School of Engineering and Applied Sciences

B. Tech Mechanical Engineering

Syllabus

AY: 2022-2026

Department of Mechanical Engineering
SRM University-Andhra Pradesh.

PROGRAM OUTCOMES

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

The program outcomes are:

- **(a)** an ability to apply knowledge of mathematics, science, andengineering
- **(b)** an ability to design and conduct experiments, as well as to analyze and interpretdata
- **(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, andsustainability
- **(d)** an ability to function on multidisciplinaryteams
- **(e)** an ability to identify, formulate, and solve engineeringproblems
- **(f)** an understanding of professional and ethicalresponsibility
- **(g)** an ability to communicateeffectively
- **(h)** the broad education necessary to understand the impact of engineering solutions in global, economic, environmental, and societalcontext
- **(i)** a recognition of the need for, and an ability to engage in life-longlearning
- **(j)** a knowledge of contemporaryissues
- **(k)** anabilitytousethetechniques,skills, andmodernengineeringtoolsnecessaryforengineering practice.

C-D-I-O INITIATIVE

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

SYMBOLS AND ABBREVIATIONS

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

B. Tech. Mechanical Engineering Curriculum – 2021-25

(Applicable for students admitted from the Academic year 2022-23)

Semester-I					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
EGL 101	COMMUNICATIVE ENGLISH	3	0	0	3
ISES 101	INDUSTRY SPECIFIC EMPLOYBILITY SKILLS	3	0	0	1
MAT 112?	CALCULUS	3	0	0	3
CHE 101	PRINCIPLES OF CHEMISTRY	2	0	0	2
CHE 101 L	PRINCIPLES OF CHEMISTRY LAB	0	0	2	1
BIO 101	BIOLOGY	2	0	0	2
CSE 105	INTRODUCTION TO PROGRAMMING USING C	3	0	0	3
CSE 105 L	INTRODUCTION TO PROGRAMMING USING C LAB	0	0	2	1
ME 103	MECHANICAL ENGINEERING TOOLS	0	0	2	1
	ENTREPRENEURSHIP OREINTATION	1	0	0	1
	HIGHER EDUCATION ORIENTATION	1	0	0	1
	TOTAL	**16**	**1**	**6**	**19**

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

Electives

Semester-II					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ENG 115	ENGINEERING MECHANICS	3	0	0	3
ISES 102	INDUSTRY SPECIFIC EMPLOYABILITY SKILLS-II	3	0	0	1
CSE 107	DATA STRUCTURES	3	0	0	3
CSE 107 L	DATA STRUCTURES LAB	0	0	2	1
ENG 105	ENGINEERING GRAPHICS	3	0	0	3
ENG 105 L	ENGINEERING GRAPHICS LAB	0	0	2	1
ENG 111	BASIC ELECTRICAL AND ELECTRONICS	3	0	0	3
ENG 111L	BASIC ELECTRONICS AND ELECTRICAL LAB	0	0	2	1
MAT 211	LINEAR ALGEBRA	3	0	0	3
PHY 101	ENGINEERING PHYSICS	2	0	0	2

PHY 101L	ENGINEERING PHYSICS	0	0	2	1
ENV 111	ENVIRONMENTAL SCIENCE	2	0	0	2
CSE 230	INDUSTRY STANDARD CODING PRACTICE-1	0	0	4	2
	TOTAL	**22**	**0**	**12**	**26**

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 thecourse

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

Semester-III					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ME 221	ELEMENTS OF STRUCTURE	3	0	0	3
ME 221 L	ELEMENTS OF STRUCTURE LAB	0	0	2	1
MAT 131	DIFFERENTIAL EQUATIONS	3	0	0	3
ME 141	THERMODYNAMICS	3	0	0	3
ME 141 L	THERMODYNAMICS LAB	0	0	2	1
ME 121	MATERIAL SCIENCE	3	0	0	3
ME 121 L	MATERIAL SCIENCE LAB	0	0	2	1
ECO 121	PRINCIPLES OF ECONOMICS	3	0	0	3
ME 225 L	3D PRINTING	0	0	2	1
ISES 201	INDUSTRY SPECIFIC EMPLOYABILITY SKILLS-III	3	0	0	1
CSE 330	INDUSTRY STANDARD CODING PRACTICE-1	0	0	4	2
	TOTAL	**18**	**0**	**12**	**22**

Semester-IV					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ME 224	MACHINE DESIGN	3	0	0	3
ME 224 L	MACHINE DESIGN LAB	0	0	2	1
MAT	PROBABILITY AND STATISTICS	3	0	0	3
ME 222	FLUID MECHANICS	3	0	0	3

ME 222L	FLUID MECHANICS LAB	0	0	2	1
	ME ELECTIVE MECHATRONICS (ROBOTICS SPECIALIZATION) CAD-CAM (ADDITIVE MANUFACTURING SPECIALIZATION) ELECTIVE MECHANICAL GENERAL	3	0	0	3
ME 172	KINEMATICS AND MECHANISMS	3	0	0	3
ME 172L	KINEMATICS AND MECHANISM LAB	0	0	2	1
	OPEN ELECTIVE	3	0	0	3
ISES 202	INDUSTRY SPECIFIC EMPLOYABILITY SKILLS-IV	3	0	0	1
CSE 331	INDUSTRY STANDARD CODING PRACTICE-3	0	0	4	2
	TOTAL	**21**	**0**	**10**	**24**

Semester-V					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ME 321	FLUID MACHINERY	3	0	0	3
ME 321L	FLUID MACHINERY LAB	0	0	2	1
ME 132	NUMERICAL METHODS	3	0	0	3
ME 132 L	NUMERICAL METHODS LAB	0	0	2	1
ME 272	DYNAMICS AND CONTROL	3	0	0	3
ME 272 L	DYNAMICS AND CONTROL LAB	0	0	2	1
ME 201	UNIVERSTY RESEARCH OPP	0	0	4	2
ME	**ME ELECTIVE** ROBOTICS (ROBOTICS SPECIALIZATION) MANUFACTURING SCIENCE (ADDITIVE MANUFACTURING SPECIALIZATION) ELECTIVE FOR MECHANICAL GENERAL	3	0	0	3
	OPEN ELECTIVE	3	0	0	3
ISES 301	INDUSTRY SPECIFIC EMPLOYABILITY SKILLS-V	3	0	0	1
	HUMAN VALUES AND ETHICS	2	0	0	2
ME 200	INTERNSHIP (OPTIONAL)	0	0	6	3
	TOTAL	**20**	**1**	**10/16**	**23/25**

Semester-VI					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ME 230	HEAT AND MASS TRANSFER	3	0	0	3
ME 230 L	HEAT AND MASS TRANSFER LAB	0	0	2	1
ME 322	ADVANCED MANUFACTURING TECHNOLOGY	3	0	0	3
ME 322 L	ADVANCED MANUFACTURING TECHNOLOGY LAB	0	0	2	1
ME 226	MEASUREMENT & INSTRUMENTATION	3	0	0	3
ME 226 L	MEASUREMENT & INSTRUMENTATION LAB	0	0	2	1
ME ME 427 ME 228	**ME ELECTIVE** MULTIBODY DYNAMICS (ROBOTICS SPECIALIZATION) ADDITIVE MANUFACTURING (ADDITIVE MANUFACTURING SPECIALIZATION) ELECTIVE MECHANICAL GENERAL	3	0	0	3
OE	OPEN ELECTIVE	3	0	0	3
ME450	MULTIDISCIPLINARY DESIGN PROJECT	0	0	4	2
	TOTAL	**15**	**0**	**10**	**20**

Semester-VII					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ME ME 402 ME 412	**ME ELECTIVE** MACHINE LEARNING (ROBOTICS SPECIALIZATION) MECHANICAL BEHVAIOR OF MATERIALS (ADDITIVE MANUFACTURING SPECIALIZATION) ELECTIVE MECHANICAL GENERAL	3	0	0	3
ME	**ME ELECTIVE**	3	0	0	3

ME 411 ME 413	ARTIFICIAL INTELLIGENCE (ROBOTICS SPECIALIZATION) DESIGN AND MODELLING ASPECTS OF AM (ADDITIVE MANUFACTURING SPECIALIZATION) ELECTIVE MECHANICAL GENERAL				
OE	OPEN ELECTIVE	3	0	0	3
ME 451	SEMINAR	0	0	2	1
	TOTAL	**9**	**0**	**2**	**10**

Semester-VIII					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ME 602	INDUSTRY CO-OP OR DESIGN PROJECT	0	0	24	12
	TOTAL	**0**	**0**	**24**	**12**

Total credits – 156 hrs

HoD
Mechanical Engineering

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School of Engineering

DEPARTMENTAL AND OPEN ELECTIVES						
COURSE CODE	CATEGORY	COURSE NAME	L	T	P	C
ME 401	P	CAD-CAM	3	0	0	3
ME 402	P	Multibody Dynamics	3	0	0	3
ME 405	P	Mechanics of composite materials	3	0	0	3
ME 406	P	Computational fluid dynamics	3	0	0	3
ME 407	P	Nano Technology	3	0	0	3
ME 408	P	Advanced materials	3	0	0	3
ME 409	P	Thermal design of electronic equipment’s	3	0	0	3
ME 410	P	Thermal power engineering	3	0	0	3
ME 411	P	Artificial intelligence and expert systems	3	0	0	3
ME 412	P	Additive manufacturing process	3	0	0	3
ME 413	P	Design and modeling aspects of am	3	0	0	3
ME 415	P	Refrigeration and air conditioning	3	0	0	3
ME 416	P	Surface engineering	3	0	0	3
ME 417	P	Compressible flow	3	0	0	3
ME 418	P	Introduction to electric vehicles	3	0	0	3
ME 427	P	Robotics	3	0	0	3
ME 430	P	Mechatronics	3	0	0	3
ME 433	P	Introduction to high performance computing	3	0	0	3
ME 434	P	Elements of mechatronics	3	0	0	3
ME 435	P	Fundamentals of hydraulics and pneumatics	3	0	0	3
ME 436	P	Industrial tribology	3	0	0	3
ME 437	P	Process planning and cost estimation				
ME 438	P	Internal combustion engines	3	0	0	3
ME 439	P	Industrial engineering	3	0	0	3
ME 440	P	Advanced fluid mechanics	3	0	0	3
ME 441	P	Operations research	3	0	0	3
ME 442	P	Advanced engineering thermodynamics	3	0	0	3
ME 443	P	Finite element methods	3	0	0	3
ME 411	P	Artificial intelligence and expert systems	3	0	0	3
ME 444	P	Micro controller and its application in robotics	3	0	0	3
ME 445	P	Machinery fault diagnostics and signal processing	3	0	0	3
ME 446	P	Advanced strength of materials	3	0	0	3
ME 447	P	Computer graphics	3	0	0	3
ME 448	P	Automotive engineering	3	0	0	3

ME 449	P	Fatigue, fracture mechanics and creep	3	0	0	3
ME 452	P	Flexible manufacturing systems	3	0	0	3
ME 453	P	Combustion engineering				
ME 454	P	Gas turbine technology	3	0	0	3
ME 455	P	Fuel cell technology	3	0	0	3
ME 456	P	Advanced thermodynamics	3	0	0	3
ME 457	P	Fundamentals of Vibration and Noise	3	0	0	3
ME 458	P	Gas Dynamics and Space Propulsion	3	0	0	3
ME 459	P	Design of Transmission Systems	3	0	0	3
ME 460	P	Additive manufacturing technology	3	0	0	3
OPEN ELECTIVES						
	P	Operation research	3	0	0	3
	P	Digital signal processing	3	0	0	3
	P	Data structures	3	0	0	3
	P	Artificial intelligence	3	0	0	3
	P	Machine learning	3	0	0	3
	P	Electric drives	3	0	0	3
	P	Electrical machines	3	0	0	3
	P	Power electronics	3	0	0	3
	P	VLSI design	3	0	0	3
	P	Digital communication	3	0	0	3
	P	Project management	3	0	0	3
	P	Business ethics	3	0	0	3
	P	Biomechanics	3	0	0	3
	P	Bioinformatics	3	0	0	3
	P	Fuel cell and battery tech	3	0	0	3
	P		3	0	0	3
	P		3	0	0	3

COURSES OFFERED TO OTHER DEPARTMENTS

COURSE CODE	CATEGORY	COURSE NAME	L	T	P	C
	P	Thermodynamics	3	0	2	4
	P	Fluid mechanics	3	0	2	4
	P	Engineering graphics	2	0	2	3

SEMESTER I

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

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

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

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

17	group.				
18	Importance of small groups in business.	2	C,D	4	1,2
19	Moment of Inertia by analytical method.	2	C,D	4	1,2
20	Group problem solving.	2	C,D	4	1,2
21	Learning to say no.	1	C,D	4	1,2
	Total contact hours*	**45**			

*Excluding assessment hours

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

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

				L	T	P	C
ISES 101	**Industry Specific Employability Skills**			**1**	**1**	**0**	**1**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	HS	Humanity Sciences	SEAS				
Course designed by	Department of ECE						
Approval							

PURPOSE	The most conspicuous perceptual error is the thought that personality is confined to physical appearance alone. Personality is a complete package of an individual's identity; it is infact a person's reality. The development of one's personality is essential for having an impressive image both in the personal & professional areas to create an electrifying impact and a lasting

	impression.

LEARNING OBJECTIVES		STUDENT OUTCOMES					
At the end of the course, student will be able to							
1.	Crack placement interviews and competitive exams.						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I – Know Thyself	**3**			
1.	Grooming & Social etiquette	1	C-I-O		1,2,3
	UNIT II - Personality Development	**3**			
2.	Personality construct, The KSAB Model	1	C-I-O		1,2,3
3.	Components of perception, perceptual errors	1	C-I-O		1,2,3
4.	perception as a precursor of attitude and behavior.	1	C-I-O		1,2,3
	UNIT III- Communication	**3**			
5.	The 3 Vs of communication: Visual or Kinesics, Vocal (Articulation), Verbal.	1	C-I-O		1,2,3
6.	Active listening, Barriers to listening.	1	C-I-O		1,2,3
7.	GARF (Giving and Receiving Feedback)	1	C-I-O		1,2,3
	UNIT IV – Presentation Skills	**3**			
8.	The four Ps of presentation.	1	C-I-O		1,2,3
9.	Handling different types of target audience.	2	C-I-O		1,2,3
	UNIT V- Time Management & Goal Setting	**3**			
10.	Pressure Cooker (Activity based on Planning, Organizing and Prioritization)	1	C-I-O		1,2,3
11.	Roller Coaster (Activity on setting SMARTER goals, planning & organizing, short & long term goals).	2	C-I-O		1,2,3
	Total contact hours	**15**			

	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	The Perception of Deception, David Icke, David Icke Books, 2014

2.	Eye and Brain: The Psychology of Seeing, Richard, Langton Gregory, Princeton University Press, 1997
3.	Awaken The Giant Within, Anthony Robbins, Pocket Books, 2001

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

PURPOSE	The objective is to equip the students with techniques of calculus and its applications

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

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Limit and Continuity	**5**			
1.	Limit of a function at a point.	1	C		1
2.	One-sided limits.	1	C		1
3.	Continuity.	2	C		1
4.	Limits involving infinity.	2	C		1
	Unit II: Differentiation	**7**			
5.	Derivative at a point.	1	C		1
6.	Derivative as a function.	1	C		1
7.	Product rule, Quotient rule and chain rule.	2	C		1
8.	Implicit differentiation.	1	C		1
9.	Rolle's Theorem.	1	C		1
10.	Mean Value Theorem.	1	C		1
	Unit III: Integration	**9**			
11.	Area as a limit of finite sums.	1	C		1
12.	Definite and indefinite integral.	2	C		1
13.	Fundamental Theorem of Calculus.	1	C		1
14.	Integration by substitution.	2	C		1
15.	Integration by parts.	1	C		1
16.	Integration by partial fractions.	2	C		1
	Unit IV: Application of Calculus	**10**			1
17.	Maxima and minima.	1	C		1

18.	Concavity and curve sketching.	1	C		1
19.	Optimization problems in Physics.	1	C		1
20.	Economics & Mathematics.	1	C		1
21.	Area between curves.	2	C		1
22.	Volumes, Arc length, Moments and centers of mass.	3	C		1
23.	Newton's method to find roots.	1	C		1
	Unit V: Sequence and Series	**7**			
24.	Sequences, Sum of a series.	1	C		1
25.	Comparison test, Root test, Ratio test.	2	C		1
26.	Leibniz theorem on alternating series.	1	C		1
27.	Power series, Taylor's and Maclaurin series.	2	C		1
28.	Absolute and conditional convergence.	1	C		1

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

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

<table>
<tr><td rowspan="2">CHE 101</td><td colspan="2" rowspan="2">Principles of Chemistry</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Co-requisite:</td><td colspan="6">NIL</td></tr>
<tr><td>Prerequisite:</td><td colspan="6">NIL</td></tr>
<tr><td>Data Book / Codes/Standards</td><td colspan="6">NIL</td></tr>
<tr><td>Course Category</td><td>BS</td><td></td><td colspan="4">Basic Science</td></tr>
<tr><td>Course designed by</td><td colspan="6">Department of Chemistry</td></tr>
<tr><td>Approval</td><td colspan="6">-- Board of Studies -- , 2018</td></tr>
</table>

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

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

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: Chemical Bonding	**8**			
1.	Ionic, covalent, and metallic bonds. Theories of bonding: Valence bond theory.	1	C-I		1,2,3,4,5,6
2.	Nature of covalent bond, sigma (σ) bond, Pi(π) bond.	1	C-I		1,2,3,4,5,6
3.	Hybridization: Types of hybridizations, sp^2, sp^3, sp^3d, d^2sp^3.	1	C-I		1,2,3,4,5,6
4.	Shapes of molecules (VSEPR Theory):$BeCl_2$,CO_2,BF_3,H_2O,NH_3, CH_4,PCl_5,XeF_2,SF_6,XeF_4..	1	C-I		1,2,3,4,5,6
5.	Molecular orbital theory: Linear combination of atomic orbitals (LCAO Method)	1	C-I		1,2,3,4,5,6
6.	Bond order, homo(H_2,O_2,N_2) and hetero nuclear diatomic molecules(NO,CO).	1	C-I		1,2,3,4,5,6
7.	Non-covalent interactions: Vander Waals interactions.	1	C-I		1,2,3,4,5,6
8.	Dipole-ipole interactions, and hydrogen bonding.	1	C-I		1,2,3,4,5,6
	UNIT II – Phase Rule and Kinetics	**4**			
9.	Phase rule: Introduction, Definition of the terms used in phase rule with examples.	1	C-I		1,2,3,4,5,6
10.	Application of phase rule to water system.	1	C-I		1,2,3,4,5,6

11.	Sulphur system and lead-silver system.	1	C-I		1,2,3,4,5,6
12.	Kinetics: Order and molecularity of reactions, zero order, first order and second order reactions.	1	C-I		1,2,3,4,5,6
	UNIT III – Water Technology	**6**			
13.	Standards for drinking water.	1	C-I		1,2,3,4,5,6
14.	Methods of Treatment of water for domestic and industrial purposes: Sedimentation.	1	C-I		1,2,3,4,5,6
15.	Coagulation, Filtration, Sterilization. Break point chlorination.	1	C-I		1,2,3,4,5,6
16.	Determination of Hardness of water by EDTA method. Demineralization of water.	1	C-I		1,2,3,4,5,6
17.	Softening of water: Lime-soda Process, Ion exchange process, Zeolite process.	1	C-I		1,2,3,4,5,6
18.	Boiler Troubles: Priming, Foaming, Scale. Sludge, Corrosion, Caustic Embrittlement.	1	C-I		1,2,3,4,5,6
	UNIT IV: Polymer Chemistry	**6**			
19.	Classification of polymers: Natural and synthetic.	1	C-I		1,2,3,4,5,6
20.	Thermoplastic and Thermosetting. Degree of polymerization.	1	C-I		1,2,3,4,5,6
21.	Types and mechanism of polymerization: Addition (Free Radical, cationic and anionic).	1	C-I		1,2,3,4,5,6
22.	Condensation and copolymerization. Properties of polymers: Tg, Tactility.	1	C-I		1,2,3,4,5,6
23.	Molecular weight average, number average and poly dispersity index.	1	C-I		1,2,3,4,5,6
24.	Techniques of polymerization: Bulk, emulsion, solution and suspension.	1	C-I		1,2,3,4,5,6
	UNIT V: Electrochemistry	**6**			
25.	Arrhenius theory of electrolytic dissociation. Classification of electrolytes; degree of Dissociation of acids.	1	C-I		1,2,3,4,5,6
26.	Dissociation constant of weak acids. Concept of Ph and pOH, buffer solutions.	1	C-I		1,2,3,4,5,6
27.	Solubility product, common ion effect indicators and theory of acid base indicator.	1	C-I		1,2,3,4,5,6
28.	Conductance of solutions-specific, molar and equivalent conductance.	1	C-I		1,2,3,4,5,6
29.	Variation of molar conductance with dilution for strong and weak electrolytes.	1	C-I		1,2,3,4,5,6
30.	Migration of ions-Kohlrausch's law of independent migration of ions. Ostwald's dilution law; Nernst equation for single	1	C-I		1,2,3,4,5,6

	electrode and electrochemical cells.				
	Total contact hours	30			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	A. Bahl and B. S. Bahl, G. D. Tuli, Essentials of physical chemistry, S Chand Publication,2014, ISBN: 8121929784.P.W. Atkins, T.L. Overton, J.P. Rourke, M.T. Weller and F.A. Armstrong Shriver andAtkins' Inorganic Chemistry, 5th Ed., Oxford University Press, London, 2010, ISBN 978-1-42-921820-7
2.	Atkins, P.W.; de Paula, J. Physical chemistry, 8th ed., 2006 Oxford University Press. ISBN0-19-870072-5
3.	B. R. Puri, L. R. Sharma & M. S. Pathania, Principles of Physical Chemistry, 46th Ed.,2013, Vishal Publication Company
4.	F.W. Billmeyer, Text Book of Polymer Science, 3rd Ed., John Wiley & Sons, New York,2003.
5.	J. Bard and L.R. Faulkner, Electrochemical methods –Fundamentals and applications, 2nd Ed., John Wiley and Sons, 2001.
6.	Jain P.C. & Monika Jain, Engineering Chemistry, Dhanpat Roy & Sons, 2015.

Course nature				**Theory**				
Assessment Method (Weightage 70%)								
In-semester	**Assessment tool**	Midterm I	Midterm II	Assignment	Class Test	Quiz	**Total**	**Final**
	Weightage	**15%**	**15%**	**10%**	**5%**	**5%**	**50%**	**35%**
End semester examination Weightage :								**35%**

CHE 101 L	**Principles of Chemistry Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	BS		Basic Science		
Course designed by	Department of Chemistry Lab				
Approval	-- Board of Studies -- , 2018				

List of Lab Experiments

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	Volumetric titration of HCl vs NaOH.	**1**	C-D-I-O		1,2,3,4,5,6
2.	Conductometric titration of HCl vs NaOH.	**2**	C-D-I-O		1,2,3,4,5,6
3.	Standardization of potassium permanganate by Oxalic acid.	**2**	C-D-I-O		1,2,3,4,5,6
4.	Iodometric Determination of Ascorbic Acid (Vitamin C)	**2**	C-D-I-O		1,2,3,4,5,6
5.	Determination of hardness of water by EDTA method.	**2**	C-D-I-O		1,2,3,4,5,6
6.	Determination of strength of given hydrochloric acid using pH meter.	**2**	C-D-I-O		1,2,3,4,5,6
7.	Estimation of iron content of the given solution using potentiometer.	**2**	C-D-I-O		1,2,3,4,5,6
8.	Determination of sodium and potassium by flame photometry.	**2**	C-D-I-O		1,2,3,4,5,6
	Total Hours	**15**			

Course nature						**Practical**
Assessment Method (Weightage 30%)						
In-semester	**Assessment tool**	Lab performance	Model exam	Observation note	**Total**	**Final**
	Weightage	**20%**	**20%**	**10%**	**50%**	**15%**
					End semester examination Weightage :	**15%**

PHY 101	**Engineering Physics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Single variable calculus (MAT ----)				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	BS (Basic Sciences)				
Course designed by	Department of Physics				
Approval					

	The course aims to cover the fundamental formalism and applications of Physics. It

PURPOSE	mainly includes basic Newtonian mechanics, Waves and oscillations, Introduction to thermodynamics, Electricity & magnetism with General properties of maters.							
LEARNING OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1.	apply the fundamental concepts of mechanics such as force, energy, momentum etc. more rigorously as needed for further studies in engineering and technology							
2.	students' physical intuition and thinking process through understanding the theory							
3.	model simple mechanical systems by correlating it to the real world practical problems							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - Review of Newtonian Mechanics	**9**			
1.	Introduction to Vector and Coordinate systems	1	C		1,2,3
2.	Kinematics: Equations of motion for constant acceleration	1	C-D		1,2,3
3.	Dynamics: Contact forces, Static friction, kinetic friction and worked examples.	1	C-D		1,2,3
4.	Free body force diagram; Applications of Newton's law. Worked examples (i.e. pulley, inclined planes)	1	D-I		1,2,3
5.	Momentum and Impulse, Impulse momentum theorem	1	C-D		1,2,3
6.	Center of Mass: Calculation of Center of mass for complex systems	1	D-I		1,2,3
7.	Work and Kinetic Energy Theorem	1	D-I		1,2,3
8.	Motion at Inclined Plane	1	C-D		1,2,3
9.	Conservation of linear and angular momenta, worked example (Fly wheel)	1	D-I		1,2,3
	UNIT II – Waves, oscillations, optics	**9**			
10.	Simple harmonic motion: simple pendulum, compound pendulum	1	C		1,2,3, 6
11.	Damped and driven harmonic oscillations, Quality factor; electrical equivalent (LCR circuit)	1	C-D		1,2,3, 6
12.	Circular motion in analogy of Simple Harmonic Motion	1	C-D		1,2,3, 6
13.	Longitudinal waves, transverse waves; standing waves	1	C-D		1,2,3, 6
14.	Concept of Electromagnetic waves	1	D-I		1,2,3, 6
15.	Optics: Interference, diffraction (qualitative)	1	D-I		1,2,3, 6
16.	Double slit interference and concept of coherence length	1	C-D		1,2,3, 6

17.	Polarization of light (qualitative)	1	C-D		1,2,3, 6
18.	Concept of Lasers	1	C-D		1, 2, 3, 6
	UNIT III – Classical thermodynamics	**9**			
19.	Thermodynamic systems and equilibrium: example of ideal gas	1	C		1,2,3
20.	Zeroth law of thermodynamics and concept of temperature	1	C-D		1,2,3
21.	First law of thermodynamics, internal energy and specific heat	1	D-I		1,2,3
22.	Second law of thermodynamics	1	C-D		1,2,3
23.	Entropy, reversibility	1	C-D		1,2,3
24.	Application of 1st and 2nd law of thermodynamics	1	I		1,2,3
25.	Concept of work and free energies	1	C-D		1,2,3
26.	Concept of Phases: Example of phase transitions	1	C-D		1,2,3
27.	Black body radiation – Stefan's law	1	C		1,2,3
	UNIT IV: REVIEW OF ELECTRO-MAGNETISM	**9**			
28.	Properties of charge and Coulomb's law, calculation of electric field and potential	1	C-D		1, 2, 4, 5
29.	Gauss's law (differential and integral form)	1	C-D		1, 2, 4, 5
30.	Application of Gauss's law (line, plane, spherical symmetry)	1	D		1, 2, 4, 5
31.	Dielectrics from the concept of dipole movements in material	1	D		1, 2, 4, 5
32.	Fields in parallel plate capacitor with dielectric medium	1	C-D		1, 2, 4, 5
33.	Biot-Savart Law for magnetic fields, Magnetic field (circular loop).	1	C-D		1, 2, 4, 5
34.	Ampere's circuital law, Examples – Infinite wire and Solenoid.	1	C-D		1, 2, 4, 5
35.	Lenz's Law, Faraday's law.	1	C-D		1, 2, 4, 5
36.	Maxwell's equations	1	C-D		1, 2, 4, 5
	UNIT V: **MATERIAL PROPERTIES**	**9**			
37.	States of Matter: Solid, Liquid, Gases and Plasma	1	C		1,2,3
38.	Mechanical Properties of solids: linear elasticity (Hooke's Law). Elastic moduli.	1	C-D		1,2,3
39.	Shear stress and strain. Rigidity modulus	1	C-D		1,2,3
40.	Moment of Cantilevers: Young's Modulus	1	C-D		1,2,3
41.	Bulk and surface properties of liquid – Adhesion, Cohesion	1	C-D		1,2,3
42.	Surface Tension	1	C-D		1,2,3
43.	Viscosity of liquids	1	C-I		1,2,3
44.	Stoke's equation	1	C-D		1,2,3
45.	Bernoulli's principle (Quantitative)	1	C-D		1,2,3
	Total contact hours	**45**			

LEARNING RESOURCES

	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	University Physics With Modern Physics with Mastering Physics - D Young, Roger A Freedman And Lewis Ford, XII Edition (2018), Publisher – PEARSON
2	Physics for Scientist and Engineers - Raymond A. Serway, John W. Jewett XIX Edition (2017), Publisher - Cengage India Private Limited
3	Concept of Modern Physics - Arthur Besier, Shobhit Mahajan, S Rai, 2017 Edition, Publisher - Tata McGraw Hill
4	Introduction to Electrodynamics – David J. Griffiths; 4th Edition (2012), Publisher - PHI Eastern Economy Editions
5	Electricity and Magnetism - A S Mahajan and AARangwala, Revised of 1Edition (2001), Publisher - McGraw-Hill
6	Advanced Engineering Mathematics - Erwin Kreyszig, X Edition (2016), Publisher - Wiley

PHY 101L	**Engineering Physics: LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	BS (Basic Sciences)				
Course designed by	Department of Physics				
Approval					

PURPOSE	The course aims to cover the applications related to fundamental formalism of Physics. It mainly includes basic Newtonian mechanics, Waves and oscillations, Introduction to thermodynamics, Electricity & magnetism with General properties of maters.							
LEARNING OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
	Understand basic equipment operation and analysis							
	Correlate fundamental concept of physics to laboratory experiments							
	Origin and analysis of error							

PURPOSE	The course aims to cover the applications related to fundamental formalism of Physics. It mainly includes basic Newtonian mechanics, Waves and oscillations, Introduction to thermodynamics, Electricity & magnetism with General properties of maters.							
LEARNING OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
	Understand basic equipment operation and analysis							
	Correlate fundamental concept of physics to laboratory experiments							
	Origin and analysis of error							

Sl. No	**Description of Experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1a	Revisions of Vernier caliper and Screw Gauge measurement methods	1	D-I-O		1, 2
1b	Plotting experimental data in graphs and error analysis				
2	To determine the moment of inertia of a flywheel	1	D-I-O		1, 2
3	(a) Measurement of time period for a given compound pendulum with different lengths (b) To determine radius of gyration of a given pendulum	1	D-I-O		1, 2
4	Verification of Stefan`s Law	1	D-I-O		1, 2
5	Measurement of specific heat capacity of any given material	1	D-I-O		1, 2
6	Verify of Hooke’s law and to determine spring contact for given spring combinations	1	D-I-O		1, 2
7	To determine the rigidity modulus of steel wire by torsional oscillations	1	D-I-O		1, 2
8	To calculate Young’s modulus of a given material by deflection method	1	D-I-O		1, 2
9	(a) To measure the capacitance as a function of area and distance between the plates. b) To determine the dielectric constant of different dielectric materials.	2	D-I-O		1, 2
10	(a) Measurement of the induced voltage impulse as a function of the velocity of the magnet. b) Calculation of the magnetic flux induced by a falling magnet as a function of the velocity of the magnet	1	D-I-O		1, 2

11	(a) To study the magnetic field along the axis of a current carrying circular loop. b) To study the dependency of magnetic field on the diameter of coil	1	D-I-O		1, 2
12	(a) To investigate the spatial distribution of magnetic field between coils and determine the spacing for uniform magnetic field. b) To demonstrate the superposition of the magnetic fields of the two individual coils.	2	D-I-O		1, 2
13	Study of B-H-Curve To study permeability curve of a given material	1	D-I-O		1, 2
	Total contact hours (Including demo and repeat labs)	**15**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Physics for Scientist and Engineers, Ninth edition (2017) - Raymond A. Serway, John W. Jewett (Publisher - Cengage India Private Limited))
2	Physics laboratory manuals

CSE 105	**Introduction to Programming using C**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	ES	Engineering Sciences	Engineering Science		
Course designed by	Department of CSE				
Approval	-- Board of Studies -- , 2020				

	Formulating algorithmic solutions to problems and implementing algorithms in C.

