SRM UNIVERSITY
(Under section 3 of UGC Act 1956)

Faculty of Engineering and Technology

CURRICULUM, PRE-REQUISITES/ CO-REQUISITES CHART AND SYLLABUS FOR B.TECH UNDER CHOICE BASED FLEXIBLE CREDIT SYSTEM REGULATIONS 2015

(For students admitted from 2015-16 onwards)

Specialization : Mechanical Department
Offering Department : Mechanical Department

Placed in the 32nd Academic Council Meeting held on 23rd July 2016

STUDENT OUTCOMES

The curriculum and syllabus for B.Tech programs (2013) conform to outcome based teaching learning process. In general, ELEVEN STUDENT 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 student 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**

FACULTY OF ENGINEERING AND TECHNOLOGY, SRM UNIVERSITY
DEPARTMENT OF MECHANICAL ENGINEERING
B.TECH MECHANICAL ENGINEERING CHOICE BASED FLEXIBLE CREDIT SYSTEM (CBFCS) Curriculum Under Regulations 2015 (For students admitted from 2015-16 onwards)

L Lecture Hour / Week | T Tutorial Hours / Week | C Credits | P Practical Hours / Week | L Laboratory Course | E Elective Courses | J Theory jointly with Lab | M Course with Multidisciplinary content

Category	Category-wise % of Credits	Year I													Year II										
		1st Semester						2nd Semester							1st Semester						2nd Semester				
		Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C
Arts & Humanities-G	8.33%	15LE101	English	2	0	0	2	15LE102	Value Education	2	0	0	2	15LE201E	German Language - I	2	0	0	2	15LE207E	German Language - II	2	0	0	2
		15PD101	Soft Skills - I	1	1	0	1	15PD102	Soft Skills - II	1	1	0	1	15LE202E	French Language - I					15LE208E	French Language - II				
								15NC101	NCC- National Cadet Corps	0	0	1	1	15LE203E	Japanese Language - I					15LE209E	Japanese Language - II				
								15NS101	NSS- National Service Scheme					15LE204E	Korean Language - I					15LE210E	Korean Language - II				
								15SP101	NSO- National Sports Organization					15LE205E	Chinese Language - I					15LE211E	Chinese Language - II				
								15YG101	Yoga					15PD201	Quantitative Aptitude & Logical Reasoning –I	1	1	0	1	15PD202	Verbal Aptitude	1	1	0	1
	15		Total	3	1	0	3		Total	3	1	1	4		Total	3	1	0	3		Total	3	1	0	3
Basic Sciences - B	21.11%	15MA101	Calculus And Solid Geometry	3	1	0	4	15MA102	Advanced Calculus And Complex Analysis	3	1	0	4	15MA202	Fourier Series, Partial Differential Equations And Their Applications	4	0	0	4	15MA206	Numerical Methods	4	0	0	4
		15PY101	Physics	3	0	0	3	15PY102L	Materials Science	2	0	2	3												
		15PY101L	Physics Laboratory	0	0	2	1	15CY102	Principles Of Environmental Science	2	0	0	2												
		15CY101	Chemistry	3	0	0	3	15BT101	Biology For Engineers	2	0	0	2												
		15CY101L	Chemistry Laboratory	0	0	2	1																		
	38		Total	9	1	4	12		Total	9	1	2	11		Total	4	0	0	4		Total	4	0	0	4
Engineering Sciences - E	12.78%	15CE101	Basic Civil Engineering	2	0	0	2	15ME101	Basic Mechanical Engineering	2	0	0	2	15EI251	Electronics And Instrumentation	3	0	0	3						
		15EE101	Basic Electrical Engineering	2	0	0	2	15EC101	Basic Electronics Engineering	2	0	0	2	15EI251L	Electronics And Instrumentation Laboratory	0	0	2	1						
		15ME105L	Engineering Graphics	1	0	4	3	15ME104L	Workshop Practice	0	0	3	2	15ME201	Thermodynamics	2	2	0	3						
		15CS101L	Programming Laboratory	1	0	2	2	15ME103L	Active Learning Laboratory	0	0	2	1												
	23		Total	6	0	6	9		Total	4	0	5	7		Total	5	2	2	7		Total	0	0	0	0
Professional - Core -P	40.00%							15ME102	Engineering Mechanics	3	1	0	4	15ME202	Manufacturing Technology	3	0	0	3	15ME205	Fluid Mechanics	2	2	0	3
														15ME203	Mechanics Of Solids	2	2	0	3	15ME206	Applied Thermal Engineering	3	1	0	4
														15ME204	Machines And Mechanisms	2	2	0	3	15ME207	Computer Aided Design And Analysis	3	0	0	3
														15ME202L	Manufacturing Process Laboratory	0	0	2	1	15ME205L	Fluid Dynamics Laboratory	0	0	2	1
														15ME203L	Strength Of Materials Laboratory	0	0	2	1	15ME207L	Computer Aided Design Laboratory	0	0	2	1
																				15ME208L	Manufacturing And Assembly Drawing	1	0	3	2
	72		Total	0	0	0	0		Total	3	1	0	4		Total	7	4	4	11		Total	9	3	7	14
Profesnl. Electives -P	5.00%																								
	9		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0
Project / Seminar / Internship-P	9.44%																								
	17		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0
Open Electives	3.33%																								
	6		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0
Total	180			18	2	10	24			19	3	8	26			19	7	6	25			16	4	7	21
			Contact hours	30					Contact hours	30					Total contact hours	32					Total Contact hours	27			

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DEPARTMENT OF MECHANICAL ENGINEERING
B.TECH MECHANICAL ENGINEERING CHOICE BASED FLEXIBLE CREDIT SYSTEM (CBFCS) Curriculum Under Regulations 2015 (For students admitted from 2015-16 onwards)

L	Lecture Hours / Week	T	Tutorial Hours / Week		C Credits	P Practical Hours / Week	L	Laboratory Course			E Elective Courses	J	Theory jointly with Lab			M Course with Multidisciplinary content					
	Year 3																Year 4					
	1st Semester						2nd Semester						1st Semester					2nd Semester				
Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C
15PD301	Communication and Reasoning Skills	1	1	0	1	15PD302	Quantitative Aptitude & Logical Reasoning – II	1	1	0	1												
	Total	1	1	0	1		Total	1	1	0	1		Total	0	0	0	0		Total	0	0	0	0
15MA301	Probability and Statistics	4	0	0	4	15MA306	Calculus of Variations And Non-Linear Programming	3	0	0	3												
	Total	4	0	0	4		Total	3	0	0	3		Total	0	0	0	0		Total	0	0	0	0
	Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0
15ME301	Fundamentals Of Vibration And Noise	2	2	0	3	15ME304	Fluid Power Control	3	0	0	3	15ME401	Economics And Principles Of Management	3	0	0	3						
15ME302	Heat And Mass Transfer	2	2	0	3	15ME305	Mechanical Engineering Design	2	2	0	3	15ME402	Metrology And Quality Control	3	0	0	3						
15ME303	Materials Technology	3	0	0	3	15ME306	Gas Dynamics And Space Propulsion	2	2	0	3	15ME403	Design Of Transmission Systems	2	2	0	3						
15ME301L	Machine Dynamics Laboratory	0	0	2	1	15ME302L	Heat And Mass Transfer Laboratory	0	0	2	1	15ME404	Computer Aided Manufacturing	3	0	0	3						
15ME303L	Materials Technology Laboratory	0	0	2	1	15ME304L	Automation Laboratory	0	0	2	1	15ME402L	Metrology And Quality Control Laboratory	0	0	2	1						
						15ME306L	Heat Power Laboratory	0	0	2	1	15ME404L	Computer Aided Manufacturing Laboratory	0	0	2	1						
						15ME308M	Multi-Disciplinary Design	2	2	0	3	15ME405	Elements of Mechatronics	3	0	0	3						
	Total	7	4	4	11		Total	9	6	6	15		Total	14	2	4	17		Total	0	0	0	0
	Dept Elective-I	3	0	0	3		Dept Elective-II	3	0	0	3		Dept Elective-III	3	0	0	3						
	Total	3	0	0	3		Total	3	0	0	3		Total	3	0	0	3		Total	0	0	0	0
	Open Elective I	3	0	0	3		Open Elective Ii	3	0	0	3												
						15ME390L	Industrial Training (To be done after IV semester)	0	0	2	1							15ME496L	Major Project	0	0	24	12
						15ME375L / 15ME380L / 15ME385L / 15ME490L	Minor Project I / Seminar I / Massive Open Online Courses (MOOCs) I / Industry Module I	0	0	3	2	15ME376L / 15ME381L / 15ME386L / 15ME491L	Minor Project II / Seminar II / Massive Open Online Courses (MOOCs) II / Industry Module II	0	0	3	2						
	Total	0	0	0	0		Total	0	0	5	3		Total	0	0	3	2		Total	0	0	24	12
	Open Elective I	3	0	0	3								Open Elective II	3	0	0	3						
	As per list / as taken by the student												As per list / as taken by the student										
	Total	3	0	0	3		Total	0	0	0	0		Total	3	0	0	3		Total	0	0	0	0
	OPEN ELECTIVE I	3	0	0	3		OPEN ELECTIVE II	3	0	0	3												
		18	5	4	22			16	7	11	25			20	2	7	25			0	0	24	12
	Total Contact hours	27					Total contact hours	34					Total contact hours	29					Total contact hours	24			

B.Tech Mechanical Engineering (Regulations 2015)							B.Tech Mechanical Engineering (Regulations 2015)							B.Tech Mechanical Engineering (Regulations 2015)					
List of Department Electives - I							List of Department Electives - II							List of Department Electives - III					
Course Code	**Course Title**	**L**	**T**	**P**	**C**		**Course Code**	**Course Title**	**L**	**T**	**P**	**C**		**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
15ME326E	Robotics Engineering And Applications	3	0	0	3		15ME352E	Advanced Engineering Thermodynamics	3	0	0	3		15ME426E	Digital Image Processing and Machine Vision	3	0	0	3
15ME327E	Industrial Tribology	3	0	0	3		15ME353E	TQM And Reliability Engineering	3	0	0	3		15ME427E	Fatigue , Fracture Mechanics and Creep	3	0	0	3
15ME328E	Process Planning And Cost Estimation	3	0	0	3		15ME354E	Modern Control Theory	3	0	0	3		15ME428E	Flexible Manufacturing Systems	3	0	0	3
15ME329E	Foundry Engineering	3	0	0	3		15ME355E	Introduction To Human Body Mechanics	3	0	0	3		15ME429E	Precision Engineering	3	0	0	3
15ME330E	Internal Combustion Engines	3	0	0	3		15ME356E	Finite Element Methods	3	0	0	3		15ME430E	Solar Energy Systems	3	0	0	3
15ME331E	Alternative Sources of Energy	3	0	0	3		15ME357E	Optimisation In Engineering Design	3	0	0	3		15ME431E	Technology Of Surface Coating	3	0	0	3
15ME332E	Industrial Engineering	3	0	0	3		15ME358E	Modern Manufacturing Techniques	3	0	0	3		15ME432E	Combustion Engineering	3	0	0	3
15ME333E	Theory of Metal Forming	3	0	0	3		15ME359E	Tool Engineering Design	3	0	0	3		15ME433E	Sustainable Energy Systems	3	0	0	3
15ME334E	Production Management	3	0	0	3		15ME360E	Energy Engineering and Management	3	0	0	3		15ME434E	Supply Chain Management	3	0	0	3
15ME335E	Elements of Space Technology	3	0	0	3		15ME361E	Turbomachines	3	0	0	3		15ME435E	Foundation Skills In Integrated Product Development	3	0	0	3
15ME336E	Introduction To Nuclear Reactor Concepts	3	0	0	3		15ME362E	Thermal Power Systems	3	0	0	3		15ME436E	Composite Materials And Mechanics	3	0	0	3
15ME337E	Welding Technology	3	0	0	3		15ME363E	Facilities Planning	3	0	0	3		15ME437E	Global Optimization Algorithms	3	0	0	3
15ME338E	Advanced Fluid Mechanics	3	0	0	3		15ME364E	Industrial Safety and Environment	3	0	0	3		15ME438E	Modeling Of Thermal Systems	3	0	0	3
15ME339E	Mechanical Handling Systems and Equipment	3	0	0	3		15ME365E	Design Of Pumps and Turbines	3	0	0	3		15ME439E	Neural Network And Fuzzy Systems	3	0	0	3
15ME340E	Design of Experiments	3	0	0	3		15ME366E	Nuclear Power Generation and Supply	3	0	0	3		15ME440E	Gas Turbine Technology	3	0	0	3
15ME341E	Sustainable Green Manufacturing	3	0	0	3		15ME367E	Artificial Intelligence and Expert Systems	3	0	0	3		15ME441E	Fuel Cell Technology	3	0	0	3
15ME342E	Energy Systems for Buildings	3	0	0	3		15ME368E	Micro Controller And Its Application In Robotics	3	0	0	3		15ME442E	Linear Elasticity	3	0	0	3
15ME343E	Solar Energy Utilization	3	0	0	3		15ME369E	Machinery Fault Diagnostics And Signal Processing	3	0	0	3		15ME443E	Design Of Pressure Vessel And Piping	3	0	0	3
15ME344E	Mechanism Design, Analysis And Synthesis	3	0	0	3		15ME370E	Environmental Pollution And Abatement	3	0	0	3		15ME444E	Kinematics And Dynamics Of Robots	3	0	0	3
15ME345E	Design For Manufacturing And Assembly	3	0	0	3		15ME371E	Advanced Strength of Materials	3	0	0	3		15ME445E	Design Of Jigs, Fixtures And Press Tools	3	0	0	3
15ME346E	Non Traditional Machining Techniques	3	0	0	3		15ME372E	Thermal Energy Storage Systems	3	0	0	3		15ME446E	Robotic Sensors	3	0	0	3
15ME347E	Operations Research	3	0	0	3		15ME373E	Additive Manufacturing Technology	3	0	0	3		15ME447E	Simulation of Mechanical Systems	3	0	0	3
15ME348E	Computational Fluid Dynamics	3	0	0	3		15ME374E	Design of Heat Exchangers	3	0	0	3		15ME448E	Modeling Systems	3	0	0	3
15ME349E	Refrigeration And Air Conditioning Systems	3	0	0	3		15ME375E	Computer Graphics	3	0	0	3		15ME449E	Computer Applications in Design	3	0	0	3
15ME350E	Materials Management	3	0	0	3		15ME376E	Automotive Engineering	3	0	0	3							
15ME351E	Nuclear Radiation and Its Application	3	0	0	3		15ME377E	Nano Robotics	3	0	0	3							

B.Tech Mechanical Engineering (Regulations 2015)					
Course offered to other departments					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
15ME215	Thermodynamics And Fluid Mechanics	3	0	0	3
15ME216	Introduction to Manufacturing Engineering	2	0	0	2
15ME315E	Fundamentals of Hydraulics And Pneumatics	3	0	0	3

B. Tech. Mechanical Engineering
Curriculum – 2015-'16
(Applicable for students admitted from the Academic year 2015-16 onwards)

SEMESTER I& II						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
THEORY						
15LE101	G	ENGLISH	2	0	0	2
15LE102	G	VALUE EDUCATION	2	0	0	2
15PD101	G	SOFT SKILLS I	1	1	0	1
15PD102	G	SOFT SKILLS II	1	1	0	1
15MA101	B	CALCULUS AND SOLID GEOMETRY	3	1	0	4
15MA102	B	ADVANCED CALCULUS AND COMPLEX ANALYSIS	3	1	0	4
15PY101	B	PHYSICS	3	0	0	3
15CY101	B	CHEMISTRY	3	0	0	3
15BT101	B	BIOLOGY FOR ENGINEERS	2	0	0	2
15PY102L	B	MATERIALS SCIENCE	2	0	2	3
15CY102	B	PRINCIPLES OF ENVIRONMENTAL SCIENCE	2	0	0	2
15CE101	E	BASIC CIVIL ENGINEERING	2	0	0	2
15EE101	E	BASIC ELECTRICAL ENGINEERING	2	0	0	2
15EC101	E	BASIC ELECTRONICS ENGINEERING	2	0	0	2
15ME101	E	BASIC MECHANICAL ENGINEERING	2	0	0	2
15ME102	P	ENGINEERING MECHANICS	3	1	0	4
PRACTICAL						
15CS101L	E	PROGRAMMING LABORATORY	1	0	2	2
15PY101L	B	PHYSICS LABORATORY	0	0	2	1
15CY101L	B	CHEMISTRY LABORATORY	0	0	2	1
15ME103L	E	ACTIVE LEARNING LABORATORY	0	0	2	1
15ME104L	E	WORKSHOP PRACTICE	0	0	3	2
15ME105L	E	ENGINEERING GRAPHICS	1	0	4	3
15NC101 / 15NS101 / 15SP101 / 15YG101	G	*NCC/NSS/NSO/YOGA	0	0	1	1
TOTAL			**37**	**5**	**18**	**50**

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

Legend:
L - Number of lecture hours per week
T - Numberof 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
P - Professional Subjects

SEMESTER III & IV						
Course Name	**Category**	**Course Name**	**L**	**T**	**P**	**C**
THEORY						
15LE201E / 15LE202E / 15LE203E / 15LE204E / 15LE205E	G	GERMAN LANGUAGE PHASE - I / FRENCH LANGUAGE PHASE - I/ JAPANESE LANGUAGE PHASE - I / KOREAN LANGUAGE PHASE - I / CHINESE LANGUAGE PHASE - I	2	0	0	2
15LE207E / 15LE208E / 15LE209E / 15LE210E / 15LE211E	G	GERMAN LANGUAGE PHASE - II / FRENCH LANGUAGE PHASE - II/ JAPANESE LANGUAGE PHASE - II/ KOREAN LANGUAGE PHASE - II / CHINESE LANGUAGE PHASE - II	2	0	0	2
15PD201	G	QUANTITATIVE APTITUDE & LOGICAL REASONING –I	1	1	0	1
15PD202	G	VERBAL APTITUDE	1	1	0	1
15MA202	B	FOURIER SERIES, PARTIAL DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS	4	0	0	4
15MA206	B	NUMERICAL METHODS	4	0	0	4
15EI251	E	ELECTRONICS AND INSTRUMENTATION	3	0	0	3
15ME201	E	THERMODYNAMICS	2	2	0	3
15ME202	P	MANUFACTURING TECHNOLOGY	3	0	0	3
15ME205	P	FLUID MECHANICS	2	2	0	3
15ME203	P	MECHANICS OF SOLIDS	2	2	0	3
15ME206	P	APPLIED THERMAL ENGINEERING	3	1	0	4
15ME204	P	MACHINES AND MECHANISMS	2	2	0	3
15ME207	P	COMPUTER AIDED DESIGN AND ANALYSIS	3	0	0	3
PRACTICAL						
15EI251L	E	ELECTRONICS AND INSTRUMENTATION LABORATORY	0	0	2	1
15ME202L	P	MANUFACTURING PROCESS LABORATORY	0	0	2	1
15ME205L	P	FLUID DYNAMICS LABORATORY	0	0	2	1
15ME203L	P	STRENGTH OF MATERIALS LABORATORY	0	0	2	1
15ME207L	P	COMPUTER AIDED DESIGN LABORATORY	0	0	2	1
15ME208L	P	MANUFACTURING AND ASSEMBLY DRAWING	1	0	3	2
TOTAL			**35**	**11**	**13**	**46**

SEMESTER V&VI						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
THEORY						
15PD301	G	COMMUNICATION AND REASONING SKILLS	1	1	0	1
15PD302	G	QUANTITATIVE APTITUDE & LOGICAL REASONING –II	1	1	0	1
15MA301	B	PROBABILITY AND STATISTICS	4	0	0	4
15MA306	B	CALCULUS OF VARIATIONS AND NON-LINEAR PROGRAMMING	3	0	0	3
15ME301	P	FUNDAMENTALS OF VIBRATION AND NOISE	2	2	0	3
15ME305	P	MECHANICAL ENGINEERING DESIGN	2	2	0	3
15ME302	P	HEAT AND MASS TRANSFER	2	2	0	3
15ME303	P	MATERIALS TECHNOLOGY	3	0	0	3
15ME306	P	GAS DYNAMICS AND SPACE PROPULSION	2	2	0	3
15ME304	P	FLUID POWER CONTROL	3	0	0	3
15ME308M	P	MULTI-DISCIPLINARY DESIGN	2	2	0	3

	P	*DEPARTMENTAL ELECTIVE – I*	3	0	0	3
	P	*DEPARTMENTAL ELECTIVE – II*	3	0	0	3
	P	*OPEN ELECTIVE – I*	3	0	0	3
PRACTICAL						
15ME301L	P	MACHINE DYNAMICS LABORATORY	0	0	2	1
15ME306L	P	HEAT POWER LABORATORY	0	0	2	1
15ME303L	P	MATERIALS TECHNOLOGY LABORATORY	0	0	2	1
15ME304L	P	AUTOMATION LABORATORY	0	0	2	1
15ME302L	P	HEAT AND MASS TRANSFER LABORATORY	0	0	2	1
15ME390L	P	INDUSTRIAL TRAINING	0	0	2	1
15ME375L / 15ME380L / 15ME385L / 15ME490L	P	MINOR PROJECT I / SEMINAR I / MASSIVE OPEN ONLINE COURSES (MOOCs) I / INDUSTRY MODULE I	0	0	3	2
TOTAL			**34**	**12**	**15**	**47**

SEMESTER VII&VIII						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
THEORY						
15ME401	P	ECONOMICS AND PRINCIPLES OF MANAGEMENT	3	0	0	3
15ME402	P	METROLOGY AND QUALITY CONTROL	3	0	0	3
15ME403	P	DESIGN OF TRANSMISSION SYSTEMS	2	2	0	3
15ME404	P	COMPUTER AIDED MANUFACTURING	3	0	0	3
15ME405	P	ELEMENTS OF MECHATRONICS	3	0	0	3
	P	*DEPARTMENTAL ELECTIVE – III*	3	0	0	3
	P	*OPEN ELECTIVE – II*	3	0	0	3
PRACTICAL						
15ME402L	P	METROLOGY AND QUALITY CONTROL LABORATORY	0	0	2	1
15ME404L	P	COMPUTER AIDED MANUFACTURING LABORATORY	0	0	2	1
15ME376L / 15ME381L / 15ME386L / 15ME491L	P	MINOR PROJECT II / SEMINAR II / MASSIVE OPEN ONLINE COURSES (MOOCs) II / INDUSTRY MODULE II	0	0	3	2
15ME496L	P	MAJOR PROJECT	0	0	24	12
TOTAL			**20**	**2**	**31**	**37**

DEPARTMENTAL ELECTIVES						
Course code	**Category**	**Course name**	**L**	**T**	**P**	**C**
15ME326E	P	ROBOTICS ENGINEERING AND APPLICATIONS	3	0	0	3
15ME327E	P	INDUSTRIAL TRIBOLOGY	3	0	0	3
15ME328E	P	PROCESS PLANNING AND COST ESTIMATION	3	0	0	3
15ME329E	P	FOUNDRY ENGINEERING	3	0	0	3
15ME330E	P	INTERNAL COMBUSTION ENGINES	3	0	0	3
15ME331E	P	ALTERNATIVE SOURCES OF ENERGY	3	0	0	3
15ME332E	P	INDUSTRIAL ENGINEERING	3	0	0	3
15ME333E	P	THEORY OF METAL FORMING	3	0	0	3
15ME334E	P	PRODUCTION MANAGEMENT	3	0	0	3
15ME335E	P	ELEMENTS OF SPACE TECHNOLOGY	3	0	0	3
15ME336E	P	INTRODUCTION TO NUCLEAR REACTOR CONCEPTS	3	0	0	3
15ME337E	P	WELDING TECHNOLOGY	3	0	0	3
15ME338E	P	ADVANCED FLUID MECHANICS	3	0	0	3

15ME339E	P	MECHANICAL HANDLING SYSTEMS AND EQUIPMENT	3	0	0	3
15ME340E	P	DESIGN OF EXPERIMENTS	3	0	0	3
15ME341E	P	SUSTAINABLE GREEN MANUFACTURING	3	0	0	3
15ME342E	P	ENERGY SYSTEMS FOR BUILDINGS	3	0	0	3
15ME343E	P	SOLAR ENERGY UTILIZATION	3	0	0	3
15ME344E	P	MECHANISM DESIGN, ANALYSIS AND SYNTHESIS	3	0	0	3
15ME345E	P	DESIGN FOR MANUFACTURING AND ASSEMBLY	3	0	0	3
15ME346E	P	NON TRADITIONAL MACHINING TECHNIQUES	3	0	0	3
15ME347E	P	OPERATIONS RESEARCH	3	0	0	3
15ME348E	P	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3
15ME349E	P	REFRIGERATION AND AIR CONDITIONING SYSTEMS	3	0	0	3
15ME350E	P	MATERIALS MANAGEMENT	3	0	0	3
15ME351E	P	NUCLEAR RADIATION AND ITS APPLICATION	3	0	0	3
15ME352E	P	ADVANCED ENGINEERING THERMODYNAMICS	3	0	0	3
15ME353E	P	TQM AND RELIABILITY ENGINEERING	3	0	0	3
15ME354E	P	MODERN CONTROL THEORY	3	0	0	3
15ME355E	P	INTRODUCTION TO HUMAN BODY MECHANICS	3	0	0	3
15ME356E	P	FINITE ELEMENT METHODS	3	0	0	3
15ME357E	P	OPTIMISATION IN ENGINEERING DESIGN	3	0	0	3
15ME358E	P	MODERN MANUFACTURING TECHNIQUES	3	0	0	3
15ME359E	P	TOOL ENGINEERING DESIGN	3	0	0	3
15ME360E	P	ENERGY ENGINEERING AND MANAGEMENT	3	0	0	3
15ME361E	P	TURBOMACHINES	3	0	0	3
15ME362E	P	THERMAL POWER SYSTEMS	3	0	0	3
15ME363E	P	FACILITIES PLANNING	3	0	0	3
15ME364E	P	INDUSTRIAL SAFETY AND ENVIRONMENT	3	0	0	3
15ME365E	P	DESIGN OF PUMPS AND TURBINES	3	0	0	3
15ME366E	P	NUCLEAR POWER GENERATION AND SUPPLY	3	0	0	3
15ME367E	P	ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS	3	0	0	3
15ME368E	P	MICRO CONTROLLER AND ITS APPLICATION IN ROBOTICS	3	0	0	3
15ME369E	P	MACHINERY FAULT DIAGNOSTICS AND SIGNAL PROCESSING	3	0	0	3
15ME370E	P	ENVIRONMENTAL POLLUTION AND ABATEMENT	3	0	0	3
15ME371E	P	ADVANCED STRENGTH OF MATERIALS	3	0	0	3
15ME372E	P	THERMAL ENERGY STORAGE SYSTEMS	3	0	0	3
15ME373E	P	ADDITIVE MANUFACTURING TECHNOLOGY	3	0	0	3
15ME374E	P	DESIGN OF HEAT EXCHANGERS	3	0	0	3
15ME375E	P	COMPUTER GRAPHICS	3	0	0	3
15ME376E	P	AUTOMOTIVE ENGINEERING	3	0	0	3
15ME377E	P	NANO ROBOTICS	3	0	0	3
15ME426E	P	DIGITAL IMAGE PROCESSING AND MACHINE VISION	3	0	0	3
15ME427E	P	FATIGUE , FRACTURE MECHANICS AND CREEP	3	0	0	3
15ME428E	P	FLEXIBLE MANUFACTURING SYSTEMS	3	0	0	3
15ME429E	P	PRECISION ENGINEERING	3	0	0	3
15ME430E	P	SOLAR ENERGY SYSTEMS	3	0	0	3
15ME431E	P	TECHNOLOGY OF SURFACE COATING	3	0	0	3
15ME432E	P	COMBUSTION ENGINEERING	3	0	0	3
15ME433E	P	SUSTAINABLE ENERGY SYSTEMS	3	0	0	3

15ME434E	P	SUPPLY CHAIN MANAGEMENT	3	0	0	3
15ME435E	P	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	3	0	0	3
15ME436E	P	COMPOSITE MATERIALS AND MECHANICS	3	0	0	3
15ME437E	P	GLOBAL OPTIMIZATION ALGORITHMS	3	0	0	3
15ME438E	P	MODELING OF THERMAL SYSTEMS	3	0	0	3
15ME439E	P	NEURAL NETWORK AND FUZZY SYSTEMS	3	0	0	3
15ME440E	P	GAS TURBINE TECHNOLOGY	3	0	0	3
15ME441E	P	FUEL CELL TECHNOLOGY	3	0	0	3
15ME442E	P	LINEAR ELASTICITY	3	0	0	3
15ME443E	P	DESIGN OF PRESSURE VESSEL AND PIPING	3	0	0	3
15ME444E	P	KINEMATICS AND DYNAMICS OF ROBOTS	3	0	0	3
15ME445E	P	DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	3	0	0	3
15ME446E	P	ROBOTIC SENSORS	3	0	0	3
15ME447E	P	SIMULATION OF MECHANICAL SYSTEMS	3	0	0	3
15ME448E	P	MODELING SYSTEMS	3	0	0	3
15ME449E	P	COMPUTER APPLICATIONS IN DESIGN	3	0	0	3

COURSES OFFERED TO OTHER DEPARTMENTS						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
15ME215	P	Thermodynamics And Fluid Mechanics	3	0	0	3
15ME216	P	Introduction to Manufacturing Engineering	2	0	0	2
15ME315E	P	Fundamentals of Hydraulics And Pneumatics	3	0	0	3

Summary of credits						
Category	**I& II**	**III & IV**	**V & VI**	**VII & VIII**	**Total**	**%**
G	**7**	**6**	**2**	**0**	**15**	**8.33%**
B	**23**	**8**	**7**	**0**	**38**	**21.11%**
E	**16**	**7**	**0**	**0**	**23**	**12.78%**
P	**4**	**25**	**29**	**31**	**89**	**49.44%**
Open Elective	**0**	**0**	**3**	**3**	**6**	**3.33%**
Departmental Elective	**0**	**0**	**6**	**3**	**9**	**5.00%**
Total	**50**	**46**	**47**	**37**	**180**	**100**

B. Tech. Mechanical Engineering Curriculum – 2015-'16
INDO-GERMAN ENGINEERING PROGRAM
(Applicable for students admitted from the Academic year 2015-16 onwards)

SEMESTER I& II						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
THEORY						
15LE103	G	BASIC GERMAN - I	4	4	0	6
15LE104	G	BASIC GERMAN - II	4	4	0	6
15MA101	B	CALCULUS AND SOLID GEOMETRY	3	1	0	4
15MA102	B	ADVANCED CALCULUS AND COMPLEX ANALYSIS	3	1	0	4
15PY101	B	PHYSICS	3	0	0	3
15CY101	B	CHEMISTRY	3	0	0	3
15PY102L	B	MATERIAL SCIENCE	2	0	2	3
15CY102	B	PRINCIPLES OF ENVIRONMENTAL SCIENCE	2	0	0	2
15CE101	E	BASIC CIVIL ENGINEERING	2	0	0	2
15EE101	E	BASIC ELECTRICAL ENGINEERING	2	0	0	2
15EC101	E	BASIC ELECTRONICS ENGINEERING	2	0	0	2
15ME101	E	BASIC MECHANICAL ENGINEERING	2	0	0	2
15ME102	P	ENGINEERING MECHANICS	3	1	0	4
PRACTICAL						
15PY101L	B	PHYSICS LABORATORY	0	0	2	1
15CY101L	B	CHEMISTRY LABORATORY	0	0	2	1
15ME104L	E	WORKSHOP PRACTICE	0	0	3	2
15ME105L	E	ENGINEERING GRAPHICS	1	0	4	3
TOTAL			**36**	**11**	**13**	**50**

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
P - Professional Subjects

SEMESTER III & IV						
Course Name	**Category**	**Course Name**	**L**	**T**	**P**	**C**
THEORY						
15LE206	G	ADVANCED GERMAN - I	4	4	0	6
15LE212	G	ADVANCED GERMAN - II	4	4	0	6
15MA202	B	FOURIER SERIES, PARTIAL DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS	4	0	0	4
15MA206	B	NUMERICAL METHODS	4	0	0	4
15ME201	E	THERMODYNAMICS	2	2	0	3
15ME202	P	MANUFACTURING TECHNOLOGY	3	0	0	3
15ME205	P	FLUID MECHANICS	2	2	0	3
15ME203	P	MECHANICS OF SOLIDS	2	2	0	3
15ME206	P	APPLIED THERMAL ENGINEERING	3	1	0	4
15ME204	P	MACHINES AND MECHANISMS	2	2	0	3
15ME207	P	COMPUTER AIDED DESIGN AND ANALYSIS	3	0	0	3
PRACTICAL						
15ME202L	P	MANUFACTURING PROCESS LABORATORY	0	0	2	1
15ME205L	P	FLUID DYNAMICS LABORATORY	0	0	2	1
15ME203L	P	STRENGTH OF MATERIALS LABORATORY	0	0	2	1
15ME207L	P	COMPUTER AIDED DESIGN LABORATORY	0	0	2	1
15CS101L	E	PROGRAMMING LABORATORY	1	0	2	2
TOTAL			**34**	**17**	**10**	**48**

SEMESTER V&VI						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
THEORY						
15LE307	G	ADVANCED GERMAN - III	5	4	0	7
15ME301	P	FUNDAMENTALS OF VIBRATION AND NOISE	2	2	0	3
15ME305	P	MECHANICAL ENGINEERING DESIGN	2	2	0	3
15ME302	P	HEAT AND MASS TRANSFER	2	2	0	3
15ME303	P	MATERIALS TECHNOLOGY	3	0	0	3
15ME306	P	GAS DYNAMICS AND SPACE PROPULSION	2	2	0	3
15ME304	P	FLUID POWER CONTROL	3	0	0	3
15ME308M	P	MULTI-DISCIPLINARY DESIGN	2	2	0	3
	P	*DEPARTMENTAL ELECTIVE – I*	3	0	0	3
	P	*DEPARTMENTAL ELECTIVE – II*	3	0	0	3
	P	*OPEN ELECTIVE – I*	3	0	0	3
	P	*OPEN ELECTIVE – II*	3	0	0	3
PRACTICAL						
15ME301L	P	MACHINE DYNAMICS LABORATORY	0	0	2	1
15ME306L	P	HEAT POWER LABORATORY	0	0	2	1
15ME303L	P	MATERIALS TECHNOLOGY LABORATORY	0	0	2	1
15ME304L	P	AUTOMATION LABORATORY	0	0	2	1
15ME302L	P	HEAT AND MASS TRANSFER LABORATORY	0	0	2	1
TOTAL			**33**	**14**	**10**	**45**

DEPARTMENTAL ELECTIVES						
Course code	**Category**	**Course name**	**L**	**T**	**P**	**C**
15ME326E	P	ROBOTICS ENGINEERING AND APPLICATIONS	3	0	0	3
15ME327E	P	INDUSTRIAL TRIBOLOGY	3	0	0	3

15ME328E	P	PROCESS PLANNING AND COST ESTIMATION	3	0	0	3
15ME329E	P	FOUNDRY ENGINEERING	3	0	0	3
15ME330E	P	INTERNAL COMBUSTION ENGINES	3	0	0	3
15ME331E	P	ALTERNATIVE SOURCES OF ENERGY	3	0	0	3
15ME332E	P	INDUSTRIAL ENGINEERING	3	0	0	3
15ME333E	P	THEORY OF METAL FORMING	3	0	0	3
15ME334E	P	PRODUCTION MANAGEMENT	3	0	0	3
15ME335E	P	ELEMENTS OF SPACE TECHNOLOGY	3	0	0	3
15ME336E	P	INTRODUCTION TO NUCLEAR REACTOR CONCEPTS	3	0	0	3
15ME337E	P	WELDING TECHNOLOGY	3	0	0	3
15ME338E	P	ADVANCED FLUID MECHANICS	3	0	0	3
15ME339E	P	MECHANICAL HANDLING SYSTEMS AND EQUIPMENT	3	0	0	3
15ME340E	P	DESIGN OF EXPERIMENTS	3	0	0	3
15ME341E	P	SUSTAINABLE GREEN MANUFACTURING	3	0	0	3
15ME342E	P	ENERGY SYSTEMS FOR BUILDINGS	3	0	0	3
15ME343E	P	SOLAR ENERGY UTILIZATION	3	0	0	3
15ME344E	P	MECHANISM DESIGN, ANALYSIS AND SYNTHESIS	3	0	0	3
15ME345E	P	DESIGN FOR MANUFACTURING AND ASSEMBLY	3	0	0	3
15ME346E	P	NON TRADITIONAL MACHINING TECHNIQUES	3	0	0	3
15ME347E	P	OPERATIONS RESEARCH	3	0	0	3
15ME348E	P	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3
15ME349E	P	REFRIGERATION AND AIR CONDITIONING SYSTEMS	3	0	0	3
15ME350E	P	MATERIALS MANAGEMENT	3	0	0	3
15ME351E	P	NUCLEAR RADIATION AND ITS APPLICATION	3	0	0	3
15ME352E	P	ADVANCED ENGINEERING THERMODYNAMICS	3	0	0	3
15ME353E	P	TQM AND RELIABILITY ENGINEERING	3	0	0	3
15ME354E	P	MODERN CONTROL THEORY	3	0	0	3
15ME355E	P	INTRODUCTION TO HUMAN BODY MECHANICS	3	0	0	3
15ME356E	P	FINITE ELEMENT METHODS	3	0	0	3
15ME357E	P	OPTIMISATION IN ENGINEERING DESIGN	3	0	0	3
15ME358E	P	MODERN MANUFACTURING TECHNIQUES	3	0	0	3
15ME359E	P	TOOL ENGINEERING DESIGN	3	0	0	3
15ME360E	P	ENERGY ENGINEERING AND MANAGEMENT	3	0	0	3
15ME361E	P	TURBOMACHINES	3	0	0	3
15ME362E	P	THERMAL POWER SYSTEMS	3	0	0	3
15ME363E	P	FACILITIES PLANNING	3	0	0	3
15ME364E	P	INDUSTRIAL SAFETY AND ENVIRONMENT	3	0	0	3
15ME365E	P	DESIGN OF PUMPS AND TURBINES	3	0	0	3
15ME366E	P	NUCLEAR POWER GENERATION AND SUPPLY	3	0	0	3
15ME367E	P	ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS	3	0	0	3
15ME368E	P	MICRO CONTROLLER AND ITS APPLICATION IN ROBOTICS	3	0	0	3
15ME369E	P	MACHINERY FAULT DIAGNOSTICS AND SIGNAL PROCESSING	3	0	0	3
15ME370E	P	ENVIRONMENTAL POLLUTION AND ABATEMENT	3	0	0	3
15ME371E	P	ADVANCED STRENGTH OF MATERIALS	3	0	0	3
15ME372E	P	THERMAL ENERGY STORAGE SYSTEMS	3	0	0	3
15ME373E	P	ADDITIVE MANUFACTURING TECHNOLOGY	3	0	0	3
15ME374E	P	DESIGN OF HEAT EXCHANGERS	3	0	0	3

15ME375E	P	COMPUTER GRAPHICS	3	0	0	3
15ME376E	P	AUTOMOTIVE ENGINEERING	3	0	0	3
15ME377E	P	NANO ROBOTICS	3	0	0	3
15ME426E	P	DIGITAL IMAGE PROCESSING AND MACHINE VISION	3	0	0	3
15ME427E	P	FATIGUE , FRACTURE MECHANICS AND CREEP	3	0	0	3
15ME428E	P	FLEXIBLE MANUFACTURING SYSTEMS	3	0	0	3
15ME429E	P	PRECISION ENGINEERING	3	0	0	3
15ME430E	P	SOLAR ENERGY SYSTEMS	3	0	0	3
15ME431E	P	TECHNOLOGY OF SURFACE COATING	3	0	0	3
15ME432E	P	COMBUSTION ENGINEERING	3	0	0	3
15ME433E	P	SUSTAINABLE ENERGY SYSTEMS	3	0	0	3
15ME434E	P	SUPPLY CHAIN MANAGEMENT	3	0	0	3
15ME435E	P	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	3	0	0	3
15ME436E	P	COMPOSITE MATERIALS AND MECHANICS	3	0	0	3
15ME437E	P	GLOBAL OPTIMIZATION ALGORITHMS	3	0	0	3
15ME438E	P	MODELING OF THERMAL SYSTEMS	3	0	0	3
15ME439E	P	NEURAL NETWORK AND FUZZY SYSTEMS	3	0	0	3
15ME440E	P	GAS TURBINE TECHNOLOGY	3	0	0	3
15ME441E	P	FUEL CELL TECHNOLOGY	3	0	0	3
15ME442E	P	LINEAR ELASTICITY	3	0	0	3
15ME443E	P	DESIGN OF PRESSURE VESSEL AND PIPING	3	0	0	3
15ME444E	P	KINEMATICS AND DYNAMICS OF ROBOTS	3	0	0	3
15ME445E	P	DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	3	0	0	3
15ME446E	P	ROBOTIC SENSORS	3	0	0	3
15ME447E	P	SIMULATION OF MECHANICAL SYSTEMS	3	0	0	3
15ME448E	P	MODELING SYSTEMS	3	0	0	3
15ME449E	P	COMPUTER APPLICATIONS IN DESIGN	3	0	0	3

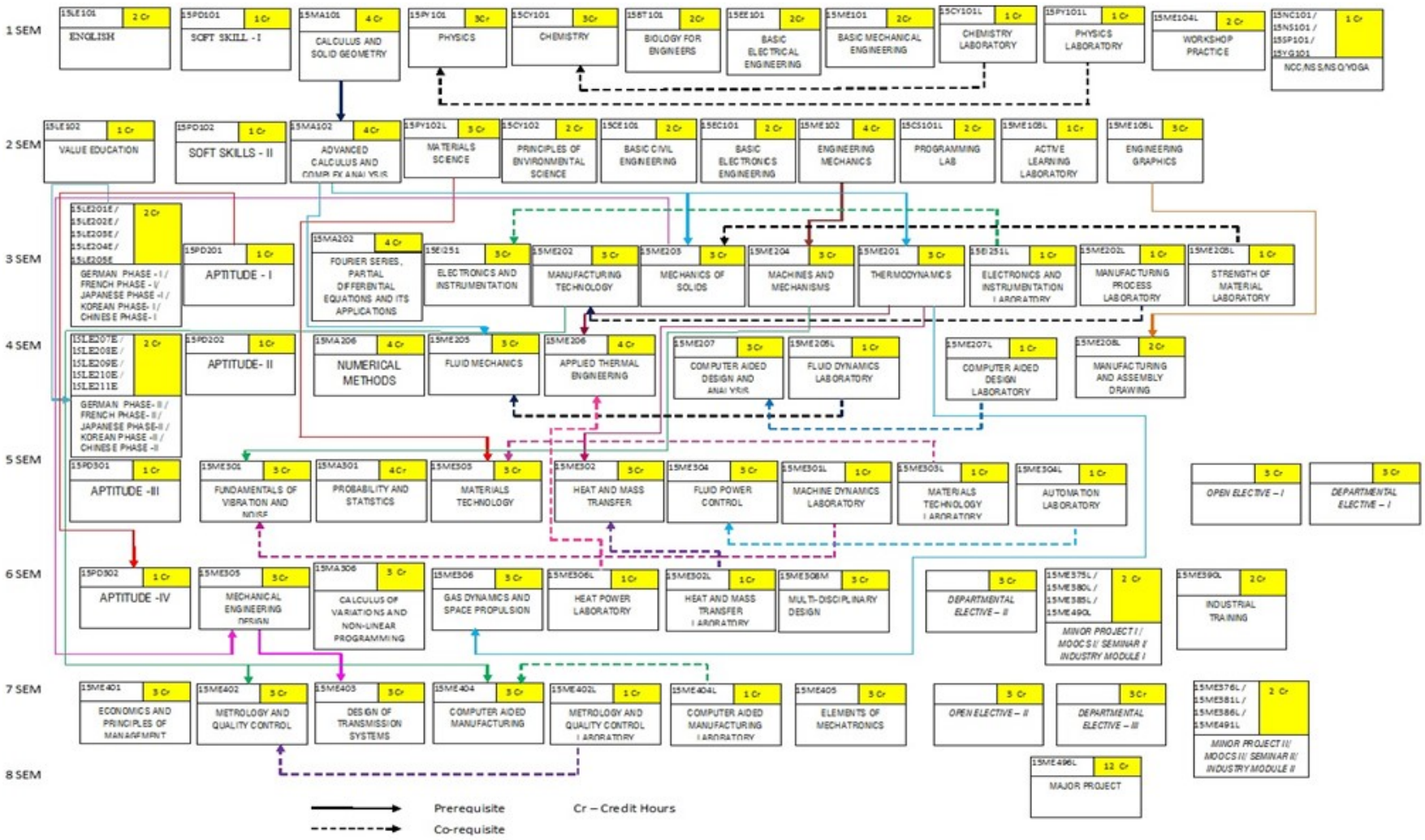
Summary of credits					
Category	**I & II**	**III & IV**	**V & VI**	**Total**	**%**
G	**12**	**12**	**7**	**31**	**21.68%**
B	**21**	**8**	**0**	**29**	**20.28%**
E	**13**	**5**	**0**	**18**	**12.59%**
P	**4**	**23**	**26**	**53**	**37.06%**
Open Elective	**0**	**0**	**6**	**6**	**4.20%**
Departmental Elective	**0**	**0**	**6**	**6**	**4.20%**
Total	**50**	**48**	**45**	**143**	**100.00%**

