engineering applications*: *A Tool Box for Prototypedevelopment*",CRC Press, 2007.
4.	Pham D.T. and Dimov S.S., "*Rapid Manufacturing; the technologiesand application of RPT and Rapid tooling*", Springer, London 2001.
5.	Gebhardt, A., "*Rapid prototyping*", Hanser Gardener Publications, 2003.
6.	Hilton, P.D. and Jacobs, P.F., "*Rapid Tooling: Technologies and Industrial Applications*", CRCpress, 2005.
7.	RafiqNoorani, "*Rapid Prototyping: Principles and Applications in Manufacturing*", John Wiley & Sons, 2006.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**CycleTest I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME ELECTIVE	**COMPUTER GRAPHICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd				

PURPOSE	To study the various graphics techniques and its representation standards							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Basic of computer graphics	a					k	
2.	Representation of special curves	a		e				
3.	Surface creation	a					k	
4.	Three dimensional graphics techniques	a					k	
5.	Available graphics standards	a			i	j	k	

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: INTRODUCTION	**9**			

1.	Origin of computer graphics	1	C	1	1
2.	Interactive graphics display	1	C	1	1
3.	Display devices , pixels	1	C	1	1
4.	Algorithms for line and circle	2	C	1	1
5.	2D transformation (scaling, rotation, translation)	1	D	1	1
6.	3D transformation (scaling, rotation, translation)	2	D	1	1
7.	Concatenation transformations	1	D	1	2
	UNIT II: SPECIAL CURVES	**9**			
8.	Curve representation	1	C	2	1
9.	Parametric representation of Bezier curve	2	C	2	1
10.	Parametric representation of Cubic spline curve	2	C	2	1
11.	Parametric representation of B-Spline curve	2	C	2	1
12.	Parametric representation of Rotational curves	1	C	2	1
	UNIT III: SURFACES	**9**			
13.	Surface modeling techniques	1	C	3	1
14.	Mathematical representation and boundaries Coons patch	2	C	3	2
15.	Mathematical representation of Bi-Cubic patch	2	C	3	1
16.	Bezier and B-Spline surfaces	4	C	3	1
	UNIT IV: THREE DIMENSIONAL COMPUTER GRAPHICS	**9**			
17.	Boundary representation (B-rep), basic elements and building operations	2	C	4	2
18.	Constructive solid geometry (CSG), basic elements and building operations	2	C	4	2
19.	Viewing transformations	1	C	4	1
20.	Clipping operations	1	C	4	1
21.	Hidden line removal for curved surfaces	1	C	4	1
22.	Algorithms for shading and rendering	2	C	4	1
	UNIT V: GRAPHICS AND COMMUNICATION STANDARDS	**9**			
23.	Graphical Kernel System	2	C	5	1
24.	Bit maps and open GL (graphics library)	2	C	5	1
25.	Data exchange standards (IGES, STEP, CALLS, DXF, STL)	3	C	5	2
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
26.	Communication standards (LAN, WAN)	2	C	5	1
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Donald Hearn and Pauline Baker M. "*Computer Graphics*", Prentice Hall, Inc., 2009.
2.	Ibrahim Zeid "*CAD/Cam Theory and Practice*", McGraw Hill, International Edition, 2010.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Harington, Stevan, "*Computer Graphics: A Programming Approach*", McGraw Hill, 1983
4.	Plastock, Roy A., &Kally, "*Theory and Problems of Computer Graphics*", McGraw Hill, 1986.

Course nature			**Theory**				
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**CycleTest I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME ELECTIVE	AUTOMOTIVE ENGINEERING	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	On completion of this course, the students are expected to understand the automotive architecture, performance, transmission, wheels, tyres, braking, suspension, steering and electrical system with advances in automotive engineering