PURPOSE								
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the notion of Operation of a CPU, Notion of an algorithm and computational procedure, editing and executing programs in Linux.	A	M					
2.	Understand and implement the concepts of branching, iteration and data representation using arrays	A	C	M				
3.	Design modular programming and recursive solution formulation	A	C	M				
4.	Understand pointers and the dynamic memory allocation	A	C	M				
5.	Understand and apply structure and union	A	C	M				
6.	Comprehend file operations	A	C	M				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION	**9**			
1.	Computer systems, hardware and software. Problem solving: Algorithm / Pseudo code, flowchart, program development steps	1	C	1	2,3
2.	Computer languages: Machine, symbolic and high-level languages	1	C	1	2,3
3.	Creating and Running Programs: Writing, editing (any editor), compiling (gcc), linking and executing in Linux environment	1	C	1	2,3
4.	Structure of a C program, identifiers	1	C	2	2,3
5.	Basic data types and sizes. Constants, Variables	1	C	2	2,3
6.	Arithmetic, relational and logical operators, increment and decrement operators	1	C	2	2,3
7.	Conditional operator, assignment operator, expressions	1	C	2	2,3
8.	Type conversions, Conditional Expressions	1	C	2	2,3
9.	Precedence and order of evaluation, Sample Programs	1	C	2	2,3
	Unit II	**9**			
10.	**SELECTION & DECISION MAKING:** if-else, null else, nested if, examples	1	C,D	2	2,3
11.	Multi-way selection: switch, else-if, examples.	1	C,D	2	2,3

12.	**ITERATION:** Loops - while, do-while and for, break, continue	1	C,D,I	2	2,3
13.	Initialization and updating, event and counter controlled loops and examples	1	C,D,I	2	2,3
14.	**ARRAYS:** Concepts, declaration, definition, storing and accessing elements	1	C,D	2	2,3
15.	One dimensional, two dimensional and multidimensional arrays	1	C,D	2	2,3
16.	Array operations and examples	1	C,D,I	2	2,3
17.	Character arrays	1	C,D	2	2,3
18.	String manipulations	1	C,D	2	2,3
	UNIT III – MODULAR PROGRAMMING:	**9**			
19.	Functions - Basics	1	C,D	3	2,3
20.	Parameter passing	1	C,D,I	3	2,3
21.	Storage classes extern, auto, register, static, scope rules	1	C,D	3	2,3
22.	User defined functions, standard library functions	1	C,D,I	3	2,3
23.	Passing 1-D arrays, 2-D arrays to functions	1	C,D,I	3	2,3
24.	Recursive functions - Recursive solutions for Fibonacci series	1	C,D,I	3	2,3
25.	Towers of Hanoi	1	C,D	3	2,3
26.	C Pre-processor	1	C,D,I	3	2,3
27.	Header files	1	C	3	2,3
	UNIT IV: POINTERS:	9			
28.	Concepts, initialization of pointer variables	1	C,D,I	4	2,3
29.	Pointers as function arguments, passing by address	1	C,D,I	4	2,3
30.	Dangling memory, address arithmetic	1	C,D,I	4	2,3
31.	Character pointers and functions	1	C,D,I	4	2,3
32.	Pointers to pointers,	1	C,D,I	4	2,3
33.	Pointers and multi-dimensional arrays	1	C,D,I	4	2,3
34.	Dynamic memory management functions	1	C,D,I	4	2,3
35.	Command line arguments.	1	C,D	4	2,3

36.	Command line arguments.	1	C,D	4	2,3
	UNIT V:	**9**			
37.	Structures - Declaration, definition and initialization of structures, accessing structures	1	C,D,I	5	2,3
38.	Nested structures, arrays of structures	1	C,D,I	5	2,3
39.	Structures and functions, pointers to structures, self-referential structures	1	C,D,I	5	2,3
40.	Unions	1	C,D,I	5	2,3
41.	Typedef, bit-fields	1	C,D	5	2,3
42.	Program applications.	1	C,D	5	2,3
43.	Bit-wise operators: logical, shift, rotation, masks.	1	C,D	5	2,3
44.	**FILE HANDLING**: Concept of a file, text files and binary files, formatted I/O	1	C,D	6	2,3
45.	I/O operations and example programs.	1	C,D	6	2,3
	Total contact hours	45			

LEARNING RESOURCES	
	TEXTBOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	The C programming Language by Dennis Richie and Brian Kernighan
2.	Problem Solving and Program Design in C, Hanly, Koffman, 7th ed, PEARSON
3.	Programming in C, Second Edition Pradip Dey and Manas Ghosh, OXFORD Higher Education.
4.	Programming in C, A practical approach Ajay Mittal PEARSON.

5.	Programming in C, B. L. Juneja, Anith Seth, Cengage Learning.

<table>
<tr><td rowspan="2">CSE 105L</td><td rowspan="2" colspan="2">Introduction to Programming using C Lab</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Co-requisite:</td><td colspan="6">NIL</td></tr>
<tr><td>Prerequisite:</td><td colspan="6">NIL</td></tr>
<tr><td>Data Book / Codes/Standards</td><td colspan="6">NIL</td></tr>
<tr><td>Course Category</td><td>ES</td><td>Engineering Sciences</td><td colspan="4">Engineering Science</td></tr>
<tr><td>Course designed by</td><td colspan="6">Department of CSE</td></tr>
<tr><td>Approval</td><td colspan="6">-- Board of Studies -- , 2020</td></tr>
</table>

	Formulating algorithmic solutions to problems and implementing algorithms in C.

PURPOSE								
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the notion of Operation of a CPU, Notion of an algorithm and computational procedure, editing and executing programs in Linux.	A	M					
2.	Understand and implement the concepts of branching, iteration and data representation using arrays	A	C	M				
3.	Design modular programming and recursive solution formulation	A	C	M				
4.	Understand pointers and the dynamic memory allocation	A	C	M				
5.	Understand and apply structure and union	A	C	M				
6.	Comprehend file operations	A	C	M				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	Basic C programs 1. Calculation of the area of triangle. 2. Find the largest of three numbers using ternary operator. 3. Swap two numbers without using a temporary variable. 4. Find the roots of a quadratic equation. 5. Takes two integer operands and one operator form the user, performs the operation and then prints the result.	2	C	2	4
2.	1. Find the sum of individual digits of a positive integer and find the reverse of the given number. 2. Generate the first n terms of Fibonacci sequence. 3. Generate all the prime numbers between 1 and n, where n is a value supplied by the user. 4. Print the multiplication table of a given number n up to a given value, where n is entered by the user. 5. Decimal number to binary conversion. 6. Check whether the given number is Armstrong number or not.	2	D	2	4
3.	1. Interchange the largest and smallest numbers in the array. 2. Sorting array elements. 3. Addition and multiplication of 2 matrices.	2	D	2	4
4.	1. Function to find both the largest and smallest number of an array of integers. 2. Liner search. 3. Replace a character of string either from beginning or	2	D	2	4

	ending or at a specified location.				
5.	1. Reading a complex number 2. Writing a complex number. 3. Addition of two complex numbers 4. Multiplication of two complex numbers	1		5	4
6.	1. Concatenate two strings 2. Append a string to another string. 3. Compare two strings 4. Length of a string 5. Find whether a given string is palindrome or not	1	D	3	4
7.	1. Illustrate call by value and call by reference. 2. Reverse a string using pointers 3. Compare two arrays using pointers	1	I	3	4
8.	1. To find the factorial of a given integer. 2. To find the GCD (greatest common divisor) of two given integers. 3. Towers of hanoi	2	I	3	4
9.	File Operations (File copy, Word, line and character count in a file).	1	I	6	4
10.	Command line arguments (Merge two files using command line arguments).	1	D	6	4
	Total Hours	15			

ENV 111	**ENVIRONMENTAL SCIENCE**		**L**	**T**	**P**	**C**
			2	**0**	**0**	**2**
Co-requisite:	NIL					
Prerequisite:	NIL					
Data Book / Codes/Standards	NIL					
Course Category	ES		Environmental Science			
Course designed by	Department of Environmental Science					
Approval	-- Board of Studies -- , 2018					

PURPOSE	This course aims to provide an integrated, quantitative and interdisciplinary approach about understanding various environmental issues and finding lasting solutions.
LEARNING OBJECTIVES	**STUDENT OUTCOMES**

At the end of this course, students will be able to								
1.	How to find sustainable solutions to various environmental issues?							
2.	Understand the ecological systems and different material cycles.							
3.	Recognize the role of policies/laws on environmental conservation.							

Session	Description of the Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT – 1: ENVIRONMENTAL CRISIS AND SUSTAINABLE DEVELOPMENT	**11**			
1.	Environment: Structure and functions in an ecosystem.	1	C-I		1,2,3
2.	Ecological succession.	1	C-I		1,2,3
3.	Ecological pyramids.	1	C-I		1,2,3
4.	Biosphere; Ecological systems and cycles – carbon cycle.	1	C-I		1,2,3
5.	Water cycle, phosphorous cycle.	1	C-I		1,2,3
6.	Nitrogen cycle, oxygen cycle.	1	C-I		1,2,3
7.	Broad nature of chemical composition of plants and animals.	1	C-I		1,2,3
8.	Natural resources covering renewable and non-renewable resources.	1	C-I		1,2,3
9.	Forests, water, minerals.	1	C-I		1,2,3
10.	Food and land; Energy sources.	1	C-I		1,2,3
11.	Growing energy demands.	1	C-I		1,2,3
	UNIT – 2: ECOSYSTEMS	**5**			
12.	Environmental Pollution: Structure and composition of atmosphere.	1	C-I		1,2,3
13.	Pollution – air, water, soil.	1	C-I		1,2,3
14.	Thermal and radiation. Effects – acid rain.	1	C-I		1,2,3
15.	Ozone layer depletion and greenhouse gas emission. Control measures.	1	C-I		1,2,3
16.	Determination of water and air quality – BOD, COD, TDS, AQI.	1	C-I		1,2,3
	UNIT – 3: RENEWABLE AND NON-RENEWABLE RESOURCES	**3**			
17.	Environmental Biotechnology. Environmental microbiology.	1	C-I		1,2,3

18.	Biomarkers. Biosensors. Biofuels. Biotransformation. Bioremediation.	1	C-I		1,2,3
19.	Factors affecting bioremediation. Molecular Ecology.	1	C-I		1,2,3
	UNIT – 4: BIODIVERSITY	**7**			
20.	Biodiversity and its conservation.	1	C-I		1,2,3
21.	Biodiversity hotspots.	1	C-I		1,2,3
22.	Values of biodiversity. Consumptive use.	1	C-I		1,2,3
23.	Productive use. Social, ethical.	1	C-I		1,2,3
24.	Aesthetic and option values.	1	C-I		1,2,3
25.	Threats to biodiversity – habitat loss.	1	C-I		1,2,3
26.	Poaching of wildlife; in-situ and ex-situ conservation.	1			1,2,3
	UNIT – 5: POLLUTION AND POLICIES	**3**			
27.	Problems related to urban living. Waste management. Climate change.	1	C-D-I-O		1,2,3
28.	Sustainable solutions.	1	C-D-I-O		1,2,3
29.	Environmental regulation.	1	C-D-I-O		1,2,3
30.	Environmental protection acts in India and environmental ethics	1	C-D-I-O		1,2,3
	Total contact hours	30			

LEARNING RESOURCES	
Textbooks / Reference Books / Other Reading Material	
1.	Basu. M, Xavier. S. “Fundamentals of Environmental Studies”, 1st edition, Cambridge University Press, 2016.
2.	Raina. M. Maier, Ian L. Pepper, Charles. P. “Environmental Microbiology” 2nd edition, Academic Press, 2004.
3.	Danial. D. C. “Environmental Science”, 8th edition, Jones and Barlett Publishers, MA, 2010.

ENV 111 L	Environmental Science lab	L	T	P	C
		0	0	2	1
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	ES		Environmental Science		
Course designed by	Department of Environmental Science				
Approval	-- Board of Studies -- , 2018				

List of Lab Experiments

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	Water parameters- Test for alkalinity and turbidity of water.	2			1,2,3
2.	Determination of dissolved oxygen in water.	2	C-D-I-O		1,2,3
3.	Test for total suspended solids and total dissolved solids.	2	C-D-I-O		1,2,3
4.	Determination of total hardness of water by EDTA titration.	2	C-D-I-O		1,2,3
5.	Determination of biological oxygen demand of wastewater.	2	C-D-I-O		1,2,3
6.	Determination of chemical oxygen demand of wastewater.	2	C-D-I-O		1,2,3
7.	Test for iron content in river water.	1	C-D-I-O		1,2,3
	Total Hours	15			

SEMESTER II

ENG 115	ENGINEERING MECHANICS		L	T	P	C
			3	0	0	3
Co-requisite:	NIL					
Prerequisite:	NIL					
Data Book / Codes/Standards	NIL					
Course Category	P	PROFESSIONAL CORE	ENGINEERING MECHANICS			
Course designed	Department of Mechanical Engineering					

by	
Approval	-- Academic Council Meeting -- , 2016

PURPOSE	The course aims at providing the solid basis in mechanics especially statics which is very useful students of core engineering branches like mechanical and civil etc. It also gives as introduction related to dynamics to the students. The fundamental concepts could be illustrated by the recent examples along with the contemporary knowledge.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Get an overview of the various branches of mechanics.							
2.	Understand the physics behind various practical phenomena in the field of mechanical engineering.							
3.	Analyze planar and spatial systems to determine the forces in members of trusses, frames.							
4.	Calculate the motion parameters for a body subjected to a given force system.							
5.	Determine the centroid and second moment of area of various objects.							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: STATICS OF PARTICLES AND RIGID BODIES	**14**			
1.	Forces on particles.	1	C	1-3	1-4
2.	Resolution of forces.	1	C	1-3	1-4
3.	Free body Diagrams.	1	C, D	2-3	1-4
4.	Equilibrium of particles.	1	C	2-3	1-4
5.	Equilibrium of particles (Numerical Problems.)	1	D, I	2-3	1-4
6.	Forces in a plane.	1	C	2-3	1-4
8.	Forces in space (Numerical Problems).	1	D, I	2-3	1-4
9.	Forces in space (Numerical Problems).	1	D, I	2-3	1-4

10.	Force equivalence.	1	C, D	2-3	1-4
11.	Force equivalence (Numerical Problems).	1	D, I	2-3	1-4
12.	Rigid body equilibrium.	1	C, D	2-3	1-4
13.	Rigid body Equilibrium (Numerical Problems).	1	D, I	2-3	1-4
14.	Rigid body equilibrium (Numerical Problems).	1	D, I	2-3	1-4
	UNIT II: FRICTION	**5**			
15.	Laws of friction, dry friction.	1	C, D, I	2-3	1-4
16.	Wedge friction, rolling friction.	1	C, D, I	2-3	1-4
17.	Belt friction.	1	C, D, I	2-3	1-4
18.	Ladder friction.	1	C, D, I	2-3	1-4
19.	Screw friction.	1	C, D, I	2-3	1-4
	UNIT III: ANALYSIS OF TRUSSES AND CENTROIDS	**10**			
20.	Types of loads, type of supports, reaction.	1	C, D	2-3	1-4
21.	Simple trusses, method of joints.	1	C, D	2-3	1-4
22.	Method of joints.	1	C, D	2-3	1-4
23.	Method of sections (Numerical Problems).	1	D, I	2-3	1-4
24.	Method of Joints (Numerical Problems).	1	D, I	2-3	1-4
25.	Method of Joints (Numerical Problems).	1	D, I	2-3	1-4
26.	Center of gravity-lines, areas.	1	C	5	1-4
27.	Volumes.	1	C	5	1-4
28.	Determinationofcentroid-integration method.	1	C	5	1-4
29.	Determination of centroid-integration method (Numerical Problems).	1	D	5	1-4

	UNIT IV: MOMENT OF INERTIAS OF SURFACE AND VOLUMES	**6**			
30.	Determination of moment of inertia using area integration method.	1	C, D	5	1-4
31.	Determination of moment of inertia using area integration method.	1	C, D	5	1-4
32.	Determination of moment of inertia using area integration method.	1	C, D	5	1-4
33.	Analytical method, radius of gyration.	1	C, D	5	1-4
34.	Polar moment of inertia.	1	C, D	5	1-4
35.	Moment of inertia of different sections.	1	D, I	5	1-4
	UNIT V: DYNAMICS	**10**			
36.	Rectilinear motion.	1	C	4	1-4
37.	Projectile motion, Newtons second law of motion.	1	C	4	1-4
38.	Projectile motion, Newtons second law of motion.	1	D, I	4	1-4
39.	Alembert’s principle.	1	C	4	1-4
40.	Work, energy.	1	C	4	1-4
41.	Impulse momentum.	1	C	4	1-4
42.	Impact/collision of elastic bodies.	1	C	4	1-4
43.	Oblique impact.	1	C	4	1-4
44.	Curve linear motion.	2	C	4	1-4
	TOTAL HOURS	**45**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Ferdinand. P. Beer. E, Russell Johnston Jr., David Mazurek, Philip J Cornwell, Vector Mechanics for Engineers: Statics and Dynamics, McGraw - Hill, New Delhi, 10th Edition, 2013.
2	R.K.Bansal, Engineering Mechanics, Laxmi Publications Ltd, 2005.
3	Meriam J.L and Kraige L.G., Engineering Mechanics, Volume I - statics, Volume II - dynamics, John Wiley & Sons, New York,7th Edition, 2012.

4	Timoshenko, Young, Engineering Mechanics, Tata Mc-Graw Hill Book Company, 5th Edition, New Delhi.

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

ISES 102	**Industry Specific Employability Skills-II**	**L**	**T**	**P**	**C**
		1	1	**0**	**1**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	G	GENERAL			
Course designed by	Department of Career Development				
Approval					

PURPOSE	To Enhance holistic development of students and improve their competitive skills, life skills and employability skills.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to		D	F	G	I			

1.	Develop Positive attitude and Self-Motivated attitude.							
2.	Develop Lateral thinking skills and understand its importance.							
3.	To work in a Team dynamic.							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: MOTIVATION	**7**			
1.	Maslow's theory of Motivation.	1	C	1, 3, 4	1
2.	Soldiers' Walk and The Japanese Fan (Activities on factors of motivation).	2	D	1, 4	
3.	Steps to ward off de-motivation.	4	I	1, 4	1
4.	**UNIT II – CREATIVITY AND INNOVATION**	**7**			
5.	Activity on Brain Storming, Types of Creativity, Common Barriers of creativity.	3	D	1	1, 2
6.	Sources of New Idea.	1	I	1, 4	2
7.	Activity topics to enhance the power of aesthetics and precision. Aim is to create interest in research.	2	O	1, 2, 4	
8.	Activity.	1	O		
	UNIT III – CRITICAL AND LATERAL THINKING	**4**			
9.	Importance's of Critical and Lateral thinking.	1	I	1	2, 3
10.	Fill Me Up, Stimulating Lateral Thinking.	1	I	1, 4	2, 3
11.	Activity to enhance critical and lateral thinking.	2	I, O	1, 2, 4	2, 3
12.	**UNIT IV: TEAM DYNAMICS**	**10**			
13.	Importance of Team Dynamics.	1	C	1, 2, 3, 4	3
14.	Story boarding, Frenzy.	2	C	1, 2	-
15.	Activities Come to my Island, Striking Cars, Defend the Egg, Tallest Tower.	4	O	1, 2, 3	-
16.	Activities on the different stages of team building, team communication, coordination and collaboration.	3	O	1, 2, 3, 4	-

17.	**UNIT V: MINI PROJECT**	**4**			
18.	Individual projects on topics provided by faculties.	4	O	1, 2, 3, 4	-
	Total contact hours	32			

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

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

ASSESSMENT

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

2. Mini Project – 25 marks.

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

CSE 107	Data Structures	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	Engineering Sciences				
Course designed by	Department of CSE				
Approval					

PURPOSE	By the end of this course, students will: ***Understand*** the working principle of various data structures. ***Apply*** the data structures concepts to solve real-world problems. ***Appreciate*** that the theory of complexity analysis is essential in developing efficient (space and time) algorithms to solve real-world problems.

	Appreciate that the theory of complexity analysis is essential in developing efficient (space and time) algorithms to solve real-world problems. ***Know*** the effective team functioning, responsibilities, practices and strategies for dealing with non-cooperative team members when group activities are given. Will be able to communicate effectively in both writing and speaking and function effectively in team works.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	**Define** the term Abstract Data Type and explain why we need ADTs							
2.	**Explain** the working principle of the given data structures such as arrays, stacks, queues, linked lists, trees, graphs, etc., with a working example.							
3.	**Use** (applying) the merge-sorting algorithm to sort a given set of elements.							
4.	Given a network communication sub-system in the form of a graph and other necessary details, choose an appropriate data structure to represent the links and nodes in the network, **develop** (cerate) an algorithm to find the shortest path between any two given nodes in the network and simulate the algorithm.							
5.	Given a problem on searching, **determine** the time complexities of the given algorithms: i) searching a key from an unsorted list and ii) searching a key from a sorted list.							
6.	Given a list of algorithms along with their respective asymptotic complexities, **choose** the most efficient one and support your claim with proper justifications.							
7.	**Demonstrate** with an example the limitations of the Array ADT and how this limitation is overcome by using linked-list ADT using structures.							
8.	**Show** effective teamwork practices employed to deal with non-cooperative situations while completing group assignments/tasks.							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I : Introduction to Data structures	**9**			
1.	Introduction to data structures.	1	C-D-I		1,2
2.	Abstract Data Type (ADT) representation and implementation.	1	C-D-I		1,2
3.	Time and space requirements of algorithms.	1	C-D-I		1,2

4.	Array ADT.	1	C-D-I		1,2
5.	representing polynomials.	1	C-D-I		1,2
6.	Sparse matrices using arrays and their operations.	1	C-D-I		1,2
7.	Implementation of double linked list various operation using C.	1	C-D-I		1,2
8.	Stacks and Queues: Representation and application, implementation of stack and queue operations using C.	1	C-D-I		1,2
	Unit II : Linked Lists	**5**			1,2
9	Single linked lists.	1	C-D-I		1,2
10	Implementation of link list.	1	C-D-I		1,2
11	various operation using C.	1	C-D-I		1,2
12	double linked list.	1	C-D-I		1,2
13	circular list and applications.	1	C-D-I		1,2
	UNIT III – Trees:	**9**	C-D-I		1,2
9.	Tree terminology.	1	C-D-I		1,2
10.	Binary tree.	1	C-D-I		1,2
11.	Binary search tree.	1	C-D-I		1,2
12.	Infix to Post fix conversion.	1	C-D-I		1,2
13.	Postfix expression evaluation.	1	C-D-I		1,2
14.	AVL Tree.	1	C-D-I		1,2
15.	Complete Binary Tree representation.	1	C-D-I		1,2
	UNIT IV: Graphs	**9**			1,2
16.	Graph terminology, Representation of graphs.	1	C-D-I		1,2
17.	Path matrix.	1	C-D-I		1,2
18.	BFS (breadth first search)	1	C-D-I		1,2
19.	Implementation of BFS using C.	1	C-D-I		1,2
20.	DFS (depth first search)	1	C-D-I		1,2

21.	Implementation of DFS using C.	1	C-D-I		1,2
22.	Topological sorting.	1	C-D-I		1,2
23.	Shortest path algorithms.	1	C-D-I		1,2
24.	Priority Queues : Heap Structures, binomial heaps, leftist heaps	1	C-D-I		1,2
	UNIT V: Sorting and Searching techniques	**9**			1,2
25.	Bubble sort	1	C-D-I-O		1,2
26.	Selection sort	1	C-D-I-O		1,2
27.	Insertion sort	1	C-D-I-O		1,2
28.	Quick sort	1	C-D-I-O		1,2
29.	Merge sort	1	C-D-I-O		1,2
30.	Heap sort	1	C-D-I-O		1,2
31.	Radix sort and Implementation	1	C-D-I-O		1,2
32.	Linear and binary search methods, implementation	1	C-D-I-O		1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
	TEXTBOOKS[a]/REFERENCE BOOKS[b]/OTHER READING MATERIAL
1[a].	"Data Structure -- A Pseudo code approach with C" by Richard R. Gilberg& Behrouz A. Forouzan, 2nd edition, 2011. Cengage Learning. Imprint: Thomson Press (India) Ltd.
2[a].	Data Structures Using C" by Aaron M. Tanenbaum, YedidvahLangsam, and Moshe J. Augenstein. Pearson Publishers, 2019.
3[b].	Data structures and Algorithm Analysis in C, Mark Allen Weiss, Pearson publications, Second Edition Programming in C. P. Dey and M Ghosh, Second Edition, Oxford University Press.
4[b].	Fundamentals of data structure in C" by Horowitz, Sahani& Anderson Freed, Computer Science Press
5[b].	G. A. V. Pai: "Data Structures & Algorithms; Concepts, Techniques & Algorithms" Tata McGraw Hill.