		L	**T**	**P**	**C**
Total credits up to III year for Indo-German students:		**103**	**42**	**33**	**143**
Total credits up to III year for Regular students:		**106**	**28**	**46**	**143**

B. Tech. Mechanical Engineering
Curriculum – 2015-'16
(Applicable for students admitted from the Academic year 2015-16 onwards)

Course code	Course name	Prerequisite	Co-requisite
15LE101	ENGLISH		
15LE102	VALUE EDUCATION		
15PD101	SOFT SKILLS I		
15PD102	SOFT SKILLS II		
15MA101	CALCULUS AND SOLID GEOMETRY		
15MA102	ADVANCED CALCULUS AND COMPLEX ANALYSIS	15MA101	
15PY101	PHYSICS		
15CY101	CHEMISTRY		
15BT101	BIOLOGY FOR ENGINEERS		
15PY102L	MATERIALS SCIENCE		
15CY102	PRINCIPLES OF ENVIRONMENTAL SCIENCE		
15CE101	BASIC CIVIL ENGINEERING		
15EE101	BASIC ELECTRICAL ENGINEERING		
15EC101	BASIC ELECTRONICS ENGINEERING		
15ME101	BASIC MECHANICAL ENGINEERING		
15ME102	ENGINEERING MECHANICS		
15CS101L	PROGRAMMING LAB		
15PY101L	PHYSICS LABORATORY		15PY101
15CY101L	CHEMISTRY LABORATORY		15CY101
15ME103L	ACTIVE LEARNING LABORATORY		
15ME104L	WORKSHOP PRACTICE		
15ME105L	ENGINEERING GRAPHICS		
15NC101 / 15NS101 / 15SP101 / 15YG101	*NCC/NSS/NSO/YOGA		
15LE201E / 15LE202E / 15LE203E / 15LE204E / 15LE205E	GERMAN LANGUAGE PHASE I / FRENCH LANGUAGE PHASE I/ JAPANESE LANGUAGE PHASE I / KOREAN LANGUAGE PHASE I / CHINESE LANGUAGE PHASE I		
15LE207E / 15LE208E / 15LE209E / 15LE210E / 15LE211E	GERMAN LANGUAGE PHASE II / FRENCH LANGUAGE PHASE II/ JAPANESE LANGUAGE PHASE II/ KOREAN LANGUAGE PHASE II / CHINESE LANGUAGE PHASE II	15LE201E / 15LE202E / 15LE203E / 15LE204E / 15LE205E	
15PD201	APTITUDE I		
15PD202	APTITUDE II		
15MA202	FOURIER SERIES, PARTIAL DIFFERENTIAL EQUATIONS AND ITS APPLICATIONS		
15MA206	NUMERICAL METHODS		
15EI251	ELECTRONICS AND INSTRUMENTATION		
15ME201	THERMODYNAMICS	15MA102	
15ME202	MANUFACTURING TECHNOLOGY		
15ME205	FLUID MECHANICS	15MA102	
15ME203	MECHANICS OF SOLIDS	15MA102	
15ME206	APPLIED THERMAL ENGINEERING	15ME201	
15ME204	MACHINES AND MECHANISMS	15ME102	
15ME207	COMPUTER AIDED DESIGN AND ANALYSIS		
15EI251L	ELECTRONICS AND INSTRUMENTATION		15EI251

	LABORATORY		
15ME202L	MANUFACTURING PROCESS LABORATORY		15ME202
15ME205L	FLUID DYNAMICS LABORATORY		15ME205
15ME203L	STRENGTH OF MATERIALS LABORATORY		15ME203
15ME207L	COMPUTER AIDED DESIGN LABORATORY		15ME207
15ME208L	MANUFACTURING AND ASSEMBLY DRAWING	15ME105L	
15PD301	APTITUDE III		
15PD302	APTITUDE IV	15PD201	
15MA301	PROBABILITY AND STATISTICS		
15MA306	CALCULUS OF VARIATIONS AND NON-LINEAR PROGRAMMING		
15ME301	FUNDAMENTALS OF VIBRATION AND NOISE	15ME204	
15ME305	MECHANICAL ENGINEERING DESIGN	15ME203	
15ME302	HEAT AND MASS TRANSFER	15ME201	
15ME303	MATERIALS TECHNOLOGY		
15ME306	GAS DYNAMICS AND SPACE PROPULSION	15ME201	
15ME304	FLUID POWER CONTROL		
15ME308M	MULTI-DISCIPLINARY DESIGN		
	DEPARTMENTAL ELECTIVE – I		
	DEPARTMENTAL ELECTIVE – II		
	OPEN ELECTIVE – I		
15ME301L	MACHINE DYNAMICS LABORATORY		15ME301
15ME306L	HEAT POWER LABORATORY		15ME206
15ME303L	MATERIALS TECHNOLOGY LABORATORY		15ME303
15ME304L	AUTOMATION LABORATORY		15ME304
15ME302L	HEAT AND MASS TRANSFER LABORATORY		15ME302
15ME390L	INDUSTRIAL TRAINING		
15ME375L / 15ME380L / 15ME385L / 15ME490L	MINOR PROJECT /SEMINAR / MOOCS / INDUSTRY MODULE –I		
15ME401	ECONOMICS AND PRINCIPLES OF MANAGEMENT		
15ME402	METROLOGY AND QUALITY CONTROL	15ME202	
15ME403	DESIGN OF TRANSMISSION SYSTEMS	15ME305	
15ME404	COMPUTER AIDED MANUFACTURING	15ME202	
15ME405	ELEMENTS OF MECHATRONICS		
	DEPARTMENTAL ELECTIVE – III		
	OPEN ELECTIVE – II		
15ME402L	METROLOGY AND QUALITY CONTROL LABORATORY		15ME402
15ME404L	COMPUTER AIDED MANUFACTURING LABORATORY		15ME404
15ME496L	MAJOR PROJECT		


1 SEM
15LE101 2 Cr ENGLISH
15PD101 1 Cr SOFT SKILL - I
15MA101 4 Cr CALCULUS AND SOLID GEOMETRY
15PY101 3Cr PHYSICS
15CY101 3Cr CHEMISTRY
15BT101 2Cr BIOLOGY FOR ENGINEERS
15EE101 2Cr BASIC ELECTRICAL ENGINEERING
15ME101 2Cr BASIC MECHANICAL ENGINEERING
15CY101L 1 Cr CHEMISTRY LABORATORY
15PY101L 1 Cr PHYSICS LABORATORY
15ME104L 2 Cr WORKSHOP PRACTICE
15NC101 / 15NS101 / 15SP101 / 15YG301 1 Cr NCC/NSS/NSO/YOGA
2 SEM
15LE102 1 Cr VALUE EDUCATION
15PD102 1 Cr SOFT SKILLS - II
15MA102 4Cr ADVANCED CALCULUS AND COMPLEX ANALYSIS
15PY102L 3 Cr MATERIALS SCIENCE
15CY102 2 Cr PRINCIPLES OF ENVIRONMENTAL SCIENCE
15CE101 2 Cr BASIC CIVIL ENGINEERING
15EC101 2 Cr BASIC ELECTRONICS ENGINEERING
15ME102 4 Cr ENGINEERING MECHANICS
15CS101L 2 Cr PROGRAMMING LAB
15ME108L 1 Cr ACTIVE LEARNING LABORATORY
15ME105L 3 Cr ENGINEERING GRAPHICS
3 SEM
15LE201E / 15LE202E / 15LE203E / 15LE204E / 15LE205E 2 Cr GERMAN PHASE - I / FRENCH PHASE - V JAPANESE PHASE -I / KOREAN PHASE- I / CHINESE PHASE - I
15PD201 1 Cr APTITUDE - I
15MA202 4 Cr FOURIER SERIES, PARTIAL DIFFERENTIAL EQUATIONS AND ITS APPLICATIONS
15EI251 3 Cr ELECTRONICS AND INSTRUMENTATION
15ME202 3 Cr MANUFACTURING TECHNOLOGY
15ME203 3 Cr MECHANICS OF SOLIDS
15ME204 3 Cr MACHINES AND MECHANISMS
15ME201 3 Cr THERMODYNAMICS
15EI251L 1 Cr ELECTRONICS AND INSTRUMENTATION LABORATORY
15ME202L 1 Cr MANUFACTURING PROCESS LABORATORY
15ME208L 1 Cr STRENGTH OF MATERIAL LABORATORY
4 SEM
15LE207E / 15LE208E / 15LE209E / 15LE210E / 15LE211E 2 Cr GERMAN PHASE- II / FRENCH PHASE- II / JAPANESE PHASE-II / KOREAN PHASE -II / CHINESE PHASE -II
15PD202 1 Cr APTITUDE- II
15MA206 4 Cr NUMERICAL METHODS
15ME205 3 Cr FLUID MECHANICS
15ME206 4 Cr APPLIED THERMAL ENGINEERING
15ME207 3 Cr COMPUTER AIDED DESIGN AND ANALYSIS
15ME208L 1 Cr FLUID DYNAMICS LABORATORY
15ME207L 1 Cr COMPUTER AIDED DESIGN LABORATORY
15ME209L 2 Cr MANUFACTURING AND ASSEMBLY DRAWING
5 SEM
15PD301 1 Cr APTITUDE -III
15ME501 3 Cr FUNDAMENTALS OF VIBRATION AND NOISE
15MA301 4 Cr PROBABILITY AND STATISTICS
15ME505 3 Cr MATERIALS TECHNOLOGY
15ME502 3 Cr HEAT AND MASS TRANSFER
15ME304 3 Cr FLUID POWER CONTROL
15ME503L 1 Cr MACHINE DYNAMICS LABORATORY
15ME505L 1 Cr MATERIALS TECHNOLOGY LABORATORY
15ME504L 1 Cr AUTOMATION LABORATORY
3 Cr OPEN ELECTIVE – I
3 Cr DEPARTMENTAL ELECTIVE – I
6 SEM
15PD302 1 Cr APTITUDE -IV
15ME505 3 Cr MECHANICAL ENGINEERING DESIGN
15MA306 3 Cr CALCULUS OF VARIATIONS AND NON-LINEAR PROGRAMMING
15ME506 3 Cr GAS DYNAMICS AND SPACE PROPULSION
15ME506L 1 Cr HEAT POWER LABORATORY
15ME502L 1 Cr HEAT AND MASS TRANSFER LABORATORY
15ME508M 3 Cr MULTI-DISCIPLINARY DESIGN
3 Cr DEPARTMENTAL ELECTIVE – II
15ME375L / 15ME380L / 15ME385L / 15ME490L 2 Cr MINOR PROJECT I / MOOCS I/ SEMINAR I/ INDUSTRY MODULE I
15ME590L 2Cr INDUSTRIAL TRAINING
7 SEM
15ME401 3 Cr ECONOMICS AND PRINCIPLES OF MANAGEMENT
15ME402 3 Cr METROLOGY AND QUALITY CONTROL
15ME403 3 Cr DESIGN OF TRANSMISSION SYSTEMS
15ME404 3 Cr COMPUTER AIDED MANUFACTURING
15ME402L 1 Cr METROLOGY AND QUALITY CONTROL LABORATORY
15ME404L 1 Cr COMPUTER AIDED MANUFACTURING LABORATORY
15ME405 3 Cr ELEMENTS OF MECHATRONICS
3 Cr OPEN ELECTIVE – II
3 Cr DEPARTMENTAL ELECTIVE – III
15ME376L / 15ME381L / 15ME386L / 15ME491L 2 Cr MINOR PROJECT II/ MOOCS II/ SEMINAR II/ INDUSTRY MODULE II
8 SEM
15ME496L 12 Cr MAJOR PROJECT
Prerequisite
Co-requisite
Cr – Credit Hours

B.Tech. Mechanical Engineering
Curriculum – 2015-'16
(Applicable for students admitted from the Academic year 2015-16 onwards)

Course offered by Mechanical Engineering Department
Contents

15ME101	BASIC MECHANICAL ENGINEERING	L	T	P	C
		2	0	0	2
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 July 2016				

PURPOSE	To familiarize the students with the basics of Mechanical Engineering.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student should be able to understand								
1.	Basic machine elements	a	e					
2.	Sources of Energy and Power Generation	a	e					
3.	Various manufacturing processes	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I- MACHINE ELEMENTS	**6**			
1.	Springs: Helical and leaf springs, Classification, Terms, Materials	1	C	1	1
2.	Springs in series and parallel, Importance of the combination of springs, Applications of springs, numerical in springs	1	C, D	1	1
3.	Cams: Types of cams and followers , Classification, Based on Input / Output Motion, Follower configuration, Follower arrangement and Cam shape	1	C	1	1
4.	Cam profile, Cam nomenclature, Application, Motion of the follower	1	C	1	1
5.	Power Transmission , Gears terminology, Spur , Helical ,Bevel gears and gear trains applications	1	C	1	1
6.	Belt drives, Types of belt drives, Belt materials and Applications, problems on open and cross belt drives, Chain drives, Comparison of gear, belt drives and chain drives	1	C, D	1	1
	UNIT II – ENERGY SOURCES	6			
7.	Renewable and Nonrenewable Sources, Characteristics, types, Advantages and disadvantages	1	C	2	3
8.	Solar thermal systems and tower power generation, Solar photovoltaic system	1	C	2	3
9.	Wind energy, Horizontal axis wind turbines, Vertical axis wind turbines, advantages and disadvantages	1	C	2	3
10.	Geothermal energy, Indian geothermal sources, advantages and disadvantages	1	C	2	3
11.	Ocean energy, ocean thermal energy conversion	1	C	2	3
12.	Tidal energy , Single pool tidal energy conversion system	1	C	2	3
	UNIT III - POWER GENERATION	**6**			
13.	Power Generation: external and internal combustion engines	1	C	2	3
14.	Classification of engines, Engine operations: 2 stroke & 4 stroke, Comparison of SI & CI engines	1	C	2	3
15.	Overview of fuels, Applications, Numerical–internal combustion engines	1	C,D	2	3
16.	Thermal Power Plants: layouts, element/component	1	C	2	3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	description, advantages, disadvantages, applications				
17.	Hydro power plants : layouts, element/component description, advantages, disadvantages, applications	1	C	2	3
18.	Nuclear power plant :layouts, element/component description, advantages, disadvantages, applications, Element/component description of boiling water reactor and pressurized water reactor	1	C	2	3
	UNIT IV: MANUFACTURING PROCESSES I	**6**			
19.	Sheet metal work : Introduction, equipment, Tools, accessories	1	C	3	2
20.	Sheet metal Various processes	1	C	3	2
21.	Sheet metal application, advantages and disadvantages.	1	C	3	2
22.	Welding : Types, Equipment, Tools and accessories, Techniques employed	1	C	3	2
23.	Applications of gas and arc welding , gas cutting	1	C	3	2
24.	Brazing and soldering, Advantages and disadvantages	1	C	3	2
	UNIT V: MANUFACTURING PROCESSES II	**6**			
25.	Lathe Practice: Types, Description of main components	1	C	3	2
26.	Lathe Cutting tools and Work holding devices ,basic operations	1	C	3	2
27.	Numerical on lathe operations	1	C, D	3	2
28.	Drilling Practice : Introduction, Types, Description, Drilling Tools	1	C	3	2
29.	Drilling operations, special operations on drilling machines, drill holding devices	1	C	3	2
30.	Numerical on drilling operations	1	C, D	3	2
	Total contact hours*	**30**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Merhyle F. Spotts , Terry E. Shoup " *Design of Machine Elements*", Pearson; 8th Edition, 2003
2.	SeropeKalpakjian, Steven Schmid," *Manufacturing Processes for Engineering Materials*", Pearson, 2016
3.	Drbal, Larry F. Boston, Patricia G. Westra, Kayla L. Black, Veatch, "*Power Plant Engineering*", Kluwer Academic Pub., 1995
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Andy Walker, "*Solar Energy*", John Wiley & Sons, 2013
5.	John G. Edwards, "*Lathe Operation and Maintenance*", Carl HanserVerlag GmbH & Co, 2003.
6.	EfstathiosE.Stathis, Michaelides, "*Alternative Energy Sources*", Springer, 2012
7.	Kumar. T, Leenus Jesu Martin and Murali. G, "*Basic Mechanical Engineering*", Suma Publications, Chennai, 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%**
End semester examination Weightage :							**50%**

15ME102	**ENGINEERING MECHANICS**	**L**	**T**	**P**	**C**

			3	**1**	**0**	**4**
Co-requisite:	Nil					
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 July 2016					

PURPOSE	To develop the ability in the engineering student, to understand, formulate, and solve a given problem in a logical manner and to apply it to solve a few basic problems in engineering mechanics.

INSTRUCTIONAL OBJECTIVES		**STUDENTOUTCOMES**						
At the end of the course, student will be able to apply concepts of								
1.	Static equilibrium of particles and rigid bodies	a	e					
2.	Friction and its applications	a	e					
3.	Trusses and centroids	a	e					
4.	Moment of inertia of surfaces and volumes	a	e					
5.	Dynamic equilibrium of particles in solving basic problems in engineering mechanics	a	e					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: STATICS OF PARTICLES AND RIGID BODIES	**12**			
1	Equilibrium of Particles: Fundamental concepts and principles of engineering mechanics, Laws of mechanics.	1	C,D	1	1,2
2	Tutorial on Equilibrium of Particles	1	C,D	1	1,2
3	Forces on particles: Concurrent forces in a plane, Coplanar forces, Vector approach on addition, subtraction of forces.	1	C,D	1	1,2
4	Tutorial on Resolution of forces, Resultant of several concurrent forces	1	C,D	1	1,2
5	Tutorial on several concurrent forces (Vector approach)	1	C,D	1	1,2
6	Free body diagram, Forces in planes.	1	C,D	1	1,2
7	Tutorial on Forces in planes	1	C,D	1	1,2
8	Forces in space: Vector approach	1	C,D	1	1,2
9	Tutorial on forces in space	1	C,D	1	1,2
10	Equilibrium of rigid bodies: Principle of transmissibility, Moment of a force ,Varignon's Theorem	1	C,D	1	1,2
11	Equivalent system of forces, Reduction of system of forces into single force and couple	1	C,D	1	1,2
12	Equilibrium of rigid bodies in two dimensions, Equilibrium of a two force body	1	C,D	1	1,2
	UNIT II: FRICTION	**12**			
13	Friction: Laws of Friction, Angle of Friction , Dry friction	1	C,D	2	1,2
14	Tutorial on Dry friction	2	C,D	2	1,2
15	Tutorial on Wedge friction	2	C,D	2	1,2
16	Tutorial on Rolling friction	1	C,D	2	1,2
17	Derivation of tension ratio of Flat Belt and V Belts	1	C,D	2	1,2
18	Tutorial on Belt Friction	1	C,D	2	1,2
19	Ladder Friction	1	C,D	2	1,2
20	Tutorial on Ladder Friction	1	C,D	2	1,2
21	Screw Friction and its application on screw jack	2	C,D	2	1,2
	UNIT III: ANALYSIS OF TRUSSES AND CENTROIDS	**12**			
22	Types of loads, Types of supports and their reactions	1	C,D	3	1,2
23	Simple Trusses: Analysis of Trusses in Method of joints	1	C,D	3	1,2
24	Tutorial on Analysis of Trusses in Method of joints	2	C,D	3	1,2
25	Analysis of Trusses in Method of sections	1	C,D	3	1,2
26	Tutorial on Analysis of Trusses in Method of sections	2	C,D	3	1,2
27	Centre of Gravity: Centroids of lines, areas and volumes	1	C,D	3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
28	Tutorial on determination of centroid by integration method	1	C,D	3	1,2
29	Theorem of Pappus & Guldinus	1	C,D	3	1,2
30	Tutorial on centroid of composite areas	2	C,D	3	1,2
	UNIT IV: MOMENT OF INERTIA OF SURFACES AND VOLUMES	**12**			
31	Moment of Inertia: Determination of moment of inertia of area by integration	1	C,D	4	1,2
32	Tutorial on Moment of Inertia by integration method	2	C,D	4	1,2
33	Moment of Inertia by analytical method	1	C,D	4	1,2
34	Tutorial on Moment of Inertia by analytical method	2	C,D	4	1,2
35	Radius of gyration, Parallel and perpendicular axis theorems	1	C,D	4	1,2
36	Tutorial on Polar moment of inertia	1	C,D	4	1,2
37	Moment of inertia of different sections	2	C,D	4	1,2
38	Tutorial on mass moment of inertia	2	C,D	4	1,2
	UNIT V: DYNAMICS OF PARTICLES	**12**			
39	Rectilinear motion, uniform velocity and uniform acceleration motion	1	C,D	5	1,2
40	Tutorial on Curvilinear motion: Rectangular, Normal, tangential, radial and transverse components of velocity and acceleration	1	C,D	5	1,2
41	Motion of projectile -horizontal range, time of flight, maximum height & tutorial	2	C,D	5	1,2
42	Tutorial on Newton's second law of motion	1	C,D	5	1,2
43	D'Alembert's principle & tutorial	1	C,D	5	1,2
44	Principle of work and energy (kinetic and potential energy), conservative forces	1	C,D	5	1,2
45	Tutorial on work energy principle	1	C,D	5	1,2
46	Principle of impulse and momentum , problems on Impulsive motion	1	C,D	5	1,2
47	Tutorial on impulse and momentum	1	C,D	5	1,2
48	Impact of elastic bodies: Tutorial on direct impact of elastic bodies	1	C,D	5	1,2
49	Tutorial on oblique impact of elastic bodies	1	C,D	5	1,2
	Total contact hours*	**60**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
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.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Hibbeler. R.C., "*Engineering Mechanics: Statics & Dynamics*", Pearson Education (US), 14th Edition, 2015.
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.	Shames. I. H, and Krishna Mohana Rao.G, "*Engineering Mechanics (Statics and Dynamics)"*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2006.
5.	Timoshenko, Young, "*Engineering Mechanics*", Tata Mc-Graw Hill Book Company, 5th Edition, New Delhi, 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%**

15ME103L	**ACTIVE LEARNING LABORATORY**	**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 July 2016				

PURPOSE	To make the students to understand some basic concepts using learning through discovery method.

INSTRUCTIONAL OBJECTIVES		**STUDENTOUTCOMES**						
At the end of the course, student will be able to								
1.	Understand and prove the basic science concepts and theorems	a	b	e	j			

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Verifying Lami's theorem using Distance method	2	C,D	1	1
2.	Verifying Lami's theorem using Angle method	2	C,D	1	1
3.	Determination of an unknown weight using Lami's theorem (Angle method)	2	C,D	1	1
4.	Determination of two unknown weights using Lami's theorem (Angle method)	2	C,D	1	1
5.	Determination of coefficient of friction between same materials with horizontal plane	2	C,D	1	1
6.	Determination of coefficient of friction between different materials with horizontal plane	2	C,D	1	1
7.	Determination of coefficient of friction between same materials with inclined plane	2	C,D	1	1
8.	Determination of coefficient of friction between different materials with inclined plane	2	C,D	1	1
9.	Verifying Grashof's Law	2	C,D	1	1
10.	Inversion of Four bar mechanism	2	C,D	1	1
	Total contact hours	**20**			

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%**

15ME104L	**WORKSHOP PRACTICE**	**L**	**T**	**P**	**C**

		0	**0**	**3**	**2**
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 July 2016				

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

LEARNING RESOURCES

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%**

15ME105L	ENGINEERING GRAPHICS	L	T	P	C
		1	0	4	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	First Angle Projection is to be followed - Practice with Computer Aided Drafting tools, IS STANDARD				
Course Category	E ENGINEERING SCIENCES				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

PURPOSE	1. To draw and interpret various projections of 1D, 2D and 3D objects. 2. To prepare and interpret the drawings of buildings.

INSTRUCTIONAL OBJECTIVES		**STUDENTOUTCOMES**						
At the end of the course, student will be able to familiarize with the								
1.	Construction of geometrical figures	g						
2.	Projection of 1D, 2D and 3D objects	g	k					
3.	Sectioning of solids and development of surfaces	g	k					
4.	Preparation and interpretation of building drawing	g	k					

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	**Introduction to Engineering Graphics and Drafting tool** **Introduction to Engineering drawing** - Drawing instruments (including Mini drafter) - Lettering - Line type - Drawing standards and codes - Drawing sheet layout (Margins and Title block) **Introduction to Drafting package** - Graphical User Interface (GUI) – - Setting work area and Title block - Draw: Line, Arc, Circle - Modify: Erase, Offset, Move, Copy	2	C,D	1,2	1,2,3
	Manual Drafting - Drawing sheet layout - Alphabets of height 5 and 7 mm - Numerals 0 to 9 of height 5 and 7 mm - Drawing basic entities	1	C,D		
	Computer Aided Drafting - Draw the given figures using drafting package	2			
2.	**Review of Geometric construction & Introduction to modifying commands** **Geometric constructions:** - Dividing a line into 'n' parts - Bisecting an arc - Drawing an arc tangent to two straight lines - Construction of polygon **Introduction to Modify commands** - Demonstration of Modify commands in drafting package	2	C	1	1,2,3
	Manual Drafting - Geometric constructions	1	D		
	Computer Aided Drafting - Draw the given figures using drafting package	2			
3.	**Layers, Dimensioning, Hatching and Text** **Demonstration of commands** - Layers - Dimensions - Hatching - Text	2	C	2	1,2,3

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
	Computer Aided Drafting - Draw the given figures using drafting package	3	D		
4.	**Conic sections and Special curves** **Construction of Conic sections:** - Parabola : Tangent and Rectangle method - Ellipse: Oblong method and concentric circle method – - Hyperbola – Eccentricity method - Construction of special curves: - Cycloid - Spiral	2	C	1,2	1,2,3
	Manual Drafting - Construction of conic sections and cycloid	2	D		
	Computer Aided Drafting - Draw the given figures using drafting package	1	D		
5.	**Introduction to orthographic projections:** - I, II, III and IV angle projections - Projection of Points in different quadrants - Projection of Lines: Inclined to one plane - Projection of planes - Conceptual free hand sketching	2	C	2,3	1,2,3
	Manual Drafting - Conceptual sketching - Projection of points, lines and planes	3	D		
6.	**Solids I** **Introduction to solids :** - Polyhedron - Prisms **Introduction to 3D Tools:** - Modeling	2	C	2	1,2,3
	Manual Drafting - Projection of solid	1	D		
	Computer Aided Drafting - Modeling of polyhedron and prisms - Generating orthographic views of solids	2	D		
7.	**Solids II** **Introduction to solids:** - Pyramids - Solids of revolution **Introduction to 3D Tools**: - Modeling	2	C	2	1,2,3
	Manual Drafting - Projection of solids	2	D		
	Computer Aided Drafting - Modeling of pyramids & solids of revolution and generating the orthographic views	1	D		
8.	**Solids – III** **Orthographic views** - Orthographic views of the given pictorial view / model - Demonstration of modeling of components using Extrude and Revolve - Boolean operations	2	C	2	1,2,3
	Manual Drafting – - Drawing orthographic views of machine components in grid sheet	1	D		
	Computer Aided Drafting - Modeling of simple machine components and	2	D		

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
	generating its orthographic views				
9.	**Solids – IV** - Demonstration of modeling of components using Loft, Sweep, Helical sweep and Shell.	2	C	2	1,2,3
	Computer Aided Drafting - Modeling of components using Boolean operations and generating its orthographic views	3	D		
10.	**Section of Solids** **Introduction to Section of regular solids** - Section plane - Sectional view	2	C	2,3	1,2,3
	Manual Drafting - Section of solids	2	D		
	Computer Aided Drafting - Modeling the regular solids and section it to obtain the sectional views	1	D		
11.	**Development of surfaces** - Introduction - Methods - Application	2	C	2,3	1,2,3
	Manual Drafting - Development of surfaces	3	D		
12.	**Building Drawing** - Components of a building - Conventional representation of building materials - Scale	2	C	4	1,2,3
	Computer Aided Drafting - Drawing the plan, elevation and sectional views of a building	3	D		
	Total contact hours	**60** **60**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Bhatt, N.D., "*Elementary Engineering Drawing (First Angle Projection)"*, Charotar Publishing Co., Anand, 1999.
2.	Bethune, J.D.,"*Engineering Graphics with AutoCAD 2013"*, PHI Learning Private Limited, Delhi, 2013.
3.	Shah, M. B. and Rana, B. C., "*Engineering Drawing"*, Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2005.
4.	Venugopal, K. and Prabhu Raja, V., "*Engineering Graphics"*, Eighth Edition (Revised), New Age International Publishers, Chennai, 2007.
5.	Natarajan, K.V., "*A Text Book of Engineering Graphics"*, 21st Edition, Dhanalakshmi Publishers, Chennai, 2012.
6.	Jeyapoovan, T., "*Engineering Drawing and Graphics using AutoCAD"*, Vikas Publishing House Pvt. Ltd., New Delhi, 2010.
7.	Narayanan, K. L. and Kannaiah, P.,"*Engineering Graphics"*, Scitech Publications, Chennai, 1999.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	**Experiments**	**Record**	**MCQ/Quiz/Viva Voce**	**Model examination**	**Total**
	Weightage	**50%**	**-**	**-**	**10%**	**60%**
					End semester examination Weightage :	**40%**

15ME201	**THERMODYNAMICS**	**L**	**T**	**P**	**C**
		2	**2**	**0**	**3**

Co-requisite:	NIL
Prerequisite:	15MA102
Data Book / Codes/Standards	Approved Steam tables
Course Category	E ENGINEERING SCIENCES
Course designed by	Department of Mechanical Engineering
Approval	-- Academic Council Meeting -- , 23rd July 2016

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%**

15ME202	**MANUFACTURING TECHNOLOGY**	**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 July 2016		

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%**

15ME202L	**MANUFACTURING PROCESS LABORATORY**	**L**	**T**	**P**	**C**

		0	**0**	**2**	**1**
Co-requisite:	15ME202				
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 July 2016				

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%**
15ME203	**MECHANICS OF SOLIDS**				**L**	**T**	**P**	**C**

			2	**2**	**0**	**3**
Co-requisite:	Nil					
Prerequisite:	15MA101					
Data Book / Codes/Standards	Nil					
Course Category	P	PROFESSIONAL CORE	DESIGN ENGINEERING			
Course designed by	Department of Mechanical Engineering					
Approval	-- Academic Council Meeting -- , 23rd July 2016					

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*	**60**			

*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**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15ME203L	STRENGTH OF MATERIALS LABORATORY	L	T	P	C
		0	0	2	1
Co-requisite:	15ME203				
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 July 2016				

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%**

15ME204	MACHINES AND MECHANISMS			L	T	P	C
				2	2	0	3
Co-requisite:	Nil						
Prerequisite:	15ME102						
Data Book / Codes/Standards	Nil						
Course Category	**P**	PROFESSIONAL CORE	DESIGN ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting --, 23rd July 2016						

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%**

15ME205	FLUID MECHANICS	L	T	P	C
		2	2	0	3
Co-requisite:	Nil				
Prerequisite:	15MA102				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE	THERMAL ENGINEERING			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

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, 20th 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%**

15ME205L	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 July 2016				

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%**

15ME206	APPLIED THERMAL ENGINEERING			L	T	P	C
				3	1	0	4
Co-requisite:	NIL						
Prerequisite:	15ME201						
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 July 2016						

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%**

15ME207	COMPUTER AIDED DESIGN AND ANALYSIS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
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 July 2016				

PURPOSE	To study how computer can be used as a tool in mechanical engineering design.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Apply concepts of modeling in 2D and 3D	a		k				
2.	Use Mathematical Representation for curves and surfaces	a	e					
3.	Use concepts of Computer Graphics	a						
4.	Use relevant CAD Standards			k				
5.	Use computer as a tool in analysis	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO CAD	**9**			
1.	Definition, History and Benefits of Computer Aided Design	1	C	1	1
2.	Product Life Cycle	1	C	1	1,2
3.	Design process (Shigley, Pahl&Beitz and Oshuga)	2	C	1	3
4.	Coordinate Systems	1	C	1	1,2
5.	Wire frame modeling	1	C	1	1
6.	Surface modeling	1	C	1	1,2
7.	Solid modeling, Constructive Solid Geometry and Boundary Representation	2	C	1	1,2,3
8.	Feature Entities and Representation.	1	C	1	1,2
	UNIT II: - REPRESENTATION OF CURVES AND SURFACES	**9**			
9.	Mathematical representation of lines, circle, ellipse & parabola	2	C	2	1
10.	Cubic Spline Curve	1	C	2	1,3
11.	Bezier Curve and B-spline Curve.	2	C	2	1,3
12.	Curve Fitting Techniques	1	C	2	1,3
13.	Bicubic surface.	1	C	2	1,3
14.	Bezier Surface and B-spline Surface.	2	C	2	1,3
	UNIT III: GRAPHICS CONCEPTS	**9**			
15.	Transformations: Translation, Scaling, Rotation and Reflection	2	C	3	1,2,7
16.	Concatenated and Inverse Transformations	1	C	3	1,2,7
17.	Orthographic, Isometric and Perspective Projections	1	C	3	1,2
18.	Cohen Sutherland Clipping Algorithm	1	C	3	2,7
19.	Hidden line removal, Visibility Techniques, Priority and Area-oriented Algorithm.	2	C	3	1
20.	Hidden Surface removal, z-Buffer and Warnock's Algorithm	1	C	3	1,7
21.	Coloring and Shading	1	C	3	1
	UNIT IV:CAD STANDARDS AND RECENT TECHNOLOGY	**9**			
22.	Introduction to Data exchange standards	1	C	4	1,2,3
23.	Data exchange standards: IGES,STEP,DXF and CALS	2	C	4	1,2,3
24.	GKS,GKS-3D,PHIGS and NAPLPS	1	C	4	2,3
25.	Rapid Prototyping and its types	2	C	4	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
26.	Animation Types and Techniques	2	C	4	1
27.	Simulation Technique	1	C	4	1
	UNIT V:FINITE ELEMENT ANALYSIS	**9**			
28.	Introduction to FEA and Steps involved in FEA.	1	C	5	1,2,4
29.	Shape function for 1 D element linear (2 nodes) and quadratic (3 nodes)	1	C	5	4
30.	Derivation of element stiffness matrices, Assembly of element stiffness matrices and load vectors, Solution techniques.	1	C	5	4
31.	Analysis of springs and Simple Problems	1	C,D	5	4
32.	Simple problems in stepped bar subjected to axial loads	2	C,D	5	4
33.	Problems in simple structural members for triangular element	2	C,D	5	4
34.	Procedure for Finite Element Modeling	1	C	5	1,2,4
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Ibrahim Zeid, "*Mastering CAD /CAM (Sie)*", Tata McGraw-Hill, New Delhi, 2010
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	P.N. Rao, "*CAD/CAM Principles and Application*",3rd Edition, Tata McGraw-Hill, New Delhi, 2012
3.	Chris Mcmahon and Jimmie Browne, "CAD/CAM", AdisionWesly, NewYork, 2000
4.	Olek C. Zienkiewicz, Robert L. Taylor, "*The Finite Element Method for Solid and Structural Mechanics*", Butterworth -Heinemann Ltd, 6th Revised Edition 2005.
5.	Newman and Sproul R.F, "*Principles of interactive computer graphics*", Tata McGraw-Hill, New Delhi, 2007.
6.	Mikell P. Groover, Emory W. Zimmers Jr., "*CAD/CAM: Computer Aided Design and Manufacturing*", Prentice Hall of India Private Ltd., New Delhi, 2008.
7.	Donald Hearn and Pauline Baker M, "*Computer Graphics C version* ", 2nd Edition, Pearson education, 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%**

15ME207L	COMPUTER AIDED DESIGN LABORATORY	L	T	P	C
		0	0	2	1
Co-requisite:	15ME207				
Prerequisite:	NIL				
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 July 2016				

PURPOSE	To provide hands-on training to the students on various software in Mechanical Engineering.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Drafting practice using computer.	a						
2.	Modeling of 2D and 3D parts.	a						
3.	Assembly of modeled parts.	a	b	j				
4.	Analysis of modeled parts.	a	b	e	k			

Session	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
I - Review of Drafting Package					
1.	Drafting the Orthographic views of Mechanical Joint.	2	C, D	1	1
I – EXERCISE IN SOLID MODELING SOFTWARE					
2.	Introduction	2	C, D	2	3,4,5
3.	Modeling of Simple Mechanical Components	2	C, D	2	
4.	Modeling of components with sweep and loft feature	2	C, D	2	
5.	Modeling of temporary fasteners	3	C, D	2	
6.	Modeling of components with variable-sweep and blend feature	2	C, D	2	
II - EXERCISE IN PARAMETRIC DRAWING					
7.					
III – EXERCISE ON ASSEMBLY OF COMPONENTS					
8.	Assembly of components	2	C, D	3	3,4,5
9.	Conversion of 3D to 2D and mass property calculations	2	C, D	3	5
IV – EXERCISE ON FINITE ELEMENT ANALYSIS SOFTWARE					
10.	Structural analysis	4	C, D	4	6
11.	Thermal Analysis	2	C, D	4	6
12.	Kinematic Analysis	2	C, D	4	7
	Total contact hours*	**30**			

*Any 10 experiments will be offered

LEARNING RESOURCES	
1.	Laboratory Manual
2.	P.S.G Tech.., *"Design Data Book",* KalaikathirAchchagam, 2012
3.	http://www.3ds.com/
4.	http://www.3ds.com/products-services/enovia
5.	http://www.solidworks.in/
6.	http://www.mece.ualberta.ca/tutorials/ansys/
7.	http://www.mscsoftware.com/page/adams-tutorial-kit-mechanical-engineering-courses
8.	http://learningexchange.ptc.com/tutorials/listing/product_version_id:44

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%**

15ME208L	MANUFACTURING AND ASSEMBLY DRAWING	L	T	P	C
		1	0	3	2
Co-requisite:	NIL				
Prerequisite:	15ME105L				
Data Book / Codes/Standards	Approved data book, BIS Code books				
Course Category	P PROFESSIONAL CORE	MANUFACTURING ENGINEERING			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

PURPOSE	To enable the students to prepare a detailed manufacturing and assembly drawing for given machine components, jigs, and fixtures.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand Indian standards for machine drawing.	c	g					
2.	Understand Fits and Tolerances in manufacturing drawing.	c	g	k				
3.	Prepare assembly drawings of joints, couplings and machine elements.	c	g	k				
4.	Design and prepare drawing for Jigs and fixtures of given components.	c	g	k				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	BIS Code of practice for Engineering Drawing: General principles of presentation, conventional representation of dimensioning and sectioning, threaded parts, gears, springs and common features	1	C	1	2
2.	Orthographic Projection and Section of solids (Review)	3	I	1	2
3.	Abbreviations and symbols used in technical drawings	1	C	1	2
4.	Conventional representation of Engineering parts and Dimensioning	3	I	1	2
5.	Types of Tolerances and its representation on the drawings	1	C	2	2
6.	Assembly Drawing for keys and keyways in cotter joints, knuckle joints and threaded fasteners	3	I	3	2
7.	Types of Fits and its selection for different applications	1	C	2	2
8.	Assembly Drawing for Couplings - Flange coupling and universal coupling	3	I	3	2
9.	Fits and Tolerances for Basic hole systems	1	C, D	2	2
10.	Assembly Drawing for Bearings, Plummer block	3	I	3	2
11.	Fits and Tolerances for Basic shaft systems	1	C, D	2	2
12.	Assembly Drawing for Lathe tail stock, Lathe chuck	3	I	3	2
13.	Allowances	1	C, D	2	2
14.	Assembly Drawing for Screw jack	3	I	3	2
15.	Geometrical tolerances : Form and positional	1	C, D	2	1
16.	Assembly Drawing for Machine vice	3	I	3	2
17.	Datum and datum features: symbols used to represent geometrical tolerances	1	C, D	2	1
18.	Assembly Drawing for Tool head of shaper	3	I	3	2
19.	Introduction of Manufacturing Drawing	1	C	2	9
20.	Assembly Drawing for Connecting rod	3	I	3	2
21.	Development of Manufacturing Drawing	1	C	2	9
22.	Working Drawing for tolerances in Part and Assembly drawing	3	I	2	9
23.	Jigs types and Design consideration in plate, latch, channel, box, post, pot jigs, automatic drill jigs	2	C, D	4	3
24.	Assembly Drawing for plate, latch, channel, box, post, pot drill jigs, automatic drill jigs	3	I	4	2
25.	lathe, milling and broaching fixtures types and Design considerations	1	C, D	4	3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
26.	Assembly Drawing for lathe, milling and broaching fixtures	3	I	4	3
27.	Grinding, planning, shaping fixtures types and Design considerations	1	C, D	4	3
28.	Assembly Drawing for Grinding, planning, shaping fixtures	3	I	4	3
29.	Welding fixtures types and Design considerations	1	C, D	4	3
30.	Assembly Drawing for welding fixtures	3	I	4	3
	Total contact hours	**60**			

NOTE:
1. Computer aided approach shall be followed.
2. Examination must include an assembly drawing of machine elements.