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Broaden the understanding of automotive architecture and performance	c						
2.	Introduce students about the transmission system	c						
3.	Familiarize about the wheels, tyres, and braking system	c						
4.	Understand the suspension and steering system	c						
5.	Learn about the electrical systems and advances in automotive engineering		d					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: AUTOMOBILE ARCHITECTURE AND PERFORMANCE	**9**			
1.	Automotive components, subsystems and their positions of Chassis, frame and body	3	C	1	1, 3
2.	Front, rear and four wheel drives	1	C	1	1, 2
3.	Operation and performance	1	C, D	1	1, 2
4.	Traction force and traction resistance	2	C, D	1	1, 2
5.	Power required for automobile	2	C, D	1	1, 2
	UNIT II: TRANSMISSION SYSTEMS	**9**			
6.	Clutch types, coil spring and diaphragm type clutch, single and multi plate clutch, centrifugal clutch	3	C	2	1,3
7.	Gear box types, constant mesh, sliding mesh and synchromesh gear box, layout of gear box, gear selector and shifting mechanism	3	C, D	2	1,3
8.	Overdrive, automatic transmission, Rolling, air and gradient resistance	1	C	2	1,3
9.	Propeller shaft, universal joint, slip joint	1	C	2	1,3
10.	Differential and real axle arrangement, hydraulic coupling	1	C	2	1,3
	UNIT III: WHEEL, TYRES, AND BRAKING SYSTEM	**9**			
11.	Types of wheels, construction, wired wheels	1	C	3	1, 2
12.	Tyres, construction, radial, bias & belted bias, slip angle, tread patterns, tyre retreading cold & hot, tubeless tyres	3	C	3	1, 2
13.	Forces on vehicles, tyre grip, load transfer, braking distribution between axles, stopping distance	2	C, D	3	1, 2
14.	Types of brakes, Mechanical, Hydraulic, Air brakes, Disc & Drum brakes	2	C	3	1, 3
15.	Engine brakes, anti lock braking system	1	C	3	1, 3

	UNIT IV: SUSPENSION AND STEERING SYSTEM	**9**			
16.	Types-front and rear suspension, conventional and independent type suspension	2	C	4	1, 3
17.	Leaf springs, coil springs, dampers, torsion bars, stabilizer bars, arms, air suspension systems	2	C	4	1, 3
18.	Types of steering systems, Ackermann principle, Davis steering gear, steering gear boxes, steering linkages	2	C	4	1, 3
19.	Power steering, wheel geometry, caster, camber toe in, toe out	2	C	4	1, 3
20.	Wheel Alignment and balancing	1	C	4	1, 3
	UNIT V: ELECTRICAL SYSTEM AND ADVANCES IN AUTOMOTIVE ENGINEERING	**9**			
21.	Battery, General electrical circuits, Dash board instrumentation	2	C, D	5	1, 3
22.	Passenger comfort, safety and security, HVAC , seat belts, air bags	2	C	5	1, 2
23.	Automotive Electronics , Electronic Control Unit (ECU)	1	C, D	5	1, 2
24.	Variable Valve Timing (VVT), Active Suspension System (ASS), Electronic Brake Distribution (EBD)	2	C, D	5	1, 2
25.	Electronic Stability Program (ESP), Traction Control System (TCS), Global Positioning System (GPS), Electric Hybrid Vehicle	2	C, D	5	1, 2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Kirpal Singh, "*Automobile Engineering*", Standard Publishers, Vol-I & II, 2004.
2.	Ramalingam, K. K, "*Automobile Engineering*", Scitech Publications, 2014.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Rajput R K, "*A Text book of Automobile Engineering*", Laxmi Publication, 2015.
4.	Crouse, W.H., and Anglin, D.L., "*Automotive Mechanics*", Tata McGraw Hill, 2005.
5.	Narang, G.B., "*Automobile Engineering*", Khanna Publishers, 2001.
6.	Kamaraju Ramakrishna, "*Automobile Engineering*", PHI Learning Pvt. Ltd, 2012.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**CycleTest I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME ELECTIVE	**FATIGUE , FRACTURE MECHANICS AND CREEP**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	Nil				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd				

PURPOSE	To bring awareness and education of very important topic of fatigue, fracture mechanics and creep
INSTRUCTIONAL OBJECTIVES	**STUDENT OUTCOMES**