Course nature					**Theory**	
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Mid Term 1	Mid Term 2	CLA 1	CLA 2	**Total**
	Weightage	15%	15%	10%	10%	50%
End semester examination Weightage :						50%

CSE 107 L			**Data Structures Lab**	**L**	**T**	**P**	**C**
				0	**0**	**2**	**1**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category		Core Course	Engineering Science				
Course designed by	Department of CSE						
Approval							

Week	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1 & 2	**Simulate the following operations**	**3**			
	a. Conversion of infix expression to postfix	1	C-D-I-O		1

	expression.				
	b .Evaluation of expressions.	1	C-D-I-O		1
	c. Assignment-1: Tower of Hanoi is a mathematical puzzle where we have three rods and n disks. The objective of the puzzle is to move the entire stack to another rod, obeying the following simple rules: i. Only one disk can be moved at a time. ii. Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack i.e. a disk can only be moved if it is the uppermost disk on a stack. iii. No disk may be placed on top of a smaller disk iv. You can choose to use the function move (4, 1, 3, 2), where 4 represents the number of disks. 1 represents disks on source shaft, 3 represents the destination shaft which holds the disks after the move and finally 2 represents the intermediate support shaft – temporary storage. Write a C program to simulate the given problem and : Perform the algorithmic complexity analysis for the solution you propose.	1	C-D-I-O		1
3 & 4	**Simulate the following tasks:**	**3**	C-D-I-O		2
	a. Implementation of the following operations: enqueue, dequeue and finding an element	1			2
	i. Linear Queue using arrays	1	C-D-I-O		2
	ii.Circular queue arrays	1	C-D-I-O		2
	iii.Priority queue singly linked list	1	C-D-I-O		2
	b. **Assignment-2:** The “4-Queens Problem” consists of placing four queens on a 4 x 4 chessboard so that no two queens can capture each other. That is, no two queens are allowed to be placed on the same row, the same column or the same diagonal (both primary and secondary diagonals). Write a C program to simulate the given problem and perform the algorithmic complexity analysis for the solution you propose.	1	C-D-I-O		2
5 & 6	**Demonstrate the following though simulation:**	3	C-D-I-O		3
	a. Create a singly linked list and perform the following operations:	1	C-D-I-O		3
	i. Add an element at the end of the list ii. Delete an element from the beginning of the list iii. Find the middle element of the list iv. Search the given key form the list	1	C-D-I-O		3

	v. Polynomial addition using linked list vi. Sparse matrix operations using linked list				
	b. **Assignment-3:** Let us consider a small but busy airport with only one run-way (shown in figure). In each time unit, one plane can land or one plane can take off, but not both. Planes arrive ready to land or to take off at random times, so at any given unit of time, the runway may be idle or a plan may be landing or taking off, and there may be several planes waiting either to land or take off. We therefore need two queues, called landing and takeoff, to hold these planes. It is better to keep a plane waiting on the ground than in the air, so a small airport allows a plane to take off only if there are no planes waiting to land. Hence, after receiving requests from new planes to land or take off, our simulation will first service the head of the queue of planes waiting to land, and only if the landing queue is empty will it allow a plane to take off. We shall wish to run the simulation through many units of time, and therefore, we embed the main action of the program in a loop that runs for cur-time (denoting current time) from 1 to a variable end-time. Simulate the given scenario using and write the output for different inputs	1	C-D-I-O		3
7 & 8	**Write code to perform the following operations:**	2	C-D-I-O		
	a. Develop a code to test whether the given tree is binary tree or not. b. Implementation of Binary tree traversals techniques – pre-order, in-order, and post-order. c. Implementation of AVL tree and its operations	1	C-D-I-O		4
	d. Assignment-4: Given a mathematical expression, evaluate it using appropriate tree structure.	1	C-D-I-O		4
9 & 10	**Write the codes to perform the following tasks**	3	C-D-I-O		
	A Implementation of Graph traversals techniques: i) BFS and ii) DFS.	1	C-D-I-O		5
	b. Assignment-5: The **Dijkstra'salgorithm** is an algorithm that gives the shortest path between two given vertices of a graph. In this problem we are given a directed graph with each edge having a non-negative weight. Thus, a solution requires a path of many other that costs least. We can think of the problem as like this: think graph G as a map of the airline routes, each node of the graph as the cities and the weights on each edge as the cost of flying from one city to another city. The solution we have to find a routing from a city v to city w such that the total cost is minimum. Write aC program to simulate thegiven problem. That is find the shortestpathbetween nodeA and nodeFin thegiven graph	1	C-D-I-O		5

11 & 12	Implementation of the following algorithms: **a**. Linear search b. Binary search c. Implementation of Bubble sort algorithm d. Implementation of Selection sort algorithm e. Implementations of Merge sort algorithm	1	C-D-I-O		5
13 & 14	**a.** Implementation of Insertion sort algorithm	1	C-D-I-O		5
	b. Implementation of quick sort algorithm	1	C-D-I-O		5
	c. Assignment-6: Suppose you work at college library. You are in the middle of a quiet afternoon when suddenly a shipment of 3928 different books arrives. The books have been dropped of in one long straight line, but they are all out of order, and the automatic sorting system is broken. To make matter worse, classes will start tomorrow, which means that first thing in the morning, students will show up in droves looking for these books. How can you get them all sorted in time.? Simulate the given scenario using C code. Perform the algorithmic time complexity analysis for the solution you propose. Also give the space complexity.	1	C-D-I-O		5
15	Our Text editor will allow us to read a file into memory i.e., it is stored in the buffer. We consider each line of text to be a string and buffer will be a list of these lines. we shall then devise editing commands that will do list operations on lines in buffer and will do string operations on characters in a single line. Here are few commands; a. R – Read the text file b. W – Write to text file c. I – Insert a new line d. D – Delete the current line e. P – Previous line (back up one line in buffer) f. B – Go to first line of buffer g. E – Go to last line of buffer h. Q – Quit the editor Tasks we do are: a) Receiving a command from user b) Get Command () – this function gets the command from user c) Do Command () – this function performs the command Now we have to perform the command for example if the command is ‘b’ we have to go beginning of buffer; if it is ‘n’ we must move to next line. All these commands can be performed using switch case statement. Using the switch case statements, we check for the command and specify the functions to perform the appropriate task. **Reading and WritingFiles:**	1	C-D-I-O		5

3.

	a. Reads thefilecontents of input fileinto bufferstopping at the end of file.Here weusesome functions List Empty (), Clear List (), Create List (), Insert List (), seethecode in thebookforbetterunderstanding. b. Searching fora String:Here wesearchforastring fromuserand informs the user ifthe target is found ornot. c. Changing one string toanother:Here wechangethestring that the userwantstoreplace from theexisting string. If thestring is not founduserwill be informed that string is not found.Iffound,we should replacethe old string with the new string. Perform thealgorithmic complexity analysisforthe solution youpropose.				

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	https://www.youtube.com/watch?v=YstLjLCGmgg
2.	Data Structures and Program Design in C by Robert Kruse, C L Tondo, Bruce Leung and Shashi Mogalla. For pseudocode, refer the following pages 98 to 105. **Online Reference**:https://www.youtube.com/watch?v=xFv_Hl4B83A
3.	Data Structures and Program Design in C by Robert Kruse, C L Tondo, Bruce Leung and Shashi Mogalla. For pseudocode, refer the following pages 139 to 150
4.	Data Structures and Program Design in C by Robert Kruse, C L Tondo, Bruce Leung and Shashi Mogalla. For pseudocode, refer the following pages 510 to 514

5.	Data Structures and Program Design in C by Robert Kruse, C. L. Tondo , Bruce Leung and Shashi Mogalla. For pseudocode, refer the following pages 302 to 312. Online resources: Use the following link to get a better understanding on the problem. https://www.youtube.com/watch?v=PgBzjlCcFvc https://www.programiz.com/dsa/quick-sort

Note :-	
1.	The assignments can be performed in groups (not more than 4 in a group).
2.	**Deliverables:** Areport containing the following
3.	**a.** Title of the problem/program
4.	b. Problem statement and Objective(s) of the problem
5.	c. Working code, without errors.
6.	d. Output written for different input cases.
7.	e. Conclusion: Algorithmic complexity and the problem you faced during the learning to execution stage.

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

PURPOSE	To provide the students with hands on experience on different trades of engineering like fitting, carpentry, smithy, welding and sheet metal.

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

*Any 10 experiments will be offered

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

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

ENG 105	**ENGINEERING GRAPHICS**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Co-requisite:	Nil					
Prerequisite:	Nil					
Data Book / Codes/Standards	Nil					
Course Category	EG	ENGINEERING				
Course designed by	Department of Mechanical Engineering					
Approval	Academic Council Meeting					

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

INSTRUCTIONAL OBJECTIVES		**STUDENTOUTCOMES**						
At the end of the course, student will be able to apply concepts of								
1.	How to project points, lines and planes on 3D planes	a	e					
2.	How to project and section solids	a	e					

3.	How to draw isometric and perspective views	a	e						
4.	Geometric dimensioning and tolerances	a	e						
5.	How to use software tool to create machine drawing views	a	e						

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I:PROJECTION OF POINTS, LINES, PLANES, SOLIDS	**9**			
1	Projection of points	1	C,D	1	1,2
2	Projection of lines	2	C,D	1	1,2
3	Projection of planes	2	C,D	1	1,2
4	Projection of solids	2	C,D	1	1,2
5	Use of software tool to create projections	2			
	UNIT II: SECTIONS AND DEVELOPMENTS	**9**			
6	Sections of solids	2	C,D	2	1,2
7	True shape of the section	2	C,D	2	1,2
8	Development of surfaces of sectioned solids	3	C,D	2	1,2
9	CAD exercises	2	C,D	2	1,2
	UNIT III: ISOMETRIC VIEWS	**9**			
10	Isometric projections of simple and truncated solids	3	C,D	3	1,2
11	Isometric to orthographic and vice versa	2	C,D	3	1,2
12	Perspective projection	2	C,D	3	1,2
13	CAD exercises	2	C,D	3	1,2
	UNIT IV: GEOMETRIC DIMENSIONING AND TOLERANCES	**9**			
15	GD and T rules and concepts	2	C,D	4	1,2
16	Geometric characteristics and modifiers	2	C,D	4	1,2
17	Fourier transform, bode plot, bandwidth	2	C,D	4	1,2
18	Datums and datum references	2	C,D	4	1,2
19	CAD excersizes	1	C,D	4	1,2
	UNIT V FREE HAND SKETCHING AND CAD	9			
20	Free hand sketching of real objects	2	C,D	5	1,2
21	Free hand sketching of multiple views from pictorial views	3	C,D	5	1,2
22	CAD excersizes	2	C,D	5	1,2
23	Assignments of 2D and 3D drawings	2	C,D	5	1,2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Bhatt, N.D, Engineering Drawing, Charotar Publishers, 2014
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Bhatt, N.D, Machine Drawing, Charotar Publishers, 2014
3.	Venugopal, K. and Prabhu Raja, V., Engineering Graphics, Eighth Edition (Revised), New Age International Publishers, Chennai, 2007
4	Narayanan, K. L. and Kannaiah, P., Engineering Graphics, Scitech Publications, Chennai, 1999.

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

ENG 105 L	**ENGINEERING GRAPHICS LAB**		**L**	**T**	**P**	**C**
			0	**0**	**2**	**1**
Co-requisite:	Nil					
Prerequisite:	Nil					
Data Book / Codes/Standards	Nil					
Course Category	EG	ENGINEERING				
Course designed by	Department of Civil Engineering					
Approval						

Sl. No	**Description of Experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	GUI familiarity, features, commands.				

2.	Shortcuts, mouse features, drop down menus etc.				
3.	Sketch entities Inference line, centreline, line, circle, arc, ellipse.				
4.	Rectangle, slots, polygon, spline, points, text, snap, grid Sketch Tools Fillet, chamfer, offset, trim.				
5.	Extend, mirror, copy, rotate, scale, sketch.				
6.	Blocks, create blocks, add/remove, explode.				
7.	Relations, dimensioning.				
8.	Part modeling, extrude, revolve, swept, extruded cut.				
9.	Loft, reference, curves, fillet, pattern.				
10.	Assembly modeling, mating.				
11.	Manipulating components.				
12.	Surface modeling tools.				
13.	All views of the object, dimensions.				
14.	Drafting tools.				
15.	Simulation express, stress-strain analysis.				
	TOTAL HOURS	**15**			

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

MAT 121	**MULTI VARIABLE CALCULUS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P				
Course designed by	DEPARTMENT OF MATHEMATICS				
Approval	-- Academic Council Meeting -- , 2016				

PURPOSE	This is a fundamental course Student able to learn how to find double integral, triple integral& surface integral.
LEARNING OBJECTIVES	**STUDENT OUTCOMES**

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

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I VECTORS AND MATRICES	**15**			
1.	Three-dimensional coordinate system.	3	C		1
2.	Vectors.	3	C		1
3.	Dot products.	3	C		1
4.	Vector products.	3	C		1
5.	Lines and planes.	3	C		1
	UNIT-II PARTIAL DERIVATIVES	**9**			
6.	Functions of several variables.	3	C		1
7.	Limits and continuity for several variable functions.	3	C		1
8.	Partial derivatives.	3	C		1
9.	The chain rules.	1	C		1
10.	Directional derivatives.	1	C		1
11.	Gradient.	1	C		1
	UNIT- III DOUBLE INTEGRAL AND LINE, INTEGRAL IN PLANES	**9**	C		1
12.	Extreme values.	3	C		1
13.	Saddle points.	3	C		1
14.	Lagrange multipliers.	3	C		1
	UNIT-IV TRIPLE INTEGRALS IN 3D	**9**			
15.	Double and integrated integrals.	5	C		1
16.	Area by double integration.	4	C		1
17.	**UNIT – V SURFACE INTEGRALS IN 3D**	**9**	C		1

18.	Triple integration and applications.	9	C		1
	Total Hours	**45**			

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

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

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

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

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

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I:ELECTRICAL QUANTITIES AND THEIR MEASUREMENTS	**9**			
1	Ohm's law	1	C,D	1	1,2
2	Permanent magnet, ammeter, voltmeter.	2	C,D	1	1,2
3	Measurement of resistance using Wheatstone bridge.	2	C,D	1	1,2
4	Measurement of capacitance using different methods.	2	C,D	1	1,2
5	Measurement of inductance using different methods.	2	C,D	1	1,2
	UNIT II: SEMICONDUCTOR DEVICES	**9**			
6	Forward and reverse bias of PN junction diode.	3	C,D	2	1,2
7	Half wave, full wave bridge rectifiers.	3	C,D	2	1,2
8	Bipolar junction transistors.	1	C,D	2	1,2
9	Transistor as amplifier and buffer, photodiode/phototransistor.	2	C,D	2	1,2
	UNIT III: AC CIRCUITS AND AMPLIFIERS	**9**			
10	Phasor analysis, impedance, reactance, resonance, RLC, characteristics of amplifiers.	2	C,D	3	1,2
11	Integrator and differentiator design.	2	C,D	3	1,2
12	Differential operational amplifier.	2	C,D	3	1,2
13	Parallel and series reactance.	2	C,D	3	1,2
14	Common mode rejection ratio.	1	C,D	3	1,2
	UNIT IV: ELECTRONIC FILTERS	**9**			
15	Low and high frequency noise in electronic circuits.	2	C,D	4	1,2
16	Low pass, high pass, band pass filters.	2	C,D	4	1,2

17	Fourier transform, bode plot, bandwidth.	2	C,D	4	1,2
18	Higher order filters.	2	C,D	4	1,2
19	Applications of filters.	1	C,D	4	1,2
	UNIT V DIGITAL LOGIC FUNDAMENTALS	9			
20	Different number systems.	2	C,D	5	1,2
21	Logic gates AND OR NOT NOR X-OR X-NOR.	2	C,D	5	1,2
22	Adders/subtractors, multiplexers.	2	C,D	5	1,2
23	Dorgan laws.	3	C,D	5	1,2
	Total contact hours*	**45**			

*Excluding assessment hours

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

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

ENG 111 L	BASIC ELECTRONICS LAB		L	T	P	C
			0	0	2	1
Co-requisite:	Nil					
Prerequisite:	Nil					
Data Book / Codes/Standards	Nil					
Course Category	EG	ENGINEERING				
Course designed by	Department of Civil Engineering					
Approval	Academic Council Meeting					

Session	List of Experiments	Contact	C-D-I-O	IOs	Reference

		hours			
1.	Verification of KCL, KVL and Ohm's Laws.	1	C	1,2,3.4	1
2.	Analysis of a Given Circuit with Resistors and Sources and Verification.	2	C	1,2,3.4	1
3.	Verification of PN Junction Diode I-V Characteristics in FB and RB Operation.	2	C	1,2,3.4	2
4.	Diode based Rectifier Circuits.	1	C	1,2,3.4	2
5.	Introduction to PCB design.	1	C	1,2,3.4	2
6.	Diode based Clipper and Clamper Circuits.	1	C	1,2,3.4	2
7.	Zener Diode As Voltage Regulator.	1	C	1,2,3.4	2
8.	BJT CE Configuration Input and Output Characteristics.	2	C	1,2,3.4	3
9.	MOSFET CS Configuration Input and Output Characteristics.	2	C	1,2,3.4	3
10.	MOSFET Single stage CS Amplifier Frequency Response.	2	C	1,2,3.4	3
	Total contact hours	15			

Course nature						**Theory**	
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Quiz's	Assignments	Mid Term-I	Mid Term-II	Course Project	**Total**
	Weightage	**10%**	**10%**	**15%**	**15%**	**15%**	**65%**
End semester examination Weightage: 35%							**35%**

CSE 230	**Industry Standard Coding Practice-1**	**L**	**T**	**P**	**C**
		0	0	4	1
Co-requisite:	Computer Lab/ Laptop				
Prerequisite:	NIL				
Data Book / Codes/Standards	Listed in Reference				
Course Category					
Course designed by	As per the industry Norms by CCC				
Approval	-- Academic Council Meeting --				

PURPOSE	The purpose of this course is bridging the gap between industry and academia, through enabling students on application of problem solving and competitive coding skills irrespective of languages of their choice.

LEARNING OBJECTIVES	
At the end of the course, student will be able to	
1.	Understand importance of mathematics and problem solving approaches for programming
2.	Understand importance of optimized solutions for problems solving and its relevance to industry.
3.	Implement mathematical and logical understanding approaches to implement test driven development practices.
4.	Start participating in global coding competitions relevant to the syllabus
STUDENT OUTCOMES	
1.	Able to understand test and development aspects of programming by solving problems at Industry standards.
2.	Able to interpret any given problem using required domain skills, mathematics.
3.	Able to learn applicable methods to optimize solutions for any given problem.
4.	Able to develop programs using C language until elementary data structures with test driven development.

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Topic-1 Problem Solving through Expressions & Control Structures	**6**			
1.	Problem solving approaches using Expression evaluations, coding on expressions, control statements, if-else statements, switch case statements, loops, Examples, Practice Problems	6			
	Topic-2 Code Complexity Analysis & Linear List Data	**6**			
2.	Problem Solving through code complexity analysis, Linear/Logarithmic/Superlinear/ Polynomial/Exponential Algorithms, Factorial Algorithms, Problem Solving Examples, Problem solving on Linear List data, rotations of data, Problem solving on Order statistic problems, Problem Solving, Examples, Practice problems	6			
	Topic-3 Matrix Data	**6**			
3.	Introduction to 2D Array, 2D Array Subscript, problem solving on Matrix data, representation of matrix data in Row Major Order & Column Major Order, Coding Examples, Practice Problems	6			
	Topic-4 Memory manipulation	**6.5**			
4.	Problem solving implementing Memory manipulation techniques using pointers. Memory Arithmetic, Problem solving implementing pointer	6.5			

	to an array, Memory Layout, overcoming the segmentation faults, Runtime memory allocation, Coding comparisons of Linear list data structure and Pointer, Examples, Practice problems.				
	Topic-5 Problem Solving on String data	**6.5**			
5.	Problem solving on string data, Problem solving on String manipulations, coding problems using string handling functions, Problem solving on Multi-String Problems, Problem Solving for long strings, Examples, Practice problems.	6.5			
	Topic-6 Modular Programming	**6**			
6.	Problem solving using modular programming, Inter module communications, Memory references as parameters, Coding on various scopes of data in the code, Examples, Practice problems	6			
	Topic-7 Recursive Algorithms	**6.5**			
7.	Problem solving approaches implementing recursions, Evaluation of Recursive algorithms, Significance of mathematical Recurrence Relations, Evaluation of recurrence relations, Time Analysis, Examples, Practice problems	6.5			
	Topic-8 Testing and its Implementation in Programming	**3.5**			
8.	Problem solving through testing, implementing various testing approaches: Test strategy, Test development, Test execution, Bug fixing, Examples, Practice problems.	3.5			
	Topic-9 Implementing Github	**1**			
9.	Version control systems, Git repositories and working trees, adding new version of the files to a Git repository, Examples	1			
		48			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	
2.	
3.	

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

In-semester	Assessment tool	Mid term test I	Mid term test II	Quiz	Assignment	Total
	Weightage	25	25			100
End semester examination Weightage : 50						

SEMESTER-III

ME 221	Elements of Structure		L	T	P	C
			3	0	0	3
Co-requisite:	Nil					
Prerequisite:						
Data Book / Codes/Standards	Nil					
Course Category	P	PROFESSIONAL CORE	DESIGN ENGINEERING			
Course designed by	Department of Mechanical Engineering					
Approval	-- Academic Council Meeting --					

PURPOSE	To familiarize the students with the fundamentals of deformation, stresses, strains in structuralelements.							
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	**9**			
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.	2	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.	1	C, D	1	1
5.	Concept of Thermal stresses in simple and composite bars & Tutorial.	1	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.	1	C, D	1	1
7.	Mohr's circle: direct stress in two mutually perpendicular directions with and without shear stress& Tutorial.	1	C, D	1	1
	UNIT II: - ANALYSIS OF BEAMS	**9**			
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	1	C, D	2	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	simply supportedbeam due to pure point load, pure UDL, pure UVL& Tutorial.				
10.	Shear force and bending moment diagrams for overhanging beamdue to pure point load, pure UDL, pure UVL & Tutorial.	2	C, D	2	1
11.	Theory of pure bending derivation and bending stress in simplebeams of sections having at-least one axis of symmetry& Tutorial.	1	C, D	2	1
12.	Tutorial on bending stress in simple beams sections having at-least one axis of symmetry & Tutorial.	1	C, D	2	1
13.	Derivation of shear stress distribution in beams of differentsections (rectangular, circular), having at-least one axis of symmetry& Tutorial.	2	C, D	2	1
	UNIT III: TORSION OF SHAFTS	**9**			
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.	2	C, D	3	1
15.	Tutorial on solid shaft, finding the dimensions.	1	C, D	3	1

16.	Expression for torque in terms of polar moment of inertia in acircular shaft subjected to torsion.	1	C, D	3	1
17.	Tutorial on hollow shaft, finding dimensions, percentage ofmaterial savings.	1	C, D	3	1
18.	Circular shafts in series and parallel& Tutorial.	1	C, D	3	1
19.	Concepts on Strain energy due to torsion& Tutorial.	1	C, D	3	1
20.	Circular shaft subjected to combined bending and torsion&Tutorial.	1	C, D	3	1
21.	Composite Shaft & Tutorial.	1	C, D	3	1
	UNIT IV: DEFLECTION OF BEAMS	**9**			
22.	Relationship between deflection, slope, radius of curvature, shearforce and bending moment& Tutorial.	2	C, D	2	1
23.	Slope and deflection of cantilever beam with a point load, UDL byDouble 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.	1	C, D	2	1
25.	Slope and deflection of simply supported beam with an eccentricpoint load, UDL by Macaulay's method& tutorial.	2	C, D	2	1
26.	Slope anddeflection of cantilever beam and simplysupportedbeamwithpointloadandUDLby Momentareamethod&tutorial.	1	C, D	2	1
27.	Castigliano’s theorem & tutorial.	1	C, D	2	1
	UNIT V: COLUMNS AND CYLINDERS	**9**			
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.	1	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.	1	C, D	3	1

32.	Lame’s theory on stresses in Thick cylinders & tutorial.	1	C, D	3	1
33.	Stresses in compound thick cylinder and Shrink fit& tutorial.	2	C, D	3	1
	Total contact hours*	**45**			

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.
2.	William A. Nash, “*Theory and Problems of Strength of Materials*”, Schaum's Outline Series, McGrawHill International Edition, 3rd Edition, 2007.
3.	Egor P. Popov, “*Engineering Mechanics of Solids*”, 2nd edition, Prentice Hall of India Private Limited,New Delhi, 2009.
4.	James M. Gere,”*Mechanics of Materials*”, Eighth Edition, Brooks/Cole, USA, 2013.
5.	Shigley. J. E, “*Applied Mechanics of Materials*”, International Student Edition, McGraw Hill KoyakushaLimited, 2000.

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

ME 221 L	Elements of structure Lab			L	T	P	C
				0	0	2	1
Co-requisite:	Nil						
Prerequisite:							
Data Book / Codes/Standards	Nil						
Course Category	P	PROFESSIONAL CORE	DESIGN ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting --						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	Tensile test on Mild steel rod	1			
2.	Compression test of Concrete cubes and cylinders.	1			
3.	Test on open coil and closed coil Helical springs.	1			
4.	Izod &charpy impact test.	1			
5.	Torsion test on Graded steels.	1			
6.	Deflection test on beams of different materials using Maxwell reciprocal theorem.	1			
7.	Double shear test on metallic materials.	1			
8.	Rockwell &Brinell hardness test of metallic materials.	1			
9.	Bend test of metallic rods.	1			
10.	Fatigue testing of materials under notched and unnotched conditions.	1			
11.	Comparison of mechanical properties of Unhardened, Quenched and tempered specimen.	1			
12.	Strain measurement on rods and beams.	1			
13.	Study on photo elasticity.	1			
14.	Buckling analysis.	1			
15.	Creep Test.	1			
	Total Hours	**15**			

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

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

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I - Matrices and Gaussian elimination	**9**			
1.	Introduction, Geometry of Linear Equations.	2	C		1
2.	Gaussian Elimination.	2	C		1
3.	Matrix Notation and Matrix Multiplication.	2	C		1
4.	Triangular Factors and Row Exchanges.	2	C		1
5.	Inverses and Transposes.	1	C		1
	Unit II - Vector spaces	**9**			
6.	Vector spaces and Subspaces.	2	C		1
7.	Solving $Ax = 0$ and $Ax = b$.	1	C		1
8.	Linear Independence, Basis and Dimension.	2	C		1

9.	The Four Fundamental Subspaces.	2	C		1
10.	Graphs and Networks, Linear Transformations.	2	C		1
	Unit III – Orthogonality	**9**			
11.	Orthogonal Vectors and Subspaces.	3	C		1
12.	Cosines and Projections onto Lines.	2	C		1
13.	Projections and Least Squares.	2	C		1
14.	Orthogonal Bases and Gram-Schmidt.	2	C		1
	Unit IV – Determinants	**9**			
15.	Introduction.	2	C		1
16.	Properties of the Determinant.	2	C		1
17.	Formulas for the Determinant.	2	C		1
18.	Applications of Determinants.	3	C		1
	Unit V - Eigenvalues and eigenvectors	**9**			
19.	Introduction, Diagonalization of a Matrix.	3	C		1
20.	Difference Equations and Powers A^k	2	C		1
21.	Differential Equations and $e^{At.}$	2	C		1
22.	Complex Matrices, Similarity Transformations.	2	C		1
	Total Hours	**45**			

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

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

ME 141	THERMODYNAMICS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:					
Data Book / Codes/Standards	Approved Steam tables				
Course Category	E	ENGINEERING SCIENCES			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- ,				

PURPOSE	This course provides the basic knowledge about thermodynamic laws and relations, and their application to various processes.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to understand								
1.	Thermodynamic laws and their applications.	a	e					
2.	Concept of entropy and availability.	a	e					
3.	Properties of steam.	a	e					
4.	Fuels and combustion	a	e					
5.	Thermodynamic relations.	a	e					

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNITI: BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS	**9**			
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.	1	C,D	1	1,2
5.	Zeroth law of thermodynamics, concept	1	C	1	1,2

	of temperature.				
6.	First law of thermodynamics, energy, enthalpy, specific heats, Application of first law, Tutorials.	1	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	**9**			
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.	1	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.	1	C,D	2	1,2
16.	Introduction to exergy.	1	C	2	1,2
	UNIT III: PROPERTIES OF STEAM AND VAPOUR POWER CYCLE	**9**			
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.	1	C,D	3	1,2
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.	2	C,D	3	1,2
22.	Dryness fraction measurements.	1	C	3	1,2

	UNIT IV: FUELS AND COMBUSTION	**9**			
23.	Classification of fuels.	1	C	4	1,2
24.	Combustionequations:Theoreticalandexcess air, Stoichiometric air fuelratio.	1	C,D	4	1,2
25.	Tutorials on combustion.	2	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.	1	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	**9**			
30.	Maxwell equations.	1	C,D	5	1,2
31.	Tads equations. Equations for dH and dU.	1	C,D	5	1,2
32.	Difference in heat capacities.	1	C,D	5	1,2
33.	Joule-Thomson Co-efficient.	1	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	2	D	5	1,2
	Total contact hours*	**45**			

*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.
3.	Yunus. A Cengel and Michael A Boles, "*Thermodynamics – An Engineering Approach, 8th Edition*", Tata McGraw Hill- Education, New Delhi, 2015.
4.	Rayner Joel, "*Basic Engineering Thermodynamics*", 5th Edition, Addison Wesley Longman Limited, First ISE reprint 1999.
5.	William Z. Black, James G. Hartley, "*Thermodynamics*", Pearson,3rdEdition, 2010.
6.	Michael J Moran, and Howard N Shapiro, "*Fundamentals of Engineering Thermodynamics*",

	John Wiley & Sons, New York, 8th Edition, 2015
7.	Nag.P.K, “*Engineering Thermodynamics”*, Tata McGraw Hill Education, New Delhi, 5th Edition, 2013.