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Narayana.K.L, Kanniah.P and VenkataReddy.K, *Machine Drawing*, New Age International, New Delhi, 2006.
2.	Gopalakrishnan.K.R, *Machine Drawing,* Subash Publishers, Bangalore, 2000.
3.	Joshi P.H, "*Jigs & Fixtures",* New Delhi -Tata McGraw Hill Pub. Co. Ltd., 11th print 1999.
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	SidheswarKannaiah.N, Sastry.P.V.V.V, "*Machine Drawing",* Tata McGraw Hill, New Delhi, 1997.
5.	Bhatt.N.D, "*Machine Drawing",* Charotar publishing house, Anand, 1999.
6.	Junnarkar.N.D, "*Machine Drawing"*, First Indian print, Pearson Education (Singapore) Pvt. Ltd., 2005.
7.	P.S.G Tech..,*"Design Data Book",* KalaikathirAchchagam, 2012
8.	Revised IS codes: 10711, 10712, 10713, 10714, 9609, 11665, 10715, 10716, 11663, 11668, 10968, 11669, and 8000.
9.	Brian Griffiths, "Engineering Drawing for Manufacture", Kogan Page Science, 2003

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%**

15ME215	THERMODYNAMICS AND FLUID MECHANICS	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Approved Heat and Mass Transfer Data Book, Steam table				
Course Category	E ENGINEERING SCIENCES				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July2016				

PURPOSE	This course provides the basic knowledge about Thermodynamics and Fluid Mechanics							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To understand the Thermodynamic laws and their applications.	a	e					
2.	To understand the principles of Air standard cycles and Rankine cycles.	a	e					
3.	To understand the principles of Refrigeration & Air conditioning systems and Air compressors.	a	e					
4.	To understand the principles of Fluid Mechanics and the Measurement Techniques of Fluid properties.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I – BASICS OF THERMODYNAMICS	**9**			
1.	Introduction to Thermodynamic systems	1	C	1	1,3.4,5
2.	Zeroth law, First law of Thermodynamics	1	C	1	1,3.4,5
3.	Concept of Internal energy and Enthalpy	1	C	1	1,3.4,5
4.	Application to closed system	2	C,D	1	1,3.4,5
5.	Application to Open system	2	C,D	1	1,3.4,5
6.	Second law of Thermodynamics, Heat engine, Refrigerator and Heat pump	2	C,D	1	1,3.4,5
	UNIT II- CYCLES AND SYSTEMS	9			
7.	Otto cycle efficiency and Mean effective pressure	2	C,D	2	1,3.4,5
8.	Diesel cycle efficiency and Mean effective pressure	2	C,D	2	1,3.4,5
9.	Brayton cycle efficiency	1	C,D	2	1,3.4,5
10.	SI and CI engines - 4 Stroke and 2 Stroke Engine	1	C	2	1,3.5
11.	Heat balance test on I.C Engine	1	C,D	2	1,3,5
12.	Properties of Steam , Rankine Cycle	2	C,D	2	1,3.4,5
	UNIT III – REFRIGERATION AND AIR CONDITIONING SYSTEMS	**9**			
13.	Vapour Compression Refrigeration system	2	C,D	3	1,3.4,5
14.	Types of Air conditioning systems	1	C	3	1,3,5
15.	Reciprocating Compressors, Volumetric efficiency, Power required, Rotary Compressors	2	C,D	3	1,3.4,5
16.	Heat Transfer, Modes of Heat Transfer	1	C	3	1,3.4,5
17.	Heat conduction in Composite wall, Cylinder and Sphere	1	C,D	3	1,3.4,5
18.	Convection Heat Transfer	1	C	3	1,3.4,5
19.	Radiation Heat Transfer	1	C	3	1,3.4,5
	UNIT IV- BASICS OF FLUID MECHANICS	**9**			
20.	Properties of Fluid	1	C	4	2,6
21.	Types of Fluid flow	1	C	4	2,6
22.	Continuity Equation	1	C,D	4	2,6
23.	Euler's Equation, Bernoullis equation	2	C,D	4	2,6
24.	Flow through pipes, Hagen Poiseulli's law	2	C,D	4	2,6
25.	Major loss and Minor loss in Pipes	2	C,D	4	2,6
	UNIT V –FLUID MEASUREMENT	**9**			
26.	Flow measurement by Orificemeter and Venturimeter	2	C	4	2,6

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
27.	Flow Measurement using Rota meter and Elbow meter	1	C	4	2,6
28.	Pressure Measurement using Pitot tube and Manometer	1	C	4	2,6
29.	Pressure Measurement using Mechanical gauges	1	C	4	2,6
30.	Velocity Measurements using Anemometers cup and Vane types	2	C	4	6
31.	Velocity Measurements using Hot wire and Laser Anemometers	2	C	4	6
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Sarkar.B.K, "*Thermal Engineering*", Tata McGraw Hill Co. Ltd., India, 2005
2.	Rajput.R.K , "*Fluid Mechanics and Hydraulic Machines*" , S.Chand& Co., India, 6th Edition, 2015.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Rayner& Joel, "*Basic engineering thermodynamics"*, Addison Wesley publishing company limited, 5th edition, 1996.
4.	Nag.P.K., "*Engineering Thermo Dynamics*", Tata McGraw Hill Co. Ltd., India, 2005.
5.	Rajput. R.K, "*Thermal Engineering*", Laxmi Publications (P) Ltd., New Delhi, Edition. 2010
6.	Kumar D.S, "*Fluid Mechanics and Fluid Power Engineering*", Kataria. S.K & Sons Publishers, India, 6th Edition, 2003
	DATA BOOKS
7.	Kothandaraman. C. P, Subramanyan, S, "*Heat and Mass Transfer Data Book*", New Age International, 7th edition, 2010
8.	Khurmi. R. S, "*Steam Tables*", S. Chand Publishers, 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%**

15ME216	INTRODUCTION TO MANUFACTURING ENGINEERING	L	T	P	C
		2	0	0	2
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE	MANUFACTURING			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July2016				

PURPOSE	To make the students aware of different manufacturing processes like machining process, metal forming, casting, welding and powder metallurgy.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to learn								
1.	Various machining processes.	a	c					
2.	Concept of casting, welding and powder metallurgy.	a	c					
3.	Mechanical working of metals.	a	c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: MACHINING	**8**			
1.	Introduction and Description of Lathe, Types of Lathes.	1	C	1	1,3,4
2.	Capstan and Turret Lathe, Specification of a Lathe.	1	C	1	1,3,4
3.	Lathe Operations like step turning, facing parting off, taper turning, knurling.	1	C	1	1,3,4
4.	Description and Principle of Drilling.	1	C	1	1,3,4
5.	Drilling Operations like reaming, counter boring, counter sinking, tapping, etc.	1	C	1	1,3,4
6.	Types of Drills and their features.	1	C	1	1,3,4
7.	Introduction, Principle and Classification of Milling.	1	C	1	1,3,4
8.	Milling Machine operations and Tools with their features.	1	C	1	1,3,4
	UNIT II: CASTING, WELDING AND POWDER METALLURGY	**11**			
9.	Introduction to casting.	1	C	2	2,3,5,6
10.	Types of Pattern, Pattern materials, Pattern Allowances.	1	C	2	2,3,5,6
11.	Types of Moulding and Moulding sand.	1	C	2	2,3,5,6
12.	Gating and Risering, Cores and Core making.	1	C	2	2,3,5,6
13.	Shell, Investment casting.	1	C	2	2,3,5,6
14.	Die casting, Centrifugal casting.	1	C	2	2,3,5,6
15.	Special welding like Laser welding, Electron Beam welding.	1	C	2	2,3,5,6
16.	Ultrasonic welding, Electro slag welding.	1	C	2	2,3,5,6
17.	Friction welding, Electrical resistance welding.	1	C	2	2,3,5,6
18.	Principle of Powder Metallurgy, Powder manufacture,	1	C	2	2,3,5,6
19.	Blending, Compaction, Sintering, Finishing and Applications.	1	C	2	2,3,5,6
	UNIT III: METAL FORMIMG	**11**			
20.	Hot and Cold Working and Rolling.	1	C	3	1,4,5
21.	Forging.	1	C	3	1,4,5
22.	Wire Drawing.	1	C	3	1,4,5
23.	Extrusion and Types like forward, backward and tube extrusion.	1	C	3	1,4,5
24.	Sheet Metal Operations like Shearing, Blanking.	1	C	3	1,4,5
25.	Piercing, Punching, Trimming, Stretch forming.	1	C	3	1,4,5
26.	Bending with bending length and bending force	1	C,D	3	1,4,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	calculations and simple problems.				
27.	Drawing with blank size calculation, draw ratio and drawing force calculations.	1	C,D	3	1,4,5
28.	Tube forming.	1	C	3	1,4,5
29.	Embossing and coining.	1	C	3	1,4,5
30.	Types of dies like Progressive, compound and combination dies.	1	C	3	1,4,5
	Total contact hours*	**30**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	John A. Schey, "*Introduction to manufacturing processes",* McGraw-Hill, 2000, 3rd Edition, 2000
2.	James S Campbell, "*Principles of manufacturing materials and processes",*New Delhi : Tata McGraw-Hill, 2nd Edition, 1983
	REFERENCE BOOKS/OTHER READING MATERIAL
3. .	Roy A. Lindberg, "*Processes and materials of manufacture*", Boston:Allyn and Bacon, - Allyn and Bacon series in engineering. 1990PHI / Pearson education, 2006
4. .	Kalpakjian, "*Manufacturing Engineering and Technology*", Addison Wesley Congmen Pvt. Ltd., Singapore, 4th Edition, 2009.
5.	De Garmo et al., "*Materials and Processes in Manufacturing*", Prentice Hall of India, New Delhi,11thEdition, 2011.
6. .	Paul Degarma E, Black J.T and Ronald A. Kosher, "*Materials and Processes, in Manufacturing*", Eight Edition, Prentice – Hall of India, 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%**

15ME301	FUNDAMENTALS OF VIBRATION AND NOISE	L	T	P	C
		2	2	0	3
Co-requisite:	Nil				
Prerequisite:	15ME204				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE	DESIGN ENGINEERING			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

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%**

15ME301L	**MACHINE DYNAMICS 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 July 2016		

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%**

15ME302	**HEAT AND MASS TRANSFER**	**L**	**T**	**P**	**C**
		2	**2**	**0**	**3**

Co-requisite:	Nil		
Prerequisite:	15ME201		
Data Book / Codes/Standards	Approved Heat and Mass Transfer Data Book		
Course Category	P	PROFESSIONAL CORE	THERMAL ENGINEERING
Course designed by	Department of Mechanical Engineering		
Approval	-- Academic Council Meeting -- , 23rd July 2016		

PURPOSE	This course provides the knowledge to understand the various modes of heat transfer and the basic concept of mass transfer.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the concept of conduction.	a	c	e				
2.	Understand the convection and radiation heat transfer.	a	e					
3.	Analyze the phase change heat transfer and sizing of heat exchanger.	a	c	e				
4.	Understand the basic concept of mass transfer.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - CONDUCTION	**15**			
1.	Modes and mechanism of heat transfer	1	C	1	1,2,3
2.	General conduction equation, boundary and initial conditions	1	C,D	1	1,2,3
3.	One dimensional steady state heat conduction in plane wall, cylinder and sphere, electrical analogy	1	C	1	1,2,3
4.	Composite wall, critical thickness of insulation	2	C,D	1	1,2,3,4
5.	Conduction with internal heat generation	2	C,D	1	1,2,3
6.	Extended surfaces	2	C,D	1	1,2,3
7.	Unsteady heat conduction in lumped, semi-infinite and infinite solids	3	C,D	1	1,2
8.	Numerical solution for one and two dimensional steady state conduction.	3	C,D	1	1,2
	UNIT II -CONVECTION	**12**			
9.	Hydrodynamic and thermal boundary layer, Principles and governing equations	2	C	2	1,2
10.	Dimensional analysis of free and forced convection	2	C,D	2	1,2,3
11.	Forced Convection: External Flow over plate, cylinder and sphere	3	C	2	1,2
12.	Forced Convection: Internal flow	2	D	2	1,2
13.	Free convection: Flow over plate, cylinder and sphere	3	D	2	1,2
	UNIT III - RADIATION	**12**			
14.	Basic concepts, laws of radiation	1	C	2	1,2,3
15.	Black body radiation –Grey body radiation	2	C,D	2	1,2,3
16.	Shape factor algebra	2	C,D	2	1,2,3
17.	Electrical analogy	1	C,D	2	1,2,3
18.	Radiation shields	3	C	2	1,2,3
19.	Solar radiation	1	C,D	2	1,2,3
20.	Gas radiation.	2	C,D	2	2,3
	UNIT IV- PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS	**12**			
21.	Nusselt theory of condensation, correlations	2	C	3	1,2,3
22.	Regimes of pool boiling and flow boiling, correlations	2	C,D	3	1,2,3
23.	Heat Exchangers, types, overall heat transfer coefficient, fouling	1	C,D	3	1,2
24.	LMTD method of analysis	3	C	3	1,2,4
25.	NTU method of analysis	3	D	3	1,2,3
26.	Introduction to compact heat exchanger	1	C,D	3	2,3,4
	UNIT V - MASS TRANSFER	**9**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
27.	Basic concepts – Diffusion mass transfer – Fick's law of diffusion	1	C	4	2,3
28.	Equimolar counter diffusion	2	C,D	4	2,3
29.	Stefan's law, evaporation in atmosphere	2	C,D	4	2,3
30.	convective mass transfer – Momentum, heat and mass transfer analogy	2	C,D	4	2,3
31.	Convective mass transfer correlations	2	C	4	2,4
	Total contact hours*	**60**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**REFERENCE BOOKS/OTHER READING MATERIAL**
1.	Ozisik. M. N, "Heat Transfer", McGraw-Hill Book Co., 2003.
2.	Holman. J. P "Heat and Mass Transfer" Tata McGraw-Hill, 2008.
3.	Frank. P, Incropera and D. P. DeWitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, 2001.
4.	Yunus. A, Cengel, "Heat and Mass Transfer", Tata McGraw Hill Education, 2007.
5.	**DATA BOOKS**
6.	Kothandaraman. C. P, Subramanyan, S, "Heat and Mass Transfer Data Book", New Age International, 7th edition, 2010.
7.	Khurmi. R. S, "Steam Tables", S. Chand Publishers, 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%**

15ME302L	HEAT AND MASS TRANSFER LABORATORY	L	T	P	C
		0	0	2	1

Co-requisite:	15ME302
Prerequisite:	Nil
Data Book / Codes/Standards	Approved Heat and Mass Transfer Data Book and Refrigerant Tables and Charts.
Course Category	P PROFESSIONAL CORE THERMAL ENGINEERING
Course designed by	Department of Mechanical Engineering
Approval	-- Academic Council Meeting -- , 23rd July 2016

PURPOSE	This course provides the necessary background for the student to understand the fundamental modes of heat transfer and mass transfer.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to analyze the								
1.	Conduction, convection and radiation heat transfer.	a	b	e				
2.	Performance of heat exchangers, condensation and boiling apparatus.	a	b	e				
3.	Performance of refrigeration and air conditioning systems.	a	b	e				

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Heat transfer through the composite wall.	2	O	1	1,2
2.	Thermal conductivity of a specimen using guarded hot plate apparatus.	2	O	1	1,2
3.	Thermal conductivity of an insulating material.	2	O	1	1,2
4.	Heat Transfer through a composite lagged pipe.	2	O	1	1,2
5.	Heat transfer by natural convection.	2	O	1	1,2
6.	Heat transfer by forced convection.	2	O	1	1,2
7.	Heat transfer through pin fin by natural convection.	2	O	1	1,2
8.	Heat transfer through pin fin by forced convection.	2	O	1	1,2
9.	Determination of Emissivity of a grey surface.	2	O	1	1,2
10.	Determination of Stefan – Boltzmann's constant.	2	O	1	1,2
11.	Analysis of a parallel flow and counter flow heat exchanger.	2	O	2	1,2
12.	Analysis of a shell and tube heat exchanger.	2	O	2	1,2
13.	Analysis of a plate type heat exchanger.	2	O	2	1,2
14.	Analysis of a finned tube heat exchanger.	2	O	2	1,2
15.	Study on drop and film wise condensation apparatus.	2	O	2	1,2
16.	Study on critical heat flux apparatus.	2	O	2	1,2
17.	Performance test on a refrigeration test rig.	2	O	3	1,3
18.	Performance test on an air conditioning test rig.	2	O	3	1,3
	Total Contact Hours*	**20**			

*Any 10 experiments will be offered

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Ozisik. M. N, "*Heat Transfer*", McGraw-Hill Book Co., 2003.
3.	Holman. J. P "*Heat and Mass Transfer*" Tata McGraw-Hill, 2008.
4.	Mehta.F.S, Mathur.M.L, "*Refrigeration & Psychrometric Properties Tables & Charts"*, 3rd Edition, Jain Publishers, 2014.

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%**

15ME303	**MATERIALS TECHNOLOGY**	**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 July 2016		

PURPOSE	To impart knowledge about the behavior of materials and their applications.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Acquire knowledge through Phase diagram and control material properties by heat treatment.	a	c					
2.	Understand on elastic, plastic and fracture behaviour of engineering materials and its failure mechanism.	a	c					
3.	Select metallic and non-metallic materials for the various engineering applications.	a	c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: PHASE DIAGRAM AND HEAT TREATMENTS	**9**			
1.	Introduction to Solid solutions	1	C	1	7
2.	Basics of Intermediate phases and its types, Phase rules and its application	1	C,D	1	7
3.	Construction of Cooling curves and types of cooling curve	1	C	1	7
4.	Constructing phase diagram from cooling curve and to study phase changes in alloys	1	C	1	7
5.	Interpretation of phase diagrams and classification of phase diagram	1	C,D	1	7
6.	Equilibrium diagram of Iron and Iron–Carbide diagram	1	C	1	7
7.	Introduction to TTT Diagram, construction and its importance	1	C	1	7
8.	Construction of Ternary phase diagrams and its interpretations	1	C	1	7
9.	Definition of Annealing, Normalizing, Tempering, Hardening processes and its effect on hardness and microstructure.	1	C,D	1	5
	UNIT II: - ELASTIC AND PLASTIC BEHAVIOUR	**9**			
10.	Elasticity in metals and polymers	1	C	2	2
11.	Mechanism of plastic deformation	1	C	2	2
12.	Role of yield stress in formation of Luders band	1	C	2	3
13.	Shear strength of perfect and real crystals	1	C	2	3
14.	Strengthening Mechanisms, Concept of Work Hardening and stages of work hardening	1	C	2	3
15.	Solid solution strengthening , its types and factors governing substitutional solubility based on Hume Rothery's Rules	1	C	2	3
16.	Concept of Grain boundary strengthening and analyzing its effects with grain size, hall-petch relation.	1	C	2	3
17.	Fiber, Particle, Particulate and Dispersion strengthening	1	C	2	3
18.	Effect of temperature, strain and strain rate on plastic behavior	1	C	2	3

	UNIT III: FRACTURE BEHAVIOUR	**9**			
19.	Introduction to fracture, Types of fracture in metals, Griffith's theory of brittle fracture, Stress intensity factor	1	C,D	2	2
20.	Fracture Toughness	1	C.D	2	2
21.	Theory of Ductile to brittle transition	1	C	2	2
22.	High temperature fracture, Creep curve, Effect of creep rate in creep test	1	C	2	2
23.	Deformation mechanism maps	1	C	2	2
24.	Introduction to Fatigue, S-N curve, Low and high cycle fatigue test	1	C	2	2
25.	Stages of fatigue: Crack initiation and propagation mechanisms	1	C	2	2
26.	Fracture of Non-metallic materials	1	C	2	2
27.	Failure analysis, Sources of failure, procedure of failure analysis.	1	C	2	2
	UNIT IV: MODERN METALLIC MATERIALS	**9**			
28.	Dual phase alloys properties, its processing, composition and application.	1	C	3	5
29.	Brief introduction on Micro alloyed steels and High Strength Low alloy (HSLA) steel, its properties and comparison of strength.	1	C	3	5
30.	Processing and Characteristics of Transformation induced plasticity (TRIP) steel, its properties and application	1	C	3	2
31.	Concept of Maraging steel and Intermetallics, Ni and Ti Aluminides	1	C	3	5
32.	Introduction to Smart materials its types : piezoelectric material, shape memory alloys and MR fluid	1	C	3	8
33.	Shape memory alloys and its effect on temperature	1	C	3	8
34.	Processing of Metallic glasses, its properties and application	1	C	3	2
35.	Introduction to Quasi crystals and its properties	1	C	3	9
36.	Concept of Nano crystalline materials and its application	1	C	3	6
	UNIT V: NON METALLIC MATERIALS	**9**			
37.	Introduction to Polymeric materials, Synthesis of polymers, thermoplastic and thermoset polymers its characteristics and application.	1	C	3	5
38.	Production techniques of fiber and foams	1	C	3	5
39.	Properties and applications of engineering polymers	1	C	3	5
40.	Processing, properties and applications of advanced structure ceramics, WC, TiC	1	C	3	5
41.	Processing, properties and applications of Al_2O_3, SiC, SI_2N_4, CBN and Diamond	1	C	3	5
42.	Types and classification of composite materials. Reinforcement and matrix material	1	C	3	5
43.	Production techniques of MMC : Stir casting, Infiltration, Solid state forming, PVD and CVD process	1	C	3	5
44.	Production techniques of PMC: Injection, Blow, extrusion, thermoforming, Solid state forming. Resin transfer molding and compression molding	1	C	3	5
45.	Properties and applications of MMC and PMC	1	C	3	5
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES

Sl. No.	TEXT BOOKS
1.	Flake.C Campbell, **"***Elements of Metallurgy and Engineering Alloys",* ASM International, 2008.
2.	Dieter.G.E, "*Mechanical Metallurgy"*, McGraw Hill, Singapore, 2001.
3.	Thomas H. Courtney, "*Mechanical Behaviour of Engineering materials*", McGraw Hill, Singapore, 2000.
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Flinn.R.A and Trojan.P.K, "*Engineering Materials and their applications"*, Jaico, Bombay, 1990.
5.	Budinski.K.G and Budinski.M.K, "*Engineering Materials Properties and selection"*, Prentice Hall of India Private Limited, New Delhi, 2004.
6.	ASM Metals Hand book, "*Failure analysis and prevention"*, Vol: 10, 14th Edition, New York, 2002.
7.	R.E.Smallman&A.H.W.Ngan, *Physical Metallurgy and Advanced Materials*, 7th edition, Elsevier Ltd., 2011
8.	Michelle Addington and Daniel Schodek, "*Smart Materials and New Technologies*", Elsevier print, 2005
9.	George S. Brady, Henry R. Clauser, JhonA.Vaccari, *Materials Science Hand Book",*McGraw-Hill, 1997
10.	Sidney H Avnar , "*Introduction to physical metallurgy*", Tata McGraw-Hill Education, 2nd edition, 1997
11.	William D. Callister, David G. Rethwisch, "*Materials Science and Engineering: An Introduction*", Wiley publication, 8th Edition, 2009.
12.	Donald R. Askeland, Wendelin J. Wright , "*Science and Engineering of Materials*" , Cengage Learning – U.S.A Publication, 7th Edition, 2011
13.	Donald R. Askeland, Wendelin J. Wright , "*Essentials of Materials Science & Engineering*" , Cengage Learning – U.S.A Publication, 3rd 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%**

15ME303L	MATERIALS TECHNOLOGY LABORATORY	L	T	P	C
		0	0	2	1
Co-requisite:	15ME303				
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 July 2016				

PURPOSE	To acquire the knowledge of identifying the metals and understanding based on microstructure and the metallurgical concepts.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Prepare different metal specimen for identification.	c						
2.	Study and identify the microstructure of metals.	c		k				
3.	Understand the heat treatment process and its metallurgical changes	c	e	k				

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	A. Study of metallurgical Microscope B. Specimen preparation for identification of metals/alloys B1. Specimen mounting press B2. Hand Polishing B3. Etching	2	C, I	1	1,2
2.	Identification of Plain Carbon steel a)L.C.Sb) NORMALISED L.C.S. c)H.C.S.d) NORMALISED H.C.S	2	I,O	1,2	1,2
3.	Identification of Cast iron : a) G.C.Ib) S.G.Ic) M.C.Id) W.C.I	2	I,O	1,2	1
4.	Comparison of Vickers Hardness for heat treated steel a) (HCS) As supplied b) After Quenching c) After Annealing d) After Normalization	2	I,O	3	1,2
5.	Determination of hardness using Micro Vickers Tester	2	I,O	3	1,2
6.	Determination of coating thickness using Image analyzer	2	I,O	1.2	1,2
7.	Determining the hardness of case hardened steel	2	I,O	3	1,2
8.	Determination of hardenability for Jominy End quenched specimen	2	I,O	3	1,2
9.	Identifying the properties of GC and SG Iron using image analyzer	2	I,O	1,2	1,2
10.	Identification of Steel based alloys : a) Dual Phase steelb) HSS c) SPRING STEEL (MCS)	2	I,O	1,2	1,2
11.	Identification of Aluminum based alloys: a) ALUMINIUM ALLOY b) DURALUMINIUM	2	I,O	1,2	1,2
12.	Identification of Copper based alloys : a) BRASS b) BRONZE	2	I,O	1,2	1,2
13.	Determining the Yield stress, Ultimate Tensile Stress, Breaking Stress for Mild Steel, Ductility and type of fracture	2	I, O	1,2	1,2
14.	Determining the bending stress using tensometer	2	I,O	1,2	1,2
15.	Wear analysis using Pin-On-Disc	2	I,O	1,2	1,2
	Total contact hours*	**30**			

*Any 10 experiments will be offered

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Sidney H Avnar , "*Introduction to physical metallurgy*", Tata McGraw-Hill Education, 2nd edition, 1997
3.	Donald R. Askeland, Wendelin J. Wright , "*Science and Engineering of Materials*" , Cengage Learning – U.S.A Publication, 7th Edition, 2011.
4.	ASTM standards.

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%**

15ME304	FLUID POWER CONTROL	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 July 2016				

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.	**TEXT BOOKS**

No.	
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%**

15ME304L	AUTOMATION LABORATORY	L	T	P	C
		0	0	2	1
Co-requisite:	15ME304				
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 July 2016				

PURPOSE	To train the students in hydraulic and pneumatic circuit design using different control devices.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Design Hydraulic and Pneumatic circuits for low cost automation	b	e	k				
2.	Control stepper and servo motors	b	e					
3.	Implement photo and ultrasonic, positional and velocity sensors	b	e	k				
4.	Program and execute PLC, virtual instrumentation and pick and place robot.		e	k				

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Speed control circuits for double acting cylinder.	2	I-O	1	1,2
2.	Synchronization circuit for two cylinders	2	I-O	1	1,2
3.	Continuous reciprocation of double acting cylinder	2	I-O	1	1,2
4.	Sequencing of two cylinders Circuit	2	D-I-O	1	1,2
5.	Cascading circuit for two groups	2	D-I-O	1	1,2
6.	Cascading circuit for three groups	2	D-I-O	1	1,2
7.	Implementation of logic circuits: AND, OR	2	D-I-O	1	1,2
8.	Basic Electro Pneumatic circuits: a) Continuous reciprocation of cylinder(with timer and counter) b) Sequencing of two cylinders	2	I-O	1	1,2
9.	Force, velocity calculations in Hydraulic linear actuation	2	I-O	3	1,2
10.	Speed control of AC Servo Motor using open and closed loop control.	2	I-O	2	1
11.	PLC application Trainer.	2	I-O	4	1
12.	PLC Control Pneumatic / Hydraulic linear actuator Circuits.	2	I-O	4	1
13.	Water Level Controller using PLC.	2	I-O	4	1
14.	PLC controlled Material Handling system.	2	I-O	4	1
15.	Temperature control using virtual instrumentation	2	I-O	4	1
16.	Positional control of a stepper motor	2	I-O	3	1
17.	Characteristics of inductive, capacitive and photoelectric proximity sensors	2	I-O	2	1
18.	Pick and place operation using industrial robot in Manual mode	2	I-O	4	1
19.	Pick and place operation using industrial robot in Teach pendent method	2	I-O	4	1
	Total contact hours*	**20**			

*Any 10 experiments will be offered

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Anthony Esposito, "*Fluid Power with applications"*, Prentice Hall International, 2009.

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%

15ME305	MECHANICAL ENGINEERING DESIGN	L	T	P	C
		2	2	0	3

Co-requisite:	Nil		
Prerequisite:	15ME203		
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 -- , 23rd July 2016		

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 LEVERS AND SPRINGS	**12**			
29.	Levers: Types, applications and design of lever	1	C	3	5
30.	Design procedure and problems onfoot lever	2	C,D	3	5
31.	Design procedure and problems on cranked lever	2	C,D	3	5
32.	Design procedure and problems on bell crank lever	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	2	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*	**60**			

*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**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15ME306	GAS DYNAMICS AND SPACE PROPULSION	L	T	P	C
		2	2	0	3
Co-requisite:	Nil				
Prerequisite:	15ME201				
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 July 2016				

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%**

15ME306L	HEAT POWER LABORATORY	L	T	P	C
		0	0	2	1
Co-requisite:	15ME206				
Prerequisite:	NIL				
Data Book / Codes/Standards	Approved steam tables				
Course Category	P PROFESSIONAL CORE	THERMAL ENGINEERING			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

PURPOSE	To enable the students to acquire the knowledge on operations and performance of I.C. Engines, steam turbine and air compressor

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	understand the components and functions of IC Engines	a	b	e				
2.	test the lubricants and fuels used for IC engines	a	b	e				
3.	Conduct the performance and heat balance test on IC engines using various dynamometers.	a	b	e				
4.	Conduct the performance test of steam turbine and air compressor.	a	b	e				

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Valve and port timing diagram of IC Engines	2	O	1	1,2,3
2.	Determination of viscosity using Redwood&Saybolt viscometer.	2	O	2	1
3.	Determination of flash and fire point	2	O	2	1
4.	Performance test on twin-cylinder diesel engine with the electrical dynamometer	2	O	3	1,2,3
5.	Performance test on single cylinder high speed diesel engine with rope brake dynamometer.	2	O	3	1,2,3
6.	Retardation test on slow speed diesel engine	2	O	3	1,2,3
7.	Performance test on petrol engine with electrical dynamometer	2	O	3	1,2,3
8.	Heat balance test on four stroke diesel engine with calorimeter.	2	O	3	1,2,3
9.	Heat balance test on four stroke diesel engine without calorimeter	2	O	3	1,2,3
10.	Morse test on multi-cylinder petrol engine	2	O	3	1,2,3
11.	Performance test on CI engine using eddy current dynamometer	2	O	3	1,2,3
12.	Performance test on two stage reciprocating air compressor	2	O	3	1
13.	Performance test on steam turbine.	2	O	4	1
14.	Emission measurement using exhaust gas analyzer	2	O	3	1,2,3
15.	Performance test on variable compression ratio engine with eddy current dynamometer and data acquisition system	2	O	3	1,2,3
	Total contact hours*	**20**			

*Any 10 experiments will be offered

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Ganesan. V, "*Internal Combustion Engines*", Tata McGraw-Hill, New Delhi, 2015
3.	Mathur. M. L, and Sharma. R. P, "*A course in Internal Combustion Engines*", DhanpatRai& Sons, New Delhi, 2010.

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%**

15ME308M	MULTI-DISCIPLINARY DESIGN	L	T	P	C
		2	2	0	3
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 July 2016				

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%**

Pedagogy:

Theme or major/broad domains will be announced by the department every semester. Multi-disciplinary designs will be made by the students in groups (group size may be decided by the course coordinator), with the topic of interest falling within the theme or major/broad domains as announced by the department, applying any combinations of the disciplines in engineering. 3D modelling and / or simulation must be used to validate the design.

In a combination of lecture and hands-on experiences, students must be exposed to understand and analyse engineering designs (or products) and systems, their realization process and project management. Analysis of the design criteria for safety, ergonomics, environment, life cycle cost and sociological impact is to be covered. Periodic oral and written status reports are required. The course culminates in a comprehensive written report and oral presentation. If required guest lecturers from industry experts from the sub-domains may be arranged to provide an outside perspective and show how the system design is being handled by the industry. The Conceive Design Implement Operate (CDIO) principles must be taught to the students.

A full-scale fabrication is not within the purview /scope of this course. Of course this design, if scalable and approved by the department, can be extended as the major project work

This course is 100% internal continuous assessment.

15ME375L	MINOR PROJECT I	L	T	P	C
		0	0	3	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 July 2016				

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**

15ME376L	MINOR PROJECT II	L	T	P	C
		0	0	3	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 July 2016				

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
	AMultidisciplinary 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	Panel of reviewers	Originality, Multi-disciplinary	**20**

	• Concept Sketches, Design 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**

15ME380L	SEMINAR I	L	T	P	C
		0	0	3	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 July 2016				

PURPOSE								
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To understand the research methodology adopted by various researchers	h	i	j				
2.	To mathematically model a problem, critically analyse it and adopt strategies to solve	b	c	e				
3.	To understand and present a well-documented research	e	g					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Guidelines for conducting 15ME380L Seminar for B.Tech 1. Upon registering for the course the student must identify a sub-domain of the degree specialization that is of interest to the student and start collecting research papers as many as possible. 2. After collecting sufficient number of research papers the student must peruse all the papers, meet the course faculty and discuss on the salient aspects of each and every paper. 3. The course faculty, after discussion with the student will approve TWO research papers that is appropriate for presentation. 4. The student must collect additional relevant reference materials to supplement and compliment the two research papers and start preparing the presentation. 5. Each student must present a 15-minute presentation on each of the approved research paper to the panel of evaluators. 6. The presenter must present one research paper within the first half of the semester (6 weeks) and another research paper in the next half of the semester (6 weeks) as per the schedule. 7. All other students registered for the course will form the audience. 8. The audience as well as the evaluators will probe the student with appropriate questions and solicit response from the presenter. 9. The presentation will be evaluated against 7 to 8 assessment criteria by 4 to 5 evaluators. 10. The score obtained through the presentations of TWO research papers will be converted to appropriate percentage of marks. This course is 100% internal continuous assessment.		C,D	1,2,3,4	
	Total contact hours	**30**			

Course nature		**100% internal continuous assessment.**		
Assessment Method (Weightage 100%)				
In-semester	**Assessment tool**	Presentation 1	Presentation 2	**Total**
	Weightage	**50%**	**50%**	**100%**
End semester examination Weightage :				**0%**

Department of Mechanical Engineering

EVALUATION OF SEMINAR PRESENTATIONS

Name of the Student: Date:
Register Number: Degree and Branch:
Topic:

Sl. No.	Criteria for Assessment	Evaluator 1	Evaluator 2	Evaluator 3	Evaluator 4	Evaluator 5
1	Understanding of the subject					
2	Clarity of presentation					
3	Appropriate use of Audio visual aids					
4	Whether cross references have been consulted					
5	Ability to respond to questions on the subject					
6	Time scheduling					
7	Completeness of preparation					

Poor	1	Below	2	Average	3	Good	4	Very Good	5

Overall Grades:
Remarks:
Signature of Course Coordinator

15ME381L	SEMINAR II	L	T	P	C
		0	0	3	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 July 2016				

PURPOSE								
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To understand the research methodology adopted by various researchers	h	i	j				
2.	To mathematically model a problem, critically analyse it and adopt strategies to solve	b	c	e				
3.	To understand and present a well-documented research	e	g					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Guidelines for conducting 15ME381L Seminar for B.Tech 1. Upon registering for the course the student must identify a sub-domain of the degree specialization that is of interest to the student and start collecting research papers as many as possible. 2. After collecting sufficient number of research papers the student must peruse all the papers, meet the course faculty and discuss on the salient aspects of each and every paper. 3. The course faculty, after discussion with the student will approve TWO research papers that is appropriate for presentation. 4. The student must collect additional relevant reference materials to supplement and compliment the two research papers and start preparing the presentation. 5. Each student must present a 15-minute presentation on each of the approved research paper to the panel of evaluators. 6. The presenter must present one research paper within the first half of the semester (6 weeks) and another research paper in the next half of the semester (6 weeks) as per the schedule. 7. All other students registered for the course will form the audience. 8. The audience as well as the evaluators will probe the student with appropriate questions and solicit response from the presenter. 9. The presentation will be evaluated against 7 to 8 assessment criteria by 4 to 5 evaluators. 10. The score obtained through the presentations of TWO research papers will be converted to appropriate percentage of marks. This course is 100% internal continuous assessment.		C,D	1,2, 3,4	
	Total contact hours	**30**			

Course nature		**100% internal continuous assessment.**		
Assessment Method (Weightage 100%)				
In-semester	**Assessment tool**	**Presentation 1**	**Presentation 2**	**Total**
	Weightage	**50%**	**50%**	**100%**

End semester examination Weightage :	0%

Department of Mechanical Engineering

EVALUATION OF SEMINAR PRESENTATIONS

Name of the Student: Date:
Register Number: Degree and Branch:
Topic:

Sl. No.	Criteria for Assessment	Evaluator 1	Evaluator 2	Evaluator 3	Evaluator 4	Evaluator 5
1	Understanding of the subject					
2	Clarity of presentation					
3	Appropriate use of Audio visual aids					
4	Whether cross references have been consulted					
5	Ability to respond to questions on the subject					
6	Time scheduling					
7	Completeness of preparation					

Poor	1	Below Average	2	Average	3	Good	4	Very Good	5

Overall Grades:
Remarks:
Signature of Course Coordinator

15ME385L	MASSIVE OPEN ONLINE COURSES (MOOCs) I	L	T	P	C
		0	0	3	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 July 2016				

PURPOSE	To offer students the opportunity to study with the world's best universities by integrating select MOOCs in a regular degree programme and providing students full credit transfer, as per university regulations, if they earn a "Verified / Completion Certificate" and take a proctored examination through a secure, physical testing center.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able								
1.	To apply the concepts, theories, laws, technologies learnt herein to provide engineering solutions.	f	h	i	j			

Course nature		Online - 100% internal continuous assessment.				
Assessment Method (Weightage 100%)						
In-semester	Assessment tool	Quiz	Assignment	Non-proctored / Unsupervised Tests	Proctored / Supervised Test	Total
	Weightage	25%	25%	10%	40%	100%
End semester examination Weightage :						0%

Registration process, Assessment and Credit Transfer:

1. Students can register for courses offered by approved global MOOCs platforms like edX, Coursera or Universities with which SRM partners specifically for MOOCs.
2. Annually, each department must officially announce, to the students as well as to the Controller of Examinations, the list of courses that will be recognized and accepted for credit transfer.
3. The department must also officially announce / appoint one or more faculty coordinator(s) for advising the students attached to them, monitoring their progress and assist the department in proctoring the tests, uploading the marks / grades, and collecting and submitting the graded certificate(s) to the CoE, within the stipulated timeframe.
4. Student who desires to pursue a course, from the above department-approved list, through MOOCs must register for that course during the course registration process of the Faculty of Engineering and Technology, SRM University.
5. The maximum credit limits for course registration at SRM will include the MOOCs course registered.
6. The student must periodically submit the marks / grades obtained in various quizzes, assignments, tests etc immediately to the Faculty Advisor or the Course Coordinator for uploading in the university's academic module.
7. The student must take the final test as a Proctored / Supervised test in the university campus.
8. The student must submit the "Certificate of Completion" as well as the final overall Marks and / or Grade within the stipulated time for effecting the grade conversion and credit transfer, as per the regulations. It is solely the responsibility of the individual student to fulfil the above conditions to earn the credits.
9. 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 (7) norms; else if the credits are not transferred or transferable, the attendance will be considered as ZERO.

15ME386L	MASSIVE OPEN ONLINE COURSES (MOOCs) II	L	T	P	C
		0	0	3	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 July 2016				

PURPOSE	To offer students the opportunity to study with the world's best universities by integrating select MOOCs in a regular degree programme and providing students full credit transfer, as per university regulations, if they earn a "Verified / Completion Certificate" and take a proctored examination through a secure, physical testing center.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To apply the concepts, theories, laws, technologies learnt herein to provide engineering solutions.	f	h	i	j			

Course nature		**Online - 100% internal continuous assessment.**				
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	**Quiz**	**Assignment**	**Non-proctored / Unsupervised Tests**	**Proctored / Supervised Test**	**Total**
	Weightage	**25%**	**25%**	**10%**	**40%**	**100%**
End semester examination Weightage :						**0%**

Registration process, Assessment and Credit Transfer:

1. Students can register for courses offered by approved global MOOCs platforms like edX, Coursera or Universities with which SRM partners specifically for MOOCs.
2. Annually, each department must officially announce, to the students as well as to the Controller of Examinations, the list of courses that will be recognized and accepted for credit transfer.
3. The department must also officially announce / appoint one or more faculty coordinator(s) for advising the students attached to them, monitoring their progress and assist the department in proctoring the tests, uploading the marks / grades, and collecting and submitting the graded certificate(s) to the CoE, within the stipulated timeframe.
4. Student who desires to pursue a course, from the above department-approved list, through MOOCs must register for that course during the course registration process of the Faculty of Engineering and Technology, SRM University.
5. The maximum credit limits for course registration at SRM will include the MOOCs course registered.
6. The student must periodically submit the marks / grades obtained in various quizzes, assignments, tests etc immediately to the Faculty Advisor or the Course Coordinator for uploading in the university's academic module.
7. The student must take the final test as a Proctored / Supervised test in the university campus.
8. The student must submit the "Certificate of Completion" as well as the final overall Marks and / or Grade within the stipulated time for effecting the grade conversion and credit transfer, as per the regulations. It is solely the responsibility of the individual student to fulfil the above conditions to earn the credits.
9. 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 (7) norms; else if the credits are not transferred or transferable, the attendance will be considered as ZERO.

15ME390L	INDUSTRIAL TRAINING	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 July 2016				

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%**

15ME401	ECONOMICS AND PRINCIPLES OF MANAGEMENT	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	GENERAL			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

PURPOSE	To become familiarized about Engineering Economics and Principles Management.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	The different engineering economic principles and strategies		e					
2.	Principles of organizational management	c						
3.	Behaviour of human at organizations with modern management concepts			h				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: ENGINEERING ECONOMICS	**9**			
1.	Introduction to Economics, Scope and Definition	1	C	1	6
2.	Importance of Economics in Engineering, Demand and supply laws	1	C	1	6
3.	Economic optimization, Demand and Revenue Analysis	1	C	1	6
4.	Law of Demand , Demand Functions, Classification of Demand	1	C	1	6
5.	Demand Forecasting, Methods of Demand Forecasting, Demand curves	1	C	1	6
6.	Factors affecting Demand Factors Influencing Demand, Types of demand Forecasting	1	C	1	6
7.	Elasticity of Demand , Types, Price Elasticity, Income Elasticity, Advertisement Elasticity	1	C	1	6
8.	Demand curves Production Analysis	1	C	1	6
9.	Tutorial on elasticity of demand.	1	C, D	1	6
	UNIT II: SUPPLY, COST AND OUTPUT	**9**			
10.	Supply, Supply schedule, Law of Supply	1	C	1	6
11.	Elasticity of Supply, Cost and Supply Analysis	1	C	1	6
12.	Types of Costs, requirements of good costing system	1	C	1	6
13.	Price and output Determination, Objectives of pricing	1	C	1	6
14.	Price Fixation, Pricing methods	1	C	1	6
15.	Pricing Policies, Factors governing Pricing Policies	1	C	1	6
16.	Estimation of Break Even Point	1	C	1	6
17.	Break Even analysis, Usefulness of BEP	1	C	1	6
18.	Limitations , Simple Problems	1	C, D	1	6
	UNIT III: MANAGEMENT AND ITS ENVIRONMENT	**9**			
19.	Management - Definition - Functions	1	C	2	2
20.	Evolution of Modern Management movement	1	C	2	2
21.	Different Schools of Management thoughts	1	C	2	2
22.	Types and Forms of Business Organization	1	C	2	2
23.	Designing effective organizations	1	C	2	2
24.	Individual ownership - Partnership	1	C	2	8
25.	Joint stock companies	1	C	2	8
26.	Cooperative enterprises	1	C	2	8
27.	Public Sector Undertakings	1	C	2	8

	UNIT IV: MANAGEMENT OF HUMAN AT WORK	**9**			
28.	Human Resource Development: Staffing, Selection, development, motivation and Training	1	C	3	2
29.	Motivation theories, Techniques	1	C	3	2
30.	Motivating individuals and workgroups	1	C	3	2
31.	Leadership for Managerial Effectiveness, Types	1	C	3	9
32.	Team working, Creativity and decision making	1	C	3	2
33.	Managerial Communication: Importance, classification	1	C	3	2
34.	Time Management	1	C	3	9
35.	Performance Appraisal- promotion, methods	1	C	3	2
36.	Career Planning	1	C	3	2
	UNIT V: MODERN MANAGEMENT CONCEPTS	**9**			
37.	Management by Objectives (MBO), Features	1	C	3	3
38.	MBO-Principles and Steps	1	C	3	3
39.	MBO- Advantages and Disadvantages	1	C	3	3
40.	Management by Exception (MBE)	1	C	3	7
41.	Strategic management-Levels of strategy	1	C	3	7
42.	SWOT analysis	1	C	3	7
43.	Enterprise Resource Planning (ERP)	1	C	3	8
44.	Supply Chain Management (SCM)	1	C	3	8
45.	Activity Based Management (ABM)	1	C	3	8
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Chandran, J. S., "*Organizational Behaviours"*, Vikas Publishing House Pvt. Ltd., New Delhi, 1994
2.	Ernest Dale, "*Management Theory and Practice"*, International Student Edition, McGraw Hill Publishing Co., New Delhi, 1973
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Richard Pettinger, "*Mastering Organizational Behaviour"*, Macmillan Press, London, 2000
4.	Gail Freeman - Bell and JanesBalkwill, "*Management in Engineering - Principles and Practive*", Prentice Hall of India Pvt.Ltd., 1998
5.	R.R. Barathwal, "*Engineering Economics*", McGraw Hill, 1997
6.	Sasmita Mishra , " *Engineering Economics and Costing* " Eastern Economy Edition " , 2009
7.	L.M. Prasad, "*Principles and practice of management*", Sultan Chand and Sons, 2015
8.	O.P.Khanna, "*Industrial Engineering and Management*", Dahnpatrai Publications, 1980

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%**

15ME402	METROLOGY AND QUALITY CONTROL	L	T	P	C
		3	0	0	3
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 July 2016				

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%**

15ME402L	**METROLOGY AND QUALITY CONTROL LABORATORY**	**L**	**T**	**P**	**C**

		0	**0**	**2**	**1**
Co-requisite:	15ME402				
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 July 2016				

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%**

15ME403	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
		2	2	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 July 2016				

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%**

15ME404	COMPUTER AIDED MANUFACTURING	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	15ME202				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE	MANUFACTURING ENGINEERING			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

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.	Basics of manufacturing systems and CNC machines	c	k					
2.	Constructional features of CNC machines	c	k					
3.	Automation Systems	c	k					
4.	Material handling systems	c	k					
5.	Computer aided production planning	c	k					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: MANUFACTURING SYSTEMS AND CNC MACHINES	**9**			
1.	Manufacturing systems: Introduction, components, classification and current trends	1	C	1	1
2.	Introduction to Group technology and its types	1	C	1	1
3.	Part families, coding and classification.	1	C	1	1
4.	PFA with case study	1	C,D	1	1
5.	Machine cell design with numerical case study	1	C,D	1	1
6.	CIM principles, elements.	1	C	1	1
7.	Fundamentals of CNC machines, Classification, Developments	1	C	1	1
8.	CNC principles of operation and features.	1	C	1	1, 7
9.	Machining Centers and its types	1	C	1	1, 7
	UNIT II - ELEMENTS OF CNC MACHINES	**9**			
10.	Types of Interpolations, Open loop and closed loop systems	1	C	2	7
11.	CNC controllers : Absolute and Incremental systems	1	C	2	7
12.	Introduction to Direct Numerical Control and its types	1	C	2	7
13.	Introduction to Adaptive Control and its types with case study	1	C	2	7
14.	Machine structures and its slide ways with types	1	C	2	7
15.	Linear bearings and Recirculating ball screws	1	C	2	7
16.	Drives :Spindle and Feed drives, hydraulic& pneumatics	1	C	2	7
17.	Positional and Velocity feedback devices	1	C	2	7
18.	ATC and automatic pallet system	1	C	2	7
	UNIT III - AUTOMATION AND AUTOMATED ASSEMBLY SYSTEMS	**9**			
19.	Automated manufacturing system :Historical development and future trends	1	C	3	1
20.	Automation :Need, basic elements, levels and advanced automation functions	1	C	3	1
21.	Automated assembly: Fundamental, system configuration, part delivery at Workstation and its applications	1	C	3	1
22.	Design for automated assembly	1	C,D	3	3
23.	Quantitative analysis of assembly systems	1	C,D	3	1
24.	Line balancing algorithm: Largest candidate rule, simple problems.	1	C,D	3	1
25.	Line balancing algorithm: Kilbridge and Wester method, simple problems.	1	C,D	3	1
26.	Line balancing algorithms, Ranked positional weights method,	1	C,D	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Computerized techniques, simple problems.				
27.	Line balancing algorithms, Computerized techniques, simple problems.	1	C,D	3	1
	UNIT IV – FMS & MATERIAL HANDLING SYSTEMS	**9**			
28.	Introduction to FMS, types, applications and benefits.	1	C	4	1
29.	FMS :components, Layout Configurations, implementation	1	C	4	1
30.	Quantitative analysis of FMS, simple problems	1	C,D	4	1
31.	Automated material handling systems, conveyor system	1	C	4	1
32.	Automated guided vehicles, pallets	1	C	4	1
33.	Automated storage and retrieval systems, Carousel storage system	1	C	4	1
34.	Introduction to Industrial Robots, Robot physical Configuration, Basic Robot motions	1	C	4	1
35.	Technical features-work volume, Precision & accuracy of robot with simple problems	2	C,D	4	1
	UNIT V - COMPUTER AIDED PRODUCTION PLANNING AND CONTROL	**9**			
36.	Introduction to Computer aided production planning , Application of computers	1	C	5	1
37.	Materials Requirement planning with Case study	1	C	5	1
38.	Management Resource planning with case study	1	C	5	1
39.	Capacity Planning and Data collection systems	1	C	5	1
40.	Shop floor control and monitoring systems	1	C	5	1
41.	Inventory control and Case study	1	C	5	1
42.	JIT approach and Case study	1	C	5	1
43.	Lean Manufacturing	1	C	5	1
44.	Agile manufacturing	1	C	5	1
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Mikell P. Groover, "*Automation, Production systems and computer integrated manufacturing"*, Prentice Hall of India Private Ltd., New Delhi, 2008.
2.	YoranKoren, "*Computer Control of Manufacturing Systems*" Tata McGraw-Hill Edition 2005
3.	M.S.Sehrawat, J.S.Narang "*CNC Machines*" Dhanpat Rai & Company Private Limited, New Delhi,1999
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Ibrahim Zeid, "*CAD/CAM Theory and Practice"*, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2010.
5.	James Madison, "*CNC Machining Hand Book"*, Industrial Press Inc., New York,1996.
6.	Barry Hawkes, "*The CAD/CAM Process"*, Wheeler Publishing, 1992.
7.	Hans B. Kief and Frederick Waters, T., "*Computer Numerical Control - A CNCReference Guide"*, Macmillan / McGraw-Hill, New York, 1992.
8.	Radhakrishnan.P, Subramanyan.S and Raju.V, "*CAD/CAM/CIM*", New Age International Publishers, 20s00.
9.	Rao.P.N, Tewari.N.K and Kundra.T.K, "*Computer Aided Manufacturing"*, Tata McGraw-Hill, New Delhi, 2008
10.	Mikell P. Groover, Emory W. Zimmers Jr., "*CAD/CAM:Computer Aided Design and Manufacturing"*, Prentice Hall of India Private Ltd., New Delhi, 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%**

15ME404L	**COMPUTER AIDED MANUFACTURING LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

Co-requisite:	15ME404		
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 July 2016		

PURPOSE	To familiarize programming techniques in CNC part programming and the machining procedure in CNC machines.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Develop part programming for Lathe and milling operations.	c	k					
2.	Implement canned cycles for different operations.	c	k					
3.	Machine components using CNC Lathe and milling machine.	c	k					
4.	Apply CAM software		k					

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1	Manual Part Program for Facing, Step turning, Taper and Finish Turning using ordinary cycle	2	I	1	1,2,3
2	Manual Part Program for Facing, Step turning, Taper and Finish Turning using canned cycle.	2	I	2	1,2,3
3	Manual Part Program for Grooving, Threading and Axial Drilling using canned cycle.	2	I	2	1,2,3
4	Generate the NC Code for Turning operation using CAM software**.**	2	I	4	1
5	Manual Part Program for Linear and Circular Interpolation using Milling operation.	2	I	1	1,2,3
6	Manual Part Program for Mirroring operation	2	I	1	1,2,3
7	Manual Part Program for Drilling and Threading Operation**.**	2	I	1	1,2,3
8	Generate the NC Code for Milling operation using CAM software**.**	2	I	4	1
9	Model a Simple profile Using Turning operation and verify the toolpath using CAM software	2	I	1,4	1
10	Model a Simple profile Using Milling operation and verify the toolpath using CAM software	2	I	1,4	1
11	Model a Simple profile Using wire-cut EDM and verify the toolpath using CAM software	2	I	1,4	1
12	Machining of components on FMS Turning and Milling Center.	2	I,O	3	1
13	Machining of components on CNC Turning and Milling Center.	2	I,O	3	1
14	Machining of components on Wire Cut Electrical Discharge Machine.	2	I,O	3	1
15	Mini project	2	I,O	1,2, 3,4	2,3
	Total contact hours*	**20**			

*Any 10 experiments will be offered

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Narang, JS, "*CNC Machines and automation*", Dhanpat Rai & Co. Ltd, 2016.
3.	James Madison, "*CNC Machining Hand Book*", Industrial Press Inc., New York, 1996.