At the end of the course, student will be able to								
1.	Understand fatigue and design for fatigue life	a	b					
2.	Understand fracture and its mechanisms	a	b					
3.	Understand creep, creep rupture and creep fatigue interaction.	a	b					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO FATIGUE	**9**			
1.	Introduction to fatigue	1	C	1	1
2.	Stress and strain cycles	1	C	1	1
3.	S-N curves	1	C	1	1
4.	Statistical nature of fatigue	1	C	1	1
5.	Low cycle fatigue, High cycle fatigue	1	C	1	1
6.	Basquin equation, Coffin and Manson equation	1	C	1	1
7.	Strain life equation	1	C	1	1
8.	Design for fatigue	2	C,D	1	1
	UNIT II: EFFECT OF VARIOUS PARAMETERS ON FATIGUE	**9**			
9.	Effect of stress concentration on fatigue	1	C	1	1
10.	Size effect	1	C	1	1
11.	Surface effects and fatigue	1	C	1	1
12.	Corrosion Fatigue	1	C	1	1
13.	Effect of mean stress on fatigue	1	C	1	1
14.	Engineering analysis of fatigue strength	1	C	1	1
15.	Cumulative fatigue damage	1	C	1	1
16.	Effect of metallurgical variables on fatigue	1	C	1	1
17.	Effect of temperature on fatigue	1	C	1	1
	UNIT III: FRACTURE MECHANICS	**9**			
18.	Introduction to fracture mechanics (FM)	1	C	2	1
19.	Modes of crack and types of fracture in metals	1	C	2	1
20.	Linear elastic fracture mechanics (LEFM)	2	C	2	2
21.	Griffith's theory of brittle fracture	1	C	2	1
22.	Irwin's modification	1	C	2	1
23.	Determination of stress intensity factor(K and K_{IC})	2	C	2	2,3
24.	Plane strain fracture toughness	1	C	2	5,6
	UNIT IV: APPLICATIONS OF FRACTURE MECHANICS	**9**			
25.	Theories of elastic and plastic fracture mechanics (EPFM)	1	C	2	2
26.	Crack opening displacement (COD)	1	C	2	1,2
27.	Crack tip opening displacement (CTOD)	1	C	2	1,2
28.	J-integral	1	C	2	3
29.	Ductile fracture	1	C	2	1
30.	Notch effect	1	C	2	1
31.	Concept of fracture curve, fracture under combined stresses	1	C	2	1
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
32.	Life prediction and design	2	C,D	2	5,6
	UNIT V: CREEP, STRESS RUPTURE AND HIGH TEMPERATURE MATERIALS	**9**			
33.	Introduction to High temperature behavior	1	C	3	1
34.	The creep curve	1	C	3	1
35.	The stress rupture test	1	C	3	1
36.	Mechanisms of creep and mechanism maps	2	C	3	1
37.	Presentation of engineering creep data	1	C	3	1
38.	Prediction of long life properties	1	C	3	1
39.	Creep fractures, creep fatigue interaction and creep resistant materials	2	C	3	1
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	George E. Dieter, "*Mechanical Metallurgy"*, McGraw-Hill, 3rdSI metric edition", 1989.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Robert P. Wei, Fracture Mechanics, "*Integration of Mechanics, Materials Science and chemistry*", Cambridge University Press, 2010.
3.	Richard W. Hertzberg, "*Deformation and Fracture Mechanic of Engineering Materials*", John Wiley & sons, 1995.
4.	Prashant Kumar, "*Elements of Fracture Mechanics*", Tata McGraw-Hill, New Delhi, 2009.
5.	Suryanarayana.A.V.K, "*Testing of Metallic Materials*", 2nd Edition, BS Publication, Hyderabad, 2007.
6.	Davis H.E, Troxell G.E, Hauck G.E.W, "*Testing of Engineering Materials*", 4th Edition, McGraw Hill, Int. Students, 1982.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**CycleTest I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

ME ELECTIVE	**FLEXIBLE MANUFACTURING SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	E PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To impart knowledge on group technology, Flexible manufacturing system and itsimplementation							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the different types of production.	a						
2.	Identify the Knowledge of group technology (GT) and FMS.	a	e					
3.	Comprehend the planning and quantitative analysis of FMS.	a	e					
4.	Explore detailed study of flexible manufacturing cells and systems.	a	e					
5.	Recognize the need of FMS software and factories of Future	a	e					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: PRODUCTION SYSTEMS	**9**			
1.	Types of production system, comparison, plant layout	1	C	1	2
2.	Functions in manufacturing ,Manufacturing support system	1	C	1	2
3.	Automation in Production system	1	C	1	2
4.	Production quantity and product variety	1	C	1	2
5.	Production concepts and mathematical model	1	C	1	2
6.	Tutorial on production rate, production capacity, utilization, availability, Manufacturing lead time for all types of production	1	C,D	1	2
7.	Tutorial on Manufacturing lead time, work in progress for all types of production	1	C,D	1	2
8.	Single Product Scheduling	2	C,D	1	3,9,10,11
	UNIT II- GROUP TECHNOLOGY AND FMS	**9**			
9.	Introduction to GT, Formation of part families,	1	C	2	2,3