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

ME 141 L	THERMODYNAMICS LAB			L	T	P	C
				0	0	2	1
Co-requisite:	NIL						
Prerequisite:							
Data Book / Codes/Standards	Approved Steam tables						
Course Category	E	ENGINEERING SCIENCES					
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting -- ,						

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Valve timing diagram for four stroke diesel or petrol engines.	2			
2.	Port timing of a two stroke petrol engine.	2			
3.	Reciprocating air compressor.	2			
4.	Determination of cop of a refrigeration system.	2			
5.	Study of steam boilers Part I: introduction to the types of steam boilers Part II: study of various types of boilers Part III: study of boiler mountings & accessories	3			
6.	Performance test on ac test rig.	2			
7.	Demonstration of various parts of bmw engine.	2			
	Total contact hours*	**15**			

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

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

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: Metal Structure	**9**			
1.	Crystal structures.	1	C	1-4	1,2
2.	Elastic-plastic behavior.	1	C	1	1,2
3.	Deformation mechanisms, Slip, twinning Imperfections.	2	C	1	1,2

4.	Types of fracture	1	C	1	1,2
5.	Three Stages in creep.	2	C		1,2
6.	Fatigue mechanism.	2	C		1,2
	UNIT II: Material properties.	**9**			
7.	Testing of metals.	2	C	2	1,2,3,4
8.	Properties, strength, plasticity, stiffness.	2	C	2	1,2,3,4
9.	Properties, toughness, brittleness, ductility.	2	C		1,2,3,4
10.	Hardness.	1	C	2	1,2,3,4,
11.	Creep and fatigue tests.	2	C		1,2,3,4
	UNIT III: Heat Treatment	**9**			
12.	Solidification, crystal growth, Rule.	1	C,D	4	1,2,3,4
13.	Phase diagram, Gibbs Phase rule, Equilibrium diagrams, lever rule.	1	C,D		1,2,3,4
14.	Iron Carbon diagram, solidification of steel and cast irons.	1	C,D		1,2,3,4
15.	Heat treatment, TTT curves, annealing, normalizing, hardening, tempering, inductionhardening, age hardening.	2	C,D		1,2,3,4
16.	Martempering, au tempering, carburizing, cyaniding, nitriding, flame and induction hardening, age hardening.	2	C,D,	4	1,2,3,4
17.	Ferrous, Non-ferrous metals, Cast Iron, Steel, Copper, Aluminum alloys.	2	C,D		1,2,3,4
	UNIT IV: Composite materials	**9**			
18.	Composites.	2	C	4	1,2,3,4

19.	Fiber reinforced composites.	2	C	4	1,2,3,4
20.	Manufacturing methods.	2	C	4	1,2,3,4
21.	Metal matrix composites.	3	C		1,2,3,4
	UNIT V: Powder Metallurgy	**9**			
22.	Powder metallurgy: Powder characterization, size analysis, compaction and sintering.	3	C	4	5
23.	Manufacturing methods: Mechanical, chemical and physical.	3	C	4	5
24.	Additive manufacturing.	3	C	4	5
	Total contact hours	**45**			

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

ME 121 L	**MATERIAL SCIENCE LAB**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards					
Course Category	C	CORE			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 2019				

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

9.	Mini project-Design of heat cycle to improve properties of given alloy.	2	D,I,O		
	Total contact hours	**15**			

Course nature				**Theory + Practical**		
Assessment Method – Theory Component (Weightage 50%)						
In-semester	**Assessment tool**	Mid Term-I	Mid Term II	Surprise test/Assignment	**Total**	
	Weightage	**20%**	**20%**	**10%**	**50%**	
End semester examination Weightage :						**50%**
Assessment Method – Practical Component (Weightage 50%)						
In-semester	**Assessment tool**	Experiments	Record /report/Quiz/Viva	**Total**		
	Weightage	**30%**	**20%**	**50%**		
End semester examination Weightage :						**50%**

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

PURPOSE	To expose the students to learn the fundamentals of various laws governing rigid bodies andits 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 excessenergy 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 performkinematic 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	**9**			
1	Introduction to mechanism and its elements. Degrees offreedom, its application in different mechanism.	2	C, D	1	1,2
2	Four Bar Chain, Gasthof's law, Cutback's and Grumbler'scriterion.	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 relativevelocity 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 ICmethod.	1	C, D	1	1,2
	UNIT II: FORCE ANALYSIS AND FLYWHEELS	**9**			
11	Inertia forces, D-Alembert's principle.	1	C, D	2	1,2
12	Velocity and acceleration of the reciprocating parts inengines.	1	C, D	2	1,2
13	Tutorial on derivation and calculation of gas forces.	1	C, D	2	1,2
14	Dynamically equivalent systems.	1	C, D	2	1,2
15	Tutorial on determination of equivalent system forconnecting 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(□E), coefficient of fluctuation of energy.	1	C, D	2	1,2
18	Tutorial on calculation of □E using TMD and torque equations.	1	C, D	2	1,2
19	Tutorial on flywheel applications.	1	C, D	2	1,2
	UNIT III: BALANCING	**9**			
20	Need for balancing, Static and dynamic balancing of rotatingmasses.	1	C, D	3	1,2

21	Tutorial on balancing of several masses rotating in sameplane 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 differentplanes using couple and force polygon	1	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.	1	C, D	3	1,2
26	Balancing of in-line engines.	1	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	**8**			
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 differentfollower motion.	1	C, D	4	1,2
32	Tutorial on construction of cam profile for radial followerwith different motion.	2	C, D	4	1,2
33	Tutorial on construction of cam profile for offset followerwith different motion.	1	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 specifiedContours.	1	C, D	4	1,2
	UNIT V: GEAR, GEAR TRAINS AND GYROSCOPES	**9**			
36	Gear terminology, types, law of gearing.	1	C, D	5	1,2
37	Tutorial on path of contact, arc of contact, sliding velocity.	1	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 epicyclicgear train.	1	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.	1	C, D	5	1,2
TOTAL CONTACT HOURS*		**45**			

*Excluding assessment hours

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

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

ME 172 L	KINEMATICS AND MECHANISMS LAB			L	T	P	C
				0	0	2	1
Co-requisite:	15ME301						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	DESIGN ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting -- , 23rd						

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

Sl. No.	Description of experiments	Contact hours	C-D- I-O	IOs	Reference
1.	Analysis of Cam and Follower.	1	O	1	1
2.	Dynamic analysis of Epi-cyclic gear trains.	1	O	1	1
3.	Dynamic analysis of Gyroscope.	1	O	1	1
4.	Dynamic analysis of Porter Governor.	1	O	1	1
5.	Dynamic analysis of Prolegomenon.	1	O	1	1

6.	Dynamic Balancing of rotating masses.	1	O	1	1
7.	Dynamic Balancing of reciprocating masses.	1	O	1	1
8.	Measurement of cutting forces in Drilling, turning and Milling using Dynamometers.	1	O	1	1
9.	Study of Free Vibration of helical springs.	1	O	2	1
10.	Free damped and un-damped torsional vibration of single rotor systems.	1	O	2	1
11.	Free & forced vibratio1n of equivalent spring mass System.	1	O	2	1
12.	Transmissibility Ratio in Vibrating Systems.	1	O	2	1
13.	Free and forced transverse vibration analysis for beams.	1	O	2	1
14.	Whirling of shaft.	1	O	2	1
15.	Vibration measurement using strain gauge.	1	O	2	1
16.	Free vibration analysis with Impact hammer.	1	O	2	1
17.	Forced vibration analysis with exciter.	1	O	2	1
18.	Transmission loss analysis using Sound level meter.	1	O	2	1
	Total contact hours*	**18**			

*Any 10 experiments will be offered

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual

Course nature	**Practical**					
Assessment Method (Weightage 100%)						
	Assessment tool	**Experiments**	**Record**	**MCQ/Quiz/ Viva Voce**	**Model examination**	**Total**

In-semester	Weightage	40%	5%	5 %	10%	60%
					End semester examination Weightage :	40%

ME 225 L	3D Printing	L	T	P	C
		0	0	2	1
Co-requisite:					
Prerequisite:					
Data Book / Codes/Standards					
Course Category					
Course designed by	DEPARTMENT OF				
Approval	-- Academic Council Meeting -- , 20				

PURPOSE	

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

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I	**4**			
1.	Concepts of CAD, Algorithms used in design, Design of Assembly (Spur gear, Helical screw, simple design)	2			
2.	Introduction to G Code.	1			
3.	Lab practice of Solid works software.	1			

	UNIT-II	**4**			
4.	What is a Mesh?,Historical Review of 3DP, From CAD to CAM, CAD Overview, Introductory lecture on 3D printer and Rapid Prototyping	2			
5.	Introduction to Rapid prototype, Introduction to different types of 3D Printers.	1			
6.	Introduction to RepRap, Materials used for printing.	1			
	UNIT- III	**4**			
7.	Design for 3DP, Understand the basics of G code generation.	2			
8.	CAM Skills, Mesh Repair.	1			
9.	Get to Know the 3D Printer, Weekly Assignments (3DP).	1			
	UNIT-IV	**3**			
10.	Installation of 3DP, bed levelling, filament loading and unloading.	1			
11.	, pre heating, nozzle cleaning and various techniques while printing the complex shapes.	2			
	Total contact hours	**15**			

LEARNING RESOURCES	
	TEXTBOOKS/
1.	3D Printing and Additive Manufacturing (Principles and Applications), By Chee Kai Chua and Kah Fai Leong.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Getting Started with 3D Printing: A Hands-on Guide to the Hardware, Software, and Services Behind the New Manufacturing Revolution by Liza and Nick.

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

ISES 201	**Industry Specific Employability Skills-III**	**L**	**T**	**P**	**C**
		1	**1**	**0**	**1**
Co-requisite:	Nil				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	Skill Building				
Course designed by	Department of CDC				
Approval					

PUR-POSE	To impart knowledge and equip with skills and aptitude that will enable learners ace competitive exams and placement tests with speed and precision.							
LEARNING OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1.	An ability to apply knowledge of mathematics, science and engineering							
2.	An ability to function on multidisciplinary teams							
3.	Enhance lexical skills through systematic application of concepts and careful analysis of style, usage, syntax, semantics and logic							
4.	Build vocabulary through methodical approaches and nurture passion for learning new words							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I	8			
1.	Percentages, profit and loss, SI and CI	4	C and I		1
2.	Time and work, Average and progression.	4	C and I		1

	UNIT-II	6			
3.	Time – speed and distance	3	C and I		1
4.	Number system and arrangements	3	C and I		1,2
	III	6			
5.	Ratio and proportions, Mixtures and Alligation, Direction problems	3	C and I		1
6.	Direction problems, coding and decoding, Number series and Alphabet series.	3	C and I		2
	UNIT-IV	6			
7.	Antonyms, synonyms, odd words	3	C and I		3,4
8.	Idioms and phrasal verbs, same word with different part of speech.	3	C and I		3,4
	UNIT-V	6			
9.	Word analogy. Sentence completion	3	C and I		5,6,7
10.	Text completion, Sentence equivalence	3	C and I		5,6,7
	Total contact hours	32			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	Arun Sharma – How to prepare for Quantitative Aptitude, Tata Mcgraw Hill.
2.	RsAgarwal,A Modern Approach to Verbal and Non Verbal Reasoning,S.Chand Publications.
3.	Verbal Ability and Reading comprehension-Sharma and Upadhyay.
4.	Charles Harrington Elstor, Verbal Advantage: Ten Easy Steps to a Powerful Vocabulary, Large Print, September 2000.
5.	GRE Word List 3861 – GRE Words for High Verbal Score, 2016 Edition
7.	The Official Guide to the GRE-General Revised Test, 2nd Edition, Mc Graw Hill Publication

CSE 330	Industry Standard Coding Practice-2	L	T	P	C
		0	0	4	1
Co-requisite:	Computer Lab/ Laptop				
Prerequisite:	NIL				
Data Book / Codes/Standards	Listed in Reference				
Course Category					
Course designed by	As per the industry Norms by CCC				
Approval	-- Academic Council Meeting --				

PURPOSE	The purpose of this course is bridging the gap between industry and academia, through enabling students on application of problem solving and competitive coding skills irrespective of languages of their choice.
LEARNING OBJECTIVES	
At the end of the course, student will be able to	
1.	Understand importance of mathematics and problem solving approaches for programming
2.	Understand importance of optimized solutions for problems solving and its relevance to industry.
3.	Implement mathematical and logical understanding approaches to implement test driven development practices.
4.	Start participating in global coding competitions relevant to the syllabus
STUDENT OUTCOMES	
1.	Able to understand test and development aspects of programming by solving problems at Industry standards.
2.	Able to interpret any given problem using required domain skills, mathematics.
3.	Able to learn applicable methods to optimize solutions for any given problem.
4.	Able to develop programs using C language until elementary data structures with test driven development.

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Topic-1 User Defined Datatypes	**6**			
1.	Requirement of User-Defined data, Problem solving implementing structures, Nested Structures, Unions, Enumeration, Usage of Preprocess statements in coding problems, Examples, Practice Problems	6			
	Topic-2 Problem solving using Mathematical approaches	**6**			
2.	Problem Solving on primes, sieve, series, factorization, divisiors, catalan numbers, modular arithmetic, Set theory, examples	6			
	Topic-3 Structure Pointers & Linked Lists	**6**			
3.	Structure member reference, member pointer reference, Coding to form links, Example codes, Problem solving on operational and traversal logics on linked lists.	6			
	Topic-4 Problem Solving on Linked Lists	**6**			
4.	Problem solving to compare linked lists, detection of a cycle/merge point, Merging sorted linked lists, coding problems on circular linked lists/Double linked lists, Examples, Practice problems	6			
	Topic-5 Problem Solving using Search & Sort Algorithms	**6**			
5.	Search operations implementing linear/binary search, Bubble Sort, Selection Sort, Insertion Sort, Evaluation of sorting Algorithms. Problem solving using Quick Sort, Merge Sort, O(n log n) algorithms, Examples, Practice problems	6			
	Topic-6 DBMS I	**7**			
6.	Industry Standards of leveraging DBMS concepts: SQL Queries, Entity Relationship Models, Question and answers.	7			
	Topic-7 DBMS II	**7**			
7.	Industry Standards of leveraging DBMS concepts: Query Optimization, Transactions & Concurrency, Normalization, case studies, Question and answers	7			
	Topic-8 Optimized Problem Solving Approaches	**3**			
8.	Problem solving Methods and techniques: Encoding methods, Handling faults within the code, Examples, Practice problems.	3			
	Topic-9 Implementing Github	**1**			

9.	Push a branch to GitHub, creating a pull request, Merging a pull request, Get back the changes from Github, Examples.	1			
		48			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	
2.	
3.	

Course nature				**Theory &Practicals**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Mid term test I	Mid term test II	Quiz	Assignment	**Total**
	Weightage	25	25			**100**
End semester examination Weightage : 50						

SEMESTER-IV

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

PURPOSE	To study the basic design principles and apply the principles to the design of various elements encountered in Mechanical machines and structures.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Determine the strength of the components.	a						
2.	Determine the failure conditions and apply them to real life problems.		b			j		
3.	Design simple joints, fasteners levers and springs.			c	e			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: FUNDAMENTALS OF MECHANICAL DESIGN	**9**			
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	2	C,D	1	2

	reliability				
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	1	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	1	C,D	1	2
7.	Eccentric loading in curved beams, cranehooks,frames,clamps.	1	C,D	1	2
	UNIT II: DESIGN FOR VARIABLE STRESSES	**9**			
8.	Members subjected to variable stresses, Failure andendurance limit.	2	C	2	3
9.	Stress concentration, Methods of reducing stressconcentration, 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	2	D	2	3
13.	Problems on variable stresses using Goodman method	2	D	2	3
14.	Members subjected to impact loads	2	C,D	2	1
15.	Members subjected to dynamic loads	2	C,D	2	1
	UNIT III: DESIGN OF SHAFTS AND TEMPORARY JOINTS.	**9**			
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.	2	C,D	1	2
18.	Cotter joints: Types, design procedure and problems onSocket and spigot cotter joint	2	C,D	3	5
19.	Knuckle joints: Design procedure and problems onknuckle joint	1	C,D	3	5
20.	Bolted joints: Design procedure and problems on boltedjoints with eccentric load parallel to axis of bolt	2	C,D	3	1
21.	Design procedure and problems on bolted joints witheccentric	1	C,D	3	1

	load perpendicular to axis of bolt				
	UNIT IV: DESIGN OF PERMANENT JOINTS.	**9**			
22.	Riveted joints: Types, materials, failures	1	C	3	2
23.	Design procedure and problems on riveted joints forpressurevessels	1	C,D	3	2
24.	Design procedure and problems on riveted joints forstructuralapplications	1	C,D	3	2
25.	Design procedure and problems on eccentric loadedriveted 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 weldedjoints	1	C,D	3	2
28.	Design procedure and problems on eccentric loadedweldedjoint.	2	C,D	3	2
	UNIT V : DESIGN OF GEARS AND SPRINGS	**9**			
29.	Design of spur gears	1	C	3	5
30.	Design helical gears	1	C,D	3	5
31.	Design bevel gears	1	C,D	3	5
32.	Design of work gears	1	C,D	3	5
33.	Springs: Stresses and deflections in helical springs	1	C	3	1
34.	Design procedure and problems on helical springs	1	C,D	3	1
35.	Design procedure and problems on helical springs with fatigue load	1	C,D	3	1
36.	Leaf springs: Construction, Nipping, Materials	1	C,D	3	1
37.	Design procedure and problems on leaf springs	1	C,D	3	1
	Total contact hours*	**45**			

*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, 8^{th} edition., 2008
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 , 14^{th} 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**	**Practical (Int+endsem)**	**End Sem exam**	**Quiz**	**Total**
	Weightage	**15%**	**15%**	**15%+15%**	**35 %**	**5%**	**100%**

ME 224 L	MACHINE DESIGN LAB			L	T	P	C
				0	0	2	1
Co-requisite:	Nil						
Prerequisite:							
Data Book / Codes/Standards	*Approved Design Data Book*						
Course Category	P	PROFESSIONAL CORE	DESIGNENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting --						

Session	**List of Experiments**	**Contact hours**	**C-D- I-O**	**IOs**	**Reference**
1.	Critical speed of shaft or whirling of shaft.	2			
2.	Cam analysis apparatus.	2			
3.	Journal bearing test rig.	1			
4.	Motorised gyroscope apparatus.	2			
5.	Universal governor apparatus.	2			
6.	Balancing of rotating masses.	2			
7.	Universal vibration apparatus.	2			
8.	Photo elastic test bench	2			
TOTAL HOURS		**15**			

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

PURPOSE	This introductory course on ordinary differential equations (**ODEs**) covers the theory, solution techniques, and applications surrounding linear and non-linear first and second-order differential equations, including systems of equations.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	model some elementary physical situations by writing an appropriate differential equation.							
2	be able to solve first order simple, linear, and separable equations							
3	solve higher order differential equations using characteristic roots, undetermined coefficients, and the Laplace transform.							
4	understand the qualitative nature of the solution to the linear and non-linear systems of equations.							

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

		hours			
	UNIT-I First Order Differential Equations	**7**			
1.	Geometric meaning of $y' = f(x, y)$, Direction Fields.	1	C		1
2.	Euler's Method, Classification of ODEs (Linear, Non-linear, Exact, Separable).	1	C		1
3.	Integrating Factor, Bernoulli Equations.	2	C		1
4.	Initial Value Problem.	1	C		1
5.	Modelling (Free falling object, Radioactivity, RL-circuit).	2	C		1
	NIT-II Second and Higher Order Linear ODEs	**8**			
6.	Homogeneous Linear ODEs.	1	C		1
7.	Modelling of Free Oscillations of a Mass-Spring System.	2	C		1
8.	Euler-Cauchy Equations.	1	C		1
9.	Non-homogeneous ODEs.	2	C		1
10.	Variation of Parameters, Modelling (Forced Oscillations, Electric Circuits).	2	C		1
	UNIT-III System of ODEs	**10**			
11.	Modelling Engineering problems (Electric Network, Mixing problem in two tanks etc.) as syst	3	C		1
12.	kian, Phase-Plane Method.	2	C		1
13.	Critical Points & Stability, Qualitative Methods for Nonlinear Systems.	3	C		1
14.	Nonhomogeneous Linear Systems of ODEs.	2	C		1
	UNIT -IV Series Solutions of ODEs	**7**			
15.	ıction to power series method.	1	C		1
16.	Legendre's equation & polynomials.	2	C		1

17.	Frobenius Method.	2	C		1
18.	Bessel’s Equations & Functions.	2	C		1
	UNIT-V Laplace Transforms	**12**			
19.	Laplace transforms of standard functions.	1	C		1
20.	Shifting Theorems, Transforms of derivatives and integrals.	2	C		1
21.	Unit step function, Dirac’s delta function.	3	C		1
22.	Inverse Laplace transforms, Convolution theorem (without proof).	3	C		1
23.	Application: Solutions of ordinary differential. equations using Laplace transforms.	3	C		1
	Total Hrs.	**45**			

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

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

ME 222	FLUID MECHANICS			L	T	P	C
				3	0	0	3
Co-requisite:	Nil						
Prerequisite:							
Data Book / Codes/Standards	Nil						
Course Category	P	PROFESSIONAL CORE	THERMAL ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting -- , 23rd						

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

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: PROPERTIES OF FLUIDS AND FLUID STATICS	**9**			

1.	Properties of fluids: density, specific weight, specificvolume, specific gravity, vapor pressure.	2	C	1	1,2
2.	Viscosity: Dynamic and Kinematic viscosity, Newton'slaw of viscosity, factors affecting viscosity.	2	C	1	1,2
3.	Types of fluids, Tutorial-Problems on fluid properties.	1	C,D	1	1,2
4.	Surface tension, compressibility and bulk modulusconcepts.	1	C,D	1	1,2
5.	Fluid statics- Pascal's law, Hydrostatic law.	1	C,D	1	1,2
6.	Manometry: Types of manometers, Piezometer, U-tubeManometer.	1	C,D	1	1,2
7.	Tutorials on manometers.	1	C,D		1,2
	UNIT II: - FLUID KINEMATICS AND DYNAMICS	**9**			
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 fluidparticle.	1	D	2	1,2
10.	Fluid flow pattern: Streamline, streak line, path line.	1	C	2	1,2
11.	Continuity equation.	1	C,D	2	1,2
12.	Fluid dynamics: Euler's equation of motion, Bernoulli'sEquation.	1	C	2	1,2
13.	ApplicationsofBernoulli'sequationinflowmeasurementDevices: Venturi meter.	1	C, D	2	1,2
14.	Orifice meter, Pitot tube, nozzle flow meter.	1	C,D	2	1,2
15.	Impulse momentum equation.	1	C,D	2	1,2
	UNIT III: DIMENSIONAL ANALYSIS AND FLOW THROUGH PIPES	**10**			
16.	Dimensiona analysis: DimensionsDimensionalhomogeneity.	1	C	3	1,2
17.	Rayleigh method, Buckingham's Pi-theorem, non-dimensional analysis.	1	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
20.	Froude’s model law – Problems.	1	C,D	3	1,2
21.	Euler’s model law, Weber model law and Mach modellaw.	1	C	3	1,2
22.	Laminar and Turbulent flow, Reynold’s experiment, Flow through circular pipes –Hagen. Poiseuille law.	1	C,D	3	1,2
23.	Turbulent flow – Derivation of Darcy Weisbachequation,Tutorial – Problems on Darcy Wisbech equation.	1	C,D	3	1,2
24.	Minor loss due to sudden enlargement, sudden contraction, inlet and exit of pipes, problems.	1	C,D	3	1,2
25.	Flow through pipes in series and parallel – problems.	1	C,D	3	1,2
	UNIT IV: HYDRAULIC MACHINES	**8**			
26.	Hydraulic turbines- classification, Impulse and reactionturbine.	1	C	4	1,2
27.	Design parameters and performance of Pelton turbine.	1	C,D	4	1,2
28.	Design parameters and performance of Francis turbine.	1	C,D	4	1,2
29.	Design parameters and performance of Kaplan turbine.	1	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 velocitytriangles.	1	C,D	4	1,2
32.	Cavitation’s in pumps, Thomas’s cavitation number.	1	C	4	1,2
	UNIT V: BOUNDARY LAYER THEORY	**9**			

33.	Boundary layer theory: laminar and turbulent boundarylayer over a flat plate.	1	C	3	1,2
34.	Displacement, Momentum, Energy thickness: derivationsand problems.	2	C,D	3	1,2
35.	Momentum integral equation derivation.	2	C	3	1,2
36.	Separation of flow over bodies: streamlined and bluffbodies, Flow over cylinders.	2	C, D	3	1,2
37.	Aero foil description, definition of parameters involved inaero foil, velocity and pressure acting over the aero foil.	2	C, D	3	1,2
	Total contact hours*	**45**			

*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.
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%**

ME 222 L	FLUID MECHANICS LAB			L	T	P	C
				0	0	2	1
Co-requisite:	Nil						
Prerequisite:							
Data Book / Codes/Standards	Nil						
Course Category	P	PROFESSIONAL CORE	THERMAL ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting -- , 23rd						

Session	**List of Experiments**	**Contact hours**	**C-D- I-O**	**IOs**	**Reference**
1.	Experiment on venturimeter.	2			
2.	Reynolds flow apparatus.	2			
3.	Experiment on orifice meter.	1			
4.	Experiment on loss of head in pipe fittings - minor losses.	2			
5.	Experiment on friction in pipes – major losses.	2			
6.	Impact of jet on vanes.	2			
7.	Free vortex flow experimental setup	2			
8.	Pitot tube.	1			
9.	Bernoulli’s theorem apparatus	1			

TOTAL HOURS	**15**

ECO 121	**Principles of Economics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category			PRINCIPLES OF ECONOMICS		
Course designed by	Department of Economics				
Approval					

PURPOSE	This course will provide you with a basic understanding of the principles of microeconomics. At its core, the study of economics deals with the choices and decisions we make to manage the scarce resources available to us. Microeconomics is the branch of economics that pertains to decisions made at the individual level, such as the choices individual consumers and companies make after evaluating resources, costs, and tradeoffs							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Analyse relevant economic concepts and economic models which inform the study of microeconomics.	D						
2.	Apply the principles of microeconomics associated with supply and demand in determining market equilibrium and the effects of price controls and elasticity.	D	I	J	A			
3.	Apply the principles of microeconomics associated with production and consumption in determining the behavior	D	A	I	J			

	of individuals and producers in successful markets and situations where markets fail or contribute to income inequality.							
4.	Analyze market structures and apply theoretical concepts of perfect competition to identify the behavior of monopolies and imperfect competition.	D	I	A	J			
5.	Analyze resource markets to understand the decision-making of resource allocation and interrelationships among key markets in the economy.	D	I	A	J			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO ECONOMICS	**5**			
1.	Why study economics? Scope and method of economics; the economic problem: scarcity and choice; the question of what to produce, how to produce and how to distribute output.	1	C		1
2.	science of economics; the basic competitive model; prices.	1	C		1,2
3.	science of economics; the basic competitive model; prices.	1	C		2
4.	property rights and profits; incentives and information; rationing.	1	C	1	1
5.	opportunity sets; economic systems; reading and working with graphs.	1	C-D-I		
6.	**UNIT II – DEMAND AND SUPPLY**	**8**			
7.	Determinants of individual demand/supply; demand/supply schedule and demand/supply curve; market versus individual demand/supply.	1	C		1
8.	Shifts in the demand/supply curve, demand and supply together.	1	C		1
9.	How prices allocate resources; elasticity and its application.	1	C		1
10.	How prices allocate resources; elasticity and its application.	1	C-I	2,3	1
11.	Controls on prices; taxes and the costs of taxation.	1	C	1,2	1

12.	Controls on prices; taxes and the costs of taxation.	1	C	2	1
13.	Consumer surplus; producer surplus and the efficiency of the markets.	1	C	2	1
14.	Consumer surplus; producer surplus and the efficiency of the markets.	1	C	2	1
15.	**UNIT III- CONSUMER THEORY**	**10**			
16.	The consumption decision - budget constraint.	1	C	3	2
17.	The consumption decision - budget constraint, consumption and income/price changes.	1	C	3	2
18.	Demand for all other goods and price changes.	1	C	3	2
19.	Utility and preferences (indifference curves); properties of indifference curves.	1	C	3	2
20.	Utility and preferences (indifference curves); properties of indifference curves.	1	C	3	2
21.	Consumer ‘s optimum choice.	1	C	3	2
22.	Income and substitution effects.	1	C	3	2
23.	Income and substitution effects;	1	C	3	2
24.	Applying consumer theory: Labour.	1	C-I	3	2
25.	Applying consumer theory: Labour.	1	C-I		
26.	**UNIT IV: PRODUCER THEORY**	**12**			
27.	Production, short- ran production function and returns to factor.	1	C	2	2
28.	Production, short- run production function and returns to factor.	1	C	2	2
29.	Production, short- run production function and returns to factor.	1	C		
30.	Average-marginal relationship.	1	C	3	1
31.	Long– run production function and laws of return to scale- role of technology.	1	C	3	1

32.	Long– run production function and laws of return to scale- role of technology.	1	C	3	1
33.	Long– run production function and laws of return to scale- role of technology.	1	C		
34.	Cost function and cost structure of a firm in the short- run.	1	C	3	2
35.	Cost function and cost structure of a firm in the short- run.	1	C	3	2
36.	Cost function and cost structure of a firm in the short- run.	1	C	3	2
37.	Long run cost function and cost structure.	1	C	3	2
38.	Long run cost function and cost structure.	1	C		
39.	**UNIT V: TYPES OF MARKET**	**10**			
40.	Perfect competition -features.	1	C	4	1
41.	Perfect competition- profit maximization.	1	C	4	1
42.	Shut-down and break-even points.	1	C	4	1
43.	Shut-down and break-even points.	1	C	4	1
44.	Monopoly: marginal revenue; marginal cost; profit maximization.	1	C	4	2
45.	Monopoly: marginal revenue; marginal cost; profit maximization.	1	C	4	2
46.	Shutdown rule; market power; price discrimination.	1	C	4	2
47.	Shutdown rule; market power; price discrimination.	1	C	4	2
48.	Monopolistic competition and product differentiation.	1	C	4	2
49.	Monopolistic competition and product differentiation.	1	C		
	Total contact hours	**45**			

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

Course nature	**Theory**

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

ISES 202	**Industry Specific Employability Skills-IV**	**L**	**T**	**P**	**C**
		1	**1**	**0**	**1**
Co-requisite:	Nil				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	Skill Building				
Course designed by	Department of CDC				
Approval					

PUR-POSE	To impart knowledge and equip with skills and aptitude that will enable learners ace competitive exams and placement tests with speed and precision.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	An ability to apply knowledge of mathematics, science and engineering							
2.	An ability to function on multidisciplinary teams							
3.	Enhance lexical skills through systematic application of concepts and careful analysis of style, usage, syntax, semantics and logic							
4.	Build vocabulary through methodical approaches and nurture passion for learning new words							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I	**8**			
1	Permutation and Combination, Probability	4	C and I		1
2	Geometry, and Algebra	4	C and I		1
	UNIT-II	**6**			

1.	Clocks, Calendars and Blood Relations	3	C and I		1
2.	Arrangements, Cubes and Syllogism	3	C and I		1,2
	UNIT- III : CRITICAL REASONING	4			
3.	Introduction to Different Parts of an Argument in Reasoning , Assumption of an Argument	2	C and I		1
4.	Strengthening of an Argument, Weakening of an argument	2	C and I		2
5.	Para jumbles	2	C and I		2
	UNIT-IV: Verbal reasoning	6			
6.	Word Analogy	2	C and I		3,4
7.	Sentence Completion & Text Completion.	2	C and I		3,4
8.	Sentence Equivalence	2	C and I		3,4
	UNIT-V	6			
9.	Reading Comprehension	3	C and I		5,6,7
10.	Identification of errors, Sentence correction	3	C and I		5,6,7
	Total contact hours	32			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	Arun Sharma – How to prepare for Quantitative Aptitude, Tata Mcgraw Hill.
2.	RsAgarwal,A Modern Approach to Verbal and Non Verbal Reasoning,S.Chand Publications.
3.	Verbal Ability and Reading comprehension-Sharma and Upadhyay.
4.	Manhattan GMAT Sentence Correction Guide, 5th Edition
5.	R.S.Aggarwal, A Modern Approach to Verbal & Non-Verbal Reasoning. S.Chand Publications,
7.	The Official Guide to the GRE-General Revised Test, 2nd Edition, Mc Graw Hill Publication

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

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

CSE 331	**Industry Standard Coding Practice-3**	**L**	**T**	**P**	**C**
		0	0	4	1
Co-requisite:	Computer Lab/ Laptop				
Prerequisite:	NIL				
Data Book / Codes/Standards	Listed in Reference				
Course Category					
Course designed by	As per the industry Norms by CCC				
Approval	-- Academic Council Meeting --				

PURPOSE	The purpose of this course is bridging the gap between industry and academia, through enabling students on application of problem solving and competitive coding skills irrespective of languages of their choice.
LEARNING OBJECTIVES	
At the end of the course, student will be able to	
1.	Understand importance of mathematics and problem solving approaches for programming
2.	Understand importance of optimized solutions for problems solving and its relevance to industry.
3.	Implement mathematical and logical understanding approaches to implement test driven development practices.
4.	Start participating in global coding competitions relevant to the syllabus
STUDENT OUTCOMES	
1.	Able to understand test and development aspects of programming by solving problems at Industry standards.
2.	Able to interpret any given problem using required domain skills, mathematics.
3.	Able to learn applicable methods to optimize solutions for any given problem.
4.	Able to develop programs using C language until elementary data structures with test driven

	development.