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%**

15ME405	**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 July 2016		

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%**

15ME490L	**INDUSTRY MODULE I**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**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 July 2016

PURPOSE	To impart and insight into the current Industrial trends and Practices							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To obtain an insight into the current industrial trends and practices			j				
2.	To obtain an insight into the technologies adopted by industries			j				
3.	To obtain an insight into the technical problems encountered by the industries and the scope for providing solutions.		h					
4.	To network with industry	g						

Description of Topic	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1. The department will identify and shortlist few emerging topics that are trending in industry. 2. The department will identify experts from industry who are willing to deliver modules on the shortlisted topics. 3. The identified expert will assist the department in formulating the course content to be delivered as a 30-hour module, prepare lectures notes, ppt, handouts and other learning materials. 4. The department will arrange to get the necessary approvals for offering the course, from the university's statutory academic bodies well before the actual offering. 5. The department must officially announce, to the students as well as to the Controller of Examinations, the list of courses that will be offered as industry module. 6. The department must also officially announce / appoint one or more faculty coordinator(s) for advising the students attached to them, monitoring their progress and assist the department in proctoring/supervising/assessment the quizzes, assignments, tests etc, uploading the marks, attendance etc, within the stipulated timeframe. 7. The Student who desires to pursue a course, from the above department-approved list, must register for that course during the course registration process of the Faculty of Engineering and Technology, SRM University. 8. The maximum credit limits for course registration at SRM will include the Industry Module also. 9. All academic requirements of a professional course like minimum attendance, assessment methods, discipline etc will be applicable for this Industry Module. 10. The course will be conducted on weekends or beyond the college regular working hours.		C,D, I,O	1,2,3,4	
Total contact hours	**30**			

Course nature							**100% internal continuous assessment.**
Assessment Method – Theory Component (Weightage 50%)							
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%**

15ME491L	**INDUSTRY MODULE II**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**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 July 2016		

PURPOSE	To impart and insight into the current Industrial trends and Practices							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To obtain an insight into the current industrial trends and practices			j				
2.	To obtain an insight into the technologies adopted by industries			j				
3.	To obtain an insight into the technical problems encountered by the industries and the scope for providing solutions.		h					
4.	To network with industry	g						

Description of Topic	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1. The department will identify and shortlist few emerging topics that are trending in industry. 2. The department will identify experts from industry who are willing to deliver modules on the shortlisted topics. 3. The identified expert will assist the department in formulating the course content to be delivered as a 30-hour module, prepare lectures notes, ppt, handouts and other learning materials. 4. The department will arrange to get the necessary approvals for offering the course, from the university's statutory academic bodies well before the actual offering. 5. The department must officially announce, to the students as well as to the Controller of Examinations, the list of courses that will be offered as industry module. 6. The department must also officially announce / appoint one or more faculty coordinator(s) for advising the students attached to them, monitoring their progress and assist the department in proctoring/supervising/assessment the quizzes, assignments, tests etc, uploading the marks, attendance etc, within the stipulated timeframe. 7. The Student who desires to pursue a course, from the above department-approved list, must register for that course during the course registration process of the Faculty of Engineering and Technology, SRM University. 8. The maximum credit limits for course registration at SRM will include the Industry Module also. 9. All academic requirements of a professional course like minimum attendance, assessment methods, discipline etc will be applicable for this Industry Module. 10. The course will be conducted on weekends or beyond the college regular working hours.		C,D, I,O	1,2, 3,4	
Total contact hours	**30**			

Course nature				**100% internal continuous assessment.**			
Assessment Method – Theory Component (Weightage 50%)							
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%**

15ME496L	**MAJOR PROJECT**	**L**	**T**	**P**	**C**
		0	**0**	**24**	**12**
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 July 2016	

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%**

15ME315E	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 July 2016				

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%**

15ME326E	ROBOTICS ENGINEERING AND APPLICATIONS	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 July 2016				

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%**

15ME327E	INDUSTRIAL TRIBOLOGY	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15ME303				
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 July 2016				

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%**

15ME328E	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 July 2016				

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%**
					End semester examination Weightage :		**50%**

15ME329E	FOUNDRY 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 July 2016				

PURPOSE	To impart the students clear knowledge about foundry engineering.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Patterns and pattern making.	c	j					
2.	Concepts of moulding	c	j					
3.	Various casting processes and equipment	c	j					
4.	Modernization of foundry shop	c	j					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: PATTERNS AND PATTERN MAKING	**9**			
1.	Introduction to foundry	1	C	1	T2
2.	Steps involved in casting	1	C	1	T2
3.	Advantages, limitations and applications of casting processes.	1	C	1	T2
4.	Pattern types	2	C	1	T2
5.	Allowances for pattern	2	C	1	T2
6.	Pattern materials colour coding and storing of patterns	2	C	1	T2
	UNIT II: MOULDING	**9**			
7.	Moulding methods and process	1	C	2	T2
8.	Materials and equipment for moulding	1	C	2	T2
9.	Sand ingredients and essential requirements	1	C	2	T2
10.	Sand preparation and control testing in moulding	1	C	2	T2
11.	Cores and core making	1	C	2	T2
12.	Design considerations in casting gating	2	C	2	T2
13.	Gating and risering in casting.	1	D	2	T2
14.	Directional solidification in castings	1	C	2	T2
	UNIT III : CASTING PROCESS	**9**			
15.	Sand casting and Pressure die casting	1	C	3	T2
16.	Permanent mould casting	1	C	3	T2
17.	Centrifugal casting and Precision investment casting	1	C	3	T2
18.	Shell moulding and CO_2 moulding	1	C	3	T2
19.	Continuous casting, Squeeze casting and Electro slag casting	2	C	3	T2
20.	Fettling and finishing	2	C	3	T2
21.	Defects in castings and Near Net techniques	1	C	3	T2
	UNIT IV - MELTING, POURING AND TESTING	**9**			
22.	Selection of furnaces	1	C	3	T2
23.	Crucibles oil fired furnaces	1	C	3	T2
24.	Electric furnaces	2	C	3	T2
25.	Cupola furnace and Calculation of cupola charges	1	C	3	T2
26.	Hot blast cupola, remelting and Degasification	2	C	3	T2
27.	Inoculation and Pouring equipment in casting	1	C	3	T2
28.	Inspection of castings	1	C	3	T2
	UNIT V : MODERNIZATION AND MECHANIZATION IN FOUNDRY SHOP	9			
29.	Need for modernization in foundry shop	1	C	4	T2
30.	Areas for mechanization in foundry shop	1	C	4	T2
31.	Typical layout of foundry shop	1	C	4	T2
32.	Sand reclamation techniques	2	C	4	T2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
33.	Material handling in foundry shop	2	C	4	T2
34.	Pollution control in foundry shop	1	C	4	T2
35.	Computers in castings.	1	C	4	T2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Banga.T.R and Agarwal.R.L, "*Foundry Engineering*", Khanna publishers, New Delhi, 1992.
2.	Jain.P.L, "*Principles of Foundry Technology*", Tata McGraw-Hill Education, 2003.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Sharma.P.C, "*A Text book of Production Engineering"*, New Delhi, 2014.
4.	Taylor.H.F, Flemings.M.C and Wulff. J, "*Foundry Engineering*", Wiley Eastern Ltd., New Delhi, 1993.
5.	Gupta.R.B, "*Foundry Engineering*", Sathyaparkasam, New Delhi, 1989.
6.	ASM Metals, "*Hand Book on Castings*", Vol. 15, 14th 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%**

15ME330E	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 July 2016				

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%**

15ME331E	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 July 2016				

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%**

15ME332E	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 July 2016				

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%**

15ME333E	**THEORY OF METAL FORMING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Co-requisite:	
Prerequisite:	Nil
Data Book / Codes/Standards	Nil
Course Category	P PROFESSIONAL ELECTIVE
Course designed by	Department of Mechanical Engineering
Approval	-- Academic Council Meeting -- , 23rd July2016

PURPOSE	To familiarize the students with various metal forming process and understand the stress criterion for it.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
1.	Impart knowledge about various metal forming process	c				h		
2.	Understand stress criterion for plastic deformation	c	b					
3.	Ability to identify the process parameters responsible for metal forming	c					k	
4.	Good exposure towards recent trends in metal forming process	c		e				
5.	Understand the defects and overcome with remedies	c			j			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT 1 : THEORY OF PLASTICITY	**9**			
1.	State of stress	1	C	2	1
2.	Stress tensor	1	C	2	1
3.	Engineering stress strain relationship	1	C	2	1
4.	Flow curve	1	C	2	1
5.	True stress and true strain	1	C	2	1
6.	Yield criteria	1	C	2	1
7.	Slip line field theory	1	C	2	1
8.	Plastic work	1	C	2	1
9.	Plastic anisotropy	1	C	2	1
	UNIT II : FUNDAMENTALS OF METAL WORKING	**9**			
10.	Flow stress determination	2	D	2	1
11.	Temperature in metal working	2	C	2	1
12.	Strain rate effects	1	C,D	3	1
13.	Hot, cold and warm working	1	C	3	1
14.	Metallurgical structure	1	C,D	3	1
15.	Friction and lubrication	1	C,D	3	1
16.	Hydrostatic pressure	1	C	2	1
17.	Workability	1	C	2	1
18.	Residual stresses, deformation processing system	1	C	5	1
	UNIT III :PLASTIC FORMING OF METALS :ROLLING, FORGING AND EXTRUSION	**9**			
19.	Classification of rolling process, Types of rolling mills	1	C	1	1
20.	Hot and cold rolling	1	C	1	1
21.	Forces and geometric relationship in rolling	1	C	2	1
22.	Rolling of bars and shapes, Rolling defects, causes and remedies	1	C	1	1
23.	Classification of Forging process, Forging Equipment	1	C	1	1
24.	Open and closed die forging, forging defects, residual stresses	1	C	1,5	1
25.	Classification of extrusion process, Variables affecting extrusion	1	C	1	1
26.	Hydrostatic extrusion, Production of seamless pipe and tubing	1	C	1	1
27.	Deformation, lubrication and defects in extrusion	1	C	5	1
	UNIT IV: SHEET METAL FORMING	**9**			
28.	Sheet metal forming methods	1	C	1	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
29.	Shearing, blanking	1	C	1	1
30.	Bending	1	C	1	1
31.	stretch forming	1	C	1	1
32.	deep drawing	1	C	1	1
33.	Principles and process parameters	1	C,D	3	1
34.	Sheet metal formability	1	C,D	3	1
35.	Formability limit diagram	1	C,D	3	1
36.	Defects in formed parts	1	C	5	1
	UNIT V : HIGH VELOCITY FORMING AND SUPERPLASTIC FORMING	**9**			
37.	Comparison with conventional forming methods	1	C	4	2
38.	High Energy Rate Forming	1	C	4	3,2
39.	Explosive forming	1	C	4	2
40.	Electrohydraulic forming	1	C	4	2
41.	Magnetic pulse forming	1	C	4	2
42.	Rubber pad forming	1	C	4	5
43.	Super plasticity	1	C	4	1
44.	Superplastic forming	1	C	4	2
45.	Merits and demerits of superplastic forming	1	C	4	1,2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	George E Dieter, "*Mechanical Metallurgy*", Tata McGraw-Hill Education Pvt. Ltd, 2014.
2.	SeropeKalpakjian and Stevan R Schmid, "*Manufacturing Process for Engineering Materials*", Pearson Education, 2007
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Surendar Kumar, "*Technology of Metal Forming Processes*", PHI Learning Pvt Ltd, 2008
4.	William F Hasford, Robert M Caddell "*Metal Forming : Mechanics and Metallurgy*", Cambridge University Press, 2011
5.	ASM "*Metals Handbook*, *Volume 14, Forming and Forging*", ASM Metals Park, Ohio, USA, 1998

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%**

15ME334E	PRODUCTION MANAGEMENT	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Approved statistical charts				
Course Category	P PROFESSIONALELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

PURPOSE	To get acquainted with the basic aspects of Production Management							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, students will be able to								
1.	Understand the principles of Production Management	a						
2.	Acquire knowledge on Inventory Management and Work study.	a		c		h		
3.	Perform Job evaluation and Scheduling		b	c	d			
4.	Plan and execute Project			c				
5.	Implement and assure Quality in Management			c				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO PRODUCTION MANAGEMENT	**9**			
1.	History and development of production management	1	C	1	1,2
2.	Functions and scope of different types of production processes	1	C	1	1,2
3.	Relationship of production management with other functional areas	1	C	1	1,2
4.	Capacity planning and its types	1	C	1	1,2
5.	Capacity decisions and their importance	1	C	1	1,2
6.	Capacity planning strategies: types	1	C	1	2
7.	Location planning: factors, types of planning	1	C	1	1,2
8.	Layout planning: factors and types	1	C	1	1,2
9.	Productivity management: definition, productivity index	1	C	1	1
	UNIT II -INVENTORY MANAGEMENT AND WORK STUDY	**9**			
10.	Inventory Control and cost, procurement and purchasing methods	1	C	2	2,7
11.	Warehousing Procedure and records in stock control	1	C	2	5,7
12.	Method Study and Means of increasing productivity	1	C	2	1,7
13.	Charts and diagrams used in method study	1	C	2	1,7
14.	Role of work study and human factors in work study	1	C	2	1,7
15.	Objectives and basic procedure for work study	1	C	2	1,2,7
16.	Factors affecting work study	1	C	2	1,7
17.	work measurement, objectives and techniques of work measurement	1	C	2	1
18.	Problems in Inventory control	1	D	2	1
	UNIT III -JOB EVALUATION AND SCHEDULING	**9**			
19.	Job evaluation: objectives, methods and factors affecting wage structure.	1	C	3	1,2
20.	Types of wages, methods of wage system and characteristics	1	C	3	1,2
21.	Value analysis and value engineering	1	C	3	3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
22.	Aggregate planning and strategies	1	C	3	1
23.	Forecasting and its types	1	C	3	1,4
24.	MPS and Scheduling	1	C	3	1,3,4
25.	Scheduling principles, inputs, strategies, sequence and assumptions	1	C	3	1,4
26.	Gantt chart and Johnson's algorithm	1	C	3	1,4
27.	Problems in Gantt chart and Johnson's algorithms	1	D	3	1,7
	UNIT IV - PROJECT MANAGEMENT AND MRP	**9**			
28.	Project Management Phases and Project Appraisal	1	C	4	1
29.	PERT and CPM	1	C	4	2,4
30.	Material requirement Planning (MRP)	1	C	4	1,2,7
31.	Manufacturing resources Planning (MRP II)	1	C	4	2,7
32.	Enterprise Resource Planning (ERP)	1	C	4	2,7
33.	Logistics: types and strategies	1	C	4	1,7
34.	Supply chain Management	1	C	4	2
35	Objectives and Decision Phases of Supply chain Management	1	C	4	2
36.	Roles and Development in Supply chain Management	1	C	4	1,2
	UNIT V - TOTAL QUALITY MANAGEMENT	**9**			
37.	Quality management systems and Factors controlling quality	1	C	5	2
38.	Impact of poor quality, challenges and Quality cost	1	C	5	2
39.	Quality Assurance and Quality Circle	1	C	5	1,2
40.	Statistical Process Control and Control Charts	1	C	5	1,2,7
41.	Total Quality Management	1	C	5	2,3
42.	Just in Time	1	C	5	1,2
43.	Six Sigma	1	C	5	1,2
44.	Maintenance management and its types	1	C	5	2
45.	Effects of maintenance, Reliability and Replacement Techniques	1	C	5	2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	S.K. HajraChoudhury et al, "*Production Management"*, MP publishers, New Delhi, 1990.
2.	Heizer.,"*Operations Management"*, Pearson, New Delhi, 2016.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Ahuja, K.K., "*Production Management"*, CBS Publishers, New Delhi, 2013.
4.	Agarwal and Jain, "*Production Management*", Khanna publishers, New Delhi, 1998
5.	S N.Chary, "*Production and operation management"*, Tata Mcgraw Hill publications, New Delhi, 2009
6.	Goel, B.S., "*Production Management"*, Pragathi&prakasan publishers, Mererut, 1984.
7.	S.Anil and N.Suresh, "*Production and operation Management"*, New Age International publishers, New Delhi, 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%**

15ME335E	ELEMENTS OF SPACE 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 July 2016				

PURPOSE	This course is designed to provide a broad overview of the space technology.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Develop a basic knowledge on earth's atmosphere.	c	d	e				
2.	Learn the different orbit bodies.	c	d	e				
3.	Understand the aspects of satellite injection.	c	d	e				
4.	Know the interplanetary and missile trajectories and materials for spacecraft	c	d	e				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: EARTH AND ATMOSPHERE	**9**			
1.	The solar system , Reference frames and coordinate systems	1	C	1	1,2
2.	The celestial sphere	2	C	1	1,2
3.	The ecliptic, Motion of vernal equinox	2	C	1	1,2
4.	Sidereal time, Solar time, Standard time	3	C	1	1,2
5.	The earth's atmosphere.	1	C	1	1,2
	UNIT II: THE GENERAL N-BODY PROBLEM	**9**			
6.	The Many body problem – Lagrange, Jacobi identity	2	C	2	1,2
7.	The circular restricted three body problem	2	C	2	1,2
8.	Libration points	1	C	2	1,2
9.	Relative Motion in the N-body problem	1	C	2	1,2
10.	The two body problem	1	C	2	1,2
11.	Satellite orbits ,Relations between position and time	1	C	2	1,2
12.	Orbital elements.	1	C	2	1,2
	UNIT III: SATELLITE INJECTION & SATELLITE ORBIT PERTURBATIONS	**9**			
13.	General aspects of satellite injections	1	C	3	1,2
14.	Satellite orbit transfer - Various cases	2	C	3	1,2
15.	Orbit deviations due to injection errors	1	C	3	1,2
16.	Special and general perturbations - Cowell's Method , Encke's method	2	C	3	1,2
17.	Method of variations of orbital elements	2	C	3	1,2
18.	General perturbations approach.	1	C	3	1,2
	UNIT IV: INTERPLANETARY TRAJECTORIES BALLISTIC MISSILETRAJECTORIES	**9**			
19.	Two-dimensional interplanetary trajectories - Fast interplanetary trajectories	2	C	4	1,2
20.	Three dimensional interplanetary trajectories Launch of interplanetary spacecraft	1	C	4	1,2
21.	Trajectory about the target plant.	2	C	4	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
22.	The boost phase, The ballistic phase	2	C	4	1,2
23.	Trajectory geometry - Optimal flights - Time of flight, Re-entry phase	1	C	4	1,2
24.	The position of the impact point , Influence coefficients	1	C	4	1,2
	UNIT V: MATERIALS FOR SPACECRAFT	**9**			
25.	Space environment - Peculiarities	3	C	4	1,2
26.	Effect of space environment on the selection of materials of spacecraft.	6	C	4	1,2
	Total contact hours*	**45**			

* Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Sutton. G.P, "*Rocket Propulsion Elements"*, 7th Edition, John Wiley & Sons, NewYork, 2011
2.	Cornelisse.J.W, "*Rocket Propulsion and Space Dynamics"*, W.H. Freeman & Co., New York, 2005
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Rudolph X. Meyer., "*Elements of Space Technology"*, Academic press, London, 2003.
4.	Parker.E.R, "*Materials for Missiles and Spacecraft"*, McGraw Hill Book Co., NewYork, 2000.
5.	Ramamurthi. K, "*Rocket Propulsion",* MacmillanPublishers India Ltd. 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%**

15ME336E	INTRODUCTION TO NUCLEAR REACTOR CONCEPTS	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 July 2016				

PURPOSE	To introduce to the students the concept of physics and engineering in nuclear reactors, including safety approaches								
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**							
To make familiar with the important concepts applicable to									
1.	Reactor physics	a							
2.	Steam cycles		c						
3.	Nuclear fuel cycle	a		e					
4.	Different types of reactors	a		e					
5.	Direct conversion of nuclear radiation to electricity				h				

Session	Description of Topic	Contact Hours	C-D-I-O	IOs	Reference
	UNIT I: BASICS OF NUCLEAR ENERGY	**9**			
1.	Motivation for nuclear energy	1	C	1	1
2.	Nuclear model of the atom, equivalence of mass and energy, binding energy	1	C	1	1
3.	Mechanism of nuclear fission and fusion	1	C	1	1
4.	Chicago pile	2	C,D	1	1
5.	Radio activity, half-life.	1	C,D	1	1
6.	Radiation interactions with matter, cross sections	1	C	1	1,3
7.	Principles of radiation detection	1	C,D	1	1
8.	Decay heat	1	C	1	1,4
	UNIT II: NUCLEAR FUEL CYCLE	**9**			
9.	Uranium exploration, mining,	1	C	2	1
10.	Uranium production, fuel fabrication, spent fuel handling,	1	C	2	1
11.	Reprocessing (purex, urex, diamex),	1	C	2	1
12.	Pyroprocessing,	2	C	2	1,5
13.	Fuel transportation between facilities.	1	C	2	1
14.	Radioactive waste management: types, treatment, compaction, vitrification etc.,	1	C	2	1,8
15.	Materials: fuel, structural, coolants, control, moderator, shielding	2	C	2	1
	UNIT III: NUCLEAR THERMAL HYDRAULICS	**9**			
16.	Heat transfer in fuel	1	C,D	3	1,2
17.	Fuel to coolant	1	C,D	3	1
18.	One dimensional heat conduction with heat generation.	1	C,D	3	1
19.	Heat transfer properties of water, gas, liquid metals, correlations	2	C,D	3	1,6
20.	Pressure drop: single phase, two phase.	2	C,D	3	1
21.	Instability of two phase flow	1	C	3	1
22.	Basic Carnot, Rankine and Brayton cycles	1	C	3	1,7

Session	Description of Topic	Contact Hours	C-D-I-O	IOs	Reference
	UNIT IV: TYPES OF NUCLEAR REACTORS	**9**			
23.	Components of a nuclear reactor	1	C	4	1
24.	Types of nuclear reactors	1	C	4	1
25.	Pressurized water reactor	1	C	4	1,2
26.	Boiling water reactor	2	C	4	1,4
27.	Pressurised heavy water reactor	1	C	4	1
28.	Gas cooled reactor	1	C	4	1
29.	Liquid metal cooled fast breeder reactors	1	C	4	1,5
30.	Gen IV concepts	1	C	4	1
	UNIT V: REACTOR SAFETY APPROACH	**9**			
31.	Defense in depth approach in design	1	C	5	1
32.	Redundancy, diversity, independence	1	C	5	1
33.	Reactor protection logic, shutdown systems, decay heat removal systems	1	C	5	1
34.	Design basis events, beyond design basis events.	2	C	5	1
35.	Regulatory requirements- site selection stage	1	C	5	1
36.	Design analysis, construction phase	1	C	5	1
37.	Operational phase including physical protection	1	C	5	1
38.	Decommissioning phase, environment survey lab, emergency exercises	1	C	5	1
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Glasstone, S, and Sesonske, A., "*Nuclear Reactor Engineering*", Von Nostrand, 3rd Edition 1981.
2.	Vaidyanathan, G., "*Nuclear Reactor Engineering-Concepts & Principles*", S.Chand Co., Delhi, 2013
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Lamarsh, J.R., "*Introduction to Nuclear Reactor Theory*", Wesley, 1966
4.	Duderstadt, J.J., and Hamilton, L.J., "*Nuclear Reactor Analysis*", John Wiley, 1976
5.	Walter, A.E., and Reynolds, A.B., "*Fast Breeder Reactor*", Pergamon Press, 1981
6.	Winterton, R.H.S., "*Thermal Design of Nuclear Reactors*", Pergamon Press, 1981.
7.	Collier, J.G., and Hewitt, G.F., "*Introduction to Nuclear Power*", Hemisphere Publishing, 1987.
8.	Lipschutz, R.D., "*Radioactive Waste - Politics, Technology and Risk*", Ballingor, 1980.

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%**

15ME337E	WELDING TECHNOLOGY	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15ME202				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

PURPOSE	To expose the students to the logistics approaches of welding technology								
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**							
At the end of the course, student will be able to									
1.	Understand welding techniques for various alloys	c	e						
2.	Understand welding application concepts.	c	e						
3.	Understand mechanized welding techniques	c	e						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: POWER SOURCES	**9**			
1.	Classification of welding processes by heat sources	1	C	1	1,2,3,4
2.	Classification of welding processes by power sources	1	C	1	1,2.3,4
3.	Classification of welding processes by arc characteristics	1	C	1	1,2,3,4
4.	Classification of welding processes by V-I relationship	1	C	1	1,2,3,4
5.	Classification of different types of electrodes and ingredients	2	C	1	1,2,3,4
6.	Function of electrode coverings	2	C	1	1,2,3,4
7.	Classifications of types of weld joints.	1	C	1	1,2,3,4
	UNIT II: FUSION WELDING PROCESSES	**9**			
8.	Explanation of Shielded metal arc welding processes	1	C	2	1,2,3,4
9.	Explanation of gas welding processes	2	C	2	1,2,3,4
10.	Explanation ofTIG welding processes	2	C	2	1,2,3,4
11.	Explanation ofMIG welding processes	2	C	2	1,2,3,4
12.	Explanation ofSubmerged arc welding processes	2	C	2	1,2,3,4
	UNIT III: SOLID STATE WELDING PROCESSES	**9**			
13.	Explanation ofResistance welding processes	1	C	3	1,2,3,4
14.	Explanation offriction welding processes	1	C	3	1,2,3,4
15.	Explanation offriction stir welding processes	1	C	3	1,2,3,4
16.	Explanation of ultrasonic welding processes	1	C	3	1,2,3,4
17.	Explanation ofinduction pressure welding processes	2	C	3	1,2,3,4
18.	Explanation ofdiffusion welding processes	2	C	3	1,2,3,4
19.	Explanation of explosive welding processes	2	C	3	1,2,3,4
	UNIT IV: SPECIAL WELDING PROCESSES	**9**			
20.	Explanation ofElectron beam welding processes	1	C	3	1,2,3,4
21.	Explanation oflaser beam welding processes	2	C	3	1,2,3,4
22.	Explanation of plasma arc welding processes	1	C	3	1,2,3,4
23.	Explanation of welding processes	1	C	3	1,2,3,4
24.	Explanation of explosive welding processes	1	C	3	1,2,3,4
25.	Explanation of advantages, limitations of special welding	1	C	3	1,2,3,4
26.	Introduction to Robotic welding	1	C	3	1,2,3,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
27.	Introduction to underwater welding.	1	C	3	1,2,3,4
	UNIT V: DESIGN OF WELD JOINTS, WELDABILITY AND TESTING OF WELDMENTS	**9**			
28.	Discussion of Various weld joint designs	2	C	3	1,2,3,4
29.	Discussion of Weldability of Aluminium	1	C	3	1,2,3,4
30.	Discussion of Weldability of Copper	1	C	3	1,2,3,4
31.	Discussion of Weldability of Stainless steels	1	C	3	1,2,3,4
32.	Destructive testing of weldments	2	C	3	1,2,3,4
33.	Discussion of Nondestructive testing of weldments	2	C	3	1,2,3,4
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Cornu. J.,"*Advanced Welding Systems*"-Volumes I, II and III, JAICO Publishers, 2004.
2.	Lancaster L.F, '*The Physics of Welding'*, Pergamon Press, 1996
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Rao P.N."*Manufacturing Technology (Foundry, Forming and Welding)* IIEdition", Tata McGraw Hill Pub. Co. Ltd,. New Delhi, 1998.
4.	*Welding Handbook* (Section I) American Welding Society, 1999

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%**

15ME338E	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 July 2016				

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%**

15ME339E	MECHANICAL HANDLING SYSTEMS AND EQUIPMENT	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 July 2016				

PURPOSE	To highlight the concepts of Mechanical handling systems and their applications in manufacturing							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Fundamentals of automation in material handling	a	c					
2.	Common material handling systems	a	c					
3.	Automated material handling systems like RGVS, AGVS, AS/RS, etc.,	a	c					
4.	Transfer mechanisms, conveyors, part feeding devices, robots in material handling	a	c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit –I INTRODUCTION	**9**			
1.	Introduction to work handling concepts in manufacturing	1	C	1	1, 3, 4
2.	Configuration, symbolic representation, work piece characteristics and their significance	1	C	1	3, 4
3.	Facilities planning process, Facilities design and diagrams, Storage facilities planning	1	C	1	3, 4
4.	Materials flow, Activity relationship, Space requirements	1	C,D	1	3, 4
5.	Facility lay out – computerized lay outs, Evaluation and selection of alternatives	1	C	1	3, 4
6.	Defined materials handling	1	C	1	3, 4
7.	Storage – open and closed storage systems	1	C	1	3, 4
8.	Bulk loading, Unloading, Shipping	1	C	1	3, 4
9.	Receiving systems and operations.				3, 4
	UNIT II: COMMON MATERIAL HANDLING EQUIPMENTS	**9**			
10.	Concepts of Unit Loads, Material handling and Storage	1	C	2	3, 4
11.	Equipments operation and selection	1	C	2	3, 4
12.	Containers, Pallets, Conveyor systems, Industrial trucks, Wagon tipplers	1	C	2	3, 4
13.	Transporters, stackers, reclaimers	1	C	2	3, 4
14.	Silos & hoppers and their accessories, Ropeways, Ship loaders, Cable cranes	1	C	2	3, 4
15.	Container handling systems, Electric lifts	1	C,D	2	3, 4
16.	Hoists, EOT cranes, Elevators	1	C,D	2	3, 4
17.	Material handling equipments in Steel mills, Power plants, Mines, Automobile and Transport Industries	1	C	2	3, 4
18.	Large scale Constructions etc. Case Study for All Above Mentioned Handling systems.	1	C	2	3, 4
	UNIT III: AUTOMATION OF MATERIAL HANDLING	**9**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
19.	Automated feeding arrangements for discrete parts	1	C	3	3, 4
20.	Design based in work piece requirements, orienting methods	1	C	3	3, 4
21.	One by one feeding, agonizing, stapling etc	1	C	3	3, 4
22.	Feeding continuous material liquids, granules etc	1	C	3	3, 4
23.	Automated assembly system, elements,	1	C,D	3	3, 4
24.	Automated assembly system ,configuration design, details and control	1	C	3	3, 4
25.	Special feeding mechanisms	1	C	3	3, 4
26.	Automated inspection and their design	1	C,D	3	3, 4
27.	Case study for automated material handling.	1	C	3	3, 4
	UNIT IV: CLASSIFICATION OF AUTOMATED SYSTEMS	**9**			
28.	Concepts of Unit Built Machines (UBM)	1	C	4	3, 4
29.	Gain lean and green endorsement, collaboration to achieve lean and green goals	1	C	4	3, 4
30.	Classification and elements, Power Units, self-contained and separate feed type, Change over ubms	1	C	4	3, 4
31.	Transfer lines – classification and their components	1	C	4	3, 4
32.	Automated systems for handling and transfer of prismatic, axis symmetric parts and asymmetric parts in transfer lines	1	C	4	3, 4
33.	Case studies on transfer lines – interlocked	1	C	4	3, 4
34.	Case studies on palletized and flexible inter linkage transfer lines	1	C	4	3, 4
35.	Control systems for flexible inter linkage transfer lines	1	C	4	3, 4
36.	SWARF handling and disposal systems	1	C	4	3, 4
	UNIT V: AUTOMATED MATERIAL HANDLING EQUIPMENTS	**9**			
37.	Automated handling and storage systems in manufacturing environment	1	C	5	3, 4
38.	Rail Guided Vehicles (rgvs), Automated Guided Vehicles (agvs)	1	C	5	3, 4
39.	Applications of rgvsand agvs, Automated Storage and Retrieval Systems (AS / RS)	1	C	5	3, 4
40.	AS / RS in the Automated factory	1	C,D	5	3, 4
41.	Considerations for planning an AS /RS system, Applications of AS / RS	1	C	5	3, 4
42.	Principles of work holding devices – Modular fixturing	1	C	5	3, 4
43.	Flexible fixturing systems	1	C	5	3, 4
44.	Fixturing for FMS	1	C	5	3, 4
45.	Robots and their applications in handling and storage	1	C	5	3, 4
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl.	**TEXT BOOKS**

No.	
1.	Groover. M. P., "*Automation, Production Systems and CIM"*, Prentice hall India, 2007.
2.	Morris A. Cohen, Uday M. Apte., "*Manufacturing Automation"*, Irwin, Chicago, 1997.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Ray Asfahl. C, "*Robots and Manufacturing Automation"*, 2nd edition, John Wiley & Sons, New York, 1992.
4.	James A. Tompkins., "*Facilities planning"*, John wiley& Sons Inc, 1984.
5.	James. M. Apple, "*Principles of layout and material handling"*, Ronald press, 1977.

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%**

15ME340E	DESIGN OF EXPERIMENTS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	Statistical data books				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting, 23rd July 2016				

PURPOSE	To enlighten the students about the fundamentals of design of experiment techniques.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know about design of experiment	a	e					
2.	Understand the methodology for design of experiment	a	e					
3.	Familiarize about concepts of confounding and Anova analysis	a	e	k				
4.	Expose the concepts of response surface design	a	e	k				
5.	Apply Taguchi method	a	e	k				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I: BASICS OF DESIGN OF EXPERIMENTS	**8**			
1.	Introduction in Design of experiments (DOE)	1	C	1	1,2
2.	Fundamental and practical issue in industrial experimentation	1	C	1	1,2
3.	Statistical thinking and its role within DOE	1	C	1	1,2
4.	Basic principles of DOE and Degrees of freedom	1	C	1	1,2
5.	Selection of quality characteristics for industrial experiments	1	C	1	1,2
6.	Understanding key interaction in processes	1	C	1	1,2
7.	Alternative method for calculating two-order interaction effect	1	C	1	1,2
8.	Synergistic interaction versus Antagonistic interaction	1	C	1	1,2
	UNIT-II: METHODOLOGY FOR DESIGN OF EXPERIMENTS	**8**			
9.	Need for DOE methodology	1	C	2	1,2
10.	Barriers in the successful application of DOE	1	C	2	1,2
11.	Practical methodology of DOE and Analytical tools for DOE	1	C	2	1,2
12.	Confidence interval for the mean response	1	C	2	1,2
13.	Introduction of Screening design	1	C	2	1,2
14.	Geometric and non-geometric P-B design	1	C	2	1,2
15.	Introduction of full factorial design	1	C	2	1,2
16.	2^2 , 2^3,2^4 full factorial design	1	C,D	2	1,2
	UNIT-III: CONFOUNDING	**11**			
17.	Introduction and uses of confounding	1	C	3	1,2
18.	2^3 factorial experiment with complete confounding	1	C,D	3	1,2
19.	2^3 factorial experiment with partial confounding	1	C,D	3	1,2
20.	Confounding in the 2^n series and examples	2	C,D	3	1,2
21.	Confounding of 3^2 factorial	1	C,D	3	1,2
22.	Confounding of 3^3 factorial and examples	2	C,D	3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
23.	Mixed series and examples	1	C,D	3	1,2
24.	Introduction on Anova Analysis	2	C	3	1,2
	UNIT-IV: RESPONSE SURFACE DESIGN	**9**			
25	Background of response surface design	1	C	4	7,8
26	Creation of response surface design	1	C	4	7,8
27	Central composite design	1	C	4	7,8
28	Box Behnken design	1	C	4	7,8
29	Contour profile of response surface plot	1	C	4	7,8
30	Design table	1	C	4	7,8
31	Analyze the data	1	C	4	7,8
32	Case studies on response surface design	1	C,D	4	7,8
33	utionary operation and experiment with random factor	1	C	4	7,8
	UNIT-V:TAGUCHI METHOD	**9**			
34	Taguchi design approach	1	C	5	4,5
35	Orthogonal array, S/N ratio	1	C	5	4,5
36	Smaller is better, Nominal is better and larger is better with simple case studies	2	C	5	4,5
37	Analyze the data, factor effect diagram	1	C	5	4,5
38	Levels of parameters	1	C	5	4,5
39	Confirmation test	1	C	5	4,5
40	Augmented design with simple case studies	2	C,D	5	4,5
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Jijuantony, "*Design of Experiments for Engineers and Scientists*", Elsevier, 2004.
2.	Douglas C Montgomery, " *Design and Analysis of Experiments*" , John Wiley & Sons Ltd., 2005
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	M N Das, N C Giri, "*Design and Analysis of Experiments*", New Age International (P) Limited, Publishers, 1997.
4.	Russell R. Barton, "*Graphical Methods for the Design of Experiments*", Springer, 1999.
5.	Larry B. Barrentine, "*An introduction to Design of Experiments A simplified approach*", New Age International Publishers, 2010.
6.	William G. Cochran, Gertrude M. Cox, "*Experimental Design*", John Wiley and sons, Inc, 1992.
7.	Box, G.E.P. and Draper N.R, "*Empirical Model-Building and Response Surfaces*", John Wiley &sons 1987.
8.	Myres R.H, "*Response Surface Methodology*", Boston: Allyn and Bacon, 1976.
9.	Cox C.R, "*The theory of Design of Experiments*", Chapman and Hall, CRC Press, 2000.
10.	John, P.W.M, "*Statistical Design and Analysis of Experiments*", Macmillan Publishing Company, Inc, 1972.

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%**

15ME341E	SUSTAINABLE GREEN MANUFACTURING	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 July 2016				

PURPOSE	The course aims to introduce and explain the design concepts, methods, tools and technologies, and operations of sustainable lean and green manufacturing systems and processes.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Green Manufacturing and Sustainable engineering concepts	a	c					
2.	Multi attributes decision making methods	a	c					
3.	Green manufacturing management.	a	c					
4.	Applications in green manufacturing	a	c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT –I:INTRODUCTION TO GREEN MANUFACTURING	**8**			
1.	Definition of manufacturing, Impact of manufacturing in environmental ecology	1	C	1	1, 3, 4
2.	Role of manufacturing sector in national growth	1	C	1	3,4
3.	Technological change and evolving risk	1	C,D	1	3,4
4.	concepts of "green" manufacturing need of green manufacturing	1	C	1	3,4
5.	Green manufacturing strategies	1	C	1	3,4
6.	Green manufacturing – motivation, barriers, regulation, policy	1	C	1	3,4
7.	Casting defects and remedies.	1	C	1	3,4
8.	Advantages and limitations of green manufacturing	1			3,4
	UNIT II: GREEN MANUFACTURING TOOLS	**9**			
9.	Principles of green manufacturing and its efficiency	1	C	2	3,4
10.	Green manufacturing and sustainability	1	C	2	3,4
11.	System model architecture and module	1	C	2	3,4
12.	Design and planning, control or tools for green manufacturing (Qualitative Analysis	1	C	2	3,4
13.	Consumption Analysis, Life Cycle Analysis, Efficiency, Sustainability tools).	1	C	2	3,4
14.	Standards for green manufacturing (ISO 14000 and OHSAS 18000	1	C,D	2	3,4
15.	Waste stream mapping and application	1	C,D	2	3,4
16.	Identify and apply the concepts of product and process design with environmental forethought	1	C	2	3,4
17.	Design for environment and for sustainability - Discuss the Product Life Cycle of manufactured goods.	1	C	2	3,4
	UNIT III: ATTRIBUTES DECISION MAKING METHODS	**9**			
18.	Introduction to Multi attributes decision making methods	1	C	3	3,4
19.	definition, structure for Multi attributes decision making	1	C	3	3,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	methods				
20.	variants and analysis of different methods like Simple Additive Method (SAM)	1	C	3	3,4
21.	Weighted Product Method (WPM)	1	C	3	3,4
22.	Analytic Hierarchy Process (AHP)	1	C,D	3	3,4
23.	Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Grey Relation Analysis (GRA	1	C	3	3,4
24.	Elimination and Choice Expressing Reality (ELECTRE)	1	C	3	3,4
25.	ViseKriterijumskaOptimizacija I KompromisnoResenje (VIKOR),	1	C,D	3	3,4
26.	Problems based on different MADMs.	1	C	3	3,4
	UNIT IV: CREATING LEAN AND GREEN ORGANISATION	**9**			
27.	Question wasteful practices	1	C	4	3,4
28.	Gain lean and green endorsement, collaboration to achieve lean and green goals	1	C	4	3,4
29.	Track progress for environment and profits	1	C	4	3,4
30.	Creation of sustainable growth	1	C	4	3,4
31.	Enabling techniques for assuring green manufacturing	1	C	4	3,4
32.	Drivers of green manufacturing, impact, advantages and disadvantages of drivers	1	C	4	3,4
33.	Green architecture and buildings, Sustainable manufacturing resources management	1	C	4	3,4
34.	Carbon footprint analysis and management of manufacturing processes	1	C	4	3,4
35.	Green Process Economics, Resource Recovery and Reuse	1	C	4	3,4
	UNIT V: CASE STUDIES IN GREEN MANUFACTURING	**10**			
36.	Design resources saving into product and processes	1	C	5	3,4
37.	Closed loop & Open Loop production system	1	C	5	3,4
38.	Green manufacturing through clean energy supply	1	C	5	3,4
39.	semiconductors manufacturing	1	C,D	5	3,4
40.	Various case studies of implementation of semiconductors manufacturing at industries	1	C	5	3,4
41.	Green packaging and supply chain	1	C	5	3,4
42.	Various case studies of implementation of Optimizing Logistics solution at industries	1	C	5	3,4
43.	Environmental implication of Nano manufacturing	1	C	5	3,4
44.	Various case studies of implementation of lean manufacturing at industries	1	C	5	3,4
45.	Various case studies of implementation of Optimizing process or product at industries	1	C	5	3,4
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES

Sl. No.	TEXT BOOKS
1.	Ronald G. Askin& Jeffrey B. Goldberg, "*Design and Analysis of Lean Production Systems*", John Wiley & Sons, 2003.
2.	Rao.P.N, "*Manufacturing Technology, Vol I and II",* Tata McGraw Hill PublishingCo., 3rd edition, Sixth Reprint 2010
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Charles Wankel "*21st century management: a reference handbook*" SAGE Publications, Inc., 2008.
4.	Christian N. Madu "*Handbook of environmentally conscious manufacturing*" London : Kluwer Academic Publishers, 2001.
5.	T.E. Graedel& B.R. Allenby "*Industrial Ecology*" Pearson Education, Inc. 2003.
6.	Joseph Sarkis "*Greener manufacturing and operations: from design to delivery and back*" Greenleaf Pub., 2001.
7.	Ranky, P.G.: "*An Introduction to Alternative Energy Sources: An interactive multimedia 3D eBook publication by CIMware USA, Inc. and CIMware Ltd.,* UK, ISBN 1-872631- 97-5, 2008.
8.	Ranky, P.G.: "*Digital Product Design: Design For Quality, Manufacturing, Assembly & Disassembly Principles, and an Inkjet Printer Disassembly Use Case*", DVD videopublication by CIMware USA, Inc. and CIMware Ltd., UK, 2008, UPC 632568002983
9.	Ranky, P.G.: "*Digital Product Design: Concurrent Engineering Principles, Analysis and Some Tools of Design For Quality, Manufacturing, Assembly & Disassembly, and a Desktop Telephone Disassembly Use Case, DVD duo video and 3D eBook publication by CIMware USA, Inc. and CIMware Ltd*.", UK, 2008, UPC 632568003034
10.	Graedel T. E. and Braden R. Allenby, "*Industrial Ecology and Sustainable Engineering*" by 1st edition, (ISBN 9780136008064, publisher: Prentice Hall). Copyright 2010
11.	Liker, Jeffrey. "*The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*". McGraw-Hill, 2004
12.	Palevich, Robert. "*The Lean Sustainable Supply Chain: How to Create a Green Infrastructure with Lean Technologies*", FT Press, 2012
13.	Womack, James and Jones, Daniel. "*Lean Thinking: Banish Waste and Create Wealth in Your Corporation, Revised and Updated*". Free Press (a division of Simon & Schuster), 2003.
14.	Ingrassia, Paul and White, Joseph. "Comeback: "*The Fall and Rise of the American Automobile Industry*", Simon& Schuster, 1995.
15.	David A. Dornfeld, "*Green manufacturing fundamentals and application*", Springer Publication, 2012.
16.	Ame, "*Green manufacturing case studies in lean and sustainability*", productivity press publication, 2007.
17.	Pamela J Gordon, "*Lean and green profit for your workplace and the environment*", Berrett-Koehler publication, 2001.