10.	Part classification and coding system	2	C	2	2,3
11.	Production flow analysis,	1	C	2	2,3
12.	Machine cell design, clustering algorithm	2	C,D	2	2,3
13.	GT Benefits, Introduction and evolution of FMS	1	C	2	2
14.	FMS need and Economic Justification	1	C	2	2
15.	Components and classification of FMS	1	C	2	2
	UNIT III: FMS PLANNING	**9**			
16.	Physical planning for FMS, Objective, guide line	1	C	3	1
17.	User-Supplier responsibilities in planning, User-Supplier role in site preparation	1	C	3	1
18.	Machine tool Selection and Layout	1	C	3	1,2
19.	Computer control system,Data files , types of Reports	1	C	3	2
20.	System description and sizing, factors affecting it	1	C	3	1
21.	Human resources for FMS, Objective, staffing, supervisor role	1	C	3	1
22.	Quantitative Analysis Methods for FMS, Bottle neck and extended Bottle neck model, tutorial	2	C,D	3	2
23.	FMS Benefits and limitation	1	C		2
	UNIT IV: FLEXIBLE MANUFACTURING CELLS	**9**			
24.	Introduction to manufacturing Cells, Cell description and classifications	1	C	4	1
25.	Unattended machining ,Requirement and features	1	C,D	4	1
26.	Component handling and storage system	1	C	4	1
27.	Cellular versus FMS	1	C,D	4	1
28.	System Simulation, Hardware configuration	1	C	4	1
29.	PLC and Computer Controllers,	1	C		1
30.	Communication networks	2	C		1
31.	Lean production and agile manufacturing.	1	C		2
	UNIT V: FMS SOFTWARE	**9**			
32.	Introduction to FMS Software, General Structure and requirements	1	C	5	1
33.	Functional descriptions	2	C	5	1
34.	Operational overview	1	C	5	1
35.	FMS installation	1	C	5	1
36.	Acceptance testing ,Performance goals	1	C	5	1
37.	FMS application in machining, sheet metal fabrication,	1	C	5	3
38.	prismatic component production	1	C	5	3
39.	FMS development towards factories of the future	1	C	5	3
	Total contact hours*	45			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	William W. Luggen, "*Flexible Manufacturing Cells and Systems*", Prentice Hall, New Jersey, 1991.
2.	Mikell P. Groover, "*Automation Production Systems &Computer Integrated manufacturing*", Prentice Hall of India, New Delhi, 2007.
3.	Jha.N.K, "*Handbook of Flexible Manufacturing Systems*", Academic Press Inc.,1991.
	REFERENCES
4.	David J. Parrish, "*Flexible Manufacturing*", Butterworth-Heinemann, Newton, MA, USA, 1990.
5.	Radhakrishnan.P and Subramanyan.S, "*CAD/CAM/CIM*", Wiley Eastern Ltd.,New Age International Ltd., 1994 3.
6.	Raouf.A and Ben-Daya.M, Editors, "*Flexible manufacturing systems: recent development*", Elsevier Science, 1995.
7.	Kalpakjian, "*Manufacturing engineering and technology*", Addison-Wesley Publishing Co., 1995.
8.	Taiichi Ohno, "*Toyota production system: beyond large-scale production*", Productivity Press (India) Pvt. Ltd. 1992.
	Journal Publication