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Topic-1 Problem solving using Python – Control Statements	**6**			
1.	Introduction to Python, Basic syntax, variables and data types, operators, Input and Output, conditional statements and loops, Examples, Practice problems.	6			
	Topic-2 Problem solving using Python – Strings and lists	**6**			
2.	Problem solving on accessing strings, string operations, string slices, functions and methods, Introduction to lists, accessing list, working on Lists, Matrix data, Examples, Practice problems	6			
	Topic-3 Problem Solving using Python – Methods, Dictionaries	**6**			
3.	Introduction to tuple, accessing tuples, tuple operations, introduction to dictionaries, accessing values in dictionaries, properties and functions, importing modules, math module, random module, packages and composition, Examples, Practice problems.	6			
	Topic-4 Problem Solving using Python on Exception handling	**6**			
4.	Problem solving through user defined functions and methods, implementing exception handling, except clause, try? finally clause, user defined exceptions, Advanced data types, Examples, Practice problems.	6			
	Topic-5 Problem Solving implementing OOP through Python	**6**			
5.	Problem Solving through Class and Instance Attributes - Properties vs. getters and setters - Implementing a Property Decorator, Descriptors, Inheritance, Multiple Inheritance, Multiple Inheritance Example, Magic Methods and Operator Overloading, Callable and Callable Instances, Inheritance, Python Class for Polynomial Functions, Examples, Practice problems.	6			
	Topic-6 DBMS III	**7**			
6.	Industry Standards of leveraging DBMS concepts: Implementing stored procedures, implementing functions, implementing triggers, implementing transactions, case studies, Question and answers.	7			
	Topic- 7 DBMS IV	**7**			

7.	Industry Standards of leveraging DBMS concepts: Understanding Managed code, creating managed database objects, HTTP Endpoints, Implementing HTTP Endpoints for Web Services, case studies, Question and answers.	7			
	Topic-8 Optimization in Problem Solving Approaches	**3**			
8.	Problem solving Methods and techniques: Defining the and analyzing the problem, High level strategy for a solution, Arriving at an Algorithm, Encoding, Examples, Practice problems.	3			
	Topic-9 Implementing Github	**1**			
9.	Version control systems, Adding new files to the repository, Staging the environment, Commit Examples.	1			
Total Hours		**48**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	
2.	
3.	

Course nature				**Theory &Practicals**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Mid term test I	Mid term test II	Quiz	Assignment	**Total**
	Weightage	25	25			**100**
End semester examination Weightage : 50						

SEMESTER-V

ME 321	**FLUID MACHINERY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P	PROFESSIONAL CORE	MANUFACTURING ENGINEERING		
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To understand the fluid power systems and to develop circuits for industrial applications.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the principles and characteristics of hydraulic components.		e					
2.	Familiarize the principles and characteristics of pneumatic components.		e					
3.	Design the circuit for given applications.	c	e					
4.	Analyze the maintenance and troubleshooting 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 fluidsfunctions, types, properties, selection and application.	1	C	1	1,2
2.	POWERGENERATINGELEMENTSConstruction, operation, characteristics of External Gear pump, internal Gear pump.	1	C	1	1,2
3.	Construction, operation, characteristics of Lobe, Gearmotor andScrew pumps.	1	C	1	1,2
4.	Construction, operation, characteristics of Un balanced andbalanced vane pump.	1	C	1	1,2
5.	Construction,operation,characteristics ofpressurecompensated vane pump.	1	C	1	1,2
6.	Construction, operation, characteristics of bent axis pistonpump, swash plate piston pump and Radial Piston Pump.	1	C	1	1,2
7.	Construction and working of single acting, double actinghydraulic linear actuators.	1	C	1	1,2
8.	Special cylinders: Tandem, Rowless, Telescopic.	1	C	1	1,2
9.	Cushioning arrangement for cylinders to reduce the impacton the cylinders, Various cylinder mountings.	1	C	1	1,2
10.	Construction and working of Gear, Vane, Piston motors toobtain rotary motion.	1	C	1	1,2
	UNIT II - HYDRAULICVALVES ANDACCESSORIES	**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, compoundpressure relief, pressure sequence valves.	1	C	1	1,2
14.	Construction and working of pressure reducing, counterbalance valves.	1	C	1	1,2

15.	Working principle of check valve, throttle valve, one-wayFCV, pressure compensated FCV, and their applications.	1	C	1	1,2
16.	Importance of proportional valves, Servo valves and itsapplications.	1	C	1	1,2
17.	Need for intensifier in hydraulic systems, applications.	1	C	1	1,2
18.	Different switches, filters, seals, fittings and otheraccessories used in hydraulic systems.	1	C	1	1,2
19.	Functions, types and applications of accumulators inhydraulics.	1	C	1	1,2
	UNIT III - PNEUMATIC SYSTEMS	**9**			
20.	Introduction, comparison with hydraulic systems andelectrical systems.	1	C	2	1,3
21.	Construction, operation, characteristics and symbols ofreciprocating and rotarycompressors.	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, Mufflerand 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 variousfluid 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 ofpressureandpressure dropacrosscomponents in fluid power circuits.	1	C,D	3	1,2,3
29.	Sizing of actuators, pumps, reservoirs for specificrequirement.	1	C, D	3	1,2,3
30.	Finding the capacity (Sizing) of accumulators required forhydraulic systems, Calculations on	1	C, D	3	1,2,3

	Heat generation in fluid.				
31.	Design of hydraulic/pneumatic circuit for a practical application Selection of different components such as reservoir, various valves, actuators, filters, pumps based ondesign.	1	C, D	3	1,2,3
32.	Design of hydraulic/pneumaticcircuitsforsimplereciprocation, 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, counterbalance 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, actuatorlocking.	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 materialhandlingsystems.	1	C, D	3	1,2,3
39.	Preventive and breakdown, maintenance procedures in fluidpower systems.	1	C	4	1,2,3
40.	Trouble shooting of fluid power systems, fault findingprocess equipment’s / tools used, causes and remedies.	2	C	4	1,2,3
41.	Safety aspects involved fluid power systems.	1	C	4	1,2,3
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXTBOOKS**
1.	Anthony Esposito, “*Fluid Power with applications”*, Prentice Hall International, 2009
2.	Majumdar’s, “*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
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.

<table>
<tr><th colspan="5">Course nature</th><th colspan="3">Theory</th></tr>
<tr><td colspan="8">Assessment Method (Weightage 100%)</td></tr>
<tr><td rowspan="2">In- semester</td><td>Assessment tool</td><td>Cycle Test I</td><td>Cycle Test II</td><td>Cycle Test III</td><td>Surprise Test</td><td>Quiz</td><td>Total</td></tr>
<tr><td>Weightage</td><td>10%</td><td>15%</td><td>15%</td><td>5%</td><td>5%</td><td>50%</td></tr>
<tr><td colspan="7">End semester examination Weightage :</td><td>50%</td></tr>
</table>

<table>
<tr><td rowspan="2">ME 321 L</td><td colspan="3" rowspan="2">FLUID MACHINERY LAB</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Co-requisite:</td><td colspan="7">Nil</td></tr>
<tr><td>Prerequisite:</td><td colspan="7">Nil</td></tr>
<tr><td>Data Book / Codes/Standards</td><td colspan="7">Nil</td></tr>
<tr><td>Course Category</td><td>P</td><td>PROFESSIONAL CORE</td><td colspan="5">MANUFACTURING ENGINEERING</td></tr>
<tr><td>Course designed by</td><td colspan="7">Department of Mechanical Engineering</td></tr>
<tr><td>Approval</td><td colspan="7">-- Academic Council Meeting -- , 23rd</td></tr>
</table>

Session	**List of Experiments**	**Contact hours**	**C-D- I-O**	**IOs**	**Reference**
1.	Performance test on axial flow fan.	2			
2.	Performance test on centrifugal pump (variable speed) test rig.	3			
3.	Performance test on centrifugal pump for series operation.	2			
4.	Performance test on centrifugal pump for parallel operation.	2			

5.	Performance test on reciprocating pump operation.	2			
6.	Performance test on pelton wheel turbine.	2			
7.	Performance test on francis turbine.	2			
TOTAL HOURS		**15**			

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

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

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: CURVE FITTING/ NUMERICALSOLUTIONS	**9**			
1.	Curve fitting, straight line, parabola	2	C	1	1,2
2.	Newton Raphson method	2	C,D	1	1,2
3.	Bisection method	2	C,D	1	1,2
4.	Iterative methods	2	C,D	1	1,2
5.	Power methods	1	C	1	1,2
	UNIT II: - FINITE DIFFERENES AND INTEGATION	**9**			
6	Forward difference and backward difference	2	C	2	1,2
7	Central difference	2	C	2	1,2
8.	interpolation	1	C,D	2	1,2
9.	Divided differences	2	C	2	1,2
10.	Inverse interpolation	2	C,D	2	1,2
	UNIT III: NUMERICAL DIFFERENTIAION AND INTEGRATION	**9**			
11.	Numerical differentiation, applications	3	C	3	1,2
12.	Numerical integration, applications	3	C	3	1,2
13.	Simpsons rule	2	C,D	3	1,2
14.	Trapezoidal rule	1	C,D	3	1,2
	UNIT IV: NUMERICAL SOLUTIONS OF FIST ORDER ODE	**9**			
15	Taylor series method	3	C	4	1,2
16.	Euler’s methods and applications	3	C	4	1,2
17.	Runge kurta method	2	C,D	4	1,2
18.	Predictor corrector method	1	C	4	1,2
	UNIT V: NUMERICAL SOLUTION OF PDE	**9**			
19.	Solution of elliptic equations	3	C	4	1,2
20.	Solution of Laplace equations	3	C	4	1,2
21.	Solution of parabolic equations	2	C,D	4	1,2
22.	Solutions of hyperbolic equations	1	C,D	4	1,2

	Total contact hours *	45

*Excluding assessment hours

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

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

<table>
<tr><td rowspan="2">ME 132 L</td><td colspan="3" rowspan="2">NUMERICAL METHODS LAB</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Co-requisite:</td><td colspan="7">NIL</td></tr>
<tr><td>Prerequisite:</td><td colspan="7"></td></tr>
<tr><td>Data Book / Codes/Standards</td><td colspan="7">Approved Steam Tables, Refrigeration Tables and Psychrometric Chart.</td></tr>
<tr><td>Course Category</td><td>P</td><td>PROFESSIONAL CORE</td><td colspan="5">THERMAL ENGINEERING</td></tr>
<tr><td>Course designed by</td><td colspan="7">Department of Mechanical Engineering</td></tr>
<tr><td>Approval</td><td colspan="7">-- Academic Council Meeting -- , 23rd</td></tr>
</table>

Session	**List of Experiments**	**Contact hours**	**C-D- I-O**	**IOs**	**Reference**
1.	Introduction to Numpy and Python.	1			
2.	Python plotting (line plots and contour plots) using Matplotlib.	2			
3.	Solution of linear algebraic equations using Direct methodsSolution of linear algebraic equations using Iterative methods, Jacobi, SOR, SUR.	2			
4.	Solution of the equations using Iterative solvers Newton Raphson and Bisection.	2			
5.	Curve fitting using least squares regression (linear and quadratic).	2			

6.	Solution of ordinary differential Equation using Euler, RK2 – (Heun andmidpoint),RK4	2			
7.	Differentiation of a function using central, forward, backward Finite difference methods	2			
8.	Solution of the Partial differential equations (Laplace equation of temperature distribution) using the Finite difference method.	2			
TOTAL HOURS		**15**			

ME 272	**DYNAMICS AND CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:					
Data Book / Codes/Standards	Nil				
Course Category	P	PROFESSIONAL CORE	DESIGN ENGINEERING		
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

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

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

		hours			
	UNIT I: FREE VIBRATION	**9**			
1.	Introduction to vibration terminologies and types ofvibration	1	C,D	1	1,2
2.	Equation of motion for free undamped single Degree of freedom system by Newton's and energy method.	2	C,D	1	1,2,3
3.	Tutorials on single Degree of Freedom undamped freevibration systems.	1	C,D	1	1,2
4.	Equation of motion for free damped single Degree of freedom systems	1	C,D	1	1,2
5.	Tutorials on free damped single Degree of freedomsystems.	1	C,D	1	1,2
6.	Torsional Vibration of Two Rotor and three rotorSystems	1	C,D	1	1,2
7.	Tutorials on Torsional Vibration of Two Rotor and threerotor Systems.	1	C,D	1	1,2
8.	Torsional Vibration of Geared Systems with Two andThree rotor System.	1	C,D	1	1,2
	UNIT II: FORCED VIBRATION	**9**	C,D		
9.	Equation of motion for harmonically excited singleDegree of Freedom system.	1	C,D	2	
10.	Tutorials on harmonically excited single Degree ofFreedom system.	1	C,D	2	1,2
11.	Forced vibration due to unbalanced rotating andreciprocating systems.	1	C,D	2	1,2
12.	Tutorials on Forced vibration due to unbalanced rotatingand reciprocating systems.	1	C,D	2	1,2
13.	Forced vibration due to Base excitation by Absolute andRelative amplitude Method.	1	C,D	2	1,2
14.	Tutorials on Forced vibration due to Base excitation byAbsolute and Relative amplitude Method.	2	C,D	2	
15.	Force Transmissibility and Vibration isolation.	1	C,D	2	1,2
16.	Tutorials on Force Transmissibility and Vibrationisolation.	1	C,D	2	1,2
17.	Whirling of shaft and tutorials.	1	C,D	2	1,2
	UNIT III: MULTI DEGREE OF FREEDOM	**9**			
18.	Equation of motion for free undamped	2	C,D	2	1,2

	two and threedegrees of Freedom systems and tutorials.				
19.	Equation of motion for twoandthreeDOFusingLagrangian energy method for Un-damped freevibration.	2	C,D	2	1,2
20.	Tutorials on Lagrangian energy method for Un-dampedfree vibration.	2	C,D	2	1,2
21.	Co-ordinate Coupling and tutorials.	1	C,D	2	1,2
22.	Concept of Linear and torsional undamped VibrationAbsorber.	1	C,D	2	1,2
23.	Tutorials on Linear and torsional undamped VibrationAbsorber.	1	C,D	2	1,2
	UNIT IVLANGARANGIAN DYNAMICS	**9**	C,D		
24.	Virtual work, generalized forces	3	C,D	2,3	1,2
25.	Derivation of langaragian equations	2	C,D	2,3	
26.	Eigen value problems	2	C,D	3	1,2
27.	Equilibrium analysis	2	C,D	3	1,2
	UNIT V: VIBRATION MESUREMENT	9			
31.	Vibration measuring devices and Vibration exciters.	2	C	3	1,8
32.	Free and Forced vibration Tests.	1	C	3	1,8
33.	Balancing Machines, single plane and two planebalancing.	2	C	3	1,8
34.	Condition monitoring techniques and signal analysis.	1	C	3	1,8
35.	Basics of Noise terminologies and their relations.	1	C	3	1,8
36.	Noise Control Methods at source, along Path and atreceiver.	2	C	3	1,8
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXTBOOKS**
1.	Gian carlogenta, Vibration dynamics and control, 1993, springer.
2	Leonard meirovitch, Dynamics and Control, Abe books, 1985.
3	Lazlo Kevizsky, Control Engineering, 2018.
4	Gopal, Control Systems, 1997.

5	Iyengar, Mechanical vibrations, 2010.

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

ME 272 L	**DYNAMICS AND CONTROL LAB**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**
Co-requisite:	Nil				
Prerequisite:					
Data Book / Codes/Standards	Nil				
Course Category	P	PROFESSIONAL CORE	DESIGN ENGINEERING		
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

Session	**List of Experiments**	**Contact hours**	**C-D- I-O**	**IOs**	**Reference**
1.	Motor control using 4dof development platform.	2			
2.	Control of magnetic levitation system.	3			
3.	Control of cartwheel inverted pendulum.	2			
4.	Kinematic analysis of 3dof robot.	2			
5.	Control of 3dof robot.	2			
6.	Speed control of dc motor.	2			
TOTAL HOURS		**15**			

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

PURPOSE	To obtain a hands-on experience in converting a small novel idea / technique into a workingmodel / 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 conceptualize 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
1.	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 other development work are permitted. 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 onthework done by the candidate.	30	C,D,I	1,2, 3,4	
	Total contact hours	**30**			

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 iscritical! • The 3 nearest competitors (existing solutions) andprice. • Team members name, phone number, email, department/degree program, andyear. • A description of the product	Panel of reviewers	Viability / feasibility of theproject Extent ofpreliminaryworkdone.	**0**

	opportunity that has been identified. To include: Documentation of the market need, shortcomings of existing competitive products, and definition of the target market and itssize. • Proposed supervisor /guide			
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 andpresentation , teamwork,handl ing Q&A.	
Review III	• Final Concept and Model / Algorithm/ Technique • Drawings, Plans / programmedoutput • Financial Model / costing • Prototype /Coding • Final Presentation andDemonstration.	Panel of reviewers	Originality, Multi-disciplinary component, clarity of idea and presentation, teamwork, handling Q&A.	**50**
Final technical Report	A good technical report.	Supervisor / Guide	Regularity, systematic progress, extent of work and quality of Work.	**30**
			Total	**100**

ME 430	Mechatronics	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P				
Course designed by	DEPARTMENT OF				
Approval	-- Academic Council Meeting -- , 2016				

PURPOSE	

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To make the student understand what is a mechatronics system and its significance.							
2.	To make the student learn about various elements of mechatronics system.							
3.	To make the student get the knowledge of various sensors used in a mechatronics system.							
4.	To make the student get the knowledge of various actuators used in developing a mechatronics system.							

5.	To make the student get the fundamentals of Data Acquisition Systems and the hardware used.							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I:	**9**			
10.	Definition of mechatronics, History of mechatronics.	1			
11.	evolution of mechatronics, applications of mechatronics.	1			
12.	Objectives of mechatronics, advantages and disadvantages of mechatronics.	1			
13.	philosophy of a mechatronic system.	1			
14.	practical examples of various mechatronic systems.	1			
15.	mechatronics design process.	1			
16.	mechatronics key elements.	1			
17.	measurement systems.	1			
18.	design issues in mechatronics.	1			
	UNIT II:	**9**			
19.	Sensors and transducers, Performance terminology.	1			
20.	Displacement, position and proximity measurement devices.	1			
21.	velocity and motion measurement devices.	1			
22.	Force measurement.	1			
23.	fluid pressure measurement.	1			
24.	liquid flow measurement.	1			
25.	liquid level measurement.	1			
26.	temperature measurement.	1			
27.	light sensors, selection of sensors.	1			
	UNIT III:	**9**			
28.	Actuators: Hydraulic and pneumatic actuation systems.	1			

29.	directional control valves, pressure control valves.	1			
30.	mechanical actuation systems, kinematic chains.	1			
31.	cams, gears, rachet and pawl.	1			
32.	belt and chain drives, bearings.	1			
33.	electrical actuation systems.	1			
34.	mechanical switches, solid state switches.	1			
35.	solenoid valves, DC motors, AC motors.	1			
36.	servo motors, motor selection.	1			
	UNIT IV:	**9**			
37.	Microprocessors, Micro controllers	1			
38.	applications of microprocessors and micro controllers.	2			
39.	Programmable Logic controllers.	1			
40.	timers, Ladder programming, timers, counters.	1			
41.	latching and internal relays, shift registers.	2			
42.	data handling, Analog to digital and digital to analog conversion.	2			
	UNIT V: CONDENSER	**9**			
43.	Data acquisition fundamentals, sampling and aliasing.	2			
44.	elements of a data acquisition and control systems.	2			
45.	devices for data acquisition.	2			
46.	data acquisition process.	1			
47.	Case studies of designing a mechatronics system.	2			
	Total contact hours	45			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCES
1.	William Bolton, “*Mechatronics*”, Pearson Publishers, 7th edition.

2.	Jouaneh M, "*Fundamentals of Mechatronics*", CENGAGE Learning publishers.
3.	Godfrey Onwubolu, "*Mechatronics Principles and Applications*", Elsevier publishers.
4.	Devdas Shetty and Richard A. Kolk, "*Mechatronics system design*", CENGAGE Learning publishers
5.	David G. Alciatore, "*Introduction to Mechatronics*", 5th edition, McGraw-Hill Education.

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

ME 410	Thermal Power Engineering	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P				
Course designed by	DEPARTMENT OF				
Approval	-- Academic Council Meeting -- , 2016				

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

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

1.	Carnot, Otto, Diesel, Dual and Stirling cycles.	2			
2.	p-v and T -s diagrams, description.	1			
3.	efficiencies and mean effective pressures.	2			
4.	Comparison of Otto and Diesel cycles.	1			
5.	IC engine components, their functions.	2			
6.	engine performance and efficiency.	1			
	UNIT II: GAS POWER CYCLES	**9**			
7.	Gas turbine (Brayton) cycle.	1			
8.	description and analysis.	1			
9.	Regenerative gas turbine cycle.	1			
10.	Intercooling and reheating in gas turbine cycles.	2			
11.	Introduction to Jet Propulsion cycles.	2			
12.	Turbojet, Turbofan, Turboprop.	1			
13.	Afterburner and Rockets.	1			
	UNIT III: VAPOR POWER CYCLES	**9**			
14.	Carnot vapour power cycle, drawbacks as a reference cycle.	1			
15.	Simple Rankine cycle; description, T-S diagram, analysis for performance.	1			
16.	Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance.	2			
17.	Actual vapour power cycles. Ideal and practical regenerative Rankine cycles.	1			
18.	open and closed feed water heaters. Reheat Rankine cycle.	1			
19.	Cogeneration, Combined Gas-Vapor Cycles.	1			
20.	Binary Vapor Cycles.	1			
21.	Characteristics of an Ideal working fluid in vapour power cycles.	1			
	UNIT IV: STEAM GENERATOR	**6**			
22.	Boiler types, applications, and comparison.	2			

23.	Boiler system requirements, Water Tube Boiler.	1			
24.	Fire Tube Boiler.	1			
25.	Mountings and Accessories. Performance calculations.	1			
26.	Boiler trial.	1			
	UNIT V: CONDENSER	**6**			
27.	Condenser system elements.	2			
28.	types and their advantages/disadvantages.	2			
29.	Its effect on Rankine efficiency.	2			
30.	**UNIT VI: STEAM TURBINE**	**6**			
31.	Impulse and reaction turbine.	1			
32.	velocity triangle.	1			
33.	degree of reaction, efficiencies.	2			
34.	losses, Velocity and Pressure compounding.	2			
	Total contact hours	45			

LEARNING RESOURCES	
	TEXT BOOKS
1.	Thermodynamics, Yunus A, Cengel & Michael A Boles, Tata McGraw Hill, 7th Edition.
2.	Engineering Thermodynamics P.K. Nag Tata McGraw Hill 6th Edition 2018.
3.	P. K. Nag, Powerplant Engineering, 2nd Ed., Tata McGraw Hill, 2002.

LEARNING RESOURCES	
	REFERENCES
1.	M. J. Moran & H N Shapiro, Fundamentals of Engineering Thermodynamics, 3rd Ed., John Wiley, 1995.
2.	M. M. ElWakil, Power Plant Technology, McGraw Hill International, 1992.

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

ME 415	**REFIGIRATION AND AIR CONDITIONING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:					
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd				

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

5.	Application of refrigeration and air conditioning systems.	a	e					

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNITI: VAPOURCOMPRESSION REFRIGERATIONSYSTEMS	**9**			
1.	Review of thermodynamic principles of refrigeration.	1	C	1	1,3
2.	Simple vapor 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
	UNITII:ABSORPTIONREFRIGERATIONSYSTEMS	**9**			
9.	Absorption refrigeration cycle, Water lithium bromide systems.	1	C	2	1,2
10.	Tutorial:Library 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 ofabsorptionsystemwith precompressionsystems.	1	C	2	1,2
16.	Tutorial: COP comparison of vapor compression systems with vapor 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
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	1	C	5	1,3

	hospitals.				
41.	Cryogenics applications.	1	C	5	1,3
	Total contact hours*	**45**			

*Excluding assessment hours

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

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

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

PURPOSE	

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

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I:	**9**			
1.	What is CAD. What is CAM. Applications of CAD/CAM in Engineering.	1			1,2
2.	Specific applications of CAD/CAM in Mechanical engineering. What is Geometric Modelling and its applications in Mechanical engineering.	1			1,2
3.	Introduction to computer graphics and it application in Mechanical engineering. Computer Graphics Software's useful for Mechanical engineers.	1			1
4.	Introduction, representation of points, transformations and matrices, transformation of points, Transformation of straight lines, midpoint transformation, Transformation of parallel lines, transformation of intersecting lines.	1			1
5.	Rotation, Reflection and Scaling.	1			1
6.	Combined transformations and Transformation of the unit square.	1			1
7.	Rigid body transformations and Translations and Homogeneous Coordinates.	1			1
8.	Rotation About an Arbitrary Point.	1			1
9.	Homogeneous Coordinate system and Overall Scaling.	1			1
	UNIT II –	**9**			
10.	Introduction about 3D Transformations.	1			1
11.	Three-Dimensional Scaling.	1			1
12.	Three-Dimensional Shearing, Reflection.	1			1
13.	Three-Dimensional Rotation, Translation.	1			1
14.	Three-Dimensional Combined transformations.	1			1
15.	Three-Dimensional rotations about an axis parallel to a coordinate axis.	1			1

16.	Three-Dimensional rotation about an arbitrary axis in space.	1			1
17.	Three-Dimensional reflection through an arbitrary plane, affine and perspective geometry.	1			1
18.	Introduction to orthographic projections, axonometric projections, oblique projections, perspective transformations.	1			1
	UNIT III –	**9**			
19.	Introduction about plane and space curves.	1			1
20.	Curve Representation, Implicit and Explicit representation of curves.	1			1
21.	Parametric and Non-parametric curves General and parametric representation for conic sections (Circle, Ellipse, Parabola, Hyperbola).	1			1
22.	Representation of space curves, Cubic Splines and Hermite cubic curve, normalized cubic splines.	1			1
23.	Representation of Bezier Curves.	1			1
24.	B-spline Curves and end conditions for periodic B-spline curves.	1			1
25.	B-spline Curve Fit B-spline Curve Subdivision.	1			1
26.	Rational B-spline Curves NURBS and Introduction about surfaces.	1			1
27.	Coons Bi-cubic surface, Bezier surfaces, B-spline surfaces, B-spline surface Fitting and subdivision and Rational B-spline surfaces.	1			1
	UNIT IV:	**9**			
28.	Introduction to conventional Manufacturing Processes.	1			2
29.	Removing, Forming, Deforming and joining.	1			2
30.	Introduction to CAD, CAM and CAD-CAM.	1			1,2
31.	Integration equipment’s.	1			2
32.	Integrating CAD, NC and CAM.	1			2

33.	Machine tools. Role of process planning in CAD/CAM Integration.	1			2
34.	Computer Aided Process Planning.	1			2
35.	Development, Benefits, Model and Architecture.	1			2
36.	CAPP Approaches.	1			2
	UNIT V:	**9**			
37.	Introduction to CAM.	1			2
38.	Point to point and continuous path machining.	1			2
39.	Introduction to NC, CNC and DNC – NC Programming.	1			2
40.	Basics, Languages, G Code, M Code, APT – Tool path generation and verification.	1			2
41.	NC Programming for Rectangular and circular pockets.	1			2
42.	NC Programming for drilling, peck drilling and boring.	1			2
43.	NC Programming for circular and rectangular array.	1			2
44.	NC Programming for turning, facing, threading and knurling.	1			2
45.	Production Control – Cellular Manufacturing.	1			2
	Total contact hours	**45**			

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

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

End semester examination Weightage:	**50%**

ISES 301	**Industry Specific Employability Skills-VI**	**L**	**T**	**P**	**C**
		1	**1**	**0**	**0**
Co-requisite:	Nil				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	Skill Building				
Course designed by	Department of Career Development Centre				
Approval					

PUR-POSE	To impart knowledge and equip with skills and aptitude that will enable learners ace competitive exams and placement tests with speed and precision.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
a.	An ability to apply knowledge of mathematics, science and engineering							
b.	An ability to function on multidisciplinary teams							
c.	Enhance lexical skills through systematic application of concepts and careful analysis of style, usage, syntax, semantics and logic							

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT-I	**8**			

1.	Types and Properties of Numbers and Remainders.	4	C and I		1
2.	LCM, GCD, Fractions and decimals, Surds and Progressions.	4	C and I		1
	UNIT-II	**8**			
3.	Permutations, Combinations and Probability.	4	C and I		1
4.	Data Interpretation.	4	C and I		1,3
	III	**8**			
5.	Geometry and Coordinate Geometry.	4	C and I		1
6.	Trigonometry and Mensuration.	4	C and I		1
	UNIT-IV: Reasoning	**8**			
7.	Syllogism and Non Verbal Reasoning.	4	C and I		2, 3
8.	Analytical Reasoning.	4	C and I		2, 3
	Total contact hours	**32**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	Arun Sharma – How to prepare for Quantitative Aptitude, Tata Mcgraw Hill.
2.	R.S Agarwal, A Modern Approach to Verbal and Non Verbal Reasoning, S.Chand Publications.
3.	Arun Sharma– How to Prepare for Data Interpretation & Logical Reasoning for the CAT.