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%**

15ME342E	ENERGY SYSTEMS FOR BUILDINGS	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 July 2016				

PURPOSE	To enable the students to understand and apply their knowledge to solve energy management issues of buildings.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
Upon successful completion of the course, the students are able to apply the concept and techniques of								
1.	Energy efficient buildings systems.	a	e					
2.	Solar passive heating and cooling systems.	a	e					
3.	Day lighting and electrical lighting	a	e					
4.	Heat control and ventilation methods in buildings	a	e					
5.	Green buildings and certifications.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: ENERGY TRANSFER IN BUILDINGS	**9**			
1	Concepts of energy efficient buildings	1	C	1	1,2
2	Calculation of various heating and cooling loads of the building. Heat losses - Internal heat sources. Heat load calculations.	3	C	1	1,2
3	Building's energy balance accounting for solar energy gain	2	C	1	1,2
4	Climate and its influence in building design for energy requirement. Low and zero energy buildings	3	C	1	1,2
	UNIT II:PASSIVE SOLAR HEATING AND COOLING	**9**			
5	General principles of passive solar heating.	1	C	2	1,2
6	Key design elements of passive heating and cooling, direct solar heat gain by Trombe mass walls	2	C	2	1,2
7	Water walls, evaporative cooling, convective air loops and solar chimney effects	2	C	2	1,2
8	Passive cooling, ventilation, predicting ventilation in buildings, window ventilation calculations.	2	C, D	2	1,2
9	Thermal insulation, load control, air filtration, Odor removal and heat recovery in large buildings.	2	C, D	2	1,2
	UNIT III: LIGHTING SYSTEMS OF BUILDINGS	**9**			
10	Glazing materials: sources and concepts of day lighting and optical materials	3	C	3	1,2
11	Components of daylight factor – Recommended daylight factors and day lighting analysis	3	C	3	1,2
12	Electric lighting control for day lighted buildings and illumination requirement, selection of luminaries and performance parameters	3	C, D	3	1,2
	UNIT IV: HEAT CONTROL AND VENTILATION	**9**			
13	Heat transmission through building sections and effect of heating with orientation of buildings	2	C	4	1,2
14	Design parameters influencing thermal design of	2	C, D	4	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	buildings				
15	Ventilation requirements and minimum standards for ventilation	1	C	4	1,2
16	Ventilation designs and energy conservation measures	2	C	4	1,2
17	Natural and forced ventilation methods.	2	C	4	1,2
	UNIT V: GREEN BUILDINGS	**9**			
18	Green building features and green construction materials	2	C	5	1,2
19	Integrated ecological design, sustainable site and landscaping	2	C	5	1,2
20	Indoor air quality, water and waste management systems	2	C	5	1,2
21	Green Globe, LEED, GRIHA, IGBC certifications and standards	2	C	5	1,2
22	Economics, managing initial costs and environment benefits.	1	C, D	5	1,2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Means R.S., "*Green building: project planning and cost estimating"*, Kingston, 2006.
2.	Kibert C.J., "*Sustainable Construction: Green Building Design",* 2nd edition, Wiley, 2007.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Boecker J., Scot Horst, Tom Keiter, Andrew Lau, MarkesSheffer, Brian Toevs, Bill Reed, "*Integrative Design Guide to Green Building*", Wiley, 2009.
4.	Eicker U., "*Low Energy Cooling for Sustainable Buildings*", Wiley, 2009.
5.	Gevorkian P., "*Alternative Energy Systems in Building Design*",McGraw-Hill, 2010.
6.	Harvey D.L., "*Handbook on Low-Energy Buildings and District-Energy Systems*", Earthscan, 2006.
7.	Attmann O., "*Green Architecture*", McGraw-Hill, 2010.
8.	Majumdar, M., "*Energy – Efficient Buildings in India*", Tata Energy Research Institute, Ministry of Non Conventional Energy Sources, 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%**

15ME343E	SOLAR ENERGY UTILIZATION	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 July 2016				

PURPOSE	To familiarize with the solar energy systems.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize with basics of solar radiation data and its measurement	a	e					
2.	Familiarize with construction and operation of solar thermal energy systems	a	e					
3.	Learn the operation of solar thermal power plants	a	e					
4.	Familiarize with the design of solar photovoltaic systems	a	e					
5.	Expose to the concept solar architecture in buildings and green buildings	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: SOLAR RADIATION	**9**			
1.	The Sun and the Earth, Electromagnetic spectrum	1	C	1	1,2
2.	Laws of radiation	1	C	1	1,2
3.	Solar radiation: beam and diffuse radiations, Terrestrial radiation	1	C	1	1,2
4.	Sun and Earth geometry, Solar angles	2	C	1	1,2
5.	Sunrise, sunset and day length	1	C	1	1,2
6.	Solar radiation on tilted surfaces	1	C	1	1,2
7.	Measurement of solar radiation: Pyranometer	1	C	1	1,2
8.	Measurement of solar radiation: Pyrheliometer, Sunshine Recorder	1	C	1	1,2
	UNIT II: SOLAR THERMAL SYSTEMS	**9**			
9.	Solar flat plate collectors and its design	2	C,D	2	1,2
10.	Solar evacuated tube collectors	1	C	2	1,2
11.	Domestic hot water systems: Integral collector storage, Thermosiphon system, Drain back system, Drain down system,Anti-freeze system	1	C	2	1,2
12.	Solar Cooker : Box type and Dish type, Cooking application problems	2	C,D	2	1,2
13.	Solar air heater, Solar Dryer	1	C	2	1,2
14.	Solar desalination	1	C	2	1,2
15.	Solar Pond: types, principle and application	1	C	2	1,2
	UNIT III: SOLAR CONCENTRATED POWER PLANT	**9**			
16.	Advantages and disadvantages of concentrated collectors over flat plate collectors	1	C	3	1,2
17.	Solar concentrators and receiver geometries, Concentration ratio	1	C	3	1,2
18.	Compound parabolic concentrators, Fresnel lens collectors	2	C	3	1,2
19.	Solar parabolic concentrators: trough and dish systems	2	C	3	1,2
20.	Central receiver plant or Power Tower	1	C	3	1,2
21.	Solar furnaces: types, principle and application	1	C	3	1,2
22.	Orientation and sun tracking systems	1	C	3	1,2

	UNIT IV: SOLAR PHOTOVOLTAICS	**9**			
23.	Advantages and disadvantages of Solar photovoltaic technology, Classification, Photovoltaic effect	1	C	4	1,2
24.	Semiconductors, p-n junction, Photo generation of charge carriers	1	C	4	1,2
25.	Photovoltaic cell manufacture : Czochralski, Zone refining and ribbon growth	1	C	4	1,2
26.	I-V characteristics of solar cell	1	C	4	1,2
27.	Losses in solar cell, Solar Module manufacture	1	C	4	1,2
28.	Photovoltaic system for power generation : Standalone system and grid connected system	2	C	4	1,2
29.	Photovoltaic system design : dc system and ac system	2	D	4	
	UNIT V: SOLAR-CONSCIOUS BUILDINGS	**9**			
30.	Orientation and design of buildings	2	C	5	1,2
31.	Thermal capacity, Sensible and latent heat storage in buildings, Insulation	2	C	5	1,2
32.	Solar Passive architecture : Heating of Buildings	1	C	5	1,2
33.	Solar Passive architecture : Cooling of Buildings	1	C	5	1,2
34.	Air conditioning : Solar VCRS and Solar VARS	2	C	5	1,2
35.	Green buildings, Zero energy buildings	1	C	5	9
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Duffie.J.A, &Beckman.W.A, "*Solar Engineering of Thermal Processes"*, 3rd Edition, John Wiley & Sons, Inc., 2006.
2.	Sukhatme.K, Suhas P. Sukhatme, "*Solar energy: Principles of thermal collection and storage"*, Tata McGraw Hill publishing Co. Ltd, 8th Edition, 2011.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Yogi Goswami.D, Frank Kreith, Jan F.Kreider, "*Principle of solar engineering"*, Taylor and Francis, 2nd Edition, 2000.
4.	Garg. H.P, Prakash.J, "*Solar energy fundamentals and applications"*, Tata McGraw Hill publishing Co. Ltd, 2006.
5.	G.D. Rai, *"Solar Energy Utilisation"*, Khanna Publishers, 5th Edition, 2014.
6.	Tiwari.G.N, "*Solar energy: Fundamentals, Design, Modeling and Applications"*, CRC Press Inc., 2002.
7.	Chetan Singh Solanki, *"Solar Photovoltaic technology and systems: A manual for Technicians, Trainers and Engineers"*, PHI Learning private limited, 2013.
8.	David A Bainbridge, Ken Haggard, *"Passive solar architecture: Heating, Cooling, Ventilation and more use of natural flows "*, Chelsea Green Publishing, 2011
9.	Jerry Yudelson*"Green building through integrated design"*, McGrawHill, 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%**

15ME344E	MECHANISM DESIGN, ANALYSIS AND SYNTHESIS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15ME204				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd July 2016				

PURPOSE	To study how various mechanisms can be designed.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Perform kinematic analysis of various mechanisms	a						
2	Synthesize different linkages.	a						
3	Perform the acceleration analysis of coupler points with the help of various graphical constructions.	a		e				
4	Perform the static and dynamic analysis of linkages.	a	c	e	k			
5	Perform kinematic analysis and synthesis of spatial mechanisms.	a			k			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: KINEMATIC ANALYSIS OF MECHANISMS	**12**			
1.	Review of fundamentals of kinematics, mobility analysis and classifications of mechanisms	1	C	1	1,2
2.	Kinematic Inversions, Grashoff's law,	1	C	1	1,2
3.	Mechanical advantage and Transmission angle	1	C	1	1,2
4.	Position analysis of four bar, Slider Crank mechanisms by complex and vector algebra methods	1	D	1	1,2
5.	Velocity, acceleration and jerk analysis of four bar, Slider Crank mechanisms by complex and vector algebra methods	1	C	1	1,2
6.	Tutorial on velocity, acceleration and jerk analysis of four bar, Slider Crank mechanisms by complex and vector algebra methods	2	D	1	1,2
7.	Velocity analysis of complex and six bar linkages by relative velocity method (Graphical method)	1	C	1	1,2
8.	Tutorial on velocity analysis of complex and six bar linkages by relative velocity method (Graphical method)	1	D	1	1,2
9.	Acceleration analysis of complex and six bar linkages by relative velocity method (Graphical method)	1	C	1	1,2
10.	Tutorial on acceleration analysis of complex and six bar linkages by relative velocity method (Graphical method)	2	D	1	1,2
	UNIT II: KINEMATIC SYNTHESIS OF LINKAGES	**12**			
11.	Introduction to synthesis, type, number and dimensional synthesis	1	C	2	1,3,5
12.	Two position synthesis of four bar and slider crank mechanisms by extreme position and inversion methods	1	C	2	1,3,5
13.	Tutorial on Two position synthesis of four bar and slider crank mechanisms by extreme position and inversion methods	2	D	2	1,3,5
14.	Three position synthesis of four bar and slider crank	1	C	2	1,3,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	mechanisms by inversion method				
15.	Tutorial on three position synthesis of four bar and slider crank mechanisms by inversion method	2	D	2	1,3,5
16.	Four position synthesis by point position reduction method and Overlay method.	1	C, D	2	1,3,5
17.	Coupler curve synthesis	1	C,D	2	1,3,5
18.	Analytical Methods of synthesis by Blotch's Synthesis	1	C, D	2	1,3,5
19.	Analytical Methods of synthesis by Freudestien's Method	1	C, D	2	1,3,5
20.	Cognate linkages by the Roberts - Chebyshev theorem	1	C, D	2	1,3,5
	UNIT III: PATH CURVATURE THEORY	**12**			
21.	Fixed and moving centrodes.	1	C	3	1,7
22.	Determination of radius of curvature of coupler points by Hartmann's Construction, the Euler- Savary equation	1	C	3	1,7
23.	Tutorial on radius of curvature of coupler points by Hartmann's Construction, the Euler- Savary equation	2	D	3	1,7
24.	Inflection Points, The Inflection Circle	1	C	3	1,7
25.	The collineation axis and Bobiller's theorem	1	C	3	1,7
26.	Determination of radius of curvature of coupler points by Bobiller's Construction	1	C	3	1,7
27.	Tutorial on radius of curvature of coupler points by Bobiller's Construction	2	D	3	1,7
28.	The cubic Stationary curvature - Ball's Point.	1	C	3	1,7
29.	Tutorial on cubic Stationary curvature - Ball's Point.	2	D	3	1,7
	UNIT IV: FORCE ANALYSIS OF MECHANISMS	**12**			
30.	Equilibrium of two, three and four force bodies	1	C	4	1,2,6
31.	Static force analysis of linkages, principle of super position	2	C	4	1,2,6
32.	Tutorial on static force analysis of linkages by graphical method	2	D	4	1,2,6
33.	Need for dynamics force analysis- D'Alembert's principle	1	C	4	1,2,6
34.	Determination of inertial forces on linkages	1	C	4	1,2,6
35.	Tutorial on dynamic force analysis of four bar linkage	2	D	4	1,2,6
36.	Combined static and dynamics analysis of four bar linkage, Graphical and analytical methods	2	D	4	1,2,6
37.	Shaking force and shaking couple, Introduction to force and moment balancing of linkages	1	C	4	1,2,6
	UNIT V: KINEMATICS OF SPATIAL MECHANISMS AND ROBOTICS	**12**			
38.	Mobility and description of spatial mechanisms	1	C	5	1
39.	Position, velocity and acceleration analysis of spatial mechanisms by vector algebra method	1	C	5	1
40.	Tutorial on position, velocity and acceleration analysis of spatial mechanisms by vector algebra method	2	D	5	1
41.	Kinematic synthesis of spatial mechanisms	1	D	5	7
42.	Introduction to Robot kinematics, Topological arrangements of robotic arms, Eulerian angles.	1	C	5	1
43.	Denavit - Hartenberg Parameters	1	C	5	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
44.	Kinematic analysis of robot manipulators using transformation matrices	2	C	5	1
45.	Tutorial on kinematic analysis of robot manipulators using transformation matrices	2	D	5	1
46.	Inverse kinematics of robot manipulators	1	D	5	1
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Uicker J. J., PennockG.R. andShigley, J. E "*Theory of Machines and Mechanisms"*, 4th edition, Oxford Press, 2015.
2.	Rao J. S. and Dukkipatti R.V., "*Mechanism and Machine Theory"*, 2nd Edition, New Age international (P) Ltd., 2008.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Sandor G. N. and Erdman A. G., "*Mechanism Design, Analysis and Synthesis",* Vol: I and Vol: II, Prentice Hall, 1984.
4.	Norton R. L., "*Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines"*, McGraw-Hill Higher Education, 2004.
5.	Hamilton H Mabie and Charles F. Reinhofz, "*Mechanisms and Dynamics of Machinery"*, John Wiley & Sons, 1987.
6.	A. Ghosh and A. K. Mallik, "*Theory of Mechanisms, and Machines*", 3rd Ed., East West Press Pvt Ltd, 2009.
7.	R.S.Hartenberg and J. Denavit, "*Kinematic Synthesis of Linkages",* McGraw Hill Book Company, 1964.

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%**

15ME345E	DESIGN FOR MANUFACTURING AND ASSEMBLY	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 July 2016				

PURPOSE	To study how a design can be made suitable for various manufacturing and assembly process requirements.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to study the								
1.	Various factors influencing the manufacturability of components and the use of tolerances in manufacturing.	a		e				
2.	Application of this study to various forging, casting, welding and machiningProcesses		c					
3.	Various assembly methods and processes and design for assembly guidelines	a	c	e	j			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO DFM	**9**			
1	Significance of design, qualities of a designer and Design factors	1	C	1	3
2	Systematic working plan, The engineering problem to be solved, The basic design	1	C	1	3
3	Factors influencing choice of materials and the factors influencing manufacturing	1	C	1	3
4	Process Capability Mean, Median, Variance, Mode, Standard Deviation, Normal Distribution and Process capability metrics	1	C,I	1	3
5	Process Capability	1	C,D	1	3
6	Tolerances-symbols and definition	1	C	1	1
7	Tolerances relevant to manufacturing, assembly and material condition	1	C,I	1	1
8	Tolerance stack- effects on assembly with examples	1	D	1	1
9	Methods of eliminating tolerance stack with examples	1	D	1	1
	UNIT II: FORM DESIGN-CASTING AND WELDING	**9**			
10	Influence of loading, Materials, Production methods on form design	1	C	2	1
11	Casting considerations, Grey iron castings	1	C	2	1
12	Steel castings, Aluminum Casting Requirements and rules for casting	1	C	2	1
13	Form design of pressure die castings	1	C	2	1
14	Welding considerations welding Processes	1	C	2	1
15	Requirements and rules for welding	1	C	2	1
16	Redesign of components for casting-pattern-mould-Parting Line	1	D	2	1,3
17	Redesign of components for welding	1	D	2	1,3
18	Case studies in form design-simple problems in form	1	I	2	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	design				
	UNIT III: FORM DESIGN-FORGING AND MACHINING	**9**			
19	Forging considerations hammer forging drop forging	1	C	2	1
20	Requirements and rules for forging	1	C	2	1
21	Choice between casting, forging and welding	1	I	2	1
22	Machining considerations Drills, Milling-Keyways Dwells and Dwelling Procedure Countersunk Head screws	1	C	2	1,3
23	Requirements and rules for Machining considerations and Reduction of machined areas	1	I	2	1,3
24	Redesign of components for Forging	1	D	2	1,3
25	Redesign of components for Machining	1	D	2	1,3
26	Simplification by separation and Simplification by amalgamation	1	D	2	1
27	Case studies	1	I	2	1,3
	UNIT IV: INTRODUCTION TO DFA	**9**			
28	DFA, Introduction, Distinction between assembly methods and processes	1	C	3	2
29	Factors Determining assembly methods and processes , Success and failure-Causes of failure	1	C	3	2
30	Product Design factors independent of methods and processes , Introduction-Number of operations in the product	1	C	3	2
31	Assembly Precedence, Standardization	1	C	3	2
32	Design factors dependent on Assembly methods , Introduction-Single Station Assembly	1	C	3	2
33	Line Assembly, Hybrid Systems, Manual Assembly Lines, Flexible Assembly Lines	1	C	3	2
34	Design factors dependent on Assembly processes, Factors Influencing Production rate to Facility Ratio-Parts Presentation, Manual Assembly	1	C	3	2
35	Dedicated Assembly, Transportation, Separation and Orientation-Flexible Assembly	1	C	3	2
36	Gripping, Transferring, Part Insertion, Failures and Error Recovery	1	C	3	2
	UNIT V: DESIGN FOR ASSEMBLY METHODS	**9**			
37	Approaches to design for assembly and Introduction	1	C	3	2
38	Approaches based on design principles and rules, Example DFA method using Design Principles	1	C	3	2
39	DFA Systems employing Quantitative evaluation procedures, IPA Stuttgart Method	1	C	3	2
40	DFA Methods employing a Knowledge based approach, Knowledge representation	1	C	3	2,5
41	Computer Aided DFA methods, Part model, Feature Processing	1	C	3	2
42	Assembly measures like Qualitative and Quantitative measures	1	C	3	2
43	Boothroyd and Dewhurst DFA method	1	C	3	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
44	Redesign of a simple product , Small consumer product and Fastener solution redesign using symmetry	1	D	3	2
45	Case Studies Designing of a disposal valve, Design of a lever-arch file mechanism	1	D	3	2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Harry Peck., "*Design for Manufacture*", Pittman Publications, 1983.
2.	Alan Redford and chal, "*Design for Assembly-Principles and Procedures*", McGraw Hill International Europe, London, 1994.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Robert Matousek, "*Engineering Design A Systematic Approach*", Blackie &sons Ltd., 1963.
4.	James G.Bralla, "*Hand Book of Product design for Manufacturing"*, McGraw Hill Co., 1986.
5.	Swift, K.G., "*Knowledge Based Design for Manufacture*", Kogan Page Ltd., 1987.

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%**

15ME346E	NON TRADITIONAL MACHINING TECHNIQUES	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 July 2016				

PURPOSE	To impart clear knowledge about different unconventional processes and its latest developments to the students							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to understand								
1.	Basic concepts of nontraditional machining techniques	a	e					
2.	Factors influencing the processes and their applications	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: BASICS OF NON TRADITIONAL MACHINING AND MECHANICAL ENERGY TECHNIQUES-I	**8**			
1.	Difference between traditional and non-traditional machining, Need for Non-Traditionalmachining.	1	C	1	1
2.	Machining characteristics and classificationofnon-traditional machining.	1	C	1	1,2
3.	Consideration in process and material selection. Applications of non-traditional Machining Techniques	1	C	1	1,2
4.	Operatingprinciple, elements and equipment of ultrasonic machining	1	C	1	1
5.	Cook's model for material removal and problems in estimation of MRR for ultrasonic machining	1	C,D	1	1
6.	Process parameters of ultrasonic machining. Applications, advantagesandlimitations of ultrasonic machining	1	C	2	1.2
7.	OperatingPrinciple, elements and equipment of abrasiveJetMachining	1	C	1	2
8.	Mechanism of metal removal, process parameters, application and limitations of abrasive jet machining.	1	C	1,2	2
	UNIT II: MECHANICAL ENERGY TECHNIQUES-II	**8**			
9.	Operatingprinciples and equipment of WaterJetMachining	1	C	1	2
10.	Process parameters, application and limitations of WaterJetMachining	1	C	1,2	2
11.	Operatingprinciples, equipment and mechanism of metal removal in abrasive water jet machining	1	C	1	1
12.	Parametersinfluencingmetal removal, applications, advantagesandlimitations of abrasive water jet machining	1	C	2	1
13.	OperatingPrinciple and equipment of abrasive flow machining	1	C	1	1
14.	Mechanism of metal removal, process parameters, application and limitations of abrasive flow machining	1	C	1,2	1
15.	OperatingPrinciple and equipment of magnetic abrasive machining	1	C	1	1
16.	Mechanism of metal removal, process parameters,	1	C	1,2	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	application and limitations of magnetic abrasive Machining				
	UNIT III: CHEMICAL AND ELECTRO CHEMICAL TECHNIQUES	**10**			
17. .	Fundamentals, principle and steps in chemical machining process	1	C	1	1
18. .	Classification and selection of Etchant and maskant. Advantages, limitations and application of chemical machining	1	C	1	1
19. .	Operatingprinciples, equipmentandsubsystems of electrochemicalmachining	1	C	1	2
20.	Metal removal rate and tool design in electrochemicalmachining	1	C,D	1	2
21. .	Process parameter and problems for estimation of metal removal rate in electrochemicalmachining	1	C,D	2	1
22.	Advantages,limitation, applications and recent development of ElectrochemicalMachining	1	C	1,2	2
23.	Operatingprinciples and equipmentof electrochemicalgrinding	1	C	1	1
24.	Metal removal rate and process parameters in electrochemicalgrinding	1	C	1,2	1
25.	Problems for estimation of metal removal rate in electrochemicalgrinding. Benefits and applications.	1	C,D	1	1
26.	Recent developments in electrochemicalgrinding and fundamentals of electro chemical horning, deburring process	1	C	1	1
	UNITIV:THERMOELECTRICALENERGYTECHNIQUES	**10**			
27.	Operating Principles and equipments of electricaldischargemachining	1	C	1	1,2
28.	Power circuits and metal removal rate in electricaldischargemachining	1	C	1	2
29.	Process parameters, selection of tool electrode and dielectric fluids in electricaldischargemachining.	1	C	1,2	1
30.	Characteristics of spark eroded surface, surface finish and machining accuracy in electricaldischargemachining.	1	C	1	2
31.	Problems in estimation of material removal rate, application and recent development in electricaldischargemachining.	1	C,D	1,2	2
32. .	Operatingprinciples and equipmentelectricaldischargegrinding	1	C	1	1
33.	Process parameters, surface finish and machining accuracy in electricaldischargegrinding	1	C	1,2	1
34. .	Operating principles and equipmentof wireCutelectricaldischargemachining	1	C	1	2
35.	Process parameters, advantages and disadvantage of wireCutelectricaldischargemachining.	1	C	1,2	2
36.	Machine tool selection, application and recent developments in wirecutelectricaldischargemachining	1	C	1,2	2
	UNIT V - THERMAL ENERGY TECHNIQUES	9			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
37.	Operatingprinciples and equipmentof electronbeammachining	1	C	1	2
38.	Parametersinfluencingmetal removal, applications, advantagesandlimitations of electronbeammachining	1	C	1,2	2
39.	Operatingprinciples and equipmentof plasmaarc machining	1	C	1	2
40.	Parametersinfluencingmetal removal, applications, advantagesandlimitations of plasmaarc machining	1	C	1,2	2
41.	Operatingprinciples and Equipment of laser beam machining	1	C	1	2
42.	Parametersinfluencingmetal removal and applications, advantagesandlimitations of laser beam machining	1	C	1,2	2
43. .	Operatingprinciples and Equipment of Ion beam machining	1	C	1	2
44. .	Parametersinfluencingmetal removal and applications, advantagesandlimitations of Ion beam machining	1	C	1,2	2
45. .	Recent trends in thermal energy techniques	1	C	1	2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Vijay K.Jain, "*Advanced machining processes"*, Allied publishers, 2007.
2.	Mishra P.K, "*Non-Conventional Machining"*, Narosa Publishing House, 2007
3.	BennedictG.F, "*Non Traditional Machining Techniques"*, Marcel Decker, NewYork, 1990.
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Sharma P.C, "*A Text book of Production Engineering"*, S Chand Publising, New Delhi, 2009.
5.	Pandey P.C. and Shan, "*Modern Machining Process"*, Tata McGraw Hill, 1980

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%**

15ME347E	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 July 2016				

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%**

15ME348E	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15ME201				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

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%**

15ME349E	REFRIGERATION AND AIR CONDITIONING SYSTEMS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15ME206				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd July 2016				

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%**

15ME350E	MATERIALS MANAGEMENT	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 July 2016				

PURPOSE	To expose the students to the different components and functions of material management.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Inventory control procedures.	c	d	f				
2.	Codification of materials.	c	d	f				
3.	Purchase policies and procedures.	c	d	f				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION	**9**			
1.	Materials objectives, Policy manual: A to Z items	1	C	3	1
2.	UNIDO Recommendations	1	C	3	1
3.	Purchase policy	1	C	3	1,2
4.	Purchasing cycle, A to Z purchase order	1	C	3	1,2
5.	Materials Intelligence (MIS)	1	C	3	1
6.	Specification and standardization in Materials management	2	C	3	1
7.	Make or buy decision, buying process	2	C	3	1,2
	UNIT II:MATERIALS PLANNING AND CONTROL	**9**			
8.	Material forecasting, Selection inventory control	1	C	1	1
9.	Spare parts management	1	C	1	1
10.	Inventory systems, Lead time analysis	1	C	1	1,2,4
11.	Administrative lead time, Supplier lead time	1	C	1	1,2,4
12.	Transport lead time and Inspection lead time	1	C	1	1,2,4
13.	Flow charting techniques to reduce various types of lead time	1	C	1	1,2,3
14.	Materials requirement planning	2	C	1	1,2
15.	Aggregate inventory management	1	C	1	1,4
	UNIT III: STORAGE AND DISTRIBUTION	**9**			
16.	Codification of materials	2	C	2	1,2,5
17.	Storage design, Stores layout	1	C,D	2	1,4
18.	Storage systems and equipment	2	C	2	1,4
19.	Stores preservation, Stores procedures	2	C	2	1,4
20.	Stock valuation and verification ware housing	1	C	2	1,4
21.	Distribution management	1	C	2	1,2,4
	UNIT IV: PURCHASE FUNCTION	**9**			
22.	Purchasing policies and procedures	2	C	3	1
23.	Legal aspects of purchasing	1	C	3	1
24.	Selection of sources of supply	1	C	3	1
25.	Vendor evaluation and rating	2	C	3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
26.	Vendor development, Price	2	C	3	1,2
27.	Cost analysis	1	C	3	1,2
	UNIT V: MATERIALS ACCOUNTING AND BUDGETING	**9**			
28.	Ethical buying	1	C	1	1
29.	Performance indicators	2	C	1	1,2
30.	Materials management controls	2	C	1	1,2
31.	Budgetary control	1	C	1	1,2
32.	Computer in materials management, Computer revolution, Software and hardware, Materials information system	2	C	1	1
33.	Reports and information needs, Application and limitations of computers	1	C	1	1
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Gopalakrishnan.P, "*Purchasing and Materials Management*", Tata McGraw Hill, 1990.
2.	Learnerr Lee Jr. and Donald.M.Dobbler, "*Purchasing and Material Management*", Tata McGraw Hill, 1996.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Camer Lee and Donald M Dubbler, "*Purchasing and Materials Management*, *Text and cases"*, Tata McGraw Hill, 1997.
4.	Mark.J.V, "*Operations Management*", McGraw Hill Publishers, 1984.
5.	Westing.J.K, Fine, E.V. and Zone.C.T, "*Purchasing Management Principles*", John Wiley & Sons, New York, 1986.

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%**

15ME351E	NUCLEAR RADIATION AND ITS APPLICATION	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVES				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

PURPOSE	To introduce the concept of Nuclear Radiation and its beneficial uses to the students.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to learn								
1.	Fundamental Concepts of Radiation Radioactivity	a						
2.	Radiation Interaction with Matter with Detection of Radiation	a	e					
3.	Radiation Doses and Hazardous	a						
4.	Uses of radiation in Industry	a	e					
5.	Uses of radiation in Medical Field.	a	e					

Session	Description of topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: FUNDAMENTAL CONCEPTS	**9**			
1.	Atom, atomic molecular weights, atomic models	1	C	1	1
2.	Nuclear models, isotopes	1	C	1	1
3.	Nuclear dimensions, nuclide chart	1	C	1	1
4.	Nuclear energetics- binding energy	1	C	1	1
5.	Tutorials on calculating binding energy, packing fraction.	1	C,D	1	1
6.	Nuclear reactions, q value for a reaction.	1	C,D	1	1
7.	Radioactivity- types of radioactive decay.	1	C	1	1
8.	Energetics of alpha, beta, neutron decay	1	C	1	1
9.	Atom, atomic molecular weights, atomic models	1	C	1	1
	UNIT II: RADIATION INTERACTION WITH MATTER	**9**			
10.	Photon interactions -photoelectric effect, compton scattering, pair production.	1	C	2	1,3
11.	Neutron interactions- types of interactions	1	C	2	1,3
12.	Attenuation of charged particles - stopping power, range.	1	C,D	2	1,3
13.	Detection and measurement of radiation- gas filled radiation detectors.	1	C	2	1,3
14.	Demonstration of gas detectors	1	C,D	2	3
15.	Scintillation detectors	1	C	2	3
16.	Semiconductor detectors	1	C	2	3
17.	Personal dosimeters- pocket ion chamber, film badge	1	C	2	3
18.	Thermo-luminescent dosimeter	1	C	2	3
	UNIT III: RADIATION DOSES AND HAZARDS	**9**			
19.	History about radiation and doses.	1	C	3	1
20.	Dosimetry related terms - absorbed dose, Kerma, exposure, relative biological effectiveness, dose equivalent, quality factor, effective dose.	1	C,D	3	1
21.	Natural exposures for humans	1	C	3	1
22.	Health effects from large acute doses	1	C	3	1
23.	Tutorials on radiation hazards	1	C	3	1

Session	Description of topic	Contact hours	C-D-I-O	IOs	Reference
24.	Hereditary effects	1	C	3	1
25.	Cancer risks from radiation exposure	1	C	3	1
26.	Radiation protection standards	1	C,D	3	1,2,3
27.	Waste management	1	C	3	1,2,3
	UNIT IV: NUCLEAR TECHNOLOGY IN INDUSTRY AND RESEARCH	**9**			
28.	Production of radioisotopes	1	C	4	1
29.	Industrial uses of radioisotopes and radiation, leak detection	1	C	4	1
30.	Pipeline interface, flow patterns, flow rate measurements	1	C	4	1
31.	Wear analysis, surface temperature measurements	1	C	4	1
32.	Tutorials and demonstration of industrial uses	1	C	4	1
33.	Radio dating, sewage treatment, radiography,	1	C	4	1
34.	Thickness gauging, density gauges, level gauges	1	C	4	1
35.	Absorptiometry, oil well logging, neutron activation analysis, smoke detectors, food preservation, sterilization, insect control	1	C	4	1
36.	Polymer modification, biological mutation studies, chemo-nuclear processing	1	C	4	1
	UNIT V: MEDICAL APPLICATIONS	**9**			
37.	Diagnostic imaging- introduction and history	1	C	5	1
38.	X ray imaging.	1	C	5	1,3
39.	Fluoroscopy, mammography, bone densitometry	1	C	5	1,3
40.	Computed tomography	1	C	5	1,3
41.	Demonstration of x ray and ct	1	C	5	1,3
42.	Positron emission tomography	1	C	5	1,3
43.	Magnetic resonance imaging	1	C	5	1,3
44.	Radioimmunoassay, diagnostic radiotracers,	1	C	5	1
45.	Radiation therapy	1	C	5	1
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Kenneth Shultis, J, Richard E. Faw, "*Fundamentals of Nuclear Science and Engineering*", CRC Press, 2007.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Tayal, D.C., "*Nuclear Physics*", Himalaya Publishing House, 1997
3.	Knoll, G.F., "*Radiation Detection and Measurement*", John Wiley & Sons, 2010
4.	Claude Leroy, Pier-Giorgio Rancoita, "*Principles of Radiation Interaction in Matter and Detection*", World Scientific Publishing Co. Private. Ltd. Singapore, 2004.
5.	Raymond Murray, Keith E. Holbert, "*Nuclear Energy, An Introduction to the Concepts, Systems, and Applications of Nuclear Processes*", 7th Edition, Elsevier, 2014.

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%**

15ME352E	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 July 2016				

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%**

15ME353E	TQMANDRELIABILITYENGINEERING	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
DataBook/Codes/Standards	-Nil-				
CourseCategory	P PROFESSIONALELECTIVE				
Coursedesignedby	DepartmentofMechanicalEngineering				
Approval	AcademicCouncilMeeting,23rdJuly2016				

PURPOSE	Toprovideknowledgeandunderstandingabouttheтotal QualityManagement(TQM),itsconcepts,tools andtechniques,andtounderstandthereliabilityandmaintainabilityofdifferentsystems.

INSTRUCTIONALOBJECTIVES		**STUDENTOUTCOMES**						
Attheendofthecourse,studentwillbeableto								
1.	UnderstandtheimportanceofTQManditsconcepts,toolsandtechniques.			h				
2.	Understandtheroleofhumaninvolvementtoimprovethequalityofproductand service.	a						
3.	Understandandapplythetoolsandtechniques usedforproductandservicequality.			h				
4.	Applythe concept toreliability.	a	e	h				
5.	Applytheconceptofmaintainabilityofasystem.	a	e	h				

Session	DescriptionofTopic	Contact hours	C-D-I-O	IOs	Reference
	UNITI:BASICCONCEPTS	**09**			
1	DefinitionofqualityandTotalQualityManagement,andevolution ofTQM	1	C	1	1, 4,5
2	ComparisonbetweentraditionalapproachandTQM	1	C	1	1
3	Deming,andCrosbyprinciplesofTQM	1	C	1	1, 5
4	Juran,andTaguchiconceptofTQM	1	C	1	1
5	IshikawaconceptofTQM;costofquality	1	C	1	1
6	ConceptofProductqualityandServicequality.	1	C	1	1
7	BenchmarkingandStrategicplanningforquality.	1	C	1	1
8	Goalsettingforquality;theStepsinvolved in strategicplanning.	1	C	1	1
9	TQMimplementation,itsbenefitsanditssetbacks.	1	C	1	6
	UNITII:TQMPRINCIPLES&BASICTOOLS	**09**			
10	Customersupplier chain,Customerperceptionofquality.	1	C	2	1
11	Customerfeedback,Customercomplaints,Customer retention.	1	C	2	1
12	Employeeinvolvement,Employeemotivation:Maslow'shierarch yofneeds.	1	C	2	6
13	Herzberg theoryofmotivation,Empowerment,andteamwork.	1	C	2	6
14	Introductiontosevenbasictools:Checksheet,histogram,Controlc hart.	1	C,D	2	1
15	Paretodiagram,Causeandeffectdiagram,Stratification,andScatt erdiagram.	1	C,D	2	1
16	Introductionto5S	1	C	2	6
17	IntroductiontoKaizen.	1	C	2	6
18	IntroductiontoSix-Sigma	1	C,D	2	6
	UNITIII:NEWSEVENMANAGEMENTTOOLS&ADVANCEDQUALITYTOOLS	**09**			
19	Affinitydiagram,Relationsdiagram,Treediagram,Matrixdiagram.	1	C	3	6
20	Matrixdataanalysisdiagram	1	C	3	6
21	Processdecisionprogramchart,Arrowdiagram	1	C	3	6
22	QualityFunctionDeployment(QFD)	1	C	3	6
23	Rootcauseanalysisandits uses.	1	C	3	1, 8
24	Taguchimethodandqualitylossfunction.	1	C	3	6
25	Mistake proofing(POKA–	1	C	3	7, 6

Session	DescriptionofTopic	Contact hours	C-D-I-O	IOs	Reference
	YOKE);Failuremodeandeffectsanalysis(FMEA)				
26	FailuremodeandeffectsandCriticalityanalysis(FMECA).	1	C	3	6
27	FaultTreeAnalysis(FTA)	1	C	3	6
	UNITIV:RELIABILITY	**09**			
28	Introductionanddefinitionaboutreliability,Probabilisticnatureof failures.	1	C	4	3
29	MeanfailurerateandMeantimebetweenfailures(MTBF)ofcomponent/system:Problems	1	C,D	4	2
30	Hazard rateandHazardmodels:Problems	1	C,D	4	3
31	Weibullmodelforreliabilityofcomponents/systems.	1	C	4	2
32	ReliabilityofcomponentsinSeriesconfiguration.	1	C,D	4	3
33	ReliabilityofcomponentsinParallelconfiguration.	1	C,D	4	3
34	RedundantandMixedconfigurations	1	C,D	4	3
35	Systemreliabilityimprovement	1	C,D	4	3
36	Casestudiesinreliabilityofsystem.	1	C,D	4	3
	UNITV:MAINTAINABILITY	**09**			
37	Introductionanddefinitionofmaintainability,availability.	1	C	5	6
38	Choiceofmaintenance strategy.	1	C	5	6
39	Meantimeto repair(MTTR):Problems	1	C,D	5	6
40	FactorscontributingtoMeanDownTime(MDT):Problems	1	C,D	5	3
41	Faultdiagnosis,androutinetesting forum revealedfaults.	1	C	5	3
42	FactorscontributingtoMeanMaintenanceTime(MMT):Problems	1	C,D	5	6
43	Typesofmaintenance	2	C	5	2
44	Economicsofmaintenance.	1	C	5	2
	Totalcontacthours*	**45**			

*Excludingassessmenthours

LEARNINGRESOURCES	
SL.NO.	**TEXTBOOKS**
1.	JoelE.Ross,SusanPerry, *"TotalQualityManagement:Text,Cases,andReadings",*,CRCPress,3rdEdition,1999.
2.	Srinath,L.S., "*ReliabilityEngineering"*,,EastWestPress,NewDelhi,4th Edition 1995.
	REFERENCEBOOKS/OTHERREADINGMATERIAL
3.	Balagurusamy,E., "*ReliabilityEngineering",*TataMcGrawHillpublishingCo.,NewDelhi,1984.
4.	GregBound,et.al,*Beyond, "TotalQualityManagementtowardstheemergingparadigm"*,McGrawHillInc.,1994.
5.	Zeiri, "*TotalQualityManagementforEngineers"*, WoodHeadPublishers,1991.
6.	SubburajRamasamy, "*TotalQualityManagement"*,TataMcGrawHillpublishingCo.,NewDelhi,2012.
7.	PoornimaMcharantimath, "*TotalQualityManagement"*,,PearsonEducation,2nd Edition,2011.
8.	BjornAndersen,TomFagerhaug, "*RootCauseAnalysis:SimplifiedToolsandTechniques"*, AmericanSocietyforQuality,2nd Edition,2006.

Coursenature				**Theory**			
AssessmentMethod(Weightage100%)							
In-semester	**Assessmenttool**	**CycleTest I**	**CycleTest II**	**CycleTestIII**	**SurpriseTest**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						EndsemesterexaminationWeightage:	**50%**

15ME354E	**MODERN CONTROL THEORY**	**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 July 2016

PURPOSE	To impart the knowledge of modern control methodologies , discrete time domain systems and controller parameterization methods							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to understand the following								
1.	State space equations, transfer matrices, various tests for stability	a	e					
2.	Sampling techniques and Modified z transformations	e	a					
3.	Discretization methods for discrete time systems	k	e					
4.	Transfer function-State Space and Matrix-Fraction Descriptions of Multivariable Systems.	a	e					
5.	Controller parameterization methods	c	e	d				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - INTRODUCTION-STATE SPACE ANALYSIS OF CONTINUOUS TIME MULTIVARIABLE SYSTEMS.	**9**			
1.	State equations for dynamic systems, State equations using phase, physical and canonical variables, realization of transfer matrices	3	C	1	1
2.	Minimal realization, Solution of state equation, concepts of controllability, reachability, observability	3	C	1	1
3.	Controllability and Observability tests: Kalman's testmatrix, Gilbert's test	2	C	1	1
4.	Popov-Belevitch-Hautus test, stability.	1	C	1	1
	UNIT II - CONTROL THEOREM AND TRANSFORMATION.	**9**			
5.	Discrete time control systems: sampling theorem	3	C	2	1, 2
6.	Pulse transfer function	2	C	2	2
7.	Modified Z-transform	2	C	2	2
8.	Stability analysis.	2	C	2	2
	UNIT III STATE SPACE ANALYSIS OF DISCRETE TIME MULTIVARIABLE SYSTEMS.	**9**			
9.	Discretization of State equations for dynamic systems	3	C	3	2
10.	State equations using phase physical and canonicalVariables realization of transfer matrices	3	C	3	2
11.	Minimal realization, Solution of state equation, stability.	3	C	3	1, 2
	UNIT IV TRANSFER FUNCTION-STATE SPACE AND MATRIX-FRACTION DESCRIPTIONS OF MULTIVARIABLESYSTEMS.	**9**			
12.	State observability, controllability and matrix-fraction descriptions, Some properties ofpolynomial matrices, Some basic state space realization	2	C	4	2
13.	The Smith-McMillan form of a transferfunction matrix	2	C	4	2
14.	Poles and Zeros of a transfer function matrix, Matrix-fraction description (MFD) of a transfer function	2	C	4	2
15.	State space realization from a transfer function matrix	2	C	4	2
16.	Internal stability, The generalized Nyquist and inverse Nyquist stability criterion.	1	C	4	2
	UNIT V PARAMETERIZATION TECHNIQUES-CONTROLLER PARAMETERIZATION	**9**			
17.	Affine parameterization for stable systems, PID synthesis using	3	C	5	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Affine parameterization.				
18.	Affine parameterization for systemswith dead time.	3	C	5	2
19.	Affine parameterization of multivariable control systems	3	C	5	3
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Chen C.T., "*Linear Systems: Theory & Design*", Oxford University Press New York, 1999
2.	Ogata K., "*Discrete Time Control Systems"*, Prentice Hall of India, New Delhi, 1987.
3.	Goodwin, Graebe S F & Salgado M E, "*Control System Design*", Prentice Hall, 2001.
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Gopal M., "*Modern Control Systems Theory*", New Age International New Delhi, 2014.