9.	Bahman Naderi, Ahmed Azab , *Modeling and scheduling a flexible manufacturing cell with parallel processing capability*, CIRP Journal of Manufacturing Science and Technology, 11,pp. 18–27, 2015
10.	Hang Lei , Keyi Xing, Libin Han, Fuli Xiong, Zhaoqiang Ge, *Deadlock-free scheduling for flexible manufacturing systems using Petri nets and heuristic search*, Computers & Industrial Engineering, 72, pp. 297–305, 2014.
11.	I. B. Abdallah , H. A. ElMaraghy, *Deadlock Prevention and Avoidance in FMS: A Petri Net Based Approach*, International Journal of Advanced Manufacturing Technology 14, pp. 704-715, 1998.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**CycleTest I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME ELECTIVE	**COMBUSTION ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:					
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To study the concepts of combustion of fuel and flames.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Acquire the fundamental knowledge of combustion.	c	e					
2.	Understand the thermodynamics of combustion.	c	e					
3.	Understand the kinetics of combustion.	c	e					
4.	Understand the types of flames.	c	e					
5.	Understand the combustion aspects in SI and CI Engines.	c	e	j				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I - COMBUSTION OF FUEL	**9**			
1.	Introduction	1	C	1	1,4
2.	Combustion equations	1	C	1	1,4
3.	Theoretical air	1	C	1	1,4
4.	Excess air	1	C	1	1,4
5.	Air fuel ratio	1	C	1	1,2
6.	Equivalence ratio	1	C	1	1,2
7.	Exhaust gas composition	1	C	1	1,2
8.	Air fuel ratio from exhaust gas composition	1	C	1	1,2
9.	Heating value of fuels.	1	C	1	1,2
	UNIT II -THERMODYNAMICS OF COMBUSTION	**9**			
10.	Thermo-chemistry, first law analysis of reacting systems	2	C	2	1,2
11.	Adiabatic combustion temperature	2	C	2	1,2
12.	Second law analysis of reacting systems	1	C	2	1,2
13.	Criterion for chemical equilibrium	1	C	2	1,2
14.	Equilibrium constant for gaseous mixtures	1	C	2	1,2
15.	Evaluation of equilibrium composition	1	C	2	1,2
16.	Chemical availability.	1	C	2	1,2
	UNITIII - KINETICS OF COMBUSTION	**9**			
17.	Rates of reaction	2	C	3	1,2
18.	Reaction order and complex reactions	2	C	3	1,2

19.	Chain Reactions,Arrhenius rate equation, collection theory	2	C	3	1,2
20.	Activated complex theory	1	C	3	1,2
21.	Explosive and general oxidative characteristics of fuels	2	C,D	3	1,2
	UNIT IV - FLAMES	**9**			
22.	Laminar and turbulent flames	1	C	4	1,5
23.	Premixed and diffusion flames	1	C	4	1,5
24.	Burning velocity and its determination	2	C	4	1,5
25.	Factors affecting burning velocity	1	C	4	1,5
26.	Quenching, flammability and ignition	2	C	4	1,5
27.	Flame stabilization in open burners	2	C	4	1,5
	UNIT V - ENGINE COMBUSTION	**9**			
28.	Combustion in SI and CI engines.	1	C	5	1,2
29.	Stages of combustion in SI and CI engines.	1	C	5	1,2
30.	Normal combustion and abnormal combustion.	1	C	5	1,2
31.	Emissions from premixed combustion.	2	C	5	1,2
32.	Emission from non-premixed combustion	2	C,D	5	1,2
33.	Control of emissions.	2	C	5	1,2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Stephen.R.Turns, "*An Introduction to Combustion concepts and applications"*,McGraw Hill Book Company, Boston, 3rd Edition, 2011.
2.	Ganesan.V, "*Internal Combustion Engines"*, Tata McGraw-Hill, New Delhi, 2009.
3.	Ramalingam.K.K, "*Internal Combustion Engines - Theory and practice"*, SciTechPublications India Pvt. Ltd., Chennai, 2010.
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Thipse.S.S, "*Internal Combustion Engines"*, Jaico Publication House, 2010.
5.	Thipse.S.S, "*Alternate Fuels"*, Jaico Publication House, 2010.
6.	Mathur.M.L, and Sharma.R.P, "*A course in Internal Combustion Engines"*, DhanpatRai& Sons, New Delhi, 2010.
7.	Heywood.J.B, "*Internal Combustion Engine Fundamentals"*, McGraw Hill International, New York, 2008.
8.	Domkundwar.V.M, "*A course inInternal Combustion Engines"*, DhanpatRai& Sons, 2010.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**CycleTest I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