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

CSE 332	Industry Standard Coding Practice-4	L	T	P	C
		0	0	4	1
Co-requisite:	Computer Lab/ Laptop				
Prerequisite:	NIL				
Data Book / Codes/Standards	Listed in Reference				
Course Category					
Course designed by	As per the industry Norms by CCC				
Approval	-- Academic Council Meeting --				

PURPOSE	The purpose of this course is bridging the gap between industry and academia, through enabling students on application of problem solving and competitive coding skills irrespective of languages of their choice.
LEARNING OBJECTIVES	
At the end of the course, student will be able to	
1.	Understand importance of mathematics and problem solving approaches for programming
2.	Understand importance of optimized solutions for problems solving and its relevance to industry.
3.	Implement mathematical and logical understanding approaches to implement test driven development practices.
4.	Start participating in global coding competitions relevant to the syllabus
STUDENT OUTCOMES	
1.	Able to understand test and development aspects of programming by solving problems at

	Industry standards.
2.	Able to interpret any given problem using required domain skills, mathematics.
3.	Able to learn applicable methods to optimize solutions for any given problem.
4.	Able to develop programs using C language until elementary data structures with test driven development.

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Topic-1 Problem Solving through Abstract data structures- Stacks	**3.5**			
1.	Problem solving using Stacks, Coding solutions for the implementation of stack using an array, Coding solutions for the implementation of stack using a linked list, Problem solving on expression conversion and evaluation	3.5			
	Topic-2 Problem Solving through Abstract data structures- Queues	**3.5**			
2.	Problem solving using Queues, Coding solutions for the implementation of Queue using an array, Coding solutions for the implementation of Queue using a linked list, Examples, Practice problems.	3.5			
	Topic-3 Non-linear Data structures – Trees	**7**			
3.	Problem solving approaches using Non-linear data structures, Coding problems on the height of a binary tree, Size of a binary tree, Tree order traversals, Problem Solving on Binary Trees.	7			
	Topic-4 Algorithms – Greedy Algorithms – I	**6**			
4.	Greedy Strategy, Problem solving on greedy problems: coin change, fractional Knapsack, Scenario based problem solving implementing Greedy Methods, Practice problems.	6			
	Topic-5 Algorithms – Greedy Algorithms – II	**6**			
5.	Job sequencing solutions, Activity selection problem, Scenario based problem solving implementing Greedy Methods, Practice Problems.	6			
	Topic-6 Algorithms - Dynamic Programming – I	**6**			
6.	Introduction to Dynamic programming, Coding solutions to form Sub structures, Problem solving on Dynamic Knapsack, Trip optimization problem, Scenario based problem solving using Dynamic Programming approaches	6			
	Topic-7 Algorithms - Dynamic Programming – II	**6**			
7.	Coding solutions on Coin-change sub structure, Comparison of Greedy Vs DP for Coin change,	6			

	Sum of sub sets problem, Problem solving using Grid Memo, Problem solving on Longest Common Sub string, Longest Common subsequence, Minimum Edit Distance problems.				
	Topic-8 Algorithms - Dynamic Programming – III	**6**			
8.	Problem solving on Longest Increasing Sub sequences, Min sum path matrix, Max sum Sub square, Scenario based problem solving using Dynamic Programming approaches.	6			
	Topic-9 Optimized Problem Solving Approaches	**3**			
9.	Problem solving Methods and techniques: Complete, precise and consistent specification of the problem abstract, verification and analysis of the algorithm, Examples, Practice problems	3			
	Topic-10 Implementing Github	**1**			
10.	Actions on the GitHub, Security standards of the access, creating branches, Branching and merging, Examples.	1			
Total Hours		**48**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	
2.	
3.	

Course nature				**Theory &Practicals**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Mid term test I	Mid term test II	Quiz	Assignment	**Total**
	Weightage	25	25			**100**
End semester examination Weightage : 50						

SEMESTER-VI

<table>
<tr><td rowspan="2">ME 230</td><td colspan="2" rowspan="2">HEAT AND MASS TRANSFER</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Co-requisite:</td><td colspan="6">NIL</td></tr>
<tr><td>Prerequisite:</td><td colspan="6">Thermodynamics, Fluid Mechanics, Differential calculus</td></tr>
<tr><td>Data Book / Codes/Standards</td><td colspan="6">Heat and Mass Transfer data book</td></tr>
<tr><td>Course Category</td><td>P</td><td>PROFESSIONAL CORE</td><td colspan="4">Thermal and Fluids Engineering</td></tr>
<tr><td>Course designed by</td><td colspan="6">Department of Mechanical Engineering</td></tr>
<tr><td>Approval</td><td colspan="6">Academic Council Meeting</td></tr>
</table>

<table>
<tr><td>PURPOSE</td><td colspan="2">This course gives an introduction of heat transfer and different mechanisms of heat transfer such as conduction, convection, radiation along with fundamentals of mass transfer. Firstly, 1D conduction, steady state and transient analysis of heat transfer situations are studied. Concepts of convective mode of heat transfer including both forced and free modes of convection are discussed. The radiation heat transfer between any two bodies is discussed. The principles of heat transfer are used in analyses directed towards understanding the performances of engineering systems such as Heat exchangers and phenomena of condensation and boiling. Finally, a brief introduction to mass transfer is discussed. Although, Heat Transfer may appear to be just differential equations and empirical correlations, but the real-world importance of this subject is immense. This course is a foundation course offered in thermal and fluids engineering.</td></tr>
<tr><td colspan="2">LEARNING OBJECTIVES</td><td>STUDENT</td></tr>
</table>

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

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION	**9**			
1.	Definitions of heat and heat transfer. Difference between heat transfer and thermodynamics. Basic Modes and Laws of Heat Transfer.	5	C	1	1, 3, 4
2.	Examples of Heat and Mass Transfer. Engineering Applications of Heat Transfer.	4	C	1	1, 3, 4
	UNIT II – CONDUCTION	**9**			
3.	Fourier's law of heat conduction for homogeneous, isotropic media in Cartesian coordinates and its extension to heterogeneous, isotropic media (differential form).	2	C	2,4	1, 2, 3, 4,5
4.	Vectorial form of Fourier's law for heterogeneous, isotropic continua. Fourier's law in cylindrical and spherical coordinates.	1	C	2,4	1, 2, 3, 4,5
5.	Derivation of heat conduction equation in Cartesian coordinates for heterogeneous, isotropic materials. Heat conduction equation in Cartesian coordinates for (Case of constant	2	C	2,4	1, 2, 3, 4,5

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

	Boltzmann law, Wien's Displacement law, Lambert cosine law.				
20.	Radiation exchange between black surfaces, shape factor.	2	C	3,4	1,2,3,6,8
21.	Radiation exchange between gray surfaces – Radiosity-Irradiation method Parallel plates, Enclosures (non-participating gas), Gas radiation.	3	C-D	3,4,5	1,2,3,6,8
	UNITV: HEAT EXCHANGERS, CONDENSATION AND BOILING	**9**			
22.	Heat Exchangers: Types of heat exchangers, LMTD approach – parallel, counter-flow.	2	C	4	1,3,4,7
23.	Heat Exchangers: Multi-pass and cross flow heat exchanger, NTU approach – parallel and counterflow, shell and tube, cross flow heat exchanger.	3	C-D-I	3,4,5	1,3,7,8
24.	Condensation and Boiling: Dimensionless parameters, boiling modes.	2	C	4	1,3,4,7
25.	Condensation and Boiling: Correlations Forced convection boiling, laminar film condensation on a vertical plate, turbulent film condensation.	2	C-D-I	3,4,5	1,3,7,8
	UNIT VI: MASS TRANSFER	**9**			
26.	Analogy between heat and mass transfer, mass diffusion, Fick's law of diffusion, boundary conditions.	4	C	4	1,3,4,7
27.	Steady mass diffusion through a wall, transient mass diffusion, mass convection, limitations of heat and mass transfer analogy.	5	C-D	4	1,3,4,7
	Total contact hours	**45**			

LEARNING RESOURCES	
	TEXTBOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	F. P. Incorporeal, D. P. Dewitt, T. L. Bergman and A. S. Lavine, "Fundamentals of Heat and Mass Transfer", 7th Ed., John Wiley and Sons, 2011.
2.	J. P. Holman, "Heat Transfer", 10th Ed., McGraw Hill, 2009.

3.	Yunus A. Çengel, Afshin J. Ghajar, "Heat and mass transfer: fundamentals and applications", McGraw-Hill Education, 2015.
4.	P. K. Nag, "Heat and Mass Transfer", 3^{rd} Ed., McGraw Hill.
5.	M. N. Ozisik, Heat Transfer-A Basic Approach, McGraw Hill, 1985.
6.	Frank Kreith, Raj M. Manglik and Mark S. Bohn, "Principles of Heat Transfer", 7^{th} Ed., Cengage Learning, 2011.
7.	A. Bejan, Convective Heat Transfer, 3rd Ed., John Wiley and Sons, 2004.
8.	C. P. Kothandaraman and S. Subramanyan, "Heat and Mass transfer data book 6^{th} Ed. (Multi-color, edition) ",, New Age International Publishers, 2018.

<table>
<tr><td colspan="3">Course nature</td><td colspan="3">Theory</td></tr>
<tr><td colspan="6">Assessment Method (Weightage 100%)</td></tr>
<tr><td rowspan="2">In-semester</td><td>Assessment tool</td><td>Midterm I</td><td>Midterm II</td><td>Assignment</td><td>Total</td></tr>
<tr><td>Weightage</td><td>20%</td><td>20%</td><td>10%</td><td>50%</td></tr>
<tr><td colspan="4">End semester examination Weightage:</td><td colspan="2">50%</td></tr>
</table>

<table>
<tr><td rowspan="2">ME 230 L</td><td rowspan="2" colspan="2">HEAT AND MASS TRANSFER LAB</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Co-requisite:</td><td colspan="6">NIL</td></tr>
<tr><td>Prerequisite:</td><td colspan="6">Thermodynamics, Fluid Mechanics, Differential calculus</td></tr>
<tr><td>Data Book / Codes/Standards</td><td colspan="6">Heat and Mass Transfer data book</td></tr>
<tr><td>Course Category</td><td>P</td><td>PROFESSIONAL CORE</td><td colspan="4">Thermal and Fluids Engineering</td></tr>
<tr><td>Course designed by</td><td colspan="6">Department of Mechanical Engineering</td></tr>
<tr><td>Approval</td><td colspan="6">Academic Council Meeting</td></tr>
</table>

Session	**List of Experiments**	**Contact hours**	**C-D- I-O**	**IOs**	**Reference**
1.	Thermal conductivity of insulating powder.	1			
2.	Critical radius of insulating material.	1			
3.	Cross flow experiment with heated cylinder.	1			
4.	Heat transfer in natural convection.	1			
5.	Heat transfer in forced convection.	1			
6.	Pin – fin apparatus.	1			

7.	Emissivity measurement apparatus	1			
8.	Heat pipe demonstration.	1			
9.	Unsteady state heat transfer apparatus.	2			
10.	Critical heat flux apparatus.	1			
11.	Parallel / counter flow heat exchanger.	2			
12.	Condensation in drop and film forms.	2			
TOTAL HOURS		**15**			

ME 322	**ADVANCED 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 -- ,					

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 andMaterials.	1	C	1	1,2
2.	Pattern Allowances, Molding and its types,	1	C	1	1,2
3.	Molding 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 forceCalculations.	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 defectsin 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, andmultipoint.	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**			
27.	Gear Manufacturing viz Extrusion, Stamping and PowderMetallurgy.	1	C	4	1,2
28.	Gear Machining, Forming, Spur and Helical in millingMachine.	1	C	4	1,2
29.	Gear Generating: Gear shaping, Gear hobbling.	1	C	4	1,2
30.	Grinding process, Types of Grinding machines viz. Surface,Cylindrical and Centerless.	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 andtruing.	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 Machinesanditsbasicconstruction.	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, facemilling).	1	C	5	1,2
39.	Simple and differential Indexing methods and itscalculations.	1	C,D	5	1,2
40.	Shaping and slotting Machine, Its description andOperations.	1	C	5	1,2
41.	Planers: Double house and open side, Quick returnmechanism.	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 andoperations (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.	**TEXTBOOKS**

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
3.	Roy A. Lindberg, "*Processes and materials of manufacture*" Prentice Hall,1998
4.	John A. Schey, *"Introduction to manufacturing processes*",McGraw-Hill, 3rd Edition, 2000
5.	James S Campbell, "*Principles of manufacturing materials and processes*" New Delhi : Tata McGraw-Hill ,1983
6.	SeropeKalpakjian ,Steven R Schmid "*Manufacturing Engineering and Technology*" Pearson India, 4th Edition, 2002

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

ME 322 L	ADVANCED MANUFACTURING TECHNOLOGY LAB			L	T	P	C
				0	0	2	1
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 -- ,						

Sl.No.	Description of experiments	Contact hours	C-D- I-O	IOs	Reference
1.	Performing plain turning, step turning and chamfering in Lathe	1	O	1	1,2,3
2.	Performing taper turning by compound rest/offset method and drilling in Lathe	1	O	1	1,2,3
3.	Performing External threading, Internal thread cutting and eccentric turning in Lathe.	1	O	1	1,2,3
4.	Performing Taper boring and knurling in Lathe	1	O	1	1,2,3
5.	Performing V block shaping in shaper machine	1	O	2	1,2,3

6.	Performing Polygon milling in milling machine	1	D,I,O	3	1,2,3
7.	Spur Gear cutting in milling machine	1	D,I,O	3	1,2,3
8.	Helical Gear cutting in Hobbing machine	1	D,I,O	3	1,2,3
9.	Performing surface grinding in Grinding machine	1	O	4	1,2,3
10.	Performing cylindrical grinding in Grinding machine	1	O	4	1,2,3
11.	Grinding of single point cutting tool in Tool and Cutter grinding machine	1	O	4	1,2,3
12.	Preparation of Sand mold using solid/split pattern with loose-piece pattern	1	O	5	1,2,3
	Total contact hours*	**12**			

ME 226	**MEASUREMENT AND INSTRUMENTATION**		**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					

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, Physicalmeasurement.	1	C	1	1
2.	Methods of measurements, Classification and characteristics ofMeasuring 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, GaugeDesign.	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: OPTICALMETROLOGY and FORM MEASUREMENT	**9**			
19.	Principle of light wave interference, Light sources, Measurementswith optical flat.	1	C	3	1,5
20.	Types of Interferometers, Michelson, Twyman Green Specializationsof Michelson.	1	C	3	1
21.	NPL flatness Interferometers, The Pitter NPL gauge.	1	C	3	1,5
22.	Laser interferometer, Lasermicrometer,SurfaceRoughnessmeasurement 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 andrun out.	1	C,D	3	1,5
	UNIT IV: COORDINATEAND MACHINETOOLMETROLOGY	**6**			
26.	Introduction to Coordinate Metrology, difference betweenconventional and coordinate metrology.	1	C	4	1,5,10,11
27.	Components, types and construction of CMM, Types of measuringhead 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: THEORYOFCONTROL 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 andR 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 .
4.	Kevin Harding ,”*Handbook of Optical Dimensional Metrology”*, CRC Press, A Taylor & Francis group, 2013.
5.	Robert. J Hocken, Paulo H. Pereira, “Coordinate *Measuring Machines And Systems”*, CRC Press, Taylor & Francis Group, 2011.
6.	Connie Dotson, Roger Harlow and Richard L. Thompson, “*Fundamentals of Dimensional Metrology”, Thomson Delmar Learning”*, 4th edition, 2005.
7.	Toru Yoshizawa, “*Handbook of Optical Metrology: Principles And Applications*”, CRC Press, 2009
8.	Grant E. L., “*Statistical Quality Control”*, McGraw Hill, New York, 1972
9.	*Statistical Quality Control, M.Mahajan , Dhanpat Rai & co. Gagankapur ,2010*
10.	***Journal Publication***
11.	Heinrich Schwenke’, Ulrich Neuschaefer-Rube’, Tilo Pfeifer’ , Horst Kunzmann ,“*Optical Methods for Dimensional Metrology in Production Engineering*”, CIRP Annals- Manufacturing Technology ,Volume 51, Issue 2, 2002, Pages 685–699
12.	A. Weckenmann, T. Estler, G. Peggs, D. McMurtry ,”*Probing Systems in Dimensional Metrology*”, CIRP Annals - Manufacturing Technology Volume 53, Issue 2, 2004, Pages 657–684
13.	A.M.A. Al-Ahmari, JavedAalam,”*Optimizing parameters of freeform surface reconstruction using CMM”*, Measurement, 64 (2015) 17–28

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

ME 226 L	MEASUREMENT AND INSTRUMENTATION LAB		L	T	P	C
			0	0	2	1
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					

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 androllers.	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) andprocesscapability studies.	2	I,O	5	1
11.	Various parameter measurement using Computerized profileprojector.	2	I,O	4	1

12.	Gear and Thread measurement using Computerized profileprojector.	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 makersmicroscope.	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**			

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%**

		L	T	P	C
ME 427	**ROBOTICS**	**3**	**0**	**0**	**3**

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

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

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: INTRODUCTION	**8**			
1.	Basic concepts of robotics (Laws of robotics, roboticsystems), RIA definition.	1	C	1	1
2.	Robot anatomy (Robot configurations, Robot motions, Jointnotation scheme) Manipulators.	1	C	1	1
3.	Precisionmovement(Spatialresolution, accuracy,repeatability).	1	C	1	1
4.	Work volume, robot specifications.	1	C	1	1
5.	Types of Robot drives, electric drive, Hydraulic, pneumaticdrives.	1	C	1	1
6.	Basic robot motions, Point to point control and continuouspath 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 A	**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
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: ROBOTPROGRAMMINGANDAPPLICATIONS	**10**			
33.	Robot language, classification.	1	C	3	1
34.	Programming methods, off and onlineprogramming.	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.
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.

<table>
<tr><td colspan="5">Course nature</td><td colspan="4">Theory</td></tr>
<tr><td colspan="9">Assessment Method (Weightage 100%)</td></tr>
<tr><td rowspan="2">In-Semester</td><td>Assessment tool</td><td>Cycle Test I</td><td>Cycle Test II</td><td>Cycle Test III</td><td>Surprise Test</td><td>Quiz</td><td colspan="2">Total</td></tr>
<tr><td>Weightage</td><td>10%</td><td>15%</td><td>15 %</td><td>5%</td><td>5%</td><td colspan="2">50%</td></tr>
<tr><td colspan="7">End semester examination Weightage:</td><td colspan="2">50%</td></tr>
</table>

ME 228	Manufacturing Science	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:					
Data Book / Codes/Standards	Nil				
Course Category	P	Elective			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- ,				

PURPOSE								
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to learn								
1.		a	c					

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: METAL CASTING PROCESS	**9**			
1.	Introduction to metal casting, Solidification of Metals.	1			
2.	Characteristics of sand casting, Patterns.	1			
3.	Pattern allowances Pattern materials.	1			
4.	Types of patterns, Molding materials.	1			
5.	Molding sand properties.	1			
6.	Types of sand molds, Cores.	1			
7.	Gating system, Casting Defects.	1			
8.	Special casting processes, Cast structures.	1			
9.	Melting furnaces, Methods of Sand testing.	1			
	UNIT II: METAL JOINING PROCESS	**9**			
10.	Classification of joining processes.	1			
11.	Welding technique, Different welding processes: Gas Welding.1	1			

12.	Electric Arc Welding, Tungsten Inert-gas Welding (TIG).	1			
13.	Gas Metal-Arc Welding (GMAW).	1			
14.	Plasma Arc Welding (PAW).	1			
15.	Submerged Arc Welding (SAW)	1			
16.	Resistance Welding, Friction Stir Welding (FSW)	1			
17.	Thermite welding, Electron Beam Welding (EBW)	1			
18.	Laser Beam Welding (LBW), Weld Defects.	1			
	UNIT III: BULK DEFORMATION PROCESS	**8**			
19.	Introduction to bulk deformation processes.	1			
20.	Hot and cold working, Forging.	1			
21.	Types of forging, Forging defects, Rolling.	1			
22.	Defects in rolled products, Extrusion.	1			
23.	Metal flow in extrusion, Rod drawing.	1			
24.	Wire and Tube drawing, Swaging.	1			
25.	Severe plastic deformation processes: Friction stir processing.	2			
26.	Equal channel angular extrusion and high pressure torsion.	1			
	UNIT IV: METAL REMOVAL PROCESS	**9**			
27.	Mechanism of metal cutting, Types of tools.	1			
28.	Tool Geometry, Tool Signature.	1			
29.	Orthogonal and Oblique cutting.	1			
30.	Mechanics of chip formation, Chip morphology.	1			
31.	Tool wear and failure, Machinability.	1			
32.	Cutting-tool materials, Cutting fluids.	1			
33.	Brief description of metal removal processes: Turning.	1			

34.	drilling, boring and Milling.	1			
35.	Material removal rate and machining time.	1			
	UNIT V: POWDER METALLURGY	**9**			
36.	Production of metal powders	1			
37.	Particle size and shape.	1			
38.	blending of metal powders.	1			
39.	Compaction of metal powders.	2			
40.	Shaping processes, Sintering.	2			
41.	Finishing operations, Design considerations for powder metallurgy	2			
Total Hours		**45**			

LEARNING RESOURCES	
Sl. No.	**TEXTBOOKS**
1.	Manufacturing Science, 2nd Edition, A. Ghosh and A.K. Mallik.
2.	P.N. Rao, Manufacturing Technology, 3rd Edition, Tata McGraw Hill Edu Pvt Ltd, 2012.

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	S. Nagendra Parashar and R.K. Mittal, Elements of Manufacturing Processes, PHI Learning Pvt Ltd, 2011.
2.	R.L. Timings, Manufacturing Technology, 2nd Edition, Pearson Edu Ltd, 2010.
3.	Hajra Choudhury, Elements of Workshop Technology, Vol. I and II, Media Promotors Pvt Ltd, 2001.
4.	S.Gowri, P.Hariharan, and A.Suresh Babu, Manufacturing Technology I, Pearson Education,2008.
5.	Rajput R.K, A Text book of Manufacturing Technology, Lakshmi Publications, 2007.

ISES 302	Industry Specific Employability Skills-VI	L	T	P	C
		1	1	0	0
Co-requisite:	Nil				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	Skill building				
Course designed by	Department of CDC				
Approval					

PUR-POSE	To impart knowledge and equip with skills and aptitude that will enable learners ace competitive exams and placement tests with speed and precision.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
a.	Enhance lexical skills through systematic application of concepts and careful analysis of style, usage, syntax, semantics and logic							
b.	Build vocabulary through methodical approaches and nurture passion for learning new words							
c.	Helps students create a communication strategy.							
d.	Enable students to draft and design a resume and cover letter. Enable the students to handle the interview process effectively.							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I	**6**			
1.	Antonyms, synonyms, odd words	2	C and I		1
2.	Idioms and phrasal verbs, same word with different part of speech.	2	C and I		1
3.	Word analogy. Sentence completion	2			
	UNIT-II	**6**			
4.	Text completion, Sentence equivalence	2	C and I		1
5.	Introduction to Different Parts of an Argument in Reasoning , Assumption of an Argument	2	C and I		1,2
6.	Strengthening of an Argument, Weakening of an argument	2			
	UNIT- III	**6**			

7.	Para jumbles, Sentence Completion & Text Completion.	3	C and I		1
8.	Reading Comprehension, Identification of errors, Sentence correction	3	C and I		2
	UNIT-IV	6			
9.	Resume writing	3	C and I		5.6
10.	Cover letter	3	C and I		5,6
	UNIT-V	6			
9.	GD	3	C and I		5
10.	PI	3	C and I		5
	Total contact hours	**30**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	Verbal Ability and Reading comprehension-Sharma and Upadhyay.
2.	Charles Harrington Elstor, Verbal Advantage: Ten Easy Steps to a Powerful Vocabulary, Large Print, September 2000.
3.	GRE Word List 3861 – GRE Words for High Verbal Score, 2016 Edition.
4.	The Official Guide to the GRE-General Revised Test, 2nd Edition, Mc Graw Hill Publication.
5	Soft Skills Training: A Workbook to Develop Skills for Employment Book by Frederick H. Wentz.
6	The Resume Writing Guide: A Step-by-Step Workbook for Writing ...Book by Lisa McGrimmon.

ME 450	MULTI-DISCIPLINARY DESIGN PORJECT		L	T	P	C
			0	0	4	2
Co-requisite:	Nil					
Prerequisite:	Nil					
Data Book / Codes/Standards	Nil					
Course Category	P	PROFESSIONAL CORE				
Course designed by	Department of Mechanical Engineering					
Approval	-- Academic Council Meeting -- , 23rd					

PURPOSE	Students of any specialization at an undergraduate level learn courses related to various sub- domains (Multi-disciplinary) of their specialization individually. They are not exposed to understanding how the various multi-disciplinary fields interact and integrate in real life situations. It is very common that an expert in a particular domain models and designs systems or products oblivious of the impact of other subsystems. This lack of multi-disciplinary thinking is very blatantly visible when the students take up their major project during their final year. This course aims to develop appropriate skills on systemic thinking on how to identify and formulate a problem, decompose the problem into smaller elements, conceptualize 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,regionalandnationallaws,costingandfinancialmodelandundertakedocumentationand 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 aprofessionalmanner 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.	3	C,D,I,O	1,2, 3,4	1,2
2	Identifying and formulating a problem.	3			
3	System Modelling.	3			
4	Thinking perspectives: Decomposition–Composition Thinking HierarchicalThinking,Organizational. Thinking, Lifecycle Thinking, Safety Thinking, Risk Thinking,Socio-politico-culturalthinking, Environment thinking.	3			
5	Decomposing a system – Identifying the major sub-Systems.	2			
6	Mathematical Modeling and Governing equations foreach sub systems.	2			
7	Objectives, Constraints and Design Variables.	2			
8	Conceptual Design.	2			
9	Collaborative Design – Disciplinary teams satisfy the local constraints while trying to match the global constraints set by the project coordinator.	2			
10	Tools for modeling,designing,analysis, data interpretation, decision making etc.	2			
11	Design Analysis, evaluation and selection.	2			
12	Costing and Financial model.	2			

13	Documentation, reviewing and presentation.	2			
Total contact hours		**30**			

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

PURPOSE	Most of the real-world systems are made of more than one body connected by various joints which we call multibody systems. In order analyze the behavior of the systems under various real-world circumstances, the multibody system has to be reshaped to its mathematical form. Once we formulate the mathematical model of the multibody system, we can perform various analysis on the system to ensure the sustainability of the system for real world applications. In this subject the students will learn how to reshape the multibody system to its mathematical form and they also gets the knowledge of various techniques that are available for this purpose. The content of course is useful in various applications like vehicle dynamics, automobiles, robotics and any field that requires systems of multibody.							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Recollect the fundamentals required for studying the Multibody dynamics.							
2.	learn the fundamentals required for the kinematic analysis of multibody system.							
3.	To make students learn the fundamentals required for the dynamic analysis of multibody system.							
4.	Perform the kinematic analysis of multibody systems using the body coordinate formulation approach.							
5.	To make the students perform the dynamic analysis of multibody systems using the body coordinate formulation approach.							