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%**

15ME355E	INTRODUCTION TO HUMAN BODY MECHANICS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15ME102				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd July 2016				

PURPOSE	This course provides background in musculoskeletal anatomy and principles of biomechanics. The course applies and builds on the concepts of statics and, dynamics for human activities

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize the students with the anatomical structure of the human body	a	c					
2.	Familiarize the students with the reference positions, planes, and axes associated with the human body	a	c	e				
3.	Study the interrelationships among kinematic and kinetic variables	a	b	e				
4.	Study the interrelationships among linear and angular kinematic variables	a	b	e				
5.	Study the interrelationships among linear and angular kinetic variables	a	b	e				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO BIOMECHANICS AND ANATOMY OF HUMAN BODY.	**9**			
1	Biomechanics: definition and perspective	1	C	1	1,3
2	Quantitative versus qualitative problems	1	C	1	1
3	Structure, movements and loads on the shoulder	1	C	1	1
4	Structure, movements and loads on the elbow and wrist	1	C	1	1
5	Structure, movements and loads on the hip	1	C	1	1
6	Structure, movements and loads on the knee	1	C	1	1
7	Structure, movements and loads on the spine	1	C	1	1
8	Structure, movements and loads on the foot	1	C	1	1
9	Common injuries in shoulder, elbow wrist, hip knee, spine and foot.	1	C, I	1	1
	UNIT II: EQUILIBRIUM AND HUMAN MOVEMENT.	**9**			
10	Equilibrium and Torque	1	C, I	2	1
11	Resultant Joint Torques	1	C, I	2	1
12	Levers, Anatomical levers	1	C	2	1
13	Equations of static and dynamic equilibrium	1	C	2	1
14	Center of gravity and locating the center of gravity	1	C	2	1
15	Locating the human body Center of Gravity, Stability and balance.	1	C	2	1
16	Properties of Bone, Maxwell &Voight Models of bone	1	C,D	2	1,3
17	Biomechanics of human skeletal muscle.	1	C	2	1,3
18	Biomechanics of human Skeletal Articulations	1	C	2	1,3

	UNIT III: KINEMATIC AND KINETIC CONCEPTS FOR ANALYZING HUMAN MOTION.	**9**			
19	Forms of motion -linear motion, angular motion general motion and mechanical systems	1	C	3	1
20	Standard reference terminology and anatomical reference position	1	C	3	1
21	Directional terms, anatomical reference planes and axes joint movement terminology	1	C	3	1
22	Sagittal plane, frontal plane, transverse plane and other movements and spatial reference systems	1	C	3	1
23	Tools for measuring kinematic quantities video and film and other movement-monitoring systems.	1	C,I	3	1
24	Basic concepts related to kinetics, inertia,mass,force, center of gravity, weight,pressure volume,density,torque,impulse	1	C	3	1
25	Mechanical loads on the human body compression, tension, and shear mechanical stress torsion, bending, and combined loads the effects of loading , repetitive versus acute loads	1	C	3	1
26	Tools for measuring kinetic quantities electromyography dynamography	1	C,I	3	1
27	Vector algebra, vector composition,vector resolution, graphic solution of vector problems trigonometric solution of vector Problems.	1	C,D	3	1
	UNIT IV: LINEAR AND ANGULAR KINEMATICS OF HUMAN MOVEMENT	**9**			
28	Linear kinematic quantities distance, displacement, speed and velocity,acceleration average and instantaneous quantities	1	C	4	1
29	Kinematics of projectile motion horizontal and vertical components influence of gravity influence of air resistance	1	C	4	1
30	Factors influencing projectile trajectory projection angle projection speed relative projection height optimum projection conditions	1	C	4	1
31	Analyzing projectile motion ,equations of constant acceleration	1	C	4	1
32	Problems on linear kinematics	1	C,D	4	1
33	Observing the angular kinematics of human movement measuring angles relative versus absolute angles tools for measuring body angles, instant center of rotation.	1	C	4	1
34	Angular kinematic relationships angular, distance, displacement, angular speed ,velocity, angular acceleration, angular motion vectors , average versus instantaneous angular quantities	1	C	4	1
35	Relationships Between Linear and Angular Motion, Linear and Angular Displacement,Linear and Angular Velocity, Linear and Angular Acceleration.	1	C	4	1
36	Problems on angular kinematics.	1	C,D	4	1
	UNIT V:Linear and angular Kinetics of Human Movement.	**9**			
37	Newton's laws law of inertia law of acceleration, law of reaction, law of gravitation.	1	C	5	1
38	Mechanical behavior of bodies in contact, friction, momentum, impulse, impact.	1	C	5	1
39	Work, power, and energy , relationships conservation of	1	C	5	1

	mechanical energy , principle of work and energy				
40	Simple problems in linear kinetics	1	C,D	5	1
41	Resistance to angular acceleration, moment of inertia, determining moment of inertia, human body moment of inertia.	1	C	5	1
42	Angular momentum, conservation of angular momentum,transfer of angular momentum, change in angular momentum.	1	C	5	1
43	Angular analogues of Newton's laws of motion	1	C	5	1
44	Simple problems in angular kinetics	1	C,D	5	1
45	Musculoskeletal soft and hard tissue Mechanics	1	C	5	3
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Susan .J. Hall, "*Basic biomechanics*", Tata Mcgraw Hill, Sixth edition, 2011.
2.	Y. C. Fung, "*Biomechanics",* Springer Verlang, 2nd Edition, 1997.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	D. J. Schneck and J. D. Bronzino, "*Biomechanics- Principles and Applications*", CRC Press, Second Edition, 2000
4.	Kreighbaum, E. and Barthels, K., "*Biomechanics: A Qualitative Approach for Studying HumanMovement"*, Pearson, 1996.
5.	Boston: Allyn and Bacon Alexander. R. Mc. Neill, "*Biomechanics"*, Chapman and Hall, 1975

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%**

15ME356E	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 July 2016				

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%**

15ME357E	**OPTIMISATION IN ENGINEERING DESIGN**	**L**	**T**	**P**	**C**

		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	*Approved Design Data Book*				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd July 2016				

PURPOSE	To study the principles of optimization and various techniques which can be used for mechanical engineering optimization along with applications.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Principles of Optimization and its need.	a	c	e				
2.	Various conventional optimization techniques.	a	c	e				
3.	Solving multivariable problems techniques.	a	c	e				
4.	Solving problems using unconventional optimization techniques	a	c	e				
5.	Application of optimization to design of machine elements.	a	c	e				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: INTRODUCTION	**9**			
1.	Introduction to optimization – adequate and optimum design	1	C	1	1
2.	Principles of optimization,Design Vector , Design Constraints	2	C, D	1	1
3.	Statement of an optimization problem	1	C	1	1
4.	Classification of an optimization problem	1	C, D	1	1
5.	Classical optimization techniques single variable	1	C, D	1	1
6.	Classical optimization techniques multivariable variable	2	C, D	1	1
7.	Formulation of objective function, design constraints.	2	C, D	1	1
	UNIT II: UNCONSTRAINED OPTIMIZATION TECHNIQUES	**9**			
8.	Techniques of unconstrained optimization	1	C	4	1
9.	Golden section method.	1	C, D	4	1
10.	Fibonacci method	1	C	4	1
11.	Random search,	2	D	4	1
12.	pattern search	1	D	4	1
13.	Gradient search	1	D	4	1
14.	Quadratic interpolation method	1	C, D	4	1
15.	Cubic interpolation method	1	C, D	4	1
	UNIT III: CONSTRAINED OPTIMIZATION TECHNIQUES	**9**			
16.	Direct search methods Random Jumping Method Random Walk Method	1	C	2	1
17.	Direct search methods –conjugate gradient methodquasi-Newton methods	2	C, D	2	1
18.	Indirect methods – Transformation techniques	2	C, D	2	1
19.	Indirect methods –penalty function method	2	C, D	2	1
20.	Interior penalty function method	1	C	2	1
21.	Exterior penalty function method	1	C, D	2	1

	UNIT IV: UNCONSTRAINED OPTIMIZATION TECHNIQUES.	**9**			
22.	Genetic Algorithms	3	C	3,4	1
23.	Simulated Annealing	3	C, D	3,4	1
24.	Ant colony optimization	3	C, D	3,4	1
	UNIT V: APPLICATIONS	**9**			
25.	Design of simple truss members	1	C	5	3
26.	Desirable and undesirable effects	1	C, D	5	3
27.	functional requirement	1	C, D	5	3
28.	material and geometrical parameters	1	C, D	5	3
29.	Design of simple axial loaded members for minimum cost and minimum weight	2	C	5	3
30.	Design of transverse loaded members for minimum cost and minimum weight	1	C, D	5	3
31.	Design of shafts and torsionally loaded members.	1	C, D	5	3
32.	Design of Springs	1	C, D	5	3
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Rao Singaresu.S, "*Engineering Optimization – Theory & Practice*", New Age International (P) Limited, New Delhi, 2009.
2.	Kalyanamoy Deb, "*Optimization for Engineering design algorithms and Examples*", Prentice Hall of India Pvt. Ltd., 2006.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Johnson Ray C, "*Optimum design of mechanical elements*", Wiley, John & Sons, Digitized 2007
4.	Goldberg .D.E, "*Genetic algorithms in search, optimization and machine*", Barnen, AddisonWesley, New York, 1989.
5.	William Orthwein, "*Machine Component Design"*, Vol. I and II, Jaico Publishing house, New Edition, 2006.
6.	Rao.C.S, "*Optimization Techniques"*, DhanpatRai& Sons, New Delhi
7.	Fox.R.L, "*Optimization methods for Engineering Design"*, Addison Wesley Pub, Digitized 2007.
8.	Garret N. Vanderplaats, "*Numerical optimization techniques for engineering",* McGraw-Hill Ryerson, Limited, 1984.

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%**

15ME358E	MODERN MANUFACTURING TECHNIQUES	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15ME202				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	MECHANICAL ENGINEERING			
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting, 23rd July 2016.				

PURPOSE	To develop the ability to understand the advanced manufacturing techniques evolved in manufacturing scenario.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to understand the								
1.	Advanced techniques in casting	c	e	j				
2.	Advanced forming and powder metallurgy	c	e	j				
3.	Fabrication of microelectronic devices	c	e	j				
4.	Manufacturing of composites	c	e	j				
5.	Rapid prototyping	c	e	j				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - ADVANCES IN CASTING	**9**			
1.	Newer casting techniques	1	C	1	1,3
2.	Expendable pattern casting-Pattern Making Process, Advantages, Applications	1	C	1	1,3
3.	Plaster mold casting-Antioch Process, Limitations, Advantages, Applications	1	C	1	1,3
4.	Ceramic mold casting- Process, Advantages, Applications	1	C	1	1,3
5.	Vacuum casting- Process, Advantages, Applications	1	C	1	1,3
6.	Squeeze casting- Process, Advantages, Applications	1	C	1	1,3
7.	Rapid solidification for amorphous alloys, Melt Spinning Process	1	C	1	1,3
8.	Casting techniques for single crystal components-Conventional casting of Turbine Blades, Directional Solidified Blades, Single crystal blades, Single Crystal growing	2	C	1	1,3
	UNIT II - ADVANCED FORMING AND POWDER METALLURGY PROCESSES	**9**			
9.	High speed forging machines and Die materials-General Requirements for Die Materials,Selection of Proper die materials,Common Die materials	1	C	2	1
10.	Semisolid metal forming-Types(Thixocasting,Rheocasting,Thixomolding) Advantages, Applications	1	C	2	1
11.	Peen forming of sheet metals-Process, Advantages, Applications	1	C	2	1
12.	Super plastic forming-Material requirements,Advantages,Disadvantages	1	C	2	1
13.	Forming and shaping glass-Flat Sheet,Rods and Tubes,Discrete Products,Glass Fiber	1	C	2	1
14.	Design consideration for Powder Metallurgy forming	1	C	2	1
15.	Production of metal powders-Atomization,Reduction,Electrolytic Deposition,Carbonyls,Comminution,Mechanical Alloying	1	C	2	1
16.	Compaction , Sintering	1	C	2	1
17.	Finishing of sintered parts, Secondary and finishing operations	1	C	2	1

	UNIT III - FABRICATION OF MICRO ELECTRONIC DEVICES	**10**			
18.	Semiconductors and silicon-Introduction, Structure of silicon, Properties	1	C	3	1,2
19.	Crystal growing and wafer preparation	1	C	3	1,2
20.	Film deposition-Evaporation,Sputtering, CVD	1	C	3	1,2
21.	Oxidation-Dry oxidation, Wet oxidation	1	C	3	1,2
22.	Lithography-Photolithography Process	2	C	3	1,2
23.	Etching-wet chemical etching, dry plasma etching,Cryogenic Dry Etching	1	C	3	1,2
24.	Diffusion, Drive-in Diffusion and ion implantation	1	C	3	1,2
25.	Metallization and testing	1	C	3	1,2
26.	Bonding and packing	1	C	3	1,2
	UNIT IV - MANUFACTURING OF COMPOSITES	**8**			
27.	Introduction to Composite materials, Advantages, Disadvantages, Applications	1	C	4	1
28.	Fibre reinforced Composite materials-Design variations, Classification, Fiber Alignment	2	C	4	1
29.	Metal matrix-Fiber, Matrix, Properties, Applications	1	C	4	1
30.	Ceramics matrix composites- Fiber, Matrix, Properties, Applications	1	C	4	1
31.	Nano composites Structure, Properties	1	C	4	1
32.	Manufacturing processes of composite materials	2	C	4	1
	UNIT V - RAPID PROTOTYPING	**9**			
33.	Rapid prototyping overview-Introduction, Steps in RP Technology, STL Format, Support Structures	1	C	5	1,5,6
34.	Stereo lithography	1	C	5	1,5,6
35.	Laminated object manufacturing	1	C	5	1,5,6
36.	Selective laser sintering	1	C	5	1,5,6
37.	Fused deposition modeling	1	C	5	1,5,6
38.	solid ground curing, 3D ink jet printing	1	C	5	1,5,6
39.	Applications of rapid prototyping	1	C	5	1,5,6
40.	Rapid tooling,Rapid manufacturing	1	C	5	1,5,6
41.	Future development-Virtual prototyping	1	C	5	1,5,6
	Total contact hours*	**45**			

***Excluding assessment hours**

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	SeropeKalpakjian, "*Manufacturing Engineering and Technology*", Fourth Edition, Addison-Wesley Publishing Co., Boston, 2014.
2.	Madou.M.J, "*Fundamentals of micro fabrication*", CRC Press, USA, 1997.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Amstead.B.H, Ostwald Phylips and Bageman.R.L.,"*Manufacturing Processes*", John Wiley & Sons, New York, 1987.
4.	Jaeger.R.C, "*Introduction to microelectronic Fabrication*", Addision-Wesley, Boston, 1988.
5.	Chua.C.K, "*Rapid Prototyping*", John Wiley, New York, 1997.
6.	Hilton.P.D and Marcel Dekker, "*Rapid Tooling*", New York, 2000.

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%**

15ME359E	TOOL ENGINEERING DESIGN	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 July 2016.				

PURPOSE	To develop in the engineering student the ability to design cutting tools and presstools for given condition.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize with tool materials and their properties	a						
2.	Familiarize with the design of single point cutting tools and twist drills		c					
3.	Familiarize with the design of various types of dies.		c					
4.	Familiarize with the blank development for different components	a						
5.	Familiarize with the design of jigs and fixtures for simple components		c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I : CUTTING TOOL DESIGN	**9**			
1.	Different types of tool materials: cemented carbides, coated carbides, cermets	1	C	1	1
2.	Ceramics and polycrystalline tool materials	1	C	1	1
3.	Composition and properties of tool materials	1	C	1	1
4.	Cutting tool selection and treatments	1	C	1	1
5.	Plastics as tooling materials and new tooling materials	1	C	1	1
6.	Design of single point turning and threading tools	1	D	2	1
7.	Selection of tool holders and inserts for turning	1	C	2	1
8.	Function of Chip breaker, types of chip breaker	1	C	2	1
9.	Design of twist drill and reamers	1	D	2	1
	UNIT II : PRESS TOOL DESIGN	**9**			
10.	Press working terminology	1	C	3	2
11.	Different types of Presses and press accessories	1	C	3	2
12.	Computation of capacities and tonnage requirements of presses	1	C	3	2
13.	Various types of Strip layout	1	C	4	2
14.	Different types of dies, Progressive dies, Combination dies and compound dies	1	C	3	2
15.	Design and development of various types of cutting, forming, bending and drawing dies	3	D	3	2
16.	Blank development for cylindrical and non-cylindrical shells, blank size calculation	1	C	4	2
	UNIT III: DESIGN OF JIGS	**9**			
17.	Principles of jigs and fixtures	1	C	5	3
18.	Locating principles and different locating elements	1	C	5	3
19.	Function of drill bush, types drill bushes	1	C	5	3
20.	Different types of jigs , Plate jig, latch jig, channel jig, post jig, angle plate jig, turn over jig, and pot jigs , Automatic drill jigs	3	C	5	3
21.	Design and development of jigs for given components	3	D	5	3
	UNIT IV: DESIGN OF FIXTURES	**9**			
22.	Design principles of fixtures	1	D	5	3
23.	Design of fixtures for milling operation	1	D	5	3
24.	Design of fixtures for boring operation	1	D	5	3
25.	Design of fixture for assembly	1	D	5	3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
26.	Design of fixture for inspection	1	D	5	3
27.	Design of fixture for welding	1	D	5	3
28.	Design and development of fixtures for given components	3	D	5	3
	UNIT V: CASE STUDY	**9**			
29.	Case study in jigs	3	C	5	3
30.	Case study in fixture	3	C	5	3
31.	Case study in press tools	3	C	5	3
	Total contact hours*	**45**			

***Excluding assessment hours**

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Sadasivan.T.A, and Sarathy.D, "*Cutting tools for Productive machining*", 1st edition, Widia (India) Ltd, Bangalore, 1999.
2.	Donaldson.C, Lecain.G.H and Goold.V.C, "*Tool Design*", Tata McGraw Hill publishing company limited, New Delhi, 2002
3.	Edward G. Hoffman, "*Jigs and Fixture design*", 2nd edition, Galgotia publication Pvt. Ltd., New Delhi, 1987
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Hiram E. Grant, "*Jigs and Fixtures - Nonstandard clamping device*", Tata McGraw Hill, New Delhi, 1971.
5.	Prakash H. Joshi, "*Press tool design and construction*", 1st edition, Wheeler Publishing, New Delhi, 2000.
6.	Kempster.M.H.A, "*An Introduction to Jig and tool design*", 3rd edition, ELBS, 1987
7.	Prakash H. Joshi, "*Cutting tools*", 1st edition, Wheeler Publishing, New Delhi, 1997.
8.	Prakash H. Joshi, "*Tooling Data*", 1st edition, Wheeler Publishing, New Delhi, 2000.

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%**

15ME360E	ENERGY ENGINEERING AND MANAGEMENT	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 July 2016				

PURPOSE	To familiarize the students with the concept of energy conservation and management.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to learn								
1.	Environmental aspects of energy utilization.	a	e					
2.	Energy conservation concepts.	a	e					
3.	Energy savings in thermal systems.	a	e					
4.	Energy management.	a	e					
5.	Energy economics.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: ENERGY AND ENVIRONMENT	**9**			
1	Introduction to energy and environment	1	C	1	1
2	Represent World energy consumption	1	C	1	1
3	Effect of Greenhouse gases	1	C	1	1
4	Global warming	1	C	1	1
5	Renewable energy sources	1	C	1	1
6	Environment aspects utilization	1	C	1	1
7	Energy prices	1	C	1	2
8	World energy reserves and policies	1	C	1	2
9	The energy future and the role of renewable energy	1	C	1	2
	UNIT II: ENERGY CONSERVATION	9			
10	Introduction to energy conservation	1	C	2	1
11	Energy conservation schemes	1	C	2	1
12	Industrial energy use	1	C	2	1
13	Energy surveying and auditing	1	C	2	1
14	Energy index and cost	1	C	2	1
15	Energy conservation in engineering and process industry	1	C	2	1
16	Energy conservation in thermal systems	1	C	2	1
17	Energy conservation in Buildings	1	C	2	1
18	Concept of Green building	1	C	2	1
	UNIT III: ENERGY TECHNOLOGIES	9			
19	Fuels and its consumption	**1**	C	3	1
20	Boilers and furnaces	2	C	3	1
21	Waste heat recovery systems	1	C	3	1
22	Heat pumps and refrigerators	2	C	3	1
23	Storage systems	**1**	C	3	1
24	Insulated pipe work systems	1	C	3	1
25	Heat exchangers	**1**	C	3	1
	UNIT IV: ENERGY MANAGEMENT	9			
26	Introduction to Energy management	1	C	4	3
27	Energy management principle	1	C	4	3
28	Energy resources management	2	C	4	3
29	Energy management information systems	2	C	4	3
30	Instrumentation and measurement	2	C	4	3
31	Computerized energy management	1	C	4	3

	UNIT V: ECONOMICS AND FINANCE	9			
32	Introduction to engineering economics	1	C	5	5
33	Costing techniques in energy engineering	2	C	5	5
34	Optimal target investment schedule	2	C	5	5
35	Discounted cash flow	1	C	5	5
36	Summary investment appraisal techniques	1	C	5	5
37	Optimization techniques	1	C	5	5
38	Project management	1	C	5	5
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Murphy W.R and McKay G, "*Energy Management"*, Butterworths, London, 2007.
2.	Reay D.A, "*Industrial Energy Conservation"*, Pergamon Press, 2003.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Steve Doty, Wayne C. Turner, "*Energy Management Handbook"*, FairmontPress, 7th edition, 2009.
4.	Barney L. Capehart, Wayne C. Turner, William J. Kennedy, "*Guide to EnergyManagement"*, The Faimont Press, 6th edition, 2008
5.	Callaghan P.W.O, "*Design and Management for Energy Conservation"*,Pergamon Press, Oxford, 2003.
6.	Hamies, "*Energy Auditing and Conservation; Methods"*, Measurements,Management and Case study", Hemisphere, 2003.
7.	Trivedi P.R and Jolka K.R, "*Energy Management*", Common Wealth Publication,2002.

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%**

15ME361E	TURBOMACHINES	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 July 2016				

PURPOSE	To familiarize the students about the working principles and flow aspects of turbo machines irrespective of their mechanical and material aspects.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Basic flow concepts of turbo machines and their velocity triangles.	a	e					
2.	Working and performance of centrifugal flow machines.	a	e					
3.	Working and performance of axial flow fans and compressors.	a	e					
4.	Working and performance of hydraulic turbines.	a	e					
5.	Working and performance of axial flow turbines.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: BASIC CONCEPTS OF TURBOMACHINES	**9**			
1.	Definition, classification and stages of turbo machines	1	C	1	1,3
2.	Estimation of specific work for incompressible and compressible flow machines	1	C	1	1,3
3.	Internal and external losses, various efficiencies	1	C	1	1,3
4.	Representation of specific work on T-s and h-s diagrams	1	C	1	1,3
5.	Velocity triangles - centrifugal and axial flow machine impellers	1	C	1	1,3
6.	Euler's energy equation across the impeller as applicable to all machines, slip and its estimation	1	C	1	1,3
7.	Slip and its estimation	1	C	1	1,3
8.	Degree of reaction	1	C	1	1,3
9.	Blade angles and their effects, calculations considering slip.	1	C	1	1,3
	UNIT II - CENTRIFUGAL FLOW MACHINES	**9**			
10.	Fans - different impeller sizes, shapes, blade angles, speed and construction	1	C	2	2,3
11.	Blade shape, blade number, simple design calculations	1	C	2	2,3
12.	Performance in series and parallel.	1	C	2	2,3
13.	Compressor - slip, inducers, designs without inducer but with inlet guide vanes (IGV)	1	C	2	2,3
14.	Simple problems with inducer and IGV's - blade angles, temperature rise and static pressure rise across the impeller	2	C	2	2,3
15.	Vaned and vaneless diffuser and volute casing	1	C	2	2,3
16.	Pump - system head, priming of pumps, net positive suction head, minimum starting speed and cavitations.	2	C	2	2,3
	UNIT III: AXIAL FLOW FANS AND COMPRESSORS	**9**			
17.	Blade profile, lift and drag coefficients	1	C	3	2,4
18.	Compressors - brief introduction to two-dimensional cascade and its application to design	1	C	3	2,4
19.	Flow deflection and stagnation pressure loss across blade rows	2	C	3	2,4
20.	Expression for pressure rise coefficient in terms of flow angles and loss coefficient	2	C	3	2,4
21.	Design of impeller blades for free vortex and forced vortex	**1**	C	3	2,4
22.	Simple design and performance calculations. Stall and surge phenomenon	**2**	C	3	2,4
	UNIT IV: HYDRAULIC TURBINES	**9**			
23.	Pelton turbine- impulse wheel, single jet and multiple jet units	1	C	4	2,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
24.	Velocity triangles at inlet and exit of buckets	1	C	4	2,5
25.	Performance calculations considering losses in the nozzle and buckets	1	C	4	2,5
26.	Francis turbine - reaction, impeller shapes for different shape numbers/ heads	1	C	4	2,5
27.	Calculations on impeller dimensions, blade angles and performance using velocity triangles, draft tubes	1	C	4	2,5
28.	Kaplan / Propeller Turbine - reaction, impeller (adjustable and fixed) blades and guide blades	2	C	4	2,5
29.	Calculation of performance using velocity triangles / blade angles at different radii for free vortex flow, its suitability for low heads	2	C	4	2,5
	UNIT V:AXIAL FLOW TURBINES	**9**			
30.	Introduction; Turbine stage; Turbine Blade 2-D (cascade) analysis Work Done	2	C	5	1,2,3
31.	Degree of Reaction; Losses and Efficiency	1	C	5	1,2,3
32.	Flow Passage; Subsonic, transonic and supersonic turbines, Multi-staging of Turbine	2	C	5	1,2,3
33.	Exit flow conditions; Turbine Cooling	1	C	5	1,2,3
34.	Turbine Blade design	1	C	5	1,2,3
35.	Turbine Profiles	1	C	5	1,2,3
36.	Airfoil Data and Profile construction.	1	C	5	1,2,3
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Yahya.S.M, "*Turbines, Fans and Compressors*", 3rd Edition, Tata McGraw Hill Publications, 2010
2.	Seppo A. Korpela., "*Priniciple of Turbomachinery*", John Wiley and Sons Ltd, 2012.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Venkanna. B.K, "*Fundamentals of Turbomachinery*", 4th Edition, New Delhi, PHI Learning Pvt. Ltd, 2011
4.	Gopalakrishnan.G, PrithviRaj.D, "*Treatise on Turbomachines*", 1st Edition, Chennai, SciTech Publications, 2006.
5.	Dixon.S.L, "*Fluid mechanics and Thermodynamics of Turbomachinery*", 5th edition, Elsevier Butterworth Heinemann, 2005

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%**

15ME362E	THERMAL POWER SYSTEMS	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Approved Steam tables				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

PURPOSE	To familiarize the students with various components and operations of thermal power systems and power plant economics

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know the functions of various auxiliary combustion equipments.	a	c					
2.	Understand the various thermal power plant systems.	a	c					
3.	Familiarize with the performances of boiler, condenser and cooling tower.	a	c	e				
4.	Familiarize with operation of nuclear, diesel and gas turbine power plants	a	c					
5.	Know the power plant economics	a	c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I : FUEL COMBUSTION EQUIPMENTS	9			
1	Introduction to power plant, combustion equipments and its types	1	C	1	1, 2
2	Solid fuel firing methods, classification and working of stokers	2	C	1	1,
3	Fuel and ash handling systems	1	C	1	1, 2
4	Working principle of draft system and its types	1	C	1	1, 2
5	Heat recovery equipments: economizers, preheaters and reheaters. Types of super heaters and de-superheaters	2	C	1	1, 2
6	Emissions control methods – flue gas cleaning, particulate and gaseous emission control methods	2	C	1	1, 2
	UNIT II : THERMAL POWER PLANT SYSTEMS	8			
7	Working principle and classification of steam generators	1	C	2	1, 2
8	Working of high pressure boilers and super critical boilers	3	C	2	1, 2
9	Working of fluidized bed boilers	1	C	2	1, 2
10	Boiler mountings and accessories	1	C	2	1, 2
11	Working of condensers and its types	1	C	2	1, 2
12	Working of cooling towers and its types	1	C	2	1, 2
	UNIT III : PERFORMANCE OF THERMAL POWER SYSTEMS	10			
13	**Boiler: S**election, capacity rating, testing and performance	3	C, D	3	1, 2
14	**Condensers:** design factors, air removal rate and performance.	3	C, D	3	1, 2
15	**Cooling towers:** range and approach, load and performance	3	C	3	1, 2

16	Selection of condensers and cooling towers	1	C	3	1, 2
	UNIT IV : NUCLEAR, DIESEL AND GAS TURBINE POWER PLANTS	9			
17	**Nuclear Power plant:** fuels, moderator, control rods and coolants	2	C	4	1, 2
18	Types of nuclear reactors: Boiling water reactor, Pressurized water reactor	2	C	4	1, 2
19	Radiation hazards, radioactive waste disposal.	1	C	4	1, 2
20	**Diesel power plant:** classifications, components, selection of engine type	2	C	4	1, 2
21	**Gas turbine plant:** closed and open cycles. Combined power cycles.	2	C	4	1, 2
	UNIT V : POWER PLANT ECONOMICS	9			
22	Plant load factor and utilization factor	1	C	4	1, 2
23	Cost economics and tariff rates for electricity, demand changes, load distributions	3	C	4	1, 2
24	Energy conservation in a power plant and energy audit	2	C	4	1, 2
25	Maintenance aspects of power plants	2	C	4	1, 2
26	National and Global energy scenario	1	C	4	1, 2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	El Wakil.M.M, "*Power Plant Technology*", McGraw Hill Inc., 2010.
2.	Nag.P.K, "*Power Plant Engineering*", Tata McGraw Hill, New Delhi, 4th Edition, 2014.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Ramalingam.K.K, "*Power Plant Engineering*", Scitech Publication Pvt. Ltd, 2015.
4.	Arora.S.C and Domkundwar.S, "*Power Plant Engineering*", DhanpatRai& Sons, New Delhi, 2015.
5.	Rai.G.D, "*Non-Conventional Energy Sources*", Khanna Publishers, 5th Edition, New Delhi, 2014.

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%**

15ME363E	FACILITIES PLANNING	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 July 2016.				

PURPOSE	On completion of the course the students are expected to design facilities for an Industry to meet specific requirements.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Facilities planning process.	c						
2.	The strategies adopted for designing a facility.	c						
3.	Evaluate the existing facility and modify to meet the requirements.	c						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION	**9**			
1.	Significance and objectives of facilities planning	1	C	1	1
2.	Facilities planning process	1	C	1	1
3.	Developing facilities planning strategies	1	C	1	1
4.	Influence of product	2	C	1	1
5.	Process andschedule design	2	D	1	1
6.	Facilities design and procedure	2	D	1	1
	UNIT II: REQUIREMENTS AND RELATIONSHIPS	**9**			
7.	Department planning	1	C	1	1
8.	Activity relationship	1	C	1	1
9.	Flow patterns	1	C	1	1
10.	Planning and measuring	1	C	1	1
11.	Space requirements	1	C	1	1
12.	Personnel requirements	1	C	1	1
13.	Employee, facility interface ,Restrooms, food services, health services	2	C	1	1
14.	Office facility planning	1	C	1	1
	UNIT III: MATERIAL HANDLING AND FACILITY LAYOUT DESIGN	**9**			
15.	Material Handling: Principles and classification	1	C	1	1
16.	Designing material handling systems - Estimating material handling costs - Safety consideration	1	C	1	1
17.	Layout Planning Models: Basic layout types	1	C	1	1
18.	Layout procedures – Algorithmic approaches - Pair-wise exchange method, graph based approaches	2	C	1	1
19.	Craft, blocplan, logic, multiple. Multi floor facility layout	2	C	1	1
20.	Developing layout alternatives - Computer assisted layout planning - ALDEP, CORELAP, CRAFT and Commercial facility layout packages	2	C	1	1
	UNIT IV: FACILITY DESIGN	**9**			
21.	Facility design for various functions	3	C	2	1
22.	Warehouse operation and location problems	3	C	2	1
23.	Manufacturing systems ,Services	3	C	2	1

	UNIT V:EVALUATING, SELECTING AND MAINTAINING	**9**			
24.	Facilities plan Evaluating	2	C	3	1
25.	Facilities plan selecting	2	C	3	1
26.	Facilities plan preparing	2	C	3	1
27.	Facilities plan presenting	2	C	3	1
28.	Facilities plan implementing and maintaining	1	I	3	1
	Total contact hours*	**45**			

***Excluding assessment hours**

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Tompkins.J.A, White.J.A, Bozer.Y.A, and Tan Choco.J.M.A, "*Facilities Planning"*, 4th Edition, John Wiley & sons, India, 2010.
2.	James M. Apple, "*Principles of layout and material handling"*, Ronald press, 1977.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Francis.R.L, McGinnis.L.F, and White J.A, "*Facility Layout and Location: An analytical approach"*, Prentice Hall, New Jersey, 1992.
4.	Gupta and Patel, "*Work study"*, Khanna Publishers, New Delhi.
5.	Kanna.O.P, "*Industrial Engineering and management"*, Khanna Publishers,New Delhi.

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%**

15ME364E	INDUSTRIAL SAFETY AND ENVIRONMENT	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 July 2016				

PURPOSE	To familiarize with safety issues in design, handling and industrial environment							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Conduct basic safety inspections using strategies that they have developed	c	h					
2.	Identify and demonstrate a working knowledge of the domain of occupation health and safety	c	h					
3.	Create a document addressing the principles for developing and implementing a successful occupational health and safety program and evaluation of a work site	c	h					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - ACCIDENT PREVENTION	**9**			
1.	Definitions and theories of accident, injury, unsafe act, unsafe condition and dangerous occurrence	1	C	1	2,3
2.	Theories and principles of accident causation	1	C	1	2,3
3.	Cost of accidents, Accident reporting and investigations	1	C	1	2,3
4.	Safety committees and their need, types and advantages	1	C	1	2,3
5.	Safety education and training and their importance	1	C	1	2,3
6.	Various training methods	1	C	1	2,3
7.	Accident prevention and Motivating factors of safety suggestion schemes	1	C	1	2,3
8.	Safety performance	1	C	1	2,3
9.	Definitions connected with measuring safety performance as per Indian and International standards	1	C	1	2,3
	UNIT II - SAFETY IN MATERIAL HANDLING	**9**			
10.	General safety consideration in material handling	1	C	2	2,4
11.	Ropes, Chains, Sling, Hoops, Clamps, Arresting gears and Prime movers	2	C	2	1,2,4
12.	Ergonomic consideration in material handling	1	C	2	1,2,4
13.	Design, installation, operation and maintenance of conveying equipments	2	C,D	2	1,2,4
14.	Hoisting, traveling and slewing mechanisms	1	C	2	2,4
15.	Selection, operation and maintenance of industrial trucks	1	C	2	1,2,4
16.	Mobile cranes and Tower crane	1	C	2	2,4
	UNIT III - SAFETY IN CHEMICAL INDUSTRIES	**9**			
17.	Safety in the design process of chemical plants	1	C	2	2
18.	Safety in operational and maintenance of chemical plants	1	C	2	2
19.	Exposure of personnel	1	C	2	2
20.	Operational activities and hazards	1	C	2	2
21.	Safety in storage and handling of chemicals and gases	1	C	2	2
22.	Hazards during transportation and Pipeline transport	1	C	2	2
23.	Safety in chemical laboratories	1	C	2	2
24.	Specific safety consideration for cement, paper and pharmaceutical	1	C	2	2
25.	Specific safety consideration for petroleum, petro - chemical, rubber, fertilizer and distilleries	1	C	2	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT IV - ENVIRONMENTAL IMPACT ASSESSMENT	**9**			
26.	Evolution, Concepts, Methodologies, Screening, Scoping and Checklist of EIA	1	C	3	6
27.	Rapid and Comprehensive EIA	1	C	3	6
28.	Legislative and environmental clearance procedure in India	1	C	3	6
29.	Prediction tools for EIA	1	C	3	6
30.	Assessment of Impact of air, water, soil, noise, biological and Socio cultural environment	2	C	3	6
31.	Public participation	1	C	3	6
32.	Resettlement and Rehabilitation	1	C	3	6
33.	Documentation of EIA	1	C,D	3	6
	UNIT V - REGULATIONS FOR HEALTH, SAFETY AND ENVIRONMENT	**9**			
34.	Factories act and rules	1	C	3	7
35.	Indian explosive act	1	C	3	7
36.	Gas cylinder rules	1	C	3	7
37.	Environmental pollution act	1	C	3	7
38.	Indian petroleum act and rules	1	C	3	7
39.	Oil industry safety directorate (OISD)	1	C	3	7
40.	Indian Electricity act and rules	1	C	3	7
41.	Mines act and rules	1	C	3	7
42.	Indian motor vehicles act and rules	1	C	3	7
	Total contact hours*	**45**			

***Excluding assessment hours**

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Handlin.W, "*Industrial Hand Book*", McGraw-Hill, 2000.
2.	Anton.T.J, "*Occupational safety and health management*", (2nd Edition). New York, McGraw Hill, 1989.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Heinrich.H.W, "*Industrial Accident Prevention*", McGraw-Hill, 1980.
4.	Rudenko.N, "*Material Handling Equipments*", Mir Publishers, Moscow, 1981.
5.	Lees.F.P, "Loss "*Prevention in Process Industries*", Butterworths, NewDelhi, 1986.
6.	Canter.R.L, "*Environmental Impact Assessment*", McGraw Hill
7.	IS CODES: IS 5903, IS 807, IS 2760, IS 14469, IS 13367-1, IS 5324, IS 7167, IS 7155, IS 1800.1, IS 3521 of Oil Industry Safety Directorate, Govt. of India.

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%**

15ME365E	DESIGN OF PUMPS AND TURBINES	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	15ME205				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVES				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

PURPOSE	To introduce to the students the basic design aspects, working and operation principle of Pumps and Turbines.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To know design principles of simple radial flow pumps.	a	c	e				
2.	To know design principles of various turbines.	a	c	e				
3.	To learn the effects of cavitation in hydraulic machines.	a	c	e				
4.	To getting familiar with hydro machine applicability from the cavitation point of view.	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I – REVIEW OF PRINCIPLES OF FLUID MACHINERY	**8**			
1.	Basic equations of energy transfer between fluid and rotor	1	C	1	1,2,7
2.	Performance characteristics.	2	C	1	1,2,7
3.	Dimensionless parameters, specific speed	2	C	1	1,2,7
4.	Stage velocity triangles, work and efficiency.	3	C,D	1	1,2,7
	UNIT II- THEORY OF PUMPS	9			
5.	Calculation of tangential and axial thrust methods to minimize axial thrust	2	C,D	3	4,6,7
6.	Impellers, Casings, Volute pumps, Vanes, Velocity vector diagrams and work done by pumps	2	C,D	3	4,6,7
7.	Developed head, efficiency and losses in pumps	2	C,D	3	4,6,7
8.	Specific speed, calculation of power requirement, operating characteristics.	3	C,D	3	4,6,7
	UNIT III- DESIGN OF PUMPS	10			
9.	Design procedure	1	C	3	2,3,5
10.	Design optimization of pumps.	1	C	3	2,3,5
11.	Thermal design, Selection of materials for high temperature and corrosive fluids	2	C	3	2,3,5
12.	Hydraulic design, selection of impeller.	2	C	3	2,3,5
13.	Casing dimension using industrial manuals	2	C	3	2,3,5
14.	Introduction to computer programs for iterative and interactive design	2	C	3	2,3,5
	UNIT IV- THEORY AND DESIGN OF TURBINES	10			
15.	Basic theory, Classification and application	1	C	2	4,7
16.	Construction and approximate calculation of axial flow and radial flow turbines	1	C,D	2	4,7
17.	Performance charts.	1	C	2	4,7
18.	Basic design features of axial flow and radial flow turbines.	1	C,D	2	4,7
19.	Velocity triangles, enthalpy and entropy diagrams.	2	C,D	2	4,7
20.	Stage losses and efficiency	1	C,D	2	4,7
21.	Simple stage of axial and radial flow turbines	1	C,D	2	4,7
22.	Design considerations for hydraulic turbines and draft tubes.	2	C	2	4,7
	UNIT V- CAVITATION	8			
23.	Cavitation in pumps and turbines	2	C	4	4,6

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
24.	Cavitation factor	2	C	4	4,6
25.	Effect of cavitation on performance, damage to various elements	2	C	4	4,6
26.	Design consideration to avoid cavitaion	2	C,D	4	4,6
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Dixon.S.L, "*Fluid Mechanics and Thermodynamics of Turbomachinery*", 6th Edition, Butterworth Heinemam, U.K.,2010
2.	Viktor Gelpke, "*Hydraulic turbines their design and installation*", Research press, 2010
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Igor J. Karassik and Terru McGuire, "*Centrifugal pumps*", Thomson publishing, 2nd Edition, 1996.
4.	Raabe. J, "*Hydraulic Turbomachines*", VDI-Veralag, 1970
5.	Harold H.Anderson, "*Centrifugal Pumps and allied machinery*", Elsevier, 1994.
6.	GrigoriKrivchenko, "*Hydraulic machines, Turbines and Pumps*", Lewis Publishers, CRC Press, 1994.
7.	Turton R.K, "*Principles of Turbomachinery*", E. & F.N. Spon, London 1995.

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%**

15ME366E	NUCLEAR POWER GENERATION AND SUPPLY	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	**P** **PROFESSIONAL ELECTIVES**				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

PURPOSE	To provide in-depth knowledge on Nuclear reaction materials reprocessing techniques and also to understand nuclear waste disposal techniques and radiation protection aspects, including safety approaches with economics

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
To make familiar with the important concepts applicable to								
1.	Nuclear physics	a						
2.	Nuclear fuel cycle		c					
3.	Reprocessing,	a		e				
4.	Waste disposal and Radiation protection	a		e				
5.	Power plant economics				h			

Session	Description of topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: NUCLEAR PHYSICS	**9**			
1.	Nuclear model of an atom- -binding- radio activity-half life	1	C	1	1
2.	Equivalence of mass and energy, binding energy	1	C	1	1
3.	Mechanism of nuclear fission	1	C	1	1
4.	Nuclides – radioactivity-half life	1	C,D	1	1
5.	Decay chains.	1	C,D	1	1
6.	Neutron reactions	1	C	1	1,4
7.	The fission process - BWR, PWR	1	C,D	1	1
8.	Gen iv reactors, gas cooled reactors	1	C,D	1	1,5
9.	Four factor formula	1	C,D	1	
	UNIT II: NUCLEAR FUEL CYCLE	**9**			
10.	Uranium exploration, mining,	1	C	2	1
11.	Uranium production,	1	C	2	1
12.	Uranium purification	1	C	2	1
13.	Uranium enrichment	1	C	2	1,6
14.	Fuel fabrication design and consideration	1	C	2	1
15.	Uranium fortification, conversion	1	C	2	1,6
16.	Magnox – fuel	1	C	2	1
17.	Oxide fuel assembly -	1	C	1	
18.	Other fuels like zirconium, thorium –beryllium	1	C	1	
	UNIT III: REPROCESSING	**9**			
19.	Reprocessing concept	1	C	3	1,2
20.	Spent fuel handling	1	C	3	1
21.	Spent fuel characteristics	1	C	3	1
22.	Role of solvent extraction in reprocessing	1	C	3	1,7
23.	Solvent extraction equipment	1	C	3	1
24.	Purex	1	C	3	1
25.	Urex	1	C	3	1,7
26.	Diamex	1	C	3	
27.	Thorex	1	C	3	
	UNIT IV: WASTE DISPOSAL AND RADIATION PROTECTION	**9**			
28.	Types of nuclear waste	1	C	4	1

Session	Description of topic	Contact hours	C-D-I-O	IOs	Reference
29.	Classification of waste	1	C	4	1
30.	Disposal of waste	1	C	4	1,2
31.	International convention on safety aspects	1	C	4	1,5
32.	Radiation hazards prevention	1	C	4	1
33.	Safety and disposal- nuclear plant safety	1	C	4	1
34.	Safety systems, changes and consequences of accident	1	C	4	1,6
35.	Criteria for safety	1	C	4	1
36.	Cheronobyl, TMI, Fukushima	4	C	4	
	UNIT V: POWER PLANT ECONOMICS	**9**			
37.	Power plant economics	1	C	5	3
38.	Load curve, different terms and definitions	1	C	5	3
39.	Cost of electrical energy, tariffs	1	C	5	3
40.	Performance & operating characteristics of power plants	1	C	5	3
41.	Incremental rate theory	1	C	5	3
42.	Input-output curves,	1	C	5	3
43.	Efficiency, heat rate,	1	C	5	3
44.	Economic load sharing	1	C	5	3
45.	Numerical Problems	1	C,D	5	3
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Glasstone, S, and Sesonske, A., "*Nuclear Reactor Engineering*", (3rd Edition), Von Nostrand, 1981.
2.	Vaidyanathan, G., "*Nuclear Reactor Engineering-Concepts & Principles*", S.Chand co., Delhi, 2013
3.	Nag,P.K., "*Power Plant Engineering*", 4th Edition, Tata-McGraw Hill Publication, 2014
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Lamarsh, J.R., "*Introduction to Nuclear Reactor Theory*", Wesley, 1966
5.	Duderstadt, J.J., and Hamilton, L.J., "*Nuclear Reactor Analysis*", John Wiley, 1976
6.	Walter, A.E., and Reynolds, A.B., "*Fast Breeder Reactor*", Pergamon Press, 1981
7.	Winterton, R.H.S., "*Thermal Design of Nuclear Reactors*",Pergamon Press, 1981.
8.	Collier, J.G., and Hewitt, G.F., "*Introduction to Nuclear Power*", Hemisphere Publishing, 1987.
9.	Lipschutz, R.D., "*Radioactive Waste – Politics*", Technology and Risk, Ballingor, 1980.