ME ELECTIVE	**COMPOSITE MATERIALS AND MECHANICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To study the principles, properties and analysis of composite materials.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								

1.	Upon successful completion of this course the students will be able to analyze the characteristics of fiber-reinforced plastics.	b	c					
2.	Understand the various manufacturing process of composite materials, stress analysis of composite beams, plates and shells	b	c					
3.	Understand the design aspects of composites	b	c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION	**9**			
1.	Definition, Need, General characteristics, Applications	1	C	1	1
2.	Fibers-Glass, Carbon	1	C	1	1
3.	Ceramic and Aramid fibers	1	C	1	1,4
4.	Polymer Matrices	1	C	1	1,4
5.	Ceramic Matrices	1	C	1	1,4
6.	Metal Matrices	1	C	1	1,4
7.	Characteristics of fibers and matrices	1	C	1	1
8.	Smart materials, types and Characteristics**.**	2	C	1	1
	UNIT II:MECHANICS AND PERFORMANCE	**9**			
9.	Characteristics of fiber reinforced Lamina	1	C	1	1
10.	Laminates	1	C	1	1
11.	Interlaminar stresses	1	C	1	1
12.	Static Mechanical Properties	1	C	1	1
13.	Fatigue and Impact properties	2	C	1	1
14.	Environmental effects	1	C	1	1
15.	Fracture Behavior and Damage Tolerance.	2	C	1	1
	UNIT III: MANUFACTURING	**9**			
16.	Bag Moulding	1	C	2	1
17.	Compression moulding	1	C	2	1
18.	Pultrusion	2	C	2	1
19.	Filament winding	1	C	2	1
20.	Other Manufacturing Processes	2	C	2	1
21.	Quality Inspection method	2	C	2	1
	UNIT IV: ANALYSIS	**9**			
22.	Analysis of an orthographic lamina	2	C	2	3
23.	Hooke's law, stiffness and compliance matrices	1	C	2	3
24.	Strengths of orthographic lamina	2	C	2	3
25.	Stress analysis of laminated composite Beams	1	C	2	2,3
26.	Stress analysis of laminated composite Plates	1	C	2	2,3
27.	Stress analysis of laminated composite Shells	1	C	2	2,3
28.	Free vibration	1	C	2	3
	UNIT V: DESIGN	**9**			
29.	Failure predictions in a Unidirectional Lamina	2	C	3	1
30.	Failure predictions for Unnotched Laminates	1	C	3	1
31.	Laminated Design Consideration	2	C,D	3	1
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
32.	Bolted and Bonded Joints	2	C,D	3	1
33.	Design examples	2	C,D	3	1
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Mallick, P.K., "*Fibre Reinforced composites: Materials*", Manufacturing and Design:, Marcel Dekker Inc., 1993.
2.	Halpin, J.C., "*Primer on Composite Materials, Analysis*", Techomic Publishing Co., 1984.
	REFERENCE BOOKS/OTHER READING MATERIAL

3.	Agarwal, B.D., and Broutman L.J., "*Analysis and Performance of Fibre Composites*", John Wiley and Sons, New York, 1990.
4.	Malick, P.K. and Newman S., (eds), "*Composite Materials Technology: Processes and Properties*", Hansen Publisher, Munich, 1990.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**CycleTest I**	**CycleTest II**	**Assignment**		**Quiz**	**Total**
	Weightage	**15%**	**15%**	**10%**		**10%**	**50%**
					End semester examination Weightage :		**50%**