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

2.	PRELIMINARIES OF MBD: Kinematics- Position, velocity, acceleration	1	C	1-2	1,5
3.	momentum, angular momentum.	1	C	1-2	1,5
4.	Kinetics- Force, moment, torque, equations of motion.	1	C,D	1,3	1,5
5.	Methods of formulations for MBD.	1	D	2-3	1,5
6.	MATHEMATICAL BACKGROUND FOR MBD: Vectors, Scalars, Arrays, Matrix operations.	1	D	2	1,5
7.	Differentiation of vectors, arrays and matrices.	1	D	2-3	1,5
8.	Differential equations.	1	D	2-3	1,5
	UNIT II:FUNDAMENTALS OF KINEMATICS	**6**			
9.	Kinematics of particles.	1	C	2	1,5
10.	Kinematics of a rigid body- position,velocity and acceleration of a rigid body.	1	C, D	2	1,5
11.	Array of coordinates, degrees of freedom.	1	C	2	1,5
12.	Constraint equations.	1	C	2	1,5
13.	Kinematics of joints.	1	C, D	2	1,5
14.	Numerical problems.	1	D, I	2	1,5
	UNIT III:FUNDAMENTALS OF DYNAMICS	**8**			
15.	Newton's laws of motion- Dynamics of particle and system of particles.	1	C	3	1,5
16.	Dynamics of rigid body- Centroidal equations of motion.	1	C	3	1,5
17.	Numerical problems.	1	D, I	3	1,5
18.	Non centroidal equations of motion.	1	C	3	1,5

19.	Force elements, applied forces- Gravitational forces, point to point actuator, point to point spring, point to point damper.	1	D	3	1,5
20.	Combined elements, rotational elements, viscous friction.	1	C	3	1,5
21.	Reaction Force: Method of Lagrange multipliers, Coulomb friction.	1	D	3	1,5
22.	Numerical problems.	1	D, I	3	1,5
	UNIT IV- BODY COORDINATE FORMULATION: KINEMATICS	**10**			
23.	General procedure.	1	C	4	1,5
24.	Formulation of kinematic joint constraints.	1	C, D	4	1,5
25.	Revolute, translational, composite and rigid joints.	1	C, D	4	1,5
26.	Numerical examples.	1	D, I	4	1,5
27.	Velocity and acceleration of joint constraints.	1	C	4	1,5
28.	Velocity and acceleration of joint constraints.	1	C	4	1,5
29.	Numerical examples.	1	D, I	4	1,5
30.	Formation of system Jacobian.	1	D, I	4	1,5
31.	Numerical examples.	1	D, I	4	1,5
32.	Numerical examples.	1	D, I	4	1,5
	UNIT V- BODY COORDINATE FORMULATION: DYNAMICS	**13**			
33.	Dynamics of system of unconstrained bodies.	1	C	5	1,5
34.	Dynamics of system of unconstrained bodies.	1	C	5	1,5
35.	Dynamics of two body system.	1	D	5	1,5

36.	Dynamics of two body system.	1	D	5	1,5
37.	Dynamics general unconstrained bodies.	1	C	5	1,5
38.	Numerical problems.	1	D, I	5	1,5
39.	Numerical problems.	1	D, I	5	1,5
40.	Dynamics of System of constrained bodies.	1	C	5	1,5
41.	Dynamics of System of constrained bodies.	1	C	5	1,5
42.	Numerical problems.	1	D, I	5	1,5
43.	Analysis of MBD system.	1	D, I	5	1,5
44.	Analysis of MBD system.	1	D, I	5	1,5
45.	Analysis of MBD system.	1	D, I	5	1,5
	Total Hours	**45**			

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

<table>
<tr><td colspan="4">Course nature</td><td colspan="4">Theory</td></tr>
<tr><td colspan="8">Assessment Method (Weightage 100%)</td></tr>
<tr><td rowspan="2">In-semester</td><td>Assessment tool</td><td>Cycle test I</td><td>Cycle test II</td><td>Cycle Test III</td><td>Surprise Test</td><td>Quiz</td><td>Total</td></tr>
<tr><td>Weightage</td><td>10%</td><td>15%</td><td>15%</td><td>5%</td><td>5%</td><td>50%</td></tr>
<tr><td colspan="7">End semester examination Weightage:</td><td>50%</td></tr>
</table>

ME 412	Additive Manufacturing Process	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P				
Course designed by	DEPARTMENT OF MECH				
Approval	-- Academic Council Meeting -- , 2016				

PURPOSE	

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

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I Introduction	**10**			
1.	Introduction to layered manufacturing.	1			
2.	Importance of Additive Manufacturing Additive Manufacturing in Product Development.	1			
3.	Classification of additive manufacturing processes.	1			
4.	Common additive manufacturing technologies; Fused Deposition Modeling(FDM).	1			
5.	Selective Laser Sintering(SLS), Stereo Lithography(SLA).	1			
6.	Selection Laser Melting (SLM), Jetting, 3D Printing.	1			
7.	Laser Engineering Net Shaping (LENS).	1			
8.	Laminated Object Manufacturing (LOM)	1			
9.	Electron Beam Melting (EBM). Capabilities.	1			
10.	materials, costs, advantages and limitations of different systems.	1			

	UNIT-II	**9**			
11.	Material science for additive manufacturing.	1			
12.	Mechanisms of material consolidation-FDM.	1			
13.	SLS,SLM, 3D printing and jetting technologies.	1			
14.	Polymers coalescence and sintering.	1			
15.	Photo polymerization. solidification rates.	1			
16.	Meso and macro structures.	1			
17.	Process evaluation: process.	1			
18.	structure relationships.	1			
19.	structure property relationships.	1			
	UNIT- III	**8**			
20.	Applications: Prototyping, Industrial tooling	1			
21.	Aerospace, Automobive. Medical etc.	1			
22.	Quality control and reliability: Defects in FDM.	1			
23.	SLS and SLM, Critical process parameters: Geometry.	1			
24.	temperature, composition.	1			
25.	phase transformation.	1			
26.	Numerical and experimental evaluation: roles of process parameter combination.	1			
27.	process optimization.	1			
	UNIT-IV	**9**			
28.	CAD Modelling for 3D printing: , 3D Scanning and digitization.	2			
29.	data handling &reduction Methods.	1			
30.	AM Software: data formats and standardization.	1			
31.	Slicing algorithms:-uniform flat layerslicing.	1			
32.	adaptive slicing.	1			

33.	Process-path generation: Process-path algorithms.	1			
34.	Rasterization.	1			
35.	Part Orientation and support generation.	1			
	UNIT – V	**9**			
36.	Lab: CAD Modeling: Introduction to CAD environment.	1			
37.	Sketching, Modeling and Editing Features.	1			
38.	Different file formats.	1			
39.	Export/Import geometries.	1			
40.	Part orientation.	1			
41.	Layer slicing.	1			
42.	Process path selection.	1			
43.	Printing.	1			
44.	Numerical and experimental evaluation.	1			
	Total contact hours	45			

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

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

ME 411	ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P	PROFESSIONAL ELECTIVE			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

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

Session	Description of Topic	Contact hours	C-D-I- O	IOs	Reference
	UNIT I: INTRODUCTION TO AI	**8**			
1	History, Definition of AI and Emulation of humancognitive 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 logicConnectives.	1	C	1	1
6	Nature of Environments.	2	D	1	1,2
	UNIT II: PROBLEM SOLVING AGENTS	**10**			

7	Problem Definition, formulatingproblems 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 andBreadth first search.	1	C	2	2,3
10	Uniform cost search: Depth first search, Depth limitedSearch.	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 ofknowledge in memory organization systems.	1	C	2	7
18	Matching Techniques: Need for matching and simpleMatching problems.	1	C,D	2	7
19	Partial matching, Fuzzy matching and RETE matchingAlgorithm.	1	C	2	7
20	Perception.	1	C	2	7
21	Natural language: Overview of linguistics and Basicsemantic analysis	1	C	2	7
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
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%**

Semester-VIII

ME 602	**DESIGN PROJECT/INDUSTRIAL PROJECT**		**L**	**T**	**P**	**C**
			0	**0**	**30**	**15**
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 -- , 23^{rd}					

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 thiscourse. 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 degreeprogrammed. 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 thedepartment. 5. The committee will then assess the student based on the report submitted and the presentationmade. 6. Marks will be awarded out of maximum100. 7. Appropriate grades will be assigned as per theregulations. 8. Only if a student gets a minimum of pass grade, appropriate credit will be transferred towards the degree requirements, as per theregulations. 9. It is solely the responsibility of the individual student to fulfill the above conditions to earn thecredits. 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 asZERO. 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 NOTsatisfactory.	15	D,I,O	1,2, 3,4	
	Total contact hours	**15**			

<table>
<tr><td colspan="3">Course nature</td><td colspan="2">Training – 100% internal continuous assessment</td></tr>
<tr><td colspan="5">Assessment Method (Weightage 100%)</td></tr>
<tr><td rowspan="2">In- semester</td><td>Assessment tool</td><td>Presentation</td><td>Report</td><td>Total</td></tr>
<tr><td>Weightage</td><td>80%</td><td>20%</td><td>100%</td></tr>
<tr><td colspan="4">End semester examination Weightage:</td><td>0%</td></tr>
</table>

ELECTIVES

ME 409	Thermal design for electronic equipment's	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P	Elective			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- ,				

PURPOSE	This course gives a primitive insight to electronic equipment's cooling and thermal design. The basic principles underlying in electronics cooling are introduced in this course. This is an applied subject where the knowledge of fluid mechanics and heat transfer are extensively used. The ever increasing advent of electronic gadgets and miniaturization of devices is of utmost practical relevance in the present era							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to learn								
1.		a	c					

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: FUNDAMENTALS OF HEAT TRANSFER	**9**			
2.	Review of Conduction	1			
3.	Convection and Radiation heat transfer.	2			
4.	Introduction to electronics packaging.	2			
5.	Basic definitions of electronics packaging.	2			
6.	classification of electronics packaging and self-heating in electronics packaging.	2			
	UNIT II: INTRODUCTION TO THERMAL MANAGEMENT OF ELECTRONICS PACKAGES AND DATACENTERS	**9**			
7.	Basic definitions of thermal management.	1			
8.	classification of thermal management of electronics packages and datacenters.	2			
9.	Concept of Contact resistance elastic-elastic contacts and elastic plastic contacts.	2			

10.	Conjugate heat conduction and thermal spreading: Derivation of analytical solution of heat spreading in heat sink base.	2			
11.	Fin analysis and heat sink design: Derivation of general thermal resistance network.	2			
	UNIT III	**9**			
12.	Natural convection in electronics packaging.	1			
13.	Radiation in electronic packages.	1			
14.	Forced convection in electronics, Liquid cold plates for electronics.	1			
15.	Jet impingement analytical solution derivation.	1			
16.	Boiling and Condensation.	1			
17.	Immersion cooling of electronics, design considerations	1			
18.	Introduction to heat pipes.	1			
19.	Phase change energy storage with PCM's.	1			
20.	Microchannel heat exchangers, Piezoelectric fans and synthetic jets.	1			
	UNIT IV	**9**			
21.	Thermoelectric modules.	1			
22.	derivation of analytical solution, Acoustic challenges.	2			
23.	thermal modelling of electronics packages and printed circuits.	2			
24.	Thermal design of fan heat sinks: fan/blower curves.	2			
25.	parallel plate fins, manufacturing processes.	1			
26.	design for manufacturability.	1			
	UNIT V	**9**			
27.	Thermal design of smartphones and tablets: case studies.	3			
28.	Thermal design of IT data centers Part 1 (IT equipment loop).	3			

29.	Thermal design of IT data centers Part 2 (IT facilities loop) chip to cooling tower Thermal design.	3			
Total Hours		**45**			

Sl. No.	TEXTBOOKS
1.	Lian-Tuu Yeh, Richard C. Chu, Dereje Agonafer, “Thermal management of microelectronic equipment _ heat transfer theory, analysis methods and design practices”, ASME press, 2002.
2.	F. P. Incropera, D. P. Dewitt, T. L. Bergman and A. S. Lavine, “Fundamentals of Heat and Mass Transfer”, 7th Ed., John Wiley and Sons, 2011.
3.	Allen D. Kraus and Avram Bar Cohen, “Design and Analysis of Heat Sinks”, Wiley-Interscience, 2008.
4.	Tummala Rao R., “Fundamentals of Microsystems packaging”, McGrawHill, 2004.

Sl. No.	REFERENCES
1.	Yunus A. Çengel, Afshin J. Ghajar, “Heat and mass transfer: fundamentals and applications”, McGraw-Hill Education, 2015.
2.	Ho Sung Lee, “Thermal Design: Heat Sinks, Thermo-electrics, Heat Pipes, Compact Heat Exchangers, and Solar Cells”, John Wiley and Sons,2010.
3.	Adrian Bejan, Allan D. Kraus, “Heat Tranfer Handbook”, Wiley-Interscience, 2003.
4.	Ralph Remsburg, “Thermal Design of Electronic Equipment”, CRC Press LLC, 2001.

ME 408	Advanced Materials	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Basic Metallurgy and materials				
Data Book / Codes/Standards	Nil				
Course Category	P Elective				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- ,				

PURPOSE	Materials have an important role in every field of engineering. The materials we use and how we make them can determine the function, feasibility, cost, environmental impact and many other aspects of things we create. Advanced Materials are the materials used in "High-Tec" applications, usually designed for maximum performance. Examples are titanium alloys for supersonic airplanes, magnetic alloys for computer disks, special ceramics for the heat shield of the space shuttle, etc. Design engineers, select the best material for a particular job, monitor its performance and figure out why a material failed and bring expertise on the properties of materials. To do this, design engineers need to understand that how materials are made, its structure/composition, how and why materials are useful, what is the limit of materials and how materials can be made better or create a new material that will have some desirable properties. The Advanced Materials course is to prepare the students of Mechanical Engineering for careers in Materials Engineering where knowledge of Properties and applications of different Advanced Materials can be applied for the selection of candidate material for a given task. This course will enable students to solve problems in materials upon graduation while at the same time, provide a firm foundation for the pursuit of graduate studies in Mechanical engineering.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to learn								
2.	Explain various steels with their composition, advantages, limitations and application.	a	c					
3.	Select and compare different steel for a given metallurgical application.	a	c					
4.	Describe different alloy cast irons.	a	c					
5.	Explain different Super Alloys with their strengthening mechanism, composition properties and applications.	a	c					
6.	Explain technique to producing metallic glass.	a	c					
7.	Explain different smart material with their application.							
8.	Explain requirements of biomaterials and suggest a biomaterial for a given application.							

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: SPECIAL STEELS	**14**			
42.	Metallurgical aspects, Composition.	1			
43.	Properties and applications of: different types of Stainless steels.	2			
44.	Dual phase steels, TRIP steels.	1			
45.	Maraging steels, High speed steels.	2			
46.	Hadfield steels, Free cutting steels.	2			
47.	Ausformed steels, Tool Steels, manganese steels.	2			
48.	chrome steels, electrical steels.	1			
49.	bearing steels, spring steels.	1			
50.	heat resistant steels, creep steels, HSLA steels etc.	2			
	UNIT II: ALLOY CAST IRON	**5**			
51.	Need of alloying. Silal	1			
52.	Nicrosilal, High silicon cast iron.	1			
53.	Ni-hard, Heat resistant.	1			
54.	cast iron: Composition.	1			
55.	Properties and their applications.	1			
	UNIT III: LIGHT METALS AND THEIR ALLOYS	**5**			
56.	Aluminium	1			
57.	magnesium and titanium alloys.	1			
58.	Metallurgical aspects.	1			
59.	Properties and applications.	2			
	UNIT IV: SUPER ALLOYS	**5**			
60.	Iron base.	1			

61.	nickel base and cobalt base super alloys.	1			
62.	Strengthening mechanism.	1			
63.	Composition, Properties and their applications.	2			
	RAPID SOLIDIFICATION	**6**			
64.	Metallic glasses, Atomic arrangement.	1			
65.	Comparison with crystalline alloys, properties & applications.	2			
66.	Glass transition temperature.	1			
67.	Glass forming ability	1			
68.	Techniques for Production of metallic glasses.	1			
	UNIT V: SMART MATERIALS	**5**			
69.	Shape memory alloys.	1			
70.	Piezoelectric materials.	2			
71.	Electro-rheological fluid.	1			
72.	Magneto- rheological fluids.	1			
	BIOMATERIALS	**5**			
73.	Property requirement	1			
74.	biocompatibility, bio functionality.	1			
75.	Important bio metallic alloys like: Ni-Ti alloy and Co-Cr-Mo alloys.	2			
76.	Applications	1			
Total Hours		**45**			

LEARNING RESOURCES	
Sl. No.	**TEXTBOOKS**
1.	The Science and Engineering of Materials by D. R. Askeland and P. P. Phule, Thomson Publication.
2.	Advances in Material Science by R. K. Dogra and A. K. Sharma.

3.	Material science by Van Black.
4.	Engineering Materials and Applications by R. A. Flinn and P. K. Trojan.
5.	Materials, their Nature, Properties and Fabrication by R. A. Lindberg and S. D. Sehgal, S Chand & Co.
6.	Light Alloys: Metallurgy of Light Metals by I. J. Polmear.
7.	Engineering Materials: Properties and applications of Metals and alloys by CP Sharma, PHI
8.	Engineering Materials: Polymers, ceramics and composites by AK Bhargava, PHI

ME 562	Mechanical behavior of materials	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:					
Data Book / Codes/Standards	Nil				
Course Category	P	Elective			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- ,				

PURPOSE	The central theme of this course is the mechanical behavior of engineering materials, such as metals, ceramics, polymers, and composites, subjected to different types of loading. The main objectives are to provide students with basic understanding of phase transformation by heat treating and stress-induced hardening, linear and nonlinear elastic behavior, deformation under multiaxial loading, plastic deformation and yield criteria, dislocation plasticity and strengthening mechanisms, creep, stress concentration effects, brittle versus ductile fracture, fracture mechanisms at different scales, fatigue, contact deformation, and wear.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to learn								
9.	Understand various types of deformation and failure of engineering materials subjected to various static and dynamic loadings.	a	c					
10.	Correlate microscopic and macroscopic material behaviors. Learn how to engineer the material properties to meet certain specifications.	a	c					
11.	Determine the safety factor for various possible failure modes and loadings.	a	c					
12.	Obtain hands-on- experience with standardized mechanical testing techniques and learn how to present/interpret the measurements in a formal report.	a	c					

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I	**9**			
77.	Introduction.	2			
78.	Structure property relationship.	3			
79.	Elasticity.	2			
80.	Isotropic/Anisotropic.	2			
	UNIT II	**9**			
81.	Viscoelasticity.	3			

82.	Elastic-Plastic Deformation.	3			
83.	Mechanical testing.	3			
	UNIT III	**5**			
84.	Heat Treatment. Strain Hardening.	1			
85.	Strain Rate and Temperature Effects on Deformation.	1			
86.	Slip, Dislocations	1			
87.	Twinning, and Hardening.	2			
	UNIT IV	**9**			
88.	Ductile and Brittle Fracture.	2			
89.	Fracture Mechanics. Creep	2			
90.	Fatigue	2			
91.	Cumulative Fatigue Damage.	2			
92.	Wear processes.	1			
	UNIT V	**5**			
93.	Special topics: Residual Stresses.	22			
94.	Ceramics, Glasses	2			
95.	Polymers.	1			
96.	Composites.	2			
	Mechanical Working, and Micromechanics	**2**			
Total Hours		**45**			

LEARNING RESOURCES	
Sl. No.	**TEXTBOOKS**
1.	Meyers and Chawla, Mechanical Behavior of materials, Cambridge publication

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	N. E. Dowling, Mechanical Behavior of Materials, Prentice-Hall.
2.	R.W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, 4th Ed., John Wiley & Sons, 1995.

ME 416	Surface Engineering	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:					
Data Book / Codes/Standards	Nil				
Course Category	P	Elective			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- ,				

PURPOSE								
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to learn								
13.		a	c					

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: INTRODUCTION TO SURFACE ENGINEERING	**9**			
97.	Differences between surface and bulk.	2			
98.	Properties of surfaces.	1			
99.	surface energy concepts.	1			
100.	degradation of surfaces, wear and its type	2			
101.	Adhesive, Abrasive.	1			
102.	Fretting, Erosion wear.	1			
103.	Surface fatigue.	1			
	UNIT II: FRICTION AND LUBRICATION	**9**			
104.	Fundamentals, Types and measurement of solid	2			
105.	liquid and gaseous friction.	1			
106.	Friction heat and calculation	2			
107.	Lubricants and additives.	2			

108.	mechanism of solid.	1			
109.	liquid and gaseous lubricants.	1			
	UNIT III: CORROSION	**9**			
110.	Different types of Corrosion and its prevention.	2			
111.	Galvanic corrosion.	1			
112.	Passivation, Pitting, Crevice.	1			
113.	Mircobial, High-temperature corrosion.	1			
114.	Corrosion in nonmetals.	1			
115.	polymers and glasses.	1			
116.	Protection from corrosion through surface modifications.	2			
	UNIT IV: CHANGING THE SURFACE METALLURGY	**10**			
117.	Localized surface hardening (flame, induction, laser, electron-beam hardening, Laser melting, shot peening)	1			
118.	Changing the surface chemistry: Phosphating.	1			
119.	Chromating, Anodizing (electrochemical conversion coating).	1			
120.	Carburizing, Nitriding, Ion implantation.	1			
121.	Laser alloying, boriding, Organic coatings (paints and polymeric or elastomeric coatings and linings)	1			
122.	Hot-dip galvanizing (zinc coatings).	1			
123.	Ceramic coatings (glass linings, cement linings, and porcelain enamels)	1			
124.	Advanced surface coating methods: Gaseous State (CVD, PVD etc).	1			
125.	Solution State (Chemical solution deposition, Electrochemical deposition, Sol gel, electroplating)	1			
126.	Molten or semimolten State (Laser cladding and Thermal spraying)	1			
	UNIT V: CHARACTERIZATION OF SURFACE AND COATINGS	**9**			
127.	Surface Characterization (physical and chemical methods, XPS, AES, RAMAN, FTIR etc)	2			

128.	Structural Characterization.	2			
129.	Mechanical Characterization (Adhesion, Hardness, Elastic Properties, Toughness, Scratch and Indentation etc.)	2			
130.	Tribological Characterization	2			
131.	Corrosion tests.	1			
Total Hours		**45**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Introduction to Surface Engineering and Functionally Engineered Materials, Peter Martin; Wiley, 2011.
2.	Materials and Surface Engineering: Research and Development, J. Paulo Davim; Woodhead Publishing review, 2012.
3.	Pradeep L. Menezes, "Tribology for Scientists and Engineers", Springer, 2013.
4.	Hand book, Friction, Lubrication and Wear Technology, Vol. 18, ASM.
5.	Krishna, R., Anantraman, T.R., Pande, C.S., Arora, O.P., Advanced techniques for microstructural characterization (ed), Trans Tech Publication

ECE 433	Introduction to High Performance Computing	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P				
Course designed by	DEPARTMENT OF MECH				
Approval	-- Academic Council Meeting -- ,				

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

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I	**12**			
48.	Introduction to HPC Systems.	3			
49.	architecture and OS concepts.	3			
50.	Multi-core CPUs.	3			
51.	GPU systems and High performance clusters.	3			
	UNIT-II	**12**			
52.	Introduction to basic numerical methods (stencil computations (_nite di_erences), linear system solutions, integration).	6			
53.	Sequential implementation.	6			
	UNIT- III	**10**			
54.	Programming paradigms: OpenMP and MPI	4			
55.	Thread Management	3			

56.	CUDA / OpenCL.	3			
	UNIT-IV	**11**			
57.	Data Dependency Reduction. Data flow.	3			
58.	Loop reordering. Purely Parallel Algorithms.	3			
59.	Block Decomposition Methods.	3			
60.	Parallel Programming Packages.	2			
	Total contact hours	45			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1.	Introduction to High Performance Computing for Scientists and Engineers. Chapman & Hall/CRC Computational Science Series.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	J. J. Dongarra, I. B. Du_, D. C. Sorensen and H. A. van der Vorst, Solving Linear Systems on Vector and Shared Memory Computers, SIAM, 1991.
3.	K. Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw-Hill, 1993.

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

ME 418	Introduction to Electric Vehicles	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P				
Course designed by	DEPARTMENT OF MECH				
Approval	-- Academic Council Meeting -- , 2016				

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

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I Introduction	**4**			
45.	History.	1			
46.	EV Benefits	1			
47.	EV/HEV subsystems and configurations.	2			
	UNIT-II Vehicle Dynamics	**10**			
48.	Vehicle dynamics.	2			
49.	forces acting.	2			
50.	power and torque calculations.	2			
51.	Simulations.	2			
52.	Drive cycles.	2			
	UNIT- III Batteries	**12**			

53.	Battery parameters.	2			
54.	why Li, SoH & SoC estimation/self discharge.	2			
55.	Battery pack design/development.	2			
56.	battery computations.	2			
57.	Charging.	1			
58.	BMS and its design.	2			
59.	future batteries	1			
	UNIT-IV Electrical Components for EV and HEV	**12**			
60.	EV Motors (IM, PM etc,)	3			
61.	D-q circuit.	2			
62.	DC-DC converters.	2			
63.	DC-AC converters.	2			
64.	control system overview	3			
	UNIT – V EV Design	**7**			
65.	Mechanical.	1			
66.	Electrical and Thermal design consideration.	3			
67.	Sample design calculations for EV and HEV's.	3			
	Total contact hours	45			

LEARNING RESOURCES	
	TEXT BOOKS
6.	Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
7.	Electric Powertrain - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles by John G. Hayes and A. Goodarzi, Wiley Publication
	REFERENCE BOOKS/OTHER READING MATERIAL
8.	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2018.
9.	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

<table>
<tr><td colspan="4">Course nature</td><td colspan="2">Theory</td><td></td></tr>
<tr><td colspan="6">Assessment Method (Weightage 100%)</td><td></td></tr>
<tr><td rowspan="2">In-semester</td><td>Assessment tool</td><td>Cycle test I</td><td>Cycle test II</td><td>Quiz</td><td>Assignment</td><td>Total</td></tr>
<tr><td>Weightage</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">End semester examination Weightage :</td><td></td></tr>
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ME 456	ADVANCED THERMODYNAMICS			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:							
Data Book / Codes/Standards	Approved Steam Tables, Refrigeration Tables and Psychrometric Chart.						
Course Category	P	PROFESSIONAL CORE	THERMAL ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting -- , 23rd						

PURPOSE	To expose the students to learn the fundamental concepts of gas and vapour power cycles, ICengines, 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 standardefficiency. Assumptions.	1	C	1	1,2
2.	Otto cycle: Air standard efficiency, mean effectivepressure, Power developed. Tutorials.	3	C,D	1	1,2
3.	Diesel cycle: Air standard efficiency, mean effectivepressure and power developed. Tutorials.	3	C,D	1	1,2
4.	Dual cycle: Air standard efficiency, Mean Effectivepressure 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 inBrayton 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 engines.	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 aircompressors,Construction andworking.	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 withoutclearance. 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 withoutclearance.	3	C,D	3	1,2
20.	Rotary compressors, vane compressor, roots blower - Comparison between reciprocating compressors androtary 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 andsuperheating.	2	C,D	4	1,2
28.	Simple and practical vapor absorptionrefrigeration 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 ANDAIR 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	1	C,D	4	1,2

	streams and propertycalculations.				
35.	Summer, Winter and Year-round air conditioningsystems. 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 *	**45**			

*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.
3.	Yunus A Cengel; Michael A Boles,"*Thermodynamics: An Engineering Approach*",8th edition Tata McGraw Hill, New Delhi-2015.
4.	Kothandaraman.C.P, Domkundwar.S, AnandDomkundwar, "*A Course in Thermal Engineering*", DhanpatRai& Co. (P) Ltd., 2010.
5.	Rajput.R.K, "*Thermal Engineering*", Laxmi Publications, 10th Edition, New Delhi, 2015.
6.	Sarkar.B.K, "*Thermal Engineering*", 3rd Edition, Tata McGraw Hill, New Delhi, 2009.

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

ME 457	FUNDAMENTALS OF VIBRATION AND NOISE			L	T	P	C
				3	0	0	3
Co-requisite:	Nil						
Prerequisite:							
Data Book / Codes/Standards	Nil						
Course Category	P	PROFESSIONAL CORE	DESIGN ENGINEERING				
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting -- , 23rd						

PURPOSE	To familiarize the students with the sources of vibration and noise in machines and make design modifications to reduce the vibration and noise and improve the life of the components							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know the concepts of vibration and noise.	a						
2.	Analyze the Single Degree, Two Degree and Multi degree ofFreedom 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 ofVibration.	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 freevibration systems.	2	C,D	1	1,2
4.	Equation of motion for free damped single Degree ofFreedom systems.	2	C,D	1	1,2
5.	Tutorials on free damped single Degree of FreedomSystems.	2	C,D	1	1,2

6.	Torsional Vibration of Two Rotor and three rotorSystems.	1	C,D	1	1,2
7.	Tutorials on Torsional Vibration of Two Rotor and threerotor Systems.	2	C,D	1	1,2
8.	Torsional Vibration of Geared Systems with Two andThree 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 Vibrationisolation.	1	C,D	2	1,2
17.	Whirling of shaft and tutorials.	1	C,D	2	1,2
	UNIT III: MULTI DEGREE OF FREEDOM SYSTEMS	**12**			
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. DOFusingLagrangian energy method for Un-damped freevibration.	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 VibrationAbsorber.	2	C,D	2	1,2
23.	Tutorials on Linear and torsional undamped VibrationAbsorber.	2	C,D	2	1,2
	UNIT IV: **NUMERICAL METHODS**	12	C,D		
24.	Stiffness and FlexibilityInfluence Coefficientsandtutorials.	2	C,D	2,3	1,2
25.	Eigenvalue, Eigenvector and orthogonal Properties and Tutorials.	2	C,D	2,3	
26.	Concept of Dun Kerley's and Rayleigh's method.	**1**	C,D	3	1,2
27.	Tutorials on Dun Kerley'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 systemand 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 planebalancing.	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 atreceiver.	2	C	3	1,8
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES

Sl. No.	TEXT BOOKS
1.	Rao.S.S,"*MechanicalVibrations*",5thEdition,PearsonEducatio nInc.Delhi2009.
2	Ambekar.A.G, "*Mechanical Vibrations and Noise engineering*", PHI New Delhi, 2015.
3	Thomson.W.T, "*Theory of Vibration and its Applications*",5th Edition, Prentice Hall, New Delhi, 2001.
4.	Meirovitch, L., "*Elements of Vibration Analysis*", Mc Graw – Hill Book Co., New York, 1986.
5.	Rao.J.S and Gupta.K, "*Introductory course on theory and practice of mechanical vibrations*", 2nd Edition,New Age International, New Delhi, 2014.
6.	Keith Mobley.R, "*Vibration Fundamentals*", Plant Engineering Maintenance Series, Elsevier, 2007.
7.	Ramamurthi.V, "*Mechanical Vibration Practice with Basic Theory*", 1st edition, Narosa Publishing House, Chennai, 2000.
8.	Kewelpujara, "*Vibration and noise for engineers*", Dhanpatrai& Sons, 2009.