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%**

15ME367E	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 July 2016				

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%**

15ME368E	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 July 2016				

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%**

15ME369E	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 July 2016				

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%**

15ME370E	ENVIRONMENTAL POLLUTION AND ABATEMENT	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 July 2016				

PURPOSE	To familiarize the students about the principles and methods to controlair, water and soil pollution							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to understand								
1.	Basics of pollution and the prevention methods	h	j					
2.	Different air pollutants and particle emission control.	h	j					
3.	Effects of water pollutants and physical treatment	h	j					
4.	Aerobic and anaerobic treatments	h	j					
5.	Solid waste disposal methods	h	j					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I : BASICS OF POLLUTION AND PREVENTION	**9**			
1.	Environment and environmental pollution from chemical process industries,characterization of emission and effluents	2	C	1	1,5
2.	Environmental Laws and rules, standards for ambient air	1	C	1	1,5
3.	Noise emission and effluents.	1	C	1	1,5
4.	Process modification, alternative raw material, recovery of by co-product fromindustrial emission effluents	1	C	1	1,5
5.	Recycle and reuse of waste, energy recovery and wasteutilization	1	C	1	1,5
6.	Material and energy balance for pollution minimization.	1	C	1	1,5
7.	Water use minimization	1	C	1	1,5
8.	Fugitive emission/effluents and leakages and their control-housekeeping and maintenance.	1	C	1	1,5
	UNIT II : AIR POLLUTION	**10**			
9.	Sulfur oxides (SOx); nitrogen oxides (NOx), carbon monoxide, total suspendedparticulate matter, respirable particulates, photo-chemical oxidants, specific pollutants.	2	C	2	1,6
10.	Green house effect (green house gases: CO2, CH4, N2O, CFC's, water vapor concentration, alternatives for CFC's, fire extinguishers), global warming and climate change	2	C	2	1,6
11.	Ozone layer depletion (ozone depleting processes, ozone hole, environmental effects and strategies for ozone layer protection), acid rain.	2	C	2	1,6
12.	Particulate emission control by mechanical separation and electrostatic precipitationwet gas scrubbing	1	C	2	1,6
13.	Gaseous emission control by absorption and adsorption	1	C	2	1,6
14.	Design of cyclones, ESP	1	C	2	1,6
15.	Fabric filters and absorbers	1	C	2	1,6
	UNIT III : WATER POLLUTION	**10**			
16.	Biological uptake of pollutants and their effects on land, vegetation, animals and human health	2	C	3	2,7
17.	Bio-deterioration, bioaccumulation, bio-magnification and eutrophication	2	C	3	2,7
18.	Infectious microbial agents in water system and their consequences on human health.	2	C	3	2,7

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
19.	Physical treatment, pre-treatment	1	C	3	2,7
20.	Solids removal by setting and sedimentation	1	C	3	2,7
21.	Filtration centrifugation	1	C	3	2,7
22.	Coagulation and flocculation.	1	C	3	2,7
	UNIT IV : BIOLOGICAL TREATMENT	**8**			
23.	Anaerobic treatment and, trickling filter	1	C	4	4,7
24.	Aerobic treatment	1	C	4	4,7
25.	Biochemical kinetics	1	C	4	4,7
26.	Activated sludge and lagoons	2	C	4	4,7
27.	Aeration systems	1	C	4	4,7
28.	Sludge separation and drying	2	C	4	4,7
	UNIT V : SOLIDS DISPOSAL	**8**			
29.	Solids waste disposal – composting	1	C	5	3,4
30.	Landfill, briquetting	1	C	5	3,4
31.	Gasification and incineration	2	C	5	3,4
32.	Quantum and nature of solid waste	1	C	5	3,4
33.	Bio methanation	1	C	5	3,4
34.	Pelletization, landfill and gas recovery	1	C	5	3,4
35.	Municipal solid waste disposal.	1	C	5	3,4
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Vallero D; "*Fundamentals of Air Pollution*", 5th Edition, Academic Press, 2014
2.	Eckenfelder W.W; "*Industrial Water Pollution Control*", 2nd Edition, McGraw Hill, 1999
3.	Kreith F. and Tchobanoglous G., "*Handbook of Solid Waste Management*", 2nd Edition; McGraw Hill, 2002
4.	Pichtel J; "*Waste Management Practices: Municipal,Hazardous and Industrial*", CRC Press, 2014
	REFERENCE BOOKS/OTHER READING MATERIAL
5.	Gerard Kiely, "*Environmental Engineering*", Tata McGraw Hill, 2006.
6.	Magill, Holden and Ackdey, "*Air Pollution Hand Book*", Mc-Graw Hill, New Delhi, 1998
7.	Tchobanoglous G., Burton F. L. and Stensel H.D., "*Waste Water Engineering: Treatment and Reuse*", 4th Edition, Tata McGraw Hill, 1991.

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%**

15ME371E	ADVANCED STRENGTH OF MATERIALS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15ME203				
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 July 2016				

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%**

15ME372E	THERMAL ENERGY STORAGE 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 July 2016				

PURPOSE	On completion of this course, the students will be able to understand the principles of thermal storage systems, thermal storage materials, storage construction and applications of thermal storage in heating and cooling.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize with the techniques used for storing various forms of energy	a	e					
2.	Understand the sensible thermal storage, materials and methodology	a	e					
3.	Understand the latent thermal storage materials and systems	a	e					
4.	Understand the storage materials and heat transfer fluids	a	e					
5.	Know the various techniques used for storing thermal energy in heating and cooling applications	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: ENERGY STORAGE	**9**			
1.	Energy supply and demand, energy storage and types of storage system	1	C	1	1,2
2.	Mechanical, chemical and thermal Energy storage	2	C	1	1,2
3.	Thermal energy storage for low, medium and high temperature applications	2	C	1	1,2
4.	Seasonal thermal energy storage technologies	3	C	1	1,2
5.	Comparison of thermal energy storage technologies	1	C	1	1,2
	UNIT II: SENSIBLE THERMAL ENERGY STORAGE	**9**			
6.	Sensible heat storage materials, Properties of sensible heat storage materials	2	C	2	1,2
7.	Selection of materials and methodology, container compatibility and effect of geometry of container	2	C	2	1,2
8.	STES Technologies, storage tanks using water, rock bed thermal storage and solar pond thermal storage	2	C	2	1,2
9.	Building structure thermal storage, passive solar heating storage	2	C	2	1,2
10.	Active solar heating storage and high temperature applications	2	C	2	1,2
	UNIT II: LATENT THERMAL ENERGY STORAGE	**9**			
11.	Latent heat storage materials, classification of phase change materials	1	C	3	1,2
12.	Thermal, physical, chemical, kinetic properties and economic properties of PCM, selection criteria.	2	C	3	1,2
13.	Passive and active LTES systems, PCM selection for heating and cooling applications	2	C	3	1,2
14.	Performance assessment methods of LTES systems	2	C	3	1,2
15.	Comparison of sensible and latent heat storage systems.	2	C	3	1,2
	UNIT IV: STORAGE MATERIALS AND HEAT TRANSFER FLUIDS	**9**			
16.	Thermal storage materials, containers and heat transfer fluid selection, heat transfer fluids and properties	2	C	4	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
17.	Thermal performance enhancement techniques. Geometry optimization of thermal storage	2	C	4	1,2
18.	LTES container design foe effective melting of PCM	2	C	4	1,2
19.	Thermal conductivity and convection enhancement technologies in PCM	1	C	4	1,2
20.	Chemical energy storage materials and methods	2	C	4	1,2
	UNIT V: THERMAL STORAGE APPLICATIONS	**9**			
21.	Cool storage concept and comparison of cold storage technologies	2	C	5	1,2
22.	Cool thermal storage in process cooling and building air conditioning systems	2	C	5	1,2
23.	Solar energy storage – Passive heating and cooling, green house heating	2	C	5	1,2
24.	Drying rate and heating for process industries	2	C	5	1,2
25.	Solar power plant applications.	1	C	5	1,2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Luisa F. Cabeza, "*Advances in Thermal Energy Storage Systems: Methods and Applications*",Elsevier,2015.
2.	Ibrahim Dincer and Marc A. Rosen, "*Thermal Energy Storage Systems and Applications"*, 2nd Edition, John Wiley and Sons Ltd., 2011.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Parameshwaran and S. Kalaiselvam, *"Thermal Energy Storage Technologies for Sustainability: Systems Design, Assessment and Applications"*, Academic Press Inc, 2014.
4.	Charles E. Dorgan, James S. Elleson, "*Design Guide for Cool Thermal Storage"*, ASHRAE, Atlanda, 1993.
5.	ASHRAE, "*Handbook of Fundamentals*", American Society of Heating Refrigeration and Air Conditioning Engineers, New York, 1993.

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%**

15ME373E	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 July 2016				

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%**

15ME374E	DESIGN OF HEAT EXCHANGERS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15ME302				
Data Book / Codes/Standards	Approved Heat and Mass Transfer Data Book and SRM University approved Data Book				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

PURPOSE	To impart knowledge on basic design aspects of heat exchangers and apply the principles to design various configuration of Heat exchangers.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Gain knowledge on the basics of Heat Exchanger	a						
2.	Familiarize with Design Aspects		b		e	k		
3.	Acquire the basic skills acquired to design the heat exchangers			c	e	k		
4.	familiarize with the standards and codes used in design of heat exchanger					k		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: FUNDAMENTALS OF HEAT EXCHANGER	**9**			
1.	Introduction, Recuperator and Regenerator	1	C	1,2	1,3
2.	Geometry of Construction, Tubular, Plate, Extended Surface Heat Exchangers	1	C	1,2	1,3
3.	Heat transfer Mechanisms, Flow arrangements, Application, Selection of Heat Exchangers.	1	C	1,2	1,3
4.	Overall Heat transfer coefficient, LMTD method for Heat Exchanger analysis	3	C,D	1,2	1,3
5.	ε NTU method for Heat Exchanger analysis	2	C,D	1,2	1,3
6.	Heat Exchanger design calculation	1	C,D	1,2	1,3
	UNIT II: DESIGN ASPECTS OF HEAT EXCHANGERS	**9**			
7.	Introduction, effect of turbulence, friction factor, pressure drop in tube side, Pressure drop in tube bundles.	3	C,D	2,4	1
8.	Heat Transfer and pumping power relationship	2	C,D	2,4	1
9.	Pressure Drop in Bends and fittings.	2	C,D	2,4	1
10.	Fouling of Heat exchangers	2	C,D	2,4	1
	UNIT III: DOUBLE PIPE HEAT EXCHANGERS AND SHELL & TUBE HEAT EXCHANGERS	**9**			
11.	Introduction, Thermal and hydraulic design of inner tube and analysis of annulus	2	C,D	3,4	1
12.	Design of Double Pipe Heat Exchangers	2	C,D	3,4	1
13.	Basic components of shell & tube heat exchangers.	1	C	1	1,3
14.	Design of shell & tube heat exchangers	2	C,D	3,4	1,3
15.	Shell side heat transfer and pressure drop.	2	C,D	3,4	1,3
	UNIT IV: COMPACT AND PLATE HEAT EXCHANGERS	**9**			
16.	Types, Merits and Demerits	1	C	1	1
17.	Design of compact heat exchangers	2	C,D	3,4	1
18.	Design of plate heat exchangers	2	C,D	3,4	1
19.	Operational characteristics, flow arrangements and applications	2	C	1	1
20.	Heat transfer and pressure drop calculations	2	C,D	3,4	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT V: CONDENSERS AND EVAPORATORS	**9**			
21.	Types of Condensers, Design of surface condensers	3	C,D	1,3	1,2
22.	Design of evaporative condensers	3	C,D	3,4	1,2
23.	Types of Evaporators, calculation of Evaporator surface, multiple effect Evaporators	3	C,D	1,3,4	1,2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	SadikKakac and Hongtan Liu, "*Heat Exchangers Selection, Rating and Thermal Design*", CRC Press, 2002
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Kern D.Q, "*Process Heat Transfer*", Tata McGraw Hill , 1997, Reprint 2008
3.	Ramesh K. Shah, "*Fundamentals of Heat Exchanger Design*", John Wiley & Sons,2003
4.	Arthur. P Frass, "*Heat Exchanger Design*", John Wiley & Sons, 1988.
5.	Taborek.T, Hewitt.G.F and Afgan.N, "*Heat Exchangers, Theory and Practice*", McGraw-Hill Book Co. 1980.
6.	Kuppan T, "*Heat Exchanger design handbook*", Marcel Dekker INC, 2000.
7.	Standards of Tubular Exchanger Manufacturers Association(TEMA), 9th Edition,2007 – www.tema.org
8.	Wolverine Heat Transfer Data book – III by Wolverine Tube Inc.,

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%**

15ME375E	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 July 2016				

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%**

15ME376E	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 July 2016				

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%**

15ME377E	NANO ROBOTICS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVES				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

PURPOSE	To enlighten the students about nanorobot working and its applications							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to understand the								
1.	Basics of nano robotics system	c						
2.	Micro/Nano Sensors	c						
3.	Micro/Nano Actuators	c						
4.	Micro/Nano Manipulators	c	k					
5.	Micro/Nano Robotics manufacturing and control techniques	c	k					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION	**8**			
1.	Overview of Micro/Nano robotics system	2	C	1	1,2
2.	Scaling effect in the physical parameters	2	C	1	1,2
3.	MEMS and Micro system and its products	2	C	1	1,2
4.	Micro/Nano Robotics system examples	2	C	1	1,2
	UNIT II: MICRO/NANO SENSORS	**10**			
5.	Far field and Near filed Imaging sensors	1	C	2	2,3
6.	Position and Capacitive sensors	1	C	2	2,3
7.	Linear Variable Differential Transformer	1	C	2	2,3
8.	Interferometric sensors, Accelerometers and Gyroscopes	2	C	2	2,3
9.	Force, Pressure, Chemical and Flow sensors	2	C	2	2,3
10.	Strain gauge and Deflection based AFM	1	C	2	2,3
11.	Visual force sensing ,Bending imaging and Tactile sensors	2	C	2	2,3
	UNIT III: MICRO/NANOACTUATORS	**9**			
12.	Bending type Piezoelectric actuators	1	C	3	2,4
13.	Unimorph, Bimorph and stack type actuators	1	C	3	2,4
14.	Piezo tube and Thin film types ZnO	1	C	3	2,4
15.	Surface acoustic waves, Elecrostatic,Thermal and Ultrasonic actuators	2	C	3	2,4
16.	Electro, Magnetostrictive and Shape memory alloy based actuators	2	C	3	2,4
17.	Polymer actuators, Dielectric elastomers	1	C	3	2,4
18.	CNT actuators and Bimolecular Motors	1	C	3	2,4
	UNIT IV: MICRO/NANO MANIPULATORS	**9**			
19.	SPM Probes and Micro nano grippers, Atomic manipulation using STM	2	C	4	2,6
20.	Optical Tweezers and Dielectrophoresis	2	C	4	2,6
21.	Bio manipulation with case study	2	C	4	2,6
22.	Carbon nanotube manipulation using nanoprobes	2	C	4	2,6
23.	High density data storage using nanoprobes	1	C	4	2,6
	UNIT V: MICRO/NANO ROBOTICS MANUFACTURING TECHNIQUES	**9**			
24.	Micro/Nanofabrication, Micro nano assembly and Self assembly	2	C	5	5,9
25.	Precision micro/nanoparticle assembly using SEM	1	C	5	5,9

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
26.	Guided Self Assembly	1	C	5	5,9
27.	Biomimetics and design strategies and roboflies	1	C	5	5,9
28.	Micro Mechanical Flying robot	1	C	5	5,9
29.	Kinematics and Dynamics of Robot	1	C	5	5,9
30.	Teleoperation based, Task based and automatic control robot	2	C	5	5,9
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Norio Taniguchi, "*Nanotechnology*", Oxford university press, Cambridge, 1996.
2.	Elwenspoek.M and Wiegerink.R., "*Mechanical Microsensors*", Springer-Verlag Berlin, 2001.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Fatikow.S. Rembold.U., "*Microsystem Technology and Microrobotics*", Springer Verlag, 1997.
4.	Israelachvili.J, "*Intermolecular & Surface Forces*", Academic Press Ltd., 2nd Edition, 1992.
5.	Bhushan.B., "*Handbook of Micro/Nanotribology*", CRC Press, 2nd Ed., 1999.
6.	Scherge.M and Gorb.S, "*Biological Micro- and Nano-tribology*": Nature's Solutions", Springer Verlag, Berlin Heidelberg, 2001.
7.	Morris.V.J.,Kirby.R., Gunning.P., "*Atomic Force Microscopy for Biologists*", London, Imperial College Press, 1999
8.	DrorSarid, "*Scanning Probe Microscopy*", Oxford University Press, Revised Edition, 1994.
9.	MetinSitti, "*Micro-and Nano scale Robotics*",Carnegie Mellon University,2003.
10.	Madou.M, "*Fundamentals of Microfabrication*", CRC Press, 1997.
11.	Tai-Ran Hsu, "*MEMS and Microsystems Design and Manufacture*", McGraw-Hill inc., 2002.

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%**

15ME426E	DIGITAL IMAGE PROCESSING AND MACHINE VISION	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 July 2016				

PURPOSE	To study the basic concepts of image processing and machine vision techniques.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the basic concepts of digital image processing.	a						
2.	Learn the image fundamentals and mathematical transforms necessary for image processing	a	b					
3.	Study the various image enhancement techniques	a	b					
4.	Gain knowledge about the various image restoration procedures in medical images and basic concepts of image compression procedures.	a	b					
5.	Understand the techniques involved in machine vision.			d				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - FUNDAMENTALS OF DIGITAL IMAGE PROCESSING	**9**			
1.	Introduction to image processing, classification of image, resolution	1	C	1	1,2
2.	Fundamental steps involved in image processing, source of image	1	C	1	1,2
3.	Elements of digital image processing systems	1	C	1	1,2
4.	Elements of visual perception, structure of eye	1	D	1	1,2
5.	Basic concept of Image sampling and quantization, Image model	1	C	1	1,2
6.	Representing Digital Images, Spatial and Intensity Resolution, Image Interpolation	2	C	1	1,2
7.	Matrix and singular value representation of discrete	2	C	1	1,2
	UNIT II - IMAGE TRANSFORMS AND EDGE DETECTION	**9**			
8.	The Basics of Intensity Transformations and Spatial Filtering	1	C	2	1,2
9.	One-dimensional discrete fourier transform (DFT)	1	C,D	2	1,2
10.	Two- dimensional discrete fourier transform (DFT)	1	C,D	2	1,2
11.	Cosine and Sine transform and their properties	1	C,D	2	1,2
12.	Hadamard and Haar transform and their properties	1	C,D	2	1,2
13.	Slant, KL, SVD transforms and their properties	2	C	2	1,2
14.	Edge detection and their techniques, Roberts operator, Sobel operator, Prewitt operator.	2	C	2	1,2
	UNIT III - IMAGE ENHANCEMENT	**9**			
15.	Histogram modification and specification techniques	1	C	3	1,2
16.	Image smoothing, Low pass filtering, Ideal low pass filter, Butterworth low pass filter	2	C	3	1,2
17.	Image sharpening, Butterworth filters	2	C	3	1,2
18.	Generation of spatial masks from frequency domain specification, Basic steps in frequency domain filtering	1	C,D	3	1,2
19.	Nonlinear filters, function, Max filter, Min filter	1	C,D	3	1,2
20.	Homomorphic filtering, False color, Pseudocolor and its approaches and color image processing, color model	2	C,D	3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT IV - IMAGE RESTORATION AND COMPRESSION	**9**			
21.	Image degradation models , Unconstrained and constrained restoration	1	C	4	1,2
22.	Inverse filtering , Least mean square filter, Pattern classes	1	C	4	1,2
23.	Optimal statistical classifiers, Run length coding	1	C,D	4	1,2
24.	Huffman coding, Shift codes and their steps	1	C,D	4	1,2
25.	Arithmetic coding and bit plane coding	1	C,D	4	1,2
26.	Transform coding, JPEG Standard, Wavelet transform	2	C	4	1,2
27.	Predictive techniques, Block truncation coding schemes, Facet modeling.	2	C	4	1,2
	UNIT V - MACHINE VISION	**9**			
28.	Introduction to Machine Vision	1	C	5	3,7
29.	Sensing, Image acquisition and digitization	1	C	5	3,7
30.	Illumination and its types	1	C	5	3,7
31.	Various Preprocessing methods are Image enhancement, Noise removal	2	C,D	5	3,7
32.	Image Analysis methods, Feature extraction	1	C,D	5	3,7
33.	Image interpretation such as Segmentation and Template Matching	2	C,D	5	3,7
34.	Industrial Applications	1	C	5	3,7
	Total contact hours*	45			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Anil K. Jain, "*Fundamentals of Digital Image Processing*", Prentice Hall of India, New Delhi, 2001.
2.	Rafel.C.Gonzalez and Richard E.Woods, "*Digital Image Processing*", Addison Wesley, New York, 2009.
3.	Vernon, D., "*Machine Vision - Automated Visual Inspection and Robot Vision*", Prentice Hall International Ltd., New York, 1991.
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	William K. Pratt, "*Digital Image Processing*", John Wiley, New York, 2007.
5.	Sid Ahmed M. A., "*Image Processing Theory, Algorithms and Architectures*", McGraw-Hill, New York, 1995.
6.	Umbaugh.S.E, "*Computer Vision and image processing - Practical approach using CVIP tools*", Prentice Hall of India, New Delhi, 1998.
7.	Ramesh Jain, RangacharKasturi and Brain G. Schunk, "*Machine Vision*", McGraw Hill International Editions, Computer Science Series, Singapore, 1995.

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%**

15ME427E	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 July 2016				

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%**

15ME428E	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 July 2016				

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%**

15ME429E	PRECISION 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 July 2016				

PURPOSE	To impart knowledge about basics of precision machining and different manufacturing technique in precision engineering.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize about the basics of accuracy and alignment tests.	c	e	j				
2.	Familiarize with static stiffness and thermal effects.	c	e	j				
3.	Understand principles of precision machining.	c	e	j				
4.	Understand principles ofNano measuring systems.	c	e	j				
5.	Understand principles ofvarious lithographic techniques.	c	e	j	k			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: ACCURACY AND ALIGNMENT TESTS	**9**			
1.	General concept of accuracy, Spindle rotation accuracy	1	C	1	1
2.	Test methods for displacement accuracy	1	C	1	1
3.	Dimensional wear of cutting tools	1	C	1	1
4.	Accuracy of NC systems, Clamping errors, Setting errors	1	C	1	1
5.	Location of rectangular prism, cylinder	1	C	1	1
6.	Basic type of tests, Measuring instruments used for testing machinetools	1	C	1	1
7.	Alignment, Straightness, Flatness tests	1	C	1	1
8.	Parallelism, Squareness tests	1	C	1	1
9.	Circularity, Cylindricity tests.	1	C	1	1
	UNIT II: INFLUENCE OF STATIC STIFFNESS, THERMAL EFFECTS	**9**			
10.	Static stiffness	1	C	2	1
11.	Nature of deformation in a machine tool	1	C	2	1
12.	Overall stiffness of a lathe	1	C	2	1
13.	Compliance of work piece	1	C	2	1
14.	Errors due to the variation of the cutting force and total compliance	2	C	2	1
15.	Inaccuracies due to thermal effects	1	C	2	1
16.	Methods of decreasing thermal effects	1	C	2	1
17.	Influence of vibration on accuracy	1	C	2	1
	UNIT III: PRECISION MACHINING	**9**			
18.	Introduction to Top down and bottom up approach	1	C	3	1
19.	Development of Nanotechnology	1	C	3	1
20.	Precision and micromachining	2	C	3	1
21.	Diamond turning of parts to nanometer accuracy	1	C	3	1
22.	Stereo microlithography	1	C	3	1
23.	Machining of micro-sized components	1	C	3	1
24.	Mirror grinding of ceramics	1	C	3	1
25.	Ultra precision block gauges.	1	C	3	1
	UNIT IV: NANO MEASURING SYSTEMS	**9**			
26.	In - process measurement of position of processing point	2	C	4	2
27.	Post process and online measurement of dimensional features	2	C	4	2
28.	Mechanical measuring systems	1	C	4	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
29.	Optical measuring systems	1	C	4	2
30.	Electron beam measuring systems	1	C	4	2
31.	Pattern recognition and inspection systems	2	C	4	2
	UNIT V: LITHOGRAPHY	**9**			
32.	Nano Lithography	1	C	5	2
33.	Photolithography	1	C	5	2
34.	Electron beam lithography	1	C	5	2
35.	Ion Beam lithography	1	C	5	2
36.	Optical lithography	1	C	5	2
37.	LIGA process	1	C	5	2
38.	Dip pen lithography	1	C	5	2
39.	Deep UV lithography	1	C	5	2
40.	Nanocoatings.	1	C	5	2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Murthy.R.L, "*Precision Engineering in Manufacturing"*, New Age International, New Delhi, 2005.
2.	Norio Taniguchi, "*Nanotechnology"*, Oxford university press, Cambridge, 1996.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Lee Tong Hong, "*Precision Motion control, Design and Implementation"*, Springer Verlag, U.K., 2001.
4.	Liangchi Zhang, "*Precision Machining of Advanced Materials"*, Trans Tech Publications Ltd., Switzerland, 2001.
5.	HiromuNakazawa, "*Principles of precision engineering"*, Oxford University Press, 1994.

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%**

15ME430E	SOLAR ENERGY 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 July 2016				

PURPOSE	To understand the fundamentals of solar energy and its conversion techniques for both thermal and electrical energy applications.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize with basics of solar radiation, available solar energy and its measurement	a	e					
2.	Familiarize with the solar collectors, construction and operation of solar collectors.	a	e					
3.	Understand the solar energy conversion systems,applications and power generation	a	e					
4.	Understand principles PV technology and techniques of various solar cells / materials for energy conversion	a	e					
5.	Know the advance current technology of the solar energy systems for making the process economical, environmentally safe and sustainable.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: SOLAR RADIATION	**9**			
1	Solar radiation: Sun as the source of radiation	1	C	1	1
2	Sun-Earth relationships and solar constant	1	C	1	1
3	Solar radiation at the earth's surface and depletion of solar radiation	1	C	1	1
4	Sun and Earth geometry, solar angles, solar time, sunrise, sunset and day length	2	C	1	1
5	Measurement of solar radiation: Pyranometer, Pyrheliometer, Sunshine Recorder	1	C	1	1
6	solar radiation data and empirical equations for predicting the availability of solar radiation	2	C	1	1
7	Solar radiation on tilted surfaces	1	C	1	1
	UNIT II: SOLAR COLLECTORS	**9**			
8	Solar collectors: classification, comparison of concentrating and non-concentrating types	1	C	2	3
9	Flat plate collectors: construction, working principle and effect of various parameters on performance	2	C	2	1
10	Concentrating collectors: Types, working principle of flat plate collector with plane reflectors.	1	C	2	1
11	Cylindrical parabolic concentrators and compound parabolic concentrator (CPC)	2	C,D	2	1
12	Performance evaluation of concentrating collector	1	C	2	1
13	Linear Fresnel lens collector - Paraboloidal dish collector and central tower receiver.	2	C	2	1
	UNIT III: APPLICATIONS OF SOLAR THERMAL TECHNOLOGY	**11**			
14	Solar water heating system and industrial heating system	1	C	3	3,5
15	Solar passive space heating and cooling systems, solar refrigeration and air-conditioning systems, solar desiccant cooling and solar green house	3	C	3	3,5
16	Solar cookers, solar furnaces, solar distillation and solar dryer	2	C	3	3,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
17	Low temperature solar power generation using liquid flat plate collectors, solar pond electric power plant and solar chimney power plant	2	C	3	3,5
18	Medium temperature solar power generation using line focusing cylindrical parabolic concentrating collectors	1	C	3	3,5
19	High temperature solar power generation using paraboloid dish collectors and solar central tower receiver power plant	2	C,D	3	3,5
	UNITIV:SOLAR PHOTOVOLTAIC SYSTEMS	**9**			
20	Fundamentals of solar cells and PN junction photodiode.	1	C	4	3
21	Solar cell classification, solar cell structure, solar module and panel and array construction	1	C,D	4	3
22	Photovoltaic conversion - Solar cell characteristics, solar cell efficiency, and fill factor.	2	C	4	3
23	Maximizing solar PV output and maximum power point tracker.	1	C	4	3
24	SPV system classification, components and design of simple solar PV plant analysis	2	C	4	3
24	Photovoltaic system for power generation: Stand-alone system and grid connected system	1	C	4	3
25	Applications of solar PV systems	1	C,D	4	3
	UNIT V: SOLAR ENERGY STORAGE AND ECONOMIC ANALYSIS	**7**			
26	Solar thermal energy storage- sensible and latent heat storage	2	C	5	1
27	Economic Analysis: Initial and annual costs, definition of economic terms for a solar system	2	C	5	1
28	Present worth calculation and repayment of loan in equal annual installments	1	C	5	1
29	Annual savings, cumulative savings and life cycle savings	1	C,D	5	1
30	Payback period and clean development mechanism.	1	C	5	1
	Total contact hours*	45			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Sukhatme.K, Suhas P. Sukhatme, "*Solar energy: Principles of thermal collection and storage"*, Tata McGraw Hill publishing Co. Ltd, 8th Edition, 2011.
2	Goswami D.Y., Kreith F., Kreider J.F.,*"Principles of Solar Engineering"*, Taylor and Francis, 2nd Edition, Indian reprint, 2003.
	REFERENCE BOOKS/OTHER READING MATERIAL
3	B. H. Khan, "*Non-Conventional Energy Resources"*, Tata McGraw Hill, Second edition, 2011.
4	Garg.H.P, Prakash.J, "*Solar energy fundamentals and applications"*, Tata McGraw Hill publishing Co. Ltd, 2006.
5	G.D. Rai, *"Solar Energy Utilization"*, Khanna Publishers, 5th Edition, 2014.
6	Tiwari.G.N, "*Solar energy: Fundamentals, Design, Modeling and Applications"*, CRC Press Inc., 2002.
7	Duffie, J. A. & W. A. Beckman., "*Solar Engineering of Thermal Processes"*, John Wiley & Sons, Inc., 3rd Edition, 2006.

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

15ME431E	TECHNOLOGY OF SURFACE COATING	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 July 2016				

PURPOSE	To make the students to understand the significance of surface engineered materials in modern engineering applications.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To notify the learner about the various coatings on different area.	c	d	f				
2.	To know about nanostructured coating techniques	c	d	f				
3.	To have knowledge about the coating technique with different type of the surfaces	c	d	f				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I:CONCEPT OF COATING	**7**			1
1.	Introduction to surface Engineering	1	C	3	1
2.	Difference between surface and bulk	2	C	3	1
3.	Properties of surfaces-wear, wettability	2	C	3	1,2
4.	Chemistry & Technology of Surfactants	2	C	3	1,2
	UNIT II:SPECIAL COATING TECHNIQUES-I	**11**			
5.	Introduction to Electro Chemical Deposition - Electro Plating	1	C	1	1
6.	Anodizing and Electro-Less Plating	1	C	1	1
7.	Thermal Spray Coating-Combustion Spray and Plasma Spray Process	2	C	1	1,2
8.	CVD Coating- Reaction, Adhesion System	1	C	1	1,2
9.	CVD Coating of TiC, Nitride, Chromium, Aluminium Oxide and Diamond	2	C	1	1,2
10.	PVD Coating- Vacuum, Reactive, Cathodic Arc Evaporation Deposition.	2	C	1	1,2
11.	Sputtering, Magnetron and Unbalanced Magnetron	1	C	1	1,2
12.	Radio Frequency and Pulsed DC sputtering	1	C	1	1,2
	UNIT III: SPECIAL COATING TECHNIQUES-II	**9**			
13.	Surface Coating by Wetting, Mechanism of Wetting	1	C	2	1,2
14.	Coating on Ceramics by Wetting, Coating of Monolayer Abrasive grain by Wetting	2	C	2	1,2
15.	DLC and diamond coatings, antifriction and anti-scratch coatings	2	C	2	1,2
16.	Sol Gel Coating, Laser Assisted Surface Engineering	2	C	2	1,2
17.	Micro Arc Oxidation, Electro Spark Coating	2	C	2	1,2
	UNIT IV: SURFACE ANALYSIS I	**9**			
18.	Surface specificity	1	C	3	1
19.	Spectrum of secondary electrons	1	C	3	1
20.	Electron energy analyzers	2	C	3	1
21.	Auger Electron spectroscopy	2	C	3	1,2
22.	Electron Energy Loss Spectroscopy	2	C	3	1,2
23.	Photoelectron Spectroscopy	1	C	3	1,2
	UNIT V: SURFACE ANALYSIS II	**9**			
24.	Field Emission Microscopy	1	C	1	1,2
25.	Field Ion Microscopy	1	C	1	1,2
26.	Transmission Electron Microscopy	1	C	1	1,2

27.	Reflection Electron Microscopy	1	C	1	1,2
28.	Low-Energy Electron Microscopy, - Atomic ForceMicroscopy	2	C	1	1,2
29.	Scanning Electron Microscopy	1	C	1	1,2
30.	Scanning Tunneling, Microscopy	2	C		2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	D. Satas, Arthur A. Tracton, "*Coatings technology handbook*", Marcel Dekker, 2000
2.	K. Oura, V. G. Lifshits, A. A. Saranin, A. V. Zotov and M. Katayama, "*SurfaceScience – An Introduction*" Springer, 2009.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	B G Miller, *"Surface coatings for protection against wear"*, Woodhead Publishing, 1st Edition, 2006
4.	Riviere.J.C and Myhra.S, "*Handbook of Surface and Interface analysis*", CRC Press, 2009.
5.	Hari Singh Nalwa, "*Nanostructured Materials and Nanotechnology*", Academic Press, 2002.

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%**

15ME432E	COMBUSTION ENGINEERING	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15ME201				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

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%**

15ME433E	SUSTAINABLE ENERGY 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 July 2016				

PURPOSE	On completion of this course, the students are expected to gain knowledge in energy resources, environmental impact, ecology, life-cycle analysis, and sustainable development.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize with the energy sources and environmental impact of energy generation	a	e					
2.	Familiarize with the energy conservation measures and policies	a	e					
3.	Understand the sustainable development and life-cycle analysis	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: ENERGY SOURCES	**9**			
1.	Sustainable energy and energy sources	1	C	1	1,2
2.	Renewable energy sources, solar, geothermal, biomass and fuel cells	3	C	1	1,2
3.	Non-renewable energy sources, coal, petroleum, natural and nuclear.	3	C	1	1,2
4.	Historical trends and world energy prospects	2	C	1	1,2
	UNIT II: ENVIRONMENTAL IMPACT OF ENERGY GENERATION AND UTILIZATION	**9**			
5.	Global warming and acid precipitation,	1	C	1	1,2
6.	Analysis of modeling of earth's climate, radiation balance of earth planet, greenhouse gases and radiative forcing concept	2	C,D	1	1,2
7.	Radiative forcing concept and global warming potentials	2	C,D	1	1,2
8.	Anthropogenic effect on climate and its control	1	C	1	1,2
9.	Impact of energy efficiency and other environmental impact aspects, cogeneration (simple problems)	3	C,D	1	1,2
10.	**UNIT III: ENERGY CONSERVATION**	**9**			
11.	Energy conservation measures and policies , case studies	3	C,D	2	1,2
12.	Energy management and audit	3	C,D	2	1,2
13.	Selection of more efficient energy options	3	C	2	1,2
	UNIT IV: SUSTAINABLE DEVELOPMENT AND ENERGY POLICIES	**9**			
14.	Sustainable energy strategies and policies	2	C	3	1,2
15.	Modeling instruments and case studies	1	C,D	3	1,2
16.	Sustainable assessment of solar energy and fossil fuel combustion	3	C,D	3	1,2
17.	Assessment of green energy strategies and policies	3	C	3	1,2
	UNIT V: LIFE-CYCLE (LCA) ASSESSMENT AND ECOLOGY	**9**			
18.	General description of LCA methodology	2	C	3	1,2
19.	Energetic life-cycle analysis	2	C	3	1,2
20.	Case study, comparative LCA of hydrogen-fuel cells vs gasoline vehicles	3	C,D	3	1,2
21.	Case study, comparative LCA of conventional and	2	C,D	3	1,2

	alternative vehicles				
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	I. Dincer, C. Zamfirescu, "*Sustainable Energy Systems and Applications*", Springer, 2012.
2.	Frank Kreith, Susan Krumdieck , "*Principles of Sustainable Energy Systems*", 2nd Edition, Taylor & Francis, 2014.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Muthu, Subramanian Senthilkannan, "*Social Life Cycle Assessment An Insight*", Springer, 2015
4.	Demirel, Yaşar, "*Energy Production, Conversion, Storage, Conservation, and Coupling*", Springer, 2016.

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%**

15ME434E	SUPPLY CHAIN MANAGEMENT	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 July 2016				

PURPOSE	To expose the students to the logistics approaches of supply chain management.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the role of logistics.	c	e					
2.	Understand the phases of supply chain.	c	e					
3.	Understand the models and activities of SCM.	c	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO LOGISTICS	**9**			
1.	Introduction of Logistics and its concept	1	C	1	1,3,4
2.	Logistics definitions and approaches	1	C	1	1,3,4
3.	Factors influencing logistics	1	C	1	1,3,4
4.	Basic tasks of supply chain	1	C	1	1,3,4
5.	Defection and approachesof supply chain	2	C	1	1,3,4
6.	Influencing supply chain	2	C	1	1,3,4
7.	A new corporate model.	1	C	1	1,3,4
	UNIT II: - PHASES OF SUPPLY CHAIN	**9**			
8.	The new paradigm shift	1	C	2	2,3,4
9.	The modular company	1	C	2	2,3,4
10.	The network relations in supply chain	1	C	2	2,3,4
11.	Supply processes in supply chain	2	C	2	2,3,4
12.	Procurement processes in supply chain	2	C	2	2,3,4
13.	Distribution management in supply chain	2	C	2	2,3,4
	UNIT III: EVOLUTION OF SUPPLY CHAIN MODELS	**9**			
14.	Strategy and structure of supply chain	1	C	3	2,3,4
15.	Factors of supply chain	1	C	3	2,3,4
16.	Manufacturing strategy stages	1	C	3	2,3,4
17.	Supply chain progress	1	C	3	2,3,4
18.	Introduction of Model for competing through supply chain management	2	C	3	2,3,4
19.	PLC grid in supply chain management	1	C	3	2,3,4
20.	Redesigning of supply chain	1	C	3	2,3,4
21.	Linking supply chain with customer.	1	C	3	2,3,4
	UNIT IV: SUPPLY CHAIN ACTIVITIES	**9**			
22.	Introduction of Structuring the supply chain	1	C	3	2,3,4
23.	Supply Chain	2	C	3	2,3,4
24.	New products of supply chain	2	C	3	2,3,4
25.	Frame work Design for supply chain	2	C	3	2,3,4
26.	Collaborative product commerce	2	C	3	2,3,4
	UNIT V: SCM ORGANISATION AND INFORMATION SYSTEM	**9**			
27.	The management task	1	C	3	2,3,4
28.	Types of Logistics organization	1	C	3	2,3,4
29.	The logistics in information systems	1	C	3	2,3,4
30.	Topology of Supply chain application	1	C	3	2,3,4
31.	Product Data Management	1	C	3	2,3,4
32.	Warehouse management system MRP- I,	1	C	3	2,3,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
33.	Warehouse management system MRP- 2	1	C	3	2,3,4
34.	ERP, Case study, ERP Software.	2	C	3	2,3,4
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Shari.P.B and Lassen.T.S, "*Managing the global supply chain*", Viva books, NewDelhi, 2000.
2.	Ayers.J.B, "*Hand book of supply chain management*", The St. Lencie press,2000
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Nicolas.J.N, "*Competitive manufacturing management – continuousimprovement", Lean production, customer focused quality"*, McGrawHill, NewYork, 1998.
4.	Steudel.H.J and Desruelle.P, "*Manufacturing in the nineteen - How to become amean, lean and world class competitor*", Van No strand Reinhold, New York,1992.