ME ELECTIVE	**GAS TURBINE TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Approved Gas Tables Data Book				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	On completion of this course, the students will be able to apply their knowledge to solve problems in gas turbines cycle performance.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize the functions of components of gas turbine.	a	e					
2.	Analyze the power cycles for optimum thermal performance.	a	e					
3.	Understand axial flow compressor characteristics.	a	e					
4.	Understand combustion systems and axial flow turbine operation	a	e					
5.	Familiar with the performance predictions.	a	e					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: BASICS OF GAS TURBINES	**8**			
1	Open cycle single shaft and twin shaft multi speed arrangement	1	C	1	1,2
2	Closed cycle gas turbine operation, Aircraft propulsion	3	C	1	1,2
3	Industrial applications of gas turbines	2	C	1	1,2
4	Environmental issues and future enhancement possibilities	2	C	1	1,2
	UNIT II: POWER CYCLES	**10**			
5	Ideal cycles method of accounting component losses	2	C	2	1,2
6	Design point performance calculations	3	C	2	1,2
7	Comparative performance of practical cycles - Combined cycle -Cognation schemes	2	C	2	1,2
8	Closed cycle gas turbine with reheat, inter-cooling and regenerator, problems	3	C,D	2	1,2
	Unit III: AXIAL FLOW COMPRESSORS	**9**			
9	Axial flow compressor basic operation: Elementary theory, factors effecting stagepressure ratio	3	C	3	1,2
10	Blockage in compressor annulus - Degree of reaction - Blade fixing details - Sealing materials and material selection for compressor blades	3	C	3	1,2
11	Stage performance - Design and off design performance characteristics, problems	3	C,D	3	1,2
	Unit IV: COMBUSTION SYSTEMS AND TURBINES	**10**			

12	Types of combustion and combustion requirements, Factors affecting combustion process	1	C	4	1,2
13	Combustion chamber heat calculations	2	C,D	4	1,2
14	Turbine construction, performance, impeller blade fixing.	1	C	4	1,2
15	Cooling of turbine blades, blade vibration and protective coating	1	C	4	1,2
16	Gas turbine turbo chargers and power expanders , vortex theory	2	C	4	1,2
17	Estimation of stage performance.	3	C,D	4	1,2
	UNIT V: PERFORMANCE PREDICTIONS	**8**			
18	Prediction performance of gas turbines component characteristics	2	C	5	1,2
19	Off design operation - Equilibrium running of gas generator	2	C	5	1,2
Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
20	Methods of displacing of the equilibrium running line, Incorporation of variable pressure losses	2	C	5	1,2
21	Matching procedure for two spool engines, principle of controlsystem	2	C,D	5	1,2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Saravanamuttoo. H.I.H, Rogers.G.F.C, Henry Cohen, *"Gas Turbine Theory",* Pearson Prentice Hall, 2009.
2.	Mattingly.J.D, "*Elements of Propulsion: Gas turbines and Rockets"*, McGraw Hill, 2012
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Ganesan.V, "*Gas Turbines*", Tata McGraw Hill, 3rd Edition, 2010.
4.	Yahya S.M, "*Turbines, Fans and Compressors"*, 3rd Edition, Tata McGraw Hill Publications, 2010.
5.	Gopalakrishnan.G, Prithvi Raj D, "*Treatise on Turbomachines"*, 1st Edition, Chennai, SciTech Publications, 2006.
6.	Horlock.J.H, "*Advanced Gas Turbine Cycles"*, Elsevier Science Ltd, 2003.
7.	Venkanna.B.K, "*Fundamentals of Turbomachinery",* 4th Edition, New Delhi, PHI Learning Pvt. Ltd, 2011.
	DATA BOOK
8.	Yahya.S.M, "*Gas Tables for compressible flow calculations"*, New Age International (P) Ltd, New Delhi, 6th Edition, 2011