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%**

15ME435E	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	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	TCS-NASSCOM and Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd July 2016				

PURPOSE	To impart knowledge in product development considering political, economical, social, technological, environmental, legal factors

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the fundamentals of Product Development – global trends and methods	a	c			h	j	
2.	Understand the Requirements and System Design for tangible and intangible products	a		e			j	
3.	Understand the Design and Test for product for tangible and intangible products	a		e			j	
4.	Understand the Sustenance Engineering and End-of-Life (EoL)Support for tangible and intangible products	a	c		f		j	
5.	Understand the Business Dynamics–Engineering Services Industry	a					j	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: FUNDAMENTALS OF PRODUCT DEVELOPMENT	**9**			
1.	**Global Trends Analysis and Product decision:** Types of various trends affecting product decision- Social Trends (Demographic, Behavioral, Psychographic)	1	C	1	1
2.	Technical Trends (Technology, Applications, Tools, Methods), Economical Trends (Market, Economy, GDP, Income Levels, Spending Pattern, target cost, TCO)	1	C	1	1
3.	Environmental Trends (Environmental Regulations and Compliance), Political/Policy Trends (Regulations, Political Scenario, IP Trends and Company Policies); PESTLE Analysis.	1	C	1	1
4.	**Introduction to Product Development Methodologies and Management:** Overview of Products and Services (Consumer product, Industrial product, Specialty products etc);	1	C	1	1
5.	Types of Product Development (NPD/ Re-Engineering (Enhancements, Cost Improvements)/ Reverse Engineering)	1	C	1	1
6.	Design Porting &Homologation	1	C	1	1
7.	Overview of Product Development methodologies (Over the Wall/ Waterfall/V-Model/Stage-Gate Process/Spiral/Systems Engineering/Agile);	1	C	1	1
8.	Product Life Cycle (S- Curve, Reverse Bath tub Curve)	1	C	1	1
9.	Product Development Planning and Management (Budgeting, Risk, Resources and Design Collaboration, Scheduling, Change Management, Product Cost Management).	1	C	1	1
	UNIT II:REQUIREMENTS AND SYSTEM DESIGN	**10**			
10.	**Requirement Engineering:** Types of Requirements (Functional, Performance, Physical, Regulatory, Economical)	1	C	2	1
11.	**Requirement Engineering:** Types of Requirements (Behavioral, Technical, Stakeholder, Environmental, Industry	1	C	2	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	specific, Internal-Company Specific);				
12.	Requirement Engineering : Gathering(VOC),	1	C	2	1
13.	Analysis(QFD)	1	C	2	1
14.	Design Specification	1	C	2	1
15.	Traceability Matrix and Analysis	1	C	2	1
16.	Requirement Management	1	C	2	1
17.	Introduction to System Modeling; System Optimization	1	C	2	1
18.	System Specification	1	C	2	1
19.	Sub-System Design; Interface Design.	1	C	2	1
	UNIT III: DESIGN	**9**			
20.	**Conceptualization:** Industrial Design and User Interface Design	1	C	3	1
21.	Introduction to Concept generation Techniques	1	C	3	1
22.	Concept Screening &Evaluation-Concept Design	1	C	3	1
23.	S/W Architecture, Hardware Schematics and simulation.	1	C	3	1
24.	**Detailed Design:** Component Design and Verification	1	C	3	1
25.	High Level Design/Low Level Design of S/W Programs, S/W Testing	1	C	3	1
26.	Hardware Schematic, Component design, Layout and Hardware Testing	1	C	3	1
27.	**Prototyping:** Types of Prototypes (Mockups, Engineering Assessment Prototype, Alpha, Beta, Gama)	1	C	3	1
28.	Introduction to Rapid Prototyping and Rapid Manufacturing	1	C	3	1
	UNIT IV: TESTING AND CERTIFICATION	**8**			
29.	**System Integration, Testing, Certification and Documentation:** Manufacturing / Purchase and Assembly of Systems	1	C	4	1
30.	Integration of Mechanical, Embedded and S/W systems	1	C	4	1
31.	Introduction to Product verification processes and stages: Industry specific (DFMEA)	1	C	4	1
32.	Introduction to Product verification processes and stages: Industry specific (FEA,CFD)	1	C	4	1
33.	Introduction to Product validation processes and stages - Industry specific(Sub-system Testing / Integration Testing/)	1	C	4	1
34.	Introduction to Product validation processes and stages - Industry specific(Functional Testing / Performance Testing / Compliance Testing)	1	C	4	1
35.	Product Testing standards and Certification–Industry specific	1	C	4	1
36.	Product Documentation (Compliance Documentation, Catalogue, Brochures, user manual, maintenance Manual, Spares Parts List, Warranty, Disposal Guide, IETMS, Web Tools).	1	C	4	1
	UNIT V: SUSTENANCE ENGINEERING, END-OF-LIFE (EOL) SUPPORT AND BUSINESS DYNAMICS–ENGINEERING SERVICES INDUSTRY	**9**	C		1
37.	**Sustenance:** Maintenance	1	C	5	1
38.	**Sustenance:** Repair and Enhancements	1	C	5	1
39.	**Product EoL:** Obsolescence Management	1	C	5	1
40.	Configuration Management, EoLDisposal.	1	C	5	1
41.	**The Industry:** Engineering Services Industry – overview, Product development in Industry versus Academia	1	C	5	1
42.	**The IPD Essentials:** Introduction to vertical specific product development processes	1	C	5	1
43.	Product development Trade-offs	1	C	5	1
44.	Intellectual Property Rights and Confidentiality	1	C	5	1
45.	Security and configuration management.	1	C	5	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	*Foundation Skills in Integrated Product Development (FSIPD),* 1st Edition, 2013, Published by NASSCOM.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Ulrich, Karl T. and Eppinger, Steven D, "*Product Design and Development"*, 5th Edition, McGraw-Hill, 2012.
3.	Kevin N. Otto, "*Product design – techniques in reverse engineering and new product development*",PEARSON, New Delhi, 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%**

15ME436E	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 July 2016				

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**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15ME437E	GLOBAL OPTIMIZATION ALGORITHMS	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 July 2016				

PURPOSE	To study the principles of optimization and various techniques which can be used for solving Mechanical Engineering optimization applications.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to study the following optimization techniques								
1.	Evolutionary Algorithms	a	c	e				
2.	Genetic Algorithms	a	c	e				
3.	Modern optimization techniques	a	c	e				
4.	Search Algorithms	a	c	e				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT- I: INTRODUCTION TO OPTIMIZATION ALGORITHMS	**9**			
1.	Introduction: A Classification of Optimization Algorithms, an optimum	1	C	1	1
2.	The Structure of Optimization, Formulae and Search Space, Operator Design	1	C	1	1
3.	Evolutionary Algorithms: Introduction, The Basic Principles from Nature	1	C	1	1
4.	The Basic Cycle of Evolutionary Algorithms, The Basic Evolutionary Algorithm Scheme	1	C	1	1
5.	Classification of Evolutionary Algorithms	1	C	1	1
6.	Configuration Parameters of evolutionary algorithms	1	C	1	1
7.	Fitness Assignment	1	C	1	1
8.	Tournament Selection, Ranking Selection	1	C	1	1
9.	VEGA Selection, Simple Convergence Prevention.	1	C	1	1
	UNIT II - GENETIC ALGORITHMS AND GENETIC PROGRAMMING	**9**			
10.	Genetic Algorithms: Areas of Application	1	C	1,2	1
11.	Genomes, Fixed Length String Chromosomes	1	C	1,2	1
12.	Variable Length String Chromosomes, Schema Theorem	1	C,D	1,2	1
13.	The Messy Genetic Algorithm	1	C,D	1,2	1
14.	Genotype-Phenotype Mappings and Artificial Embryogeny	1	C	1,2	1
15.	Genetic Programming, Tree Genomes	1	C	1,2	1
16.	Genotype-Phenotype Mappings, Grammars in Genetic Programming	1	C	1,2	1
17.	Linear Genetic Programming, Artificial Life and Artificial Chemistry	1	C	1,2	1
18.	Correctness of the Evolved Algorithms	1	C	1,2	1
	UNIT III - MODERN OPTIMIZATION TECHNIQUES	**9**			
19.	Ant Colony Optimization: Areas of Application	2	C,D	3	1
20.	River Formation Dynamics	1	C,D	3	1
21.	Particle Swarm Optimization: Areas of Application	2	C,D	3	1
22.	Hill Climbing: Areas of Application	1	C,D	3	1
23.	Multi-Objective Hill Climbing	1	C	3	1
24.	Hill Climbing with Random Restarts	1	C	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
25.	Random Optimization	1	C,D	3	1
	UNIT IV - MODERN OPTIMIZATION TECHNIQUES	**9**			
26.	Simulated Annealing	2	C,D	3	1
27.	Temperature Scheduling	1	C	3	1
28.	Multi-Objective Simulated Annealing	1	C	3	1
29.	External Optimization	1	C,D	3	1
30.	Tabu Search	1	C,D	3	1
31.	Memetic and Hybrid Algorithms	1	C,D	3	1
32.	Downhill Simplex (Nelder and Mead method)	2	C,D	3	1
	UNIT V - SEARCH ALGORITHMS	**9**			
33.	Search Methods: State Space Search, Uninformed Search, Breadth First Search	1	C	4	1
34.	Depth First Search	1	C	4	1
35.	Depth limited Search	1	C	4	1
36.	Iterative Deepening Depth-First Search	1	C	4	1
37.	Random Walks	1	C	4	1
38.	Informed Search	1	C	4	1
39.	GRASP, Greedy Search	2	C	4	1
40.	A* search - Adaptive Walks	1	C	4	1
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Thomas Weise, "*Global Optimization Algorithms – Theory and Application*", Thomas Weise, 2009, http://www.it-weise.de/
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Rao Singaresu.S, "*Engineering Optimization – Theory & Practice*", New Age International (P) Limited, New Delhi, 2013
3	Kalyanamoy Deb, "*Optimization for Engineering design algorithms and Examples*", Prentice Hall of India Pvt. Ltd.,2006.
4.	Goldberg.D.E, "*Genetic algorithms in search, optimization and machine*", Barnen, AddisonWesley, New York, 1989.
5.	Hans Paul Schwefel., "*Evolution and Optimum Seeking*", Wiley-Interscience, 1995.

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%**

15ME438E	MODELING OF THERMAL 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 July 2016				

PURPOSE	On completion of this course, the students are expected to gain knowledge about modeling and analysis of Thermal systems calculations.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student should be able to								
1.	Understand system design.	a	e					
2.	Analyse the mathematical modeling	a	e					
3.	Familiarize the numerical modeling.	a	e					
4.	Familiarize the optimization technique	a	e					
5.	Know the economic consideration in modeling and simulation	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I SYSTEM DESIGN	**9**			
1.	Engineering design	1	C	1	1,2
2.	Design as part of engineering system	1	C	1	1,2
3.	Design verses analysis	1	C	1	1,2
4.	Need for optimization	1	C	1	1,2
5.	Basic characteristics of thermal system	1	C	1	1,2
6.	Formulation of design problem	1	C	1	1,2
7.	Steps in the design process	1	C	1	1,2
8.	Simple problems	1	C,D	1	1,2
9.	Simple problems	1	C,D	1	1,2
	UNIT II MATHEMATICAL MODELING AND SIMULATION	**9**			
10.	Mathematical modeling overview	1	C	2	1,2
11.	Types of models	1	C	2	1,2
12.	stages	1	C	2	1,2
13.	Choosing the model equations	1	C	2	1,2
14.	Level of analysis	1	C	2	1,2
15.	Steps in model development	1	C	2	1,2
16.	Solving of models	1	C	2	1,2
17.	Testing of models	1	C	2	1,2
18.	Accuracy and validation	1	C	2	1,2
	UNIT III: NUMERICAL MODELING AND SIMULATION	**9**			
19.	Development of numerical model	1	C	3	1,2
20.	Solution procedure –linear and nonlinear algebric system	1	C	3	1,2
21.	Ordinary and partial differential equations	1	C	3	1,2
22.	Numerical modeling for a system	1	C	3	1,2
23.	System simulation	1	C	3	1,2
24.	Methods for numerical simulation -steady and dynamic lumped system	1	C	3	1,2
25.	Distributed system, simulation of large system.	1	C	3	1,2
26.	Numerical simulation verses real system	1	C	3	1,2
27.	Numerical problems	1	C,D	3	1,2
	UNIT IV: OPTIMIZATION	**9**			
28.	Formulation of optimization problems	1	C	4	1,3
29.	Calculus techniques –lagrange multipliers	1	C	4	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
30.	Search method , Concept of uncertainty reduction ratio	1	C	4	1,3
31.	reduction ratios of simple search techniques like exhaustive search,	1	C	4	1,3
32.	dichotomous search, Fibonacci search and Golden section search,	1	C	4	1,3
33.	numerical examples Method of steepest ascent/steepest descent	1	C	4	1,3
34.	conjugate gradient method: examples,	1	C	4	1,3
35.	New generation optimization techniques: Genetic algorithm and simulated annealing,	1	C	4	1,3
36.	Introduction to Bayesian framework for optimization	1	C,D	4	1,3
	UNIT V: ECONOMICS	**9**			
37.	Calculation of interest	1	C	5	1,2
38.	Worth of money as a function of time	1	C	5	1,2
39.	Series of Payments,	2	C	5	1,2
40.	Raising capital	1	C	5	1,2
41.	Taxes	1	C	5	1,2
42.	Economic factor in design	1	C	5	1,2
43.	Application of thermal system	1	C	5	1,2
44.	Numerical problems	1	C,D	5	1,2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Y Jaluria, "*Design and optimization of thermal systems*", Tata McGraw Hill, 3rd Edition, New Delhi,2007
2.	W F Stoecker, "*Design of thermal systems*", Tata McGraw Hill, 3rd Edition, New Delhi, 1989.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	C Balaji, "*Essentials of Thermal System Design and Optimization*,", Ane Books, New Delhi 2014
4.	J S Arora,"*Introduction to optimum design*", Elesiver Publication , 3rd Edition, 2012
5.	Bender.E.A , "*Introduction to Mathematical Modeling*", Dover Publication, 2000

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%**

15ME439E	NEURAL NETWORK AND FUZZY 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 July 2016				

PURPOSE	To impart the knowledge of Neural network and fuzzy systems.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Acquire basic understanding of the various algorithms involved in Neural Networks & Fuzzy Systems.		d					
2.	Acquire basic understanding of the various learning methods and methodologies	a		e				
3.	Understand various Fuzzy algorithms.	a	d	e				
4.	Analyze how to apply the concept of fuzzy & neural in mechanical applications.	a			h	k		
5.	Application of Neural and Neuro fuzzy concepts.				h	k		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - INTRODUCTION TO NEURAL NETWORKS	9			
1.	Biological foundations - ANN models, Types of activation functions	3	C	1	1
2.	Introduction to network architectures : Single layered systems and Multilayer feed forward network (MLFFN)	2	C	1	1
3.	Radial basis function network (RBFN)	2	C	1	3
4.	Recurring neural network (RNN)	2	C	1	3
5.	**UNIT II - LEARNING ALGORITHMS**	9			
6.	Learning process Supervised and unsupervised learning	2	C	2	1
7.	Error-correction learning Hebbian learning ,Boltzmann learning	2	C	2	1
8.	Single layer and multiplayer preceptors, Least mean square algorithm - Back propagation algorithm.	3	C	2	1
9.	Applications in forecasting and pattern recognition and other engineering problems	2	C	2	1
	UNIT III - INTRODUCTION TO FUZZY LOGIC	9			
10.	Fuzzy sets and Fuzzy relations	3	C	3	3
11.	Fuzzy conditional statements - Fuzzy rules	3	C	3	3
12.	Fuzzy analysis Fuzzy Relations and Fuzzy Graphs	3	C	3	3
	UNIT IV - FUZZY LOGIC CONTROL SYSTEM	9	C	4	3
13.	Fuzzy logic controller logic and Fuzzification interface	2	C	4	3
14.	Knowledge base and Decision making	2	C	4	3
15.	Defuzzification interface	2	C	4	3
16.	Fuzzy control	2	C	4	3
17.	Application of fuzzy logic in real time a Case study	1	C	4	3
	UNIT V - NEURO-FUZZY LOGIC CONTROL	9			
18.	Optimization of membership function and rules base of fuzzy logic controller using neural networks	2	C	5	3
19.	Genetic algorithm	2	O	5	3
20.	Fuzzy neuron	2	C	5	3
21.	Adaptive fuzzy systems and Adaptive neuron-fuzzy inference system (ANFIS) Case study	3	C	5	3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Jacek.M. Zurada, "*Introduction to artificial Neural Systems*", JaicoPublishing House, Mumbai, 2007.
2.	Simon Haykins, "*Neural Networks - A comprehensive foundation*", MacmillanCollege, Proc. Con. Inc. New York, 2005.
3.	Zimmermann.H.J, "*Fuzzy set theory and its applications*", Allied Publication Ltd.,Chennai, 2001.
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Tsoukalas.L.H and Robert E. Uhrig., "*Fuzzy and Neural approach in Engineering*", John Wiley and Sons, New York, 1997.
5.	Klir.G.J and Yuan.B.B, "*Fuzzy sets and fuzzy logic*", Prentice Hall of India, NewDelhi, 1997.
6.	Driankov.D, Hellendron.H and Reinfrank.M, "*An Introduction to Fuzzy control*",Narosa publishing House, New Delhi, 1996.

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%**

15ME440E	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 July 2016				

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%**

15ME441E	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 July 2016				

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%**

15ME442E	LINEAR ELASTICITY	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	15MA102 and 15ME203				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd July 2016				

PURPOSE	To introduce the concepts of the theory of elasticity and familiarize the student with the fundamental solutions of elasticity theory.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	To learn the formulation of elasticity boundary value problems	a	c					
2	To learn techniques by which some classical solutions in elasticity theory are obtained	a	c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: FOUNDATIONS	**9**			
1.	Mathematical Preliminaries-Scalar, Vector, Matrix, and Tensor Definitions	1	C,D	1	1
2.	Index notation	1	C,D	1	1
3.	Concept of Stress- Strains and Deformation	1	C,D	1	1
4.	Coordinate Transformations -Strain Transformation	1	C,D	1	1
5.	Principal Strains-Strain Compatibility	1	C,D	1	1
6.	Traction Vector	1	C,D	1	1
7.	Stress Transformation	1	C,D	1	1
8.	Equilibrium Equations	1	C,D	1	1
9.	Generalized Hooke's law.	1	C,D	1	1
	UNIT II: GENERAL RESULTS	**9**			
10.	Review of Field Equations	1	C,D	1	1
11.	Boundary Conditions and Fundamental Problem Classifications	1	C,D	1	1
12.	Stress Formulation-Beltrami-Michell compatibility equations	1	C,D	1	1
13.	Displacement Formulation	1	C,D	1	1
14.	Principle of Superposition	1	C,D	1	1
15.	Uniqueness Theorems-Reciprocal Theorem	1	C,D	1	1
16.	Principle of Virtual Work	1	C,D	1	1
17.	Principle of Minimum Potential and Complementary Energy	1	C,D	1	1
18.	Saint-Venant's Principle	1	C,D	1	1
	UNIT III: ANTI-PLANE ELASTICITY PROBLEMS	**9**			
19.	Anti-plane Strain	1	C,D	1	1
20.	Field Equations and Boundary Conditions	1	C,D	2	1
21.	Complex Variable Solutions to Anti-plane Strain Problems	1	C,D	2	1
22.	Solution using Taylor and Laurent Series	2	C,D	2	1
23.	Solution using Cauchy Integral Formula	2	C,D	2	1
24.	Solution using Conformal Mapping	2	C,D	2	1
	UNIT IV: PLANE ELASTICITY PROBLEMS	**9**			
25.	Plane Stress and Plane Strain	1	C,D	1	1
26.	Airy Stress Function	2	C,D	1	1
27.	Cartesian Coordinate Solutions Using Polynomials	2	C,D	2	1
28.	Cartesian Coordinate Solutions Using Fourier Methods	2	C,D	2	1
29.	Solutions in Polar Coordinates	2	C,D	2	1
	UNIT V: TORSION AND FLEXURE OF ELASTIC CYLINDERS	**9**			
30.	Torsion Formulation	1	C,D	1	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
31.	Prandtl Stress Function	1	C,D	1	1
32.	Torsion Solutions Derived from Boundary Equation	1	C,D	2	1
33.	Torsion Solutions Using Fourier Methods	1	C, D	2	1
34.	Torsion of Hollow Cylinders	1	C, D	2	1
35.	Torsion of Circular Shafts of Variable Diameter	2	C, D	2	1
36.	Flexure Formulation	1	C, D	1	1
37.	Flexure Problems without Twist	1	C,D	2	1
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Martin H. Sadd, "*Elasticity: Theory, "Applications and Numeric's*", Elsevier India, 2005
2.	Timoshenko S.P, Goodier J.N., "*Theory of Elasticity*", Tata McGraw-Hill Education, 2010.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	England A.H, *"Complex Variable Methods in Elasticity",* Dover Publications, 2003.
4.	Malvern L.E, *"Introduction to the Mechanics of a Continuous Medium",* Prentice Hall, 1977.
5.	Love A.E.H, "*The Mathematical Theory of Elasticity*", Dover, 2011.
6.	Landau L.D and Lifshitz E.M., "*Theory of Elasticity, Butterworth-Heinemann*", 1986.
7.	Atkin R.J and Fox N., "*An Introduction to the Theory of Elasticity*", Dover, 2005.
8.	Barber J.R., "*Elasticity*", Springer, 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%**

15ME443E	DESIGN OF PRESSURE VESSEL AND PIPING	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15ME203				
Data Book / Codes/Standards	Approved ASME Pressure Vessel and Boiler Code; Section VIII Div 1 & 2; 2003 American Standard Code for Pressure Piping ; B 31.1				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd July 2016				

PURPOSE	To present the industrial related problems, procedures and design principles for pressure vessels and enhance the understanding of design procedure of Pressure vessel and Design of piping layout.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize with basics of Pressure vessel design.		c					
2.	Familiarize with different types of stresses and their effects in pressure vessel.		c					
3.	Equip with the Pressure vessel design.	b	c	e	k			
4.	Expose to the failure in Pressure vessel.		c	e	k			
5.	Expose to the concept of piping layout and the stresses acting on it.		c	e	k			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: OVERVIEW OF PRESSURE VESSEL	**6**			
1.	Introduction, Methods for determining stresses	2	C	1	1
2.	Stress Significance , Design Approach	2	C	1	1
3.	Terminology and Ligament Efficiency	2	C	1	1
	UNIT II: - STRESS CATEGORIES AND THEIR LIMITS	**11**			
4.	Introduction , Stresses in a circular ring, cylinder	1	C,D	2	1,3
5.	Dilation of pressure vessels , Intersecting Spheres	1	C,D	2	1,3
6.	Membrane stress in Vessel under Internal pressure	1	C,D	2	1,3
7.	Thermal Stresses and their significance	2	C,D	2	1,3
8.	Thermal Stresses in Long hollow cylinders.	2	C,D	2	1,3
9.	Ultra High pressure vessel design principle.	2	C,D	2	1
10.	Discontinuity stresses in pressure vessels	2	C,D	2	1
	UNIT III: PRESSURE VESSELS DESIGN PHILOSOPHY	**14**			
11.	Stress concentration at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings	3	C,D	3	1,3
12.	Stress concentration for superposition , Dynamic and thermal transient condition	3	C,D	3	1
13.	Design of tall cylindrical self supporting process columns and support for short vertical vessels.	3	C,D		1,3
14.	Theory of Reinforced openings, nozzle reinforcement	2	C,D	3	1
15.	Pressure vessel Design	2	C,D	3	1,3
16.	Introduction to ASME pressure vessel codes	1	C	3	6
	UNIT IV: FAILURE ANALYSIS OF VESSELS	**8**			
17.	Buckling phenomenon	1	C	4	1
18.	Elastic Buckling of circular ring and cylinders under external pressure	2	C,D	4	1
19.	Collapse of thick walled cylinders or tubes under external pressure	2	C,D	4	1
20.	Effect of supports on Elastic Buckling of Cylinders	1	C,D	4	1
21.	Buckling under combined External pressure and axial loading	2	C,D	4	1

	UNIT V: FUNDAMENTALS OF PIPING DESIGN	**6**			
22.	Introduction to piping , Definition , codes	1	C	5	4,5
23.	Piping components and Flow Diagram	2	C,D	5	4,5
24.	Piping stress Analysis and Design of piping system as per standard piping codes	3	C,D	5	4,5,6
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	John F. Harvey, "*Theory and Design of Pressure Vessels*", CBS Publishers and Distributors,1987
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Henry H. Bedner, "*Pressure Vessels, Design Hand Book"*, CBS publishers and Distributors, 1987.
3.	SomnathChattopadhyay, "*Pressure Vessels: Design and Practice"*, CRC Press, 2004
4.	Smith P, "*Fundamentals of Piping Design*", Elsevier Gulf Publishing Company 2007
5.	William. J., Bees, "*Approximate Methods in the Design and Analysis of Pressure Vessels andPiping*", Pre ASME Pressure Vessels and Piping Conference, 1997.
6.	ASME Pressure Vessel and Boiler code, Section VIII Div 1 & 2, 2003American standard code for pressure piping , B 31.1
7.	Brownell. L. E & Young. E. D , "*Process equipment design"*, Wiley Eastern Ltd., India

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%**

15ME444E	KINEMATICS AND DYNAMICS OF ROBOTS	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 July 2016				

PURPOSE	To study how various mechanisms can be designed.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Control both the position and orientation of the tool in the three dimensional space.	a	e					
2.	Understand the relationship between the joint variables and the position and the orientation of the tool.	a	e					
3.	Study the planning trajectories for the tool to follow in order to perform meaningful tasks.	a	e					
4.	Precisely control the high speed motion of the system.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION	**9**			
1.	Introduction about Machines and Mechanisms and Robot anatomy	1	C	1	1, 8
2.	Arm and Wrist Configuration of Robot	1	C	1	1, 8
3.	Position and Orientation of Robots in fixed and Moving coordinate frames	1	C	1	1, 8
4.	Coordinate transformation/ Mapping in fixed angle rotation and Derivation of Rotation matrix using Dot product	2	C, D	1	1, 8
5.	Mapping between translated frames	1	C	1	1, 8
6.	Coordinate transformation/ Mapping in Translation and Homogeneous transformation	1	C, D	1	1, 8
7.	Rotation Matrix with Euler angle representation	1	C	1	1, 8
8.	Rotation Matrix with Arbitrary angle representation	1	C, D	1	1, 8
	UNIT-II: DIRECT KINEMATICS	**9**			
9.	Dot and Cross Products - Coordinate frames	1	C	2	2
10.	Translation, Rotation and Concatenation, Transformations & Homogeneous Coordinates	1	D	2	2
11.	Link coordinates for D-H representation	1	C	2	1, 2,8
12.	Arm equation with DH representation of Kinematics model	1	D	2	1, 2,8
13.	Direct Kinematics of 3 axis articulated robot	1	D	2	1,8
14.	Direct Kinematics of 3 DOF wrist	1	D	2	1, 8
15.	Direct Kinematics Analysis of 4 axis SCARA Robot	1	D	2	2,8
16.	Direct Kinematics of 5 axis articulated Robot	**1**	D	2	2,8
17.	Direct Kinematics Analysis of 6 axis Articulated Robot	1	D	2	2,8
	UNIT-III: INVERSE KINEMATICS	9			
18.	Inverse Kinematics of transformation	1	C	2	1, 2
19.	General properties of solution and tool configuration	1	D	2	1, 2,8
20.	Inverse kinematics for 3 DOF articulated robot Guide lines, solution techniques	1	D	2	1, 8
21.	Inverse kinematics for 3 DOF articulated robot, Derivation of equations	**1**	D	2	1, 8
22.	Inverse kinematics of 4 axis SCARA robot, General solution	1	D	2	2,9

23.	Inverse kinematics of 5 axis articulated robot, General solution	1	D	2	2,8
24.	Inverse kinematics of 6 axis articulated robot, General solution	1	D	2	2,8
25.	Tool configuration for 4 axis SCARA robot	1	D	2	2
26.	Tool configuration for 5 axis articulated robot	1	D	2	2
	UNIT- IV: WORKSPACE ANALYSIS AND TRACJECTORY PLANNING	9			
27.	Introduction & analysis of work space	**1**	C	3	1, 2
28.	Workspace analysis for 4 axis SCARA robot	1	D	3	1, 2
29.	Workspace analysis for 5 axis articulated robot	1	D	3	2
30.	Work space fixtures	1	C	3	2
31.	Trajectory planning Terminology, pick and place motion	1	D	3	1, 8
32.	Continuous path motion, Joint space technique	1	D	3	1, 2,8
33.	Continuous path motion, Cartesian space technique	1	D	3	1, 2,8
34.	Trajectory planning, Interpolated motion	1	D	3	1, 2
35.	Trajectory planning, straight line motion	1	D	3	1, 2
	UNIT-V: MANIPULATOR DYNAMICS	9			
36.	Introduction to manipulator dynamics	1	C	4	1, 8
37.	Lagrange's equation kinetic and potential energy	1	D	4	1, 2,8
38.	Link inertia tensor, Link jacobian manipulator inertia tensor	1	D	4	2,8
39.	Gravity and generalized forces	1	D	4	2
40.	Lagrange – Euler Dynamic model formulation	1	D	4	2
41.	L-E Dynamics model for Two axis planar robot	1	D	4	2,8
42.	L-E Dynamics model for Three axis SCARA robot	1	D	4	2,8
43.	Newton – Euler formulation	1	D	4	2
44.	N-E Dynamics model for Two axis planar robot	1	D	4	8
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	John J. Craig, "*Introduction to Robotics Mechanics and Control*", Second Edition, Addison Wesly Longman Inc. International Student edition, 1999
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Robert J. Schilling, "*Fundamentals of Robotics Analysis and Control*", Prentice Hall of India Pvt. Ltd., 2000.
3.	Richard D. Klafter, Thomas. A, Chmielewski, Michael Negin, "*Robotics Engineering an Integrated Approach*", Prentice Hall of India Pvt. Ltd., 1989
4.	P.A. Janaki Raman, "*Robotics and Image Processing An Introduction*", Tata McGraw Hill Publishing company Ltd., 1995
5.	Francis N-Nagy AndrasSiegler, "*Engineering foundation of Robotics*", Prentice Hall Inc., 1987
6.	Bernard Hodges, "*Industrial Robotics*", Second Edition, Jaico Publishing house, 1993
7.	Tsuneo Yohikwa, "*Foundations of Robotics Analysis and Control*", Prentice Hall of India Pvt. Ltd., 2001.
8.	Mittal RK, Nagrath IJ, "*Robotics and Controls*", Tata McGraw Hill Publications, 2003.

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%**

15ME445E	DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	L	T	P	C
		3	0	0	3
Co-requisite:					
Prerequisite:	15ME202				
Data Book / Codes/Standards	Design Data Hand Book, PSG College of Technology, Coimbatore.				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

PURPOSE	To gain proficiency in the design of Jigs, Fixtures and Press tools.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
1.	Explore the various locating and clamping methods	c	e	k				
2.	To understand the functions and design principles of Jigs & Fixtures	c	e	k				
3.	To understand the functions and design principles ofPress work and cutting die	c	e	k				
4.	To understand the functions and design principles of press working and elements of cutting dies	c	e	k				
5.	To understand the functions and design principles of bending, forming and drawing, bulging, swaging, embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies	c	e	k				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: LOCATING AND CLAMPING PRINCIPLES	**9**			
1.	Objectives of tool design, Function and advantages of Jigs and fixtures ,Basic elements	1	C	1	1,2
2.	Principles of location ,Locating methods and devices, Rest pads and plates	1	C	1	1,2
3.	Principles of clamping, Types of clamps	1	C	1	1,2
4.	Mechanical actuation, pneumatic and hydraulic actuation Standard parts	2	C	1	1,2
5.	Tolerances and materials used.	1	C,D	1	1,2
6.	Design of locator for given components	1	C,D	1	1,2
7.	Design of clamp for given components	2	C,D	1	1,2
	UNIT II DESIGN OF JIGS	**9**			
8.	Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs	2	C	2	1,2
9.	Indexing jigs	1	C	2	1,2
10.	Drill bushes and Jig buttons, method of construction	2	C,D	2	1,2
11.	General considerations in the design of drill jigs	2	C,D	2	1,2
12.	Design and development of jigs and for given component	2	C,D	2	1,2
	UNIT III DESIGN OF FIXTURES	9			
13.	General design principles of milling, Lathe fixtures	2	C	2	1,2
14.	General design principles of boring, broaching and grinding fixtures	2	C,D	2	1,2
15.	Assembly, Inspection and Welding fixtures	1	C,D	2	1,2
16.	Modular fixturing systems, Quick change fixtures	2	C,D	2	1,2
17.	Design and development of fixtures for given component.	2	C,D	2	1,2
	UNIT IV PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES	**9**			
18.	Press Working Terminologies, operations, Types of presses, press accessories	2	C	3	1,2
19.	Computation of press capacity, Strip layout, Material Utilization	1	C	3	1,2,4
20.	Shearing action, Clearances, Press Work Materials, Center	2	C	3	1,2,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	of pressure, Design of various elements of dies				
21.	Die Block, Punch holder, Die set, guide plates, Stops, Strippers, Pilots, Selection of Standard parts	2	C,D	3	1,2
22.	Design and preparation of four standard views of simple blanking, piercing, shaving, notching, compound and progressive dies.	2	C,D	3	1,2
	UNIT V BENDING FORMING AND DRAWING DIES	**9**			
23.	Difference between bending, forming and drawing, Blank development for above operations	1	C	4	2,5
24.	Types of Bending dies, Press capacity	1	C	4	2,5
25.	Spring back, knockouts, directand indirect, pressure pads, Ejectors	1	C	4	2,5
26.	Variables affecting Metal flow in drawingoperations, draw die inserts, draw beads, ironing	2	C	4	2,5
27.	Design and development of bending, forming, drawing reverse re-drawing and combination dies	2	C,D	4	2,5
28.	Blank development for ax- symmetric, rectangular and elliptic parts, Single and double action dies.	1	C	4	2,5
29.	Bulging, Swaging, Embossing, coining, curling, hole flanging, and sizing, assembly, fine Blanking dies	1	C	4	2,5
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Joshi, P.H. "*Jigs and Fixtures*", Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.
2.	Donaldson, Lecain and Goold "*Tool Design*", III rd Edition Tata McGraw Hill, 2007.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	K. Venkataraman, "*Design of Jigs Fixtures & Press Tools*", Tata McGraw Hill, New Delhi, 2005.
4.	Kempster, "*Jigs and Fixture Design*", Hoddes and Stoughton – Third Edition 1974.
5.	Joshi, P.H. "*Press Tools – Design and Construction*", Wheels publishing, 1996.
6.	Hoffman "*Jigs and Fixture Design*" – Thomson Delmar Learning, Singapore, 2004.
7.	ASTME Fundamentals of Tool Design Prentice Hall of India.
8.	P.S.G Tech..,*"Design Data Book",* KalaikathirAchchagam, 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%**

15ME446E	ROBOTIC SENSORS	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 July 2016				

PURPOSE	To study various sensors used in robotics and understand their application in Robotics							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	The basis of latest technology used in robots					j		
2.	Different sensing variables that are used as input to robots for sensing		c	d				
3.	Robot vision system and its over view					j		
4.	Various methods used in robot programming	a			e			
5.	Different types of grippers and gripping methods		c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I-INTRODUCTION	4			
1.	An Introduction to sensors and Transducers	1	C	1	3
2.	History and definitions	1	C	1	7
3.	SmartSensing and smart sensing devices	1	C	1	1
4.	AI sensing	1	C	1	1
5.	Need of sensors in Robotics, and various application reviews.	1	C	1	1
	UNIT II-SENSORS IN ROBOTICS	9			
6.	Position sensors– optical, non-optica	2	C	2	2
7.	Velocity sensors and tacho generators	2	C	2	2
8.	Accelerometers and gyroscopes	1	C	2	2
9.	Proximity Sensors – Contact, non-contact	1	C	2	4,6
10.	Range Sensing, touch and Slip Sensors	1	C	2	2
11.	Force and Torque Sensors	2	C	2	2
	UNIT III-MISCELLANEOUS SENSORS IN ROBOTICS	11			
12.	Different sensing variables – smell, Heat or Temperature, Humidity, Light	4	C	3	2
13.	Speech or Voice recognition Systems – case study	4	C	3	1
14.	Telepresence and related technologies	3	C	3	1,5,6,7
	UNIT IV-VISION SENSORS IN ROBTICS	10			
15.	Introduction to vision sensing, Working of Vision camera system and interfacing , Robot Control through Vision sensors, (Demo session using IRB360 vision controlled parallel manipulator)	3	O	4	2
16.	Robot vision locating position	2	C	4	6
17.	Robot guidance with vision system,	3	C	4	2
18.	End effector camera Sensor.	2	C	4	2
	UNIT V-MULTISENSOR CONTROLLED ROBOT ASSEMBLY	10			
19.	Control Computer , architecture and its operation, tasks	2	C	5	2
20.	Vision Sensor modules – classification and working	2	C	5,4	2
21.	Software Structure	1	C	5	2
22.	Vision Sensor software architecture , interfacing with control computer	2	C	5	4
23.	Robot programming, Handling, Gripper and Gripping methods, accuracy	2	C	5	5
24.	Case study - Application of Pick and place using vision sensing	1	C	5	5
	Total contact hours*	45			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Paul W Chapman, "*Smart Sensors*", an Independent Learning Module Series, 1996.
2.	Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, "*Robotics Engineering an Integrated Approach*", PHILearning., 2009.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	John Iovice, "*Robots, Androids and Animatrons*", McGraw Hill, 2003.
4.	K.S. Fu, R.C. Gonzalez, C.S.G. Lee, "*Robotics – Control Sensing, Vision and Intelligence*", Tata McGraw-Hill Education, 2008.
5.	Mikell P Groover& Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, AshishDutta, "*Industrial Robotics, Technology programming and Applications*", Tata McGraw-Hill Education, 2012.
6.	SabrieSoloman, "*Sensors and Control Systems in Manufacturing*", McGraw-Hill Professional Publishing, 2nd Edition, 2009.
7.	Julian W Gardner, "*Micro Sensor MEMS and Smart Devices*", 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%**

15ME447E	SIMULATION OF MECHANICAL 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 July 2016				

PURPOSE	To make the student aware about various simulation methods for mechanical engineering systems

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	understand the basics of modeling of physical systems	a	e					
2.	understand the types of models and the need for simulation	a	e					
3.	acquire knowledge about different methods of simulation	a	e					
4.	understand methodsto simulate translational and rotational mechanical systems	a	e	k				
5.	understand methods to simulate hydraulic and manufacturing system	a	e	k				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I INTRODUCTION	**8**			
1.	Need for modeling and simulation in mechanical systems	1	C	1	1
2.	Basics of modeling of physical systems, methods of modeling	1	C	1	1
3.	Review of basic probability and statistics	2	C,D	1	1
4.	Random variables and their properties, estimation of means, variance and correlation.	2	C,D	1	1
5.	Concept of system and environment, continues and discrete systems	1	C	1	1
6.	Linear and nonlinear systems	1	C	1	1
	UNIT II TYPES AND PRINCIPLES OFMODELING	**9**			
7.	Static and dynamic modeling with examples	1	C	2	1
8.	Stochastic models with examples	1	C	2	1
9.	Principles of modeling	2	C,D	2	1
10.	Study and evaluation of model	2	C,D	2	1
11.	Introduction to simulation, basic simulation, advantages of simulation	1	C	2	2
12.	Role of simulation in model evaluation with examples	2	C,D	2	2
	UNIT III METHODS OF SIMULATION	**10**			
13.	Monte Carlo simulation	2	C,D	3	2
14.	Experimental nature of simulation	1	C	3	2
15.	Numerical computation techniques	3	C,D	3	2
16.	Analog and hybrid system models	1	C	3	2
17.	Continues system models	1	C	3	2
18.	Role of computers in simulation, introduction to simulation software packages	2	C	3	2,3
	UNIT IV SIMULATION OF TRANSLATIONAL AND ROTATIONAL SYSTEMS	**8**			
19.	Building of simulation models in mechanical systems	1	C	4	3
20.	Simulation of translational systems with real time examples and case studies	3	C,D	4	3
21.	Simulation of rotational systems with real time examples and Case studies	3	C,D	4	3
22.	Techniques for variance reduction	1	C	4	3
	UNIT V SIMULATION OF HYDRAULIC SYSTEMS	**10**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	AND MANUFACTURING SYSTEMS				
23.	Simulation of hydraulic systems with real time examples	2	C,D	3	4
24.	Simulation of material handling systems in manufacturing with case studies	3	C,D	3	4
25.	Simulation in flexible manufacturing system with case studies	3	C,D	3	4
26.	Simulation of waiting line system in manufacturing with examples	2	C,D	3	4
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Dym C.L, "*Principles of Mathematical Modeling*", Elsevier, 2004.
2.	Geoffrey Gordon, "*System Simulation*" Prentice Hall, 1977
3.	M. Close and Dean K. Frederick, "*Modeling and Analysis of Dynamic Systems*", Houghton Mifflin, 2nd Edition, 1993
4.	Guy L, Richard M. Feldman, "*Manufacturing Systems Modeling and Analysis*", Springer, 2011
	REFERENCE BOOKS/OTHER READING MATERIAL
5.	J. Schwarzenbach and K.F. Gill, "*System Modeling and Control*".Halsted Press, New York, 1992
6.	Robert E. Shannon, "*System Simulation: The Art and Science*", Prentice Hall, 1975

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%**

15ME448E	MODELING SYSTEMS	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	15MA202				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd July 2016				

PURPOSE	A basic understanding of the systems and modelling them with mathematics							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To model systems seen in reality	c						
2.	To understand the use of mathematics in modeling	c						
3.	To understand the basic principles of modeling systems	c	k					
4.	To develop simple models	c						
5.	To understand that modeling is an interdisciplinary requirement	c	k					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference-chapter
	UNIT I: INTRODUCTION	**6**			
1.	Model – Definition – Nature - necessity	1	C	1	1
2.	History of modeling	1	C	1	1
3.	Different types of modeling	1	C	1	1
4.	Impact of computers on modeling	1	C	1	1
5.	Different areas of application – Design, Thermodynamics, Mechanics, Controls etc	1	C	1	1-2
6.	Modeling in software	1	C	1	4-1
7.	**UNIT II: USE OF MODELING MATHEMATICS**	**11**			
8.	Principles of modeling – common aspects of all mechanical systems	2	D	2	1-2
9.	Given a simple system – create a model	2	D	2	1-2
10.	Assessment of reality of the model – degree of accuracy	2	D	2	1-2
11.	Quadratic oscillator / spring mass damper system – need for such a model	2	DI	2	1-2
12.	Linearity of springs – model within a model	2	I	2	1-2
13.	Modeling damping – different types	2	I	2	1-2
14.	Modeling systems – assemble - quadratic	2	I	2	1-2
15.	Relate mathematics to real system – ODEs, Transforms - solutions	2	C		
	UNIT III: GENERATE SIMPLE MODELS	**7**			
16.	Introduction to system identification	3	C	3	1-2
17.	Model mechanical system– rectilinear and torsional	3	CD	3	1-2
18.	Model a thermal system	3	CD	3	1-2
19.	Response analysis – the reverse engineered explanation	3	C,D	3	1-2
20.	Study of response for different inputs – modeling inputs	3	C,D	3	1-2
	UNIT IV: UNDERSTANDING THE MATHEMATICS IN RESPONSE	**11**			
21.	Characteristic equation	1	C	4	1-3,4
22.	Solution to Characteristic equation – eigen values – natural frequencies – eigen vectors – mode shapes - introduction	2	C	4	1-3,4
23.	Use of Laplace transforms for stability analysis	2	C	4	1-3,4
24.	Different types of representation of systems	2	C	4	1-3,4
25.	How to analyze for controllability, observability, stabilizability	2	C	4	1-3,4
26.	Conditions for the same	2	C	4	1-3,4
27.	Relevance of these tests to modeling	2	C	4	1-3,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference-chapter
	UNIT V: PROJECT	**10**			
28.	Identify a system	1	I	4	
29.	Identify components	1	I	5	
30.	Model components – test each component	2	I	5	
31.	Assemble the model	1	I	5	
32.	Identify suitable inputs – model them	1	I	5	
33.	Analyze the response to that input	2	I	5	
34.	Submit a report / viva voce	2	I	5	
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	G.J. Olsder, J.W. van der Woude, J.G. Maks, D. Jeltsema"Mathematical Systems Theory", VSSD, Leeghwaterstraat, Delft, Netherlands, 4thEdition, 2011
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Polderman.J.W., Willems.J.C., "*Introduction to mathematical theory of systems and control*", Springer, 1997
3.	Frank L Severence, "*Systems modeling and simulation – An introduction*" Wiley student edition, 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%**

15ME449E	COMPUTER APPLICATIONS IN DESIGN	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 July 2016				

PURPOSE	To study how computer can be used in Mechanical Engineering Design.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To familiarize the basics of CAD	a	c					
2.	Writing interactive programs in C++ for mechanical design problems	a		e				
3.	Various aspects of data storage, manipulation & expanding its capability	a			k			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION	**9**			
1.	The Design process	1	D	1	1,2,3
2.	Different types of design process	1	D	1	1,2,3
3.	Role of CAD in Design	1	D	1	1,2,3
4.	Types and applications of design models	1	D	1	1,2,3
5.	Computer representation of drawings	1	D	1	1,2,3
6.	Three-dimensional modeling schemes	1	C	1	1,2,3
7.	Wire frame model	1	D	1	1,2,3
8.	Surface representation model	1	C	1	1,2,3
9.	Solid modeling.	1	C	1	1,2,3
	UNIT II: - INTRODUCTION TO CAD SOFTWARE	**9**			
10.	Introduction to C++	1	D	2	4
11.	Writing interactive programs to solve design problems using C++	1	I	2	4
12.	Design problems using C++	1	O	2	4
13.	Design problems using C++	1	O	2	4
14.	Design problems using C++	1	O	2	4
15.	Features of various solid-modeling packages	1	O	1	2
16.	Comparison of various solid-modeling packages	1	O	1	2
17.	Solid-modeling packages demonstration.	1	O	1	2
18.	Solid-modeling packages demonstration.	1	O	1	2
	UNIT III: - COMPUTER AIDED DESIGN OF MACHINE ELEMENTS	9			
19.	Introduction to Machine Drawing	1	C,D	1	5
20.	Introduction to Machine Elements	1	C,D	1	5
21.	Drawing & plotting of Machine Elements	1	C,D	1	5
22.	Drawing & plotting of Machine Elements using solid-modeling packages	1	C,D	1	5
23.	Drawing & plotting of Shafts	1	C,D	1	5
24.	Drawing & plotting of Gears	1	C,D	1	5
25.	Drawing & plotting of Pulleys	1	C,D	1	5
26.	Drawing & plotting of Flywheel	1	C,D	1	5
27.	Drawing & plotting of Connecting rods.	1	C,D	1	5
	UNIT IV: ENTITY MANIPULATION AND DATA STORAGE	**9**			
28.	Manipulation of the model	1	C	3	1
29.	Model storage	1	C	3	1
30.	Data structures	1	C	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
31.	Data base considerations	1	C	3	1
32.	Object oriented representations	1	C	3	1
33.	CIM	1	C	3	1
34.	Organizing data for CIM applications	1	C	3	1
35.	ERP	1	C	3	1
36.	Design information systems.	1	C	3	1
	UNIT V: EXPANDING THE CAPABILITY OF CAD	**9**			
37.	Parametric modeling	1	C	1	2,3
38.	variation modeling	1	C	1	2,3
39.	Feature based modeling	1	C	1	2,3
40.	Feature recognition	1	C	1	2,3
41.	Design by features	1	C,D	1	2,3
42.	Analysis including FEA software	1	C	1	6
43.	Sample Problems using analysis software	1	O	1	6
44.	Rapid prototyping	1	D	1	2,3
45.	AI in Design	1	D	1	2,3
	Total contact hours*	**45**			

*Excluding assessment hours

	TEXT BOOKS
1.	Charles. S. Knox, "*Organising data for CIM Applications*", Marcel Dekker Inc. New York 1987.
2.	Ibrahim Zeid, "*CAD/ CAM - Theory and Practice*" - McGraw Hill, International Edition, 1998.
3.	Chris McMahon and Jimmi Browne, "*CAD CAM Principles, practice and Manufacturing Management*", Pearson Education Asia, 2000.
4.	YashavantKanetkar, "*Let Us C++"* , BPB Publications, Delhi, 2003.
5.	Kr. Gopalakrishna, "*Machine Drawing*" , Subhas Stores, 2007
	REFERENCE BOOKS/OTHER READING MATERIAL
6.	Chandupatla and Belagundu, "*Introduction to Finite Element Methods in Engineering"*, Prentice Hall of India Private Limited, New Delhi, 1997.
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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%**