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**CycleTest I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME ELECTIVE	FUEL CELL TECHNOLOGY	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To study the basics of fuel cell and hydrogen technologies and their applications							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to understand								
1.	the basics of fuel cell technology	a	e					
2.	the concepts of fuel cell electrochemistry	a	e					
3.	the major types of fuel cells and their modes of operation	a						
4.	the methods of production, storage and utilization of hydrogen as a fuel	a						
5.	the application of fuel cells in power cogeneration	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO FUEL CELLS AND FUEL CELL THERMODYNAMICS	**10**			
1.	Introduction and overview of fuel cell technology: A simple fuel cell, fuel cell advantages and disadvantages	1	C	1	1
2.	Basic fuel cell operation, Layout of a Real Fuel Cell: The Hydrogen–Oxygen Fuel Cell with Liquid Electrolyte. Difference between fuel cell and batteries, fuel choice.	2	C	1	1,2
3.	Overview of types of fuel cells (with emphasis on PEMFC and DMFC technology)	1	C	1	1
4.	Fuel cell thermodynamics: Thermodynamics review, Application of first and second law to fuel cells	1	C,D	1	1
5.	Heat Potential of a fuel: Enthalpy of reaction, Work potential of a fuel: Gibbs free energy	1	C	1	1
6.	Predicting reversible voltage of a fuel cell under non-standard-state conditions.	1	C	1	1
7.	Basic Parameters of Fuel Cells. Fuel cell efficiency.	2	C,D	1	1,2
8.	Comparison with Carnot efficiency.	1	C,D	1	1,2
	UNIT II:FUEL CELL ELECTROCHEMISTRY	**9**			
9.	Fuel cell reaction kinetics, Introduction to electrode kinetics.	3	C	2	1
10.	Conversion of chemical energy to electricity in a fuel cell. Reaction rate, Butler -Volmer equation.	3	C,D	2	1
11.	Fuel cell charge and mass transport.	2	C	2	1
12.	Implications and use of fuel cell polarization curve.	1	C	2	1,2
	UNIT III:TYPES OF FUEL CELLS	**9**			
13	Classification of fuel cells	1	C	3	1,2
14	Polymer electrolyte membrane fuel cell (PEMFC)	1	C	3	1,2
15	Direct methanol fuel cells (DMFC)	1	C	3	1,2
16	Alkaline fuel cell (PAFC)	1	C	3	1,2
17	Molten Carbonate fuel cell (MCFC)	1	C	3	1,2
18	Solid oxide fuel cell (SOFC)	1	C	3	1,2
19	Comparison of fuel cell, Performance behavior	3	C	3	1,2
	UNIT IV:HYDROGEN PRODUCTION, STORAGE AND UTILIZATION	**8**			
20	Hydrogen : Its merit as a fuel, Production methods: from fossil fuels, electrolysis, thermal decomposition,	2	C	4	2,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	photochemical, photocatalytic, hybrid.				
21	Hydrogen storage methods: Onboard hydrogen storage.	1	C	4	2,4
22	Chemical storage & physical storage.	1	C	4	2,4
23	In metal and alloy hydrides.	1	C	4	2,4
24	Carbon nanotubes.	1	C	4	2,4
25	Glass capillary arrays - pipeline storage and hydrogen utilization.	2	C	4	2,4
	UNIT V : APPLICATION OF FUEL CELLS IN POWER COGENERATION	**9**			
26	Balance of fuel cell power plant, Fuel cell power plant structure	3	C	5	1,6
27	Cogeneration	1	C	5	5,6
28	Fuel cell electric vehicles	1	C	5	5,6
29	Motor cycles and bicycles, airplanes	1	C	5	5,6
30	Fueling stations	1	C	5	5,6
31	Fuel processor and fuel cell stack	1	C	5	1,5,6
32	Safety issues and cost expectation	1	C	5	1,2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, *"Fuel Cell Fundamentals",* Wiley, 2006.
2.	Viswanathan. B, AuliceScibioh, M*, "Fuel Cells – Principles and Applications",* Universities Press (India) Pvt., Ltd., 2009.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Bagotsky .V.S, *"Fuel Cells",*Wiley, 2009.
4.	DetlefStolten, *"Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications*", 2010.
5.	Larminie .J, Dicks A. "*Fuel Cell Systems*", 2nd Edition, Wiley, 2003.
6.	Barclay .F.J. "*Fuel Cells, Engines and Hydrogen*", Wiley, 2009.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**CycleTest I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

SPECIALIZATIONS / MAJOR

BTech Mechanical with specialization in ROBOTICS: Students opting for this have to finish 6 courses falling under this specialization as follows in order to get the certification
Robotics, Dynamics and Control, Multi Body Dynamics, Mechatronics, Flexible Manufacturing, Artificial Intelligence, Machine Learning

BTech Mechanical with specialization in ADDITIVE MANUFACTURING: Students opting for this have to finish 6 courses under this specialization as follows in order to get the certification
3D Printing, CAD/CAM, Additive Manufacturing Process, Modeling of additive process, Applications of AM, Material aspects of AM

MINORS

Students can opt this option and complete the 6 courses in some specific department other than mechanical to be certified as minor in that department. Following departments can be chosen.
Computer Science and Engineering, Electronics and Communication Engineering, Electrical and Electronics and Engineering, Civil Engineering, Physics, Biology, Chemistry, Humanities