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

ME 458	GAS DYNAMICS AND SPACE PROPULSION		L	T	P	C
			3	0	0	3
Co-requisite:	Nil					
Prerequisite:						
Data Book / Codes/Standards	Approved Gas Tables					
Course Category	P	PROFESSIONAL CORE	THERMAL ENGINEERING			
Course designed by	Department of Mechanical Engineering					
Approval	-- Academic Council Meeting -- , 23rd					

PURPOSE	On completion of this course, the students will be in a position to apply their knowledge to solve problems in basic compressible fluid flow, performance of aircraft and rocket engines.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the compressible fluid flow concepts	a	e					
2.	Solve isentropic flow problems through variable area ducts and normal shocks	a	e					
3.	Analyze flow through constant area duct with friction and heat transfer	a	e					
4.	Analyze the performance of aircraft propulsion	a	e					
5.	Analyze the performance of rocket propulsion	a	e					

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: FUNDAMENTALS OF COMPRESSIBLE FLOW	**9**			
1.	Energy equation for compressible fluid flow, Stagnation state and Mach number.	1	C	1	1,2
2.	Various regimes of flow, reference velocities, Critical states, second kind Mach number, Crocco number.	1	C	1	1,2
3.	Equivalent of Bernoulli’s equation for compressible flow,	2	C	1	1,2

	Effect of Mach number on compressibility.				
4.	Types of waves - subsonic, sonic and supersonic waves. Mach cone, Mach angle.	2	C	1	1,2
5.	Problems in isentropic compressible flow.	1	C	1	1,2,6
6.	Problems in isentropic compressible flow.	1	C	1	1,2,6
	UNIT II: FLOW THROUGH VARIABLE AREA DUCTS	**9**			
7.	**Flow through variablearea duct:** T-S andh-sdiagrams for nozzles and diffusers, Area ratio as a function of Mach number, Impulsefunction.	1	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 (Flinger's formula).	1	C	2	1,2,6
9.	Problems in variable area flow nozzles and diffusers.	1	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 entropyacross 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, Windtunnels.	2	C,D	2	1,2,6
	UNIT III: FLOW THROUGH CONSTANT AREA DUCTS	**9**			
13.	Flow in constant area ducts with friction (Fanno flow), Fanno curves, Fanno flow equations, Variation of flow properties.	1	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	1	C	3	1,2,6
18.	Problems in Rayleigh flow.	1	C, D	3	1,2,6
	UNIT IV: AIRCRAFT PROPULSION	**9**			
19.	Types of aircraft engines, Energy flow through Jetengines.	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.	2	C, D	4	1,2
23.	Problems in aircraft propulsion.	1	C,D	4	1,2
	UNIT V: ROCKET PROPULSION	**9**			
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.	2	C	5	1,2
27.	Rocket Propulsion theory and performance, problems.	1	C,D	5	1,2
	Total contact hours*	**45**			

*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, 5^{th} Edition, 2010.
3.	Mattingly. J. D, "*Elements of Gas turbine Propulsion*", McGraw Hill, 2005
4.	James John, Theo Keith, "*Gas Dynamics*", Pearson, 3^{rd} Edition, 2006
5.	Yahya. S. M, "*Fundamentals of compressible flow with Aircraft and Rocket Propulsion*", New Age International (P) Ltd, New Delhi, 3^{rd} Edition, 2005
6.	**DATA BOOK**
7.	Yahya.S.M, "*Gas Tables for compressible flow calculations*", New Age International (P) Ltd, New Delhi, 6^{th} Edition, 2011

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

ME 459	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

Co-requisite:	Nil		
Prerequisite:	15ME305		
Data Book / Codes/Standards	*Approved Design Data Book*		
Course Category	P	PROFESSIONAL CORE	DESIGN ENGINEERING
Course designed by	Department of Mechanical Engineering		
Approval	-- Academic Council Meeting -- , 23rd		

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

Session	Description of Topic	Contact hours	C-D- I-O	Ios	Reference
	UNIT I: DESIGN OF FLEXIBLE DRIVES	**12**			
1.	Belt drives: types, selection of belt drives, belt materialsand applications.	1	C	1	1
2.	Design procedure and problems on flat belt drives usingfundamental equations & manufacturer's data.	3	C,D	1	1
3.	Design procedure and problems on V-belt drives usingfundamental equations & manufacturer's data.	2	C,D	1	1
4.	Wire ropes: types, construction and designation of wireropes, 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 transmissionchains and sprockets.	2	C,D	1	1
	UNIT II: DESIGN OF PARALLEL GEARS	**12**			

8.	Review of gear fundamentals, Forces and stresses in geartooth.	1	C	2	1
9.	Equivalent number of teeth, gear tooth failures, selectionof gear materials.	1	C	2	1
10.	Design procedure and problems on spur gear based onstrength consideration.	3	C,D	2	1
11.	Design procedure and problems on spur gear based onwear consideration.	2	C,D	2	1
12.	Design procedure and problems on helical gear based onstrength consideration.	3	C,D	2	1
	Design procedure and problems on helical gear based onwear consideration.	2	C,D	2	1
13.	**UNIT III: DESIGN OF NON-PARALLEL GEARS**	**10**			
14.	Straight bevel gear: Terminology, Forces and stresses ongear tooth.	1	C	2	2
15.	Design procedure and problems on bevel gear based onstrength consideration.	2	C,D	2	2
16.	Design procedure and problems on bevel gear based onwear consideration.	2	C,D	2	2
17.	Worm gear: Thermal capacity, efficiency, forces andstresses.	1	C,D	2	2
18.	Design procedure and problems on worm gear based onstrength consideration.	2	C,D	2	2
19.	Design procedure and problems on worm gear based onwear consideration.	2	C,D	2	2
	UNIT IV: DESIGN OF GEAR BOXES	**12**			
20.	Geometric progression, standard step ratio, structural andray 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 gearbox.	2	C,D	3	6
24.	Design of Multi speed gear box for machine toolapplications.	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 ANDBRAKES	**14**			

27.	Sliding contactbearings: types,assumptions andterminology 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 loadrating, 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 rimclutches.	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 expandingshoe 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.
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

<table>
<tr><th colspan="4">Course nature</th><th colspan="4">Theory</th></tr>
<tr><td colspan="8">Assessment Method (Weightage 100%)</td></tr>
<tr><td rowspan="2">In-semester</td><td>Assessment tool</td><td>Cycle Test I</td><td>Cycle Test II</td><td>Cycle Test III</td><td>Surprise Test</td><td>Quiz</td><td>Total</td></tr>
<tr><td>Weightage</td><td>10%</td><td>15%</td><td>15%</td><td>5%</td><td>5%</td><td>50%</td></tr>
<tr><td colspan="7">End semester examination Weightage:</td><td>50%</td></tr>
</table>

ME 434	ELEMENTS OF MECHATRONICS	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P	PROFESSIONAL CORE	MANUFACTURING ENGINEERING		
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

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

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: INTRODUCTION TO MECHATRONICS	**8**			
1.	Introduction to Mechatronics systems.	1	C	1	1
2.	Mechatronics system components and Measurement Systems, Control Systems.	1	C	1	1
3.	Open and Closed Loops Systems temperature control.	1	C	1	1
4.	Water level controller and Shaft speed control.	2	C	1	1
5.	Transfer function: Laplace transform, system in series and System with feedback loop.	1	C,D	1	1

6.	Sequential Controllers: Washing machine control.	1	C	1	1
7.	Sequential Controllers: Digital camera.	1	C	1	1
	UNIT II: - SENSORS AND TRANSDUCERS	**11**			
8.	Introduction to sensors and transducers and classifications.	1	C	2	1
9.	Principle and working of Resistive, capacitive, inductiveand resonant transducers.	2	C	2	1
10.	Optical measurement systems for absolute and incrementalencoders.	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 magneticmeasurements.	1	C	2	1,2
14.	Temperature measurements.	1	C	2	1
15.	Chemicalmeasurements,piezoelectricsensorandaccelerometers.	1	C	2	1,2
16.	Ultrasonic sensors and transducers for flow and distance.	1	C	2	2
	UNIT III: ELECTRICAL DRIVESAND CONTROLLERS	**10**			
17.	Introduction, Electromagnetic Principles, Solenoids andRelays.	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 Dataacquisition system.	1	C	3	1
22.	Proportional, Integral, Derivative and PID controller.	1	C	3	1
23.	Introduction to Micro controller: M68HC11 andATMEGA328.	2	C	3	1
	UNIT IV:PROGRAMMABLE LOGIC CONTROLLERS	**8**			
24.	Basic structure, Programming units and Memory ofProgrammable 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 Simpleapplications.	1	C,D	4	1
	UNIT V: MECHATRONICS SYSTEM DESIGN AND APPLICATION	**8**			
30.	Mechatronics in Engineering Design, Traditional andmechatronics 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.	**TEXTBOOKS**
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.
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.

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<tr><td rowspan="2">In- semester</td><td>Assessment tool</td><td>Cycle Test I</td><td>Cycle Test II</td><td>Cycle Test III</td><td>Surprise Test</td><td>Quiz</td><td>Total</td></tr>
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<tr><td colspan="7">End semester examination Weightage:</td><td>50%</td></tr>
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	MAJOR PROJECT		**L**	**T**	**P**	**C**
			0	**0**	**22**	**11**
Co-requisite:	Nil					
Prerequisite:	Nil					
Data Book / Codes/Standards	Nil					
Course Category	P	PROFESSIONAL CORE				
Course designed by	Department of Mechanical Engineering					
Approval	-- Academic Council Meeting -- , 23rd					

PURPOSE	The Major Project experience is the culminating academic endeavor of students who earn a degree in their Undergraduate Programs. The project provides students with the opportunity to explore a problem or issue of 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, tomake 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 andskills 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, andindividuals.	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 anddemonstrate 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 aprofessional 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 herprogram 3. Major Project course consists of one semester and would be allowed to register only during the final year ofstudy. 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 basedone. 5. Each team in the major project course will consist of maximum of 5students. 6. Each project will be assigned a faculty, who will act as thesupervisor. 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 formonitoring project deliverables and group coordination.		C, D, I,O	1,2,3, 4, 5	

	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 andHumanities. 10. Each student team is expected to maintain a logbook that would normally be used to serve as a record of the way in which the project progressed during 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 subsequentwork. 12. The logbook may be formallyassessed; 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 finalreview. 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 thereport. 17. The project report must possess substantialtechnical depth and require the students to exercise analytical, evaluation and design skills at the appropriate level.				
	Total contact hours	**17**			

<table>
<tr><td colspan="3">Course nature</td><td colspan="3">Project – 100 % Internal continuous Assessment</td></tr>
<tr><td colspan="6">Assessment Method (Weightage 100%)</td></tr>
<tr><td rowspan="2">In-semester</td><td>Assessment tool</td><td>Review 1</td><td>Review 2</td><td>Review 3</td><td>Total</td></tr>
<tr><td>Weightage</td><td>10 %</td><td>15%</td><td>20%</td><td>45%</td></tr>
<tr><td rowspan="2">End semester examination</td><td>Assessment Tool</td><td>Project Report</td><td colspan="2">Viva Voce</td><td></td></tr>
<tr><td>Weightage:</td><td>25 %</td><td colspan="2">30 %</td><td>55%</td></tr>
</table>

ME 435	FUNDAMENTALS OF HYDRAULICS AND PNEUMATICS		L	T	P	C
			3	0	0	3
Co-requisite:	Nil					
Prerequisite:	Nil					
Data Book / Codes/Standards	Nil					
Course Category	P	PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering					
Approval	Academic Council Meeting, 23rd					

PURPOSE	To understand the Hydraulic, pneumatic systems and creating circuits for given industrial applications.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the basics of fluid power systems.		e					
2.	Understand principles and characteristics of hydraulic and pneumaticComponents.		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
	UNITIIHYDRAULICSYSTEMAND COMPONENTS	**11**			
7.	Sources of Hydraulic Power: Pumping theory, PumpClassification.	1	C	2	1,2
8.	Gear pumps: construction and working of internal andexternal 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, radialpiston pumps.	1	C	2	1,2
11.	Construction of Control Components: Directionalcontrol valves, types 4/2, 4/3, check valve, flow control valve.	2	C	2	1,2
12.	Pressure controlvalves: construction andworking ofrelief 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 singleacting, double acting, and telescopic cylinders.	1	C	2	1,2
15.	Rotary actuators: construction and working of gear, vaneand piston motors.	1	C	2	1,2
	UNIT III PNEUMATIC SYSTEMSAND COMPONENTS	**10**			
16.	Introduction, comparison with hydraulic systems andelectrical systems, Properties of air.	1	C	2	1,3
17.	Construction, operation, characteristics and symbols ofreciprocating and rotary compressors.	2	C	2	1,3
18.	Need for air treatment, Filter, Regulator, Lubricator,Muffler and Dryers.	1	C	2	1,3
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 DESIGNOF HYDRAULIC ANDPNEUMATIC CIRCUITS	**10**			
23.	Speed, force calculations, and Sizing of actuators in fluidpower systems.	1	C,D	3	1,2,3
24.	Design of hydraulic/pneumatic circuits for simplereciprocation, regenerative, speed control of actuators.	1	C, D	3	1,2,3
25.	Design of hydraulic/pneumatic circuits: synchronizingand sequencing circuits.	1	C, D	3	1,2,3
26.	Sequential circuit design for simple applications usingcascade method.	1	C, D	3	1,2,3
27.	Electrohydraulic and Pneumatic logic circuits, ladderdiagram 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 / pneumaticcircuits for materialhandlingsystems.	1	C, D	3	1,2,3
34.	Preventive and breakdown, maintenance procedures influid power systems.	1	C	4	1,2,3
35.	Trouble shooting of fluid power systems, fault findingprocess equipment’s / 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.	**TEXTBOOKS**
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
4.	Werner Deppert , Kurt Stoll, "*Pneumatic Application:Mechanization and Automation by Pneumatic Contro"l,* Vogel verlag, 1986.
5.	John Pippenger, Tyler Hicks, "*Industrial Hydraulics*", McGraw Hill International Edition, 1980.
6.	Andrew Parr, "*Hydraulics and Pneumatics: A technician's and engineer's guide*", Elsevier Ltd, 2011.
7.	FESTO, "*Fundamentals of Pneumatics*", Vol I, II and III.
8.	Hehn Anton, H., "*Fluid Power Trouble Shooting",* Marcel Dekker Inc., NewYork, 1995.
9.	Thomson, "*Introduction to Fluid power",* Prentice Hall, 2004.

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

ME 436	INDUSTRIAL TRIBOLOGY			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:							
Data Book / Codes/Standards	Approved design data book, Approved tribology data sheets, ASTM standards						
Course Category	P	PROFESSIONAL ELECTIVE					
Course designed by	Department of Mechanical Engineering						
Approval	Academic Council Meeting, 23rd						

PURPOSE	To present the engineering concepts of friction, its effects and different lubrication theories and types used in industries							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Identify the friction and wear in materials.	a	c	e	j			
2.	Study various types of lubricants and their properties	a	c	e				
3.	Understand the preparation of bearing materials	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: SURFACES AND FRICTION	**9**			
1.	Introduction to the concept of tribology, Tribologicalproblems.	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.	Cavitation’s, 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 LUBRICATIONTYPES	**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
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 ANDMATERIALS FOR BEARINGS	**9**			
34.	Classification of Surface modifications and Surfacecoatings.	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.
4.	Stolarski.T.A, "*Tribology in Machine Design*", Industrial Press Inc., 1990.
5.	Bowden.E.P. and Tabor.D, "*Friction and Lubrication*", Heinemann Educational Books Ltd, 1974.
6.	Cameron.A, "*Basic Lubrication Theory*", Longman, U.K., 1981.
7.	Neale.M.J. (Editor), "*Tribology Handbook*", Newnes Butter worth, Heinemann, U.K., 1975.

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

ME 437	PROCESS PLANNING AND COST ESTIMATION		L	T	P	C
			3	0	0	3
Co-requisite:	Nil					
Prerequisite:	Nil					
Data Book / Codes/Standards	Nil					
Course Category	P	PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering					
Approval	Academic Council Meeting , 23rd					

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

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: PROCESS PLANNING	**8**			
1.	Production system and Types of production.	1	C	1	1,2
2.	Standardization and Simplification.	1	C	1	1
3.	Production design and selection.	1	C	1	1,2,5,6
4.	Process planning, Selection and analysis.	1	C	1	1
5.	Manual/Experience based planning.	1	C	1	1,2
6.	Variant type CAPP.	1	C	1	1,2,3
7.	Generative type CAPP.	1	C	1	1,2,3
8.	Processes analysis, Break even analysis.	1	C,D	1	1,2
	UNIT II:COSTING AND ESTIMATION	**9**			
9.	Objectives of costing and estimation: Functions andprocedure.	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	**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: Equipment's, 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.
3.	Nanua Singh, "*System Approach to Computer Integrated Design and Manufacturing*", John Wiley & Sons, New York, 1996.
4.	Joseph G. Monks, "*Operations Management, Theory and Problems*", McGraw Hill Book Company, New Delhi, 1982.
5.	Narang.G.B.S and Kumar.V, "*Production and Planning*" , Khanna Publishers, New Delhi, 1995.
6.	Chitale.A.K and Gupta.R.C, "*Product Design and manufacturing*", Prentice Hall of India, New Delhi, 2007.

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

ME 438	INTERNAL COMBUSTION ENGINES		L	T	P	C
			3	0	0	3
Co-requisite:	Nil					
Prerequisite:	Nil					
Data Book / Codes/Standards	Nil					
Course Category	P	PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering					
Approval	-- Academic Council Meeting -- , 23rd					

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

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: COMPONENTS OF IC ENGINES AND PERFORMANCE	**9**			
1.	Classification of internal combustion engines, application of IC Engines.	1	C	1	1
2.	Function and operation of two stroke and four stroke engines.	1	C	1	1
3.	Comparison of SI and CI, two stroke and four stroke engines.	1	C	1	1
4.	Effects, limitations, and types of supercharging and scavenging process.	1	C	1	1
5.	Performance characteristics of IC engines.	2	C, D	1	1
6.	Numerical problems on performance and heat	2	C, D	1	1

	balance.				
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-cooledcooling system,coolantand antifreezesolutions.	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
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, Emissionstandards.	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.
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, NewDelhi, 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**	**Cycle**	**Cycle**	**Cycle Test**	**Surprise**	**Quiz**	**Total**

	tool	**Test I**	**Test II**	**III**	**Test**		
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

ME 230	**ALTERNATIVE SOURCES OF ENERGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	3

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

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

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: SOLAR ENERGY	**9**			
1.	Solar radiation and its measurements.	1	C	1	1,2
2.	Types of solar thermal collectors.	1	C	1	1,2
3.	Solar thermal applications for water heaters, solar stills and solar pond.	1	C	1	1,2
4.	Solar thermal applications for refrigeration and air- conditioning system.	1	C	1	1,2
5.	Solar thermal applications for solar dryer, solar cookers and solar furnaces.	1	C	1	1,2

6.	Sensible and latent heat thermal energy storage systems	1	C	1	1,2
7.	Solar thermal power generation systems	1	C	1	1,2
8.	Solar photovoltaic systems: basic working principle and components.	1	C	1	1,2
9.	Applications of solar photovoltaic systems.	1	C	1	1,2
	UNIT II: WIND ENERGY	**9**			
10.	Basic principle of wind energy conversion system.	1	C	2	1,2
11.	Wind data, site selection and energy estimation.	1	C,D	2	1,2
12.	Components of wind energy conversion systems.	1	C	2	1,2
13.	Types of Horizontal axis and Vertical axis wind turbine.	1	C	2	1,2
14.	Design consideration of horizontal axis wind turbine.	1	C	2	1,2
15.	Aero foil 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
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	1	C	3	1,2

	distribution, scope and economics for geothermal plant.				
	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.
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.

<table>
<tr><td colspan="5">Course nature</td><td colspan="3">Theory</td></tr>
<tr><td colspan="8">Assessment Method (Weightage 100%)</td></tr>
<tr><td rowspan="2">In-semester</td><td>Assessment tool</td><td>Cycle Test I</td><td>Cycle Test II</td><td>Cycle Test III</td><td>Surprise Test</td><td>Quiz</td><td>Total</td></tr>
<tr><td>Weightage</td><td>10%</td><td>15%</td><td>15%</td><td>5%</td><td>5%</td><td>50%</td></tr>
<tr><td colspan="7">End semester examination Weightage:</td><td>50%</td></tr>
</table>

ME 439	INDUSTRIAL ENGINEERING		L	T	P	C
			3	0	0	3
Co-requisite:	Nil					
Prerequisite:	Nil					
Data Book / Codes/Standards	Nil					
Course Category	P	PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering					
Approval	-- Academic Council Meeting -- , 23rd					

PURPOSE	To provide the basic features of Industrial Engineering like work study, materialhandlingproduction 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 Work study.	1	C	1	1,3,5
6.	Method study, Techniques and procedures of Productivity.	1	C	1	1,3,5
7.	Charging Techniques.	1	C	1	1,3,5

8.	Motion economy principles.	1	C	1	1,3,5
9.	SIMO chart, Ergonomics and Industrial design.	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
	UNITIII -WORKDESIGN 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.	Environmentalfactors,organizationalf actors &behavioral factors influencing effective jobdesign.	2	C	3	1,3,5
21.	Ergonomics, Objectives system approach of ergonomic.	2	C	3	1,3,5
	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 - PRODUCTIONPLANNING				

	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.
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

<table>
<tr><td colspan="4">Course nature</td><td colspan="4">Theory</td></tr>
<tr><td colspan="8">Assessment Method (Weightage 100%)</td></tr>
<tr><td rowspan="2">In- semester</td><td>Assessment tool</td><td>Cycle Test I</td><td>Cycle Test II</td><td>Cycle Test III</td><td>Surprise Test</td><td>Quiz</td><td>Total</td></tr>
<tr><td>Weightage</td><td>10%</td><td>15%</td><td>15%</td><td>5%</td><td>5%</td><td>50%</td></tr>
<tr><td colspan="7">End semester examination Weightage:</td><td>50%</td></tr>
</table>

ME 440	ADVANCED FLUID MECHANICS		L	T	P	C
			3	0	0	3
Co-requisite:	Nil					
Prerequisite:	15ME205					
Data Book / Codes/Standards	Nil					
Course Category	P	PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering					
Approval	-- Academic Council Meeting -- , 23rd					

PURPOSE	To familiarize the students about the principles and flow aspects of fluid mechanics.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the fundamentals of irrotational flows	a	e					
2.	Apply Exact Solutions of the Naiver-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 Legally 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 Naiver-Stokes Equations.	1	CC	2	1,2
7	Two-Dimensional Flow Between Parallel Plates, Poiseuille Flow in a Rectangular Conduit, Poiseuille Flow in a RoundConduit.	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'sFirstProblem, 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
16	Linear Stability Theory of Fluid Flows.	2	C	3	2,4
	Thermal Instability in a Viscous Fluid—Rayleigh- BernardConvection.	**2**	C, D	3	2,4
18	Stability of Flow Between RotatingCircular Cylinders: Couette-TaylorInstability.	**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
3.	Stevan A Jones, "*Advanced Methods for Practical Applications in Fluid Mechanics*", InTech Publishers, 2012.
4.	Hyoung Woo Oh, "*Advanced Fluid Mechancis*", InTech Publishers, 2012.

5.	Roger Kinsky, "*Fluid Mechanics Advanced Applications*", McGraw-Hill Education Europe, 1997

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

ME 441	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	Approved Standard Normal Distribution Table				
Course Category	P	PROFESSIONAL ELECTIVE			
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd				

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

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference/ Textbooks
	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,	1	C	1	1, 2

	Simplex method - Graphical method of Solution.				
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 MethodofSolution.	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 REPLACEMENTMODEL	**9**			
10.	Transportation problem –Assumption , Definition, Formulation and Solution - North west cornermethod.	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
	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'sRule.	1	C	3	1, 2
22.	Network computations – Earliest Completion time of a project and Critical path.	1	C,D	3	1, 2
23.	Program Evaluation Review Technique.	1	C,D	3	1, 2
24.	Total Slack, Free Slack, Probability of achieving completiondate.	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 quantitydiscount.	1	C,D	4	1, 2
32.	Multi item deterministic model, safety stock, storage quantitydiscount.	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	1	C,D	4	1, 2

	channel problem.				
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 makingEnvironments-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
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.
3.	Fredric.S.Hilleer and Gerold J. Lieberman, “*Introduction to Operation Research*”, 2nd Edition, CBS, 1974.
4.	Handy, “A. Taha, “*Operations Research*”, 5th Edition, Prentice Hall of India, New Delhi, 1997.
5.	Philip and Ravindran, “*Operational Research*”, John Wiley, 2000.

6.	Sundaresan.V, GanapathySubramanian.K.S, "*Resource Management Techniques: Operations Research*" A.R Publications, 2003.
7.	Panneerselvam.K, "*Operation Research*", Prentice Hall of India, 2002.

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

ME 406	COMPUTATIONAL FLUID DYNAMICS		L	T	P	C
			3	0	0	3
Co-requisite:	NIL					
Prerequisite:						
Data Book / Codes/Standards	Nil					
Course Category	P	PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering					
Approval	-- Academic Council Meeting -- , 23rd					

PURPOSE	To impart knowledge about various computational methods of fluid flow and solve simple fluid flow problems.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student should be able to understand								
1.	The formulation of governing equations for fluid flow and themmathematical 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	1	C	1	1

	equation,Three-dimensional momentum equation				
5.	Naviera'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.	Discretization of wave equation.	1	C	2	1
12.	Discretization of Laplace equation.	1	C	2	1
13.	Numerical error types and stability criterion.	1	C	2	1
14.	One dimensionaltransientheat conduction equation discretization.	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.	McCormack's Technique.	1	C	3	1
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 aero foilfrom 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 discretization-Central differencing scheme.	1	C	5	2
38.	Upwind scheme, hybrid scheme.	1	C	5	2
39.	One dimensional conduction problem.	1	C,D	5	2
40.	One dimensional convection problem.	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.	**TEXTBOOKS**
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.
4.	Suhas.V. Patankar, "*Numerical Heat Transfer and Fluid Flow*", Hemisphere Publishing Corporation, 2009.
5.	Muralidhar.K, and Sundararajan.T, "*Computational Fluid Flow and Heat Transfer"*, NarosaPublishingHouse, New Delhi, Second Edition, 2008.
6.	Ghoshdasdidar.P.S, "*Computer simulation of fluid flow and heat transfer"*, Tata McGraw Hill Publishing. Company Ltd., 1998.

7.	Anil W. Date, "*Introduction to computational fluid dynamics",* Cambridge University Press, Cambridge,2009.

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

ME 442	ADVANCED ENGINEERING THERMODYNAMICS			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:	Nil						
Data Book / Codes/Standards	Nil						
Course Category	P	PROFESSIONAL ELECTIVE					
Course designed by	Department of Mechanical Engineering						
Approval	-- Academic Council Meeting --, 23rd						

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

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I:AVAILABILITY ANALYSISAND THERMODYNAMIC 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 changesInEntropy, 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 entropydeparture, 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 reactingsystems.	3	C,D	2	1,3
12.	Second law analysis of reacting systems, Criterion forreaction equilibrium.	2	C,D	2	1,3
13.	Equilibrium constant for gaseous mixtures, evaluation ofequilibrium composition.	2	C,D	2	1,3
	UNIT IV: STATISTICAL THERMODYNAMICS	**9**			
14.	Statistical thermodynamics-introduction, energy states and energy levels, macro and	2	C	3	1,3

	microscales,thermodynamic probability				
15.	Maxwell–Boltzman, Fermi–Diarc and Bose–Einsteinstatistics statistics, distribution function.	3	C,D	3	1,3
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
4.	Bejan, A., "*Advanced Engineering Thermodynamics*", John Wiley and Cons, 1988
5.	Holman, J.P., "*Thermodynamics*", 4th Edition, McGraw – Hill Inc., 1988.
6.	Sonntag, R.E., and Van Wylen, G, "*Introduction to Thermodynamics, Classical and Statistical Themodynamics*", John Wiley and Sons, 3rd Edition, 1991

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

ME 443	FINITE ELEMENT METHODS		L	T	P	C
			3	0	0	**3**
Co-requisite:	NIL					
Prerequisite:	Nil					
Data Book / Codes/Standards	NIL					
Course Category	P	PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering					
Approval	Academic Council Meeting, 23rd					

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

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

	calculation.				
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 equationusing 2-node 1D element.	1	C,D	1,2	2, 3
12.	Example problems, solving first order differential equationusing 1D-sub-parametric elements.	2	C,D	1,2	2, 3
13.	Weighted residual approaches, Galerkin formulation andPoint-collocation.	1	C,D	1,2	2, 3
14.	Example problems on Galerkin formulation, simple regularbeam sections with different types of loads.	1	C,D	1,2	2, 3
15.	Example problems on Point-collocation- simple regular beamsections 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 – simpleregular beam sections with different types of loads.	1	C,D	1,2	2, 3
18.	Example problems on Least-square minimization – simpleregular 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, LSTand 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
	quadrilateral Elements.				
22.	Element stiffness matrix formulation for two dimensionalelements.	1	C,D	1,2	2, 3

23.	Gauss Numerical Integration- Derivation of one pointandtwo-point formula.	2	C,D	1,2	2, 3
24.	Example Problems on Gauss Numerical Integration usingone point and two-point formula (1D problems).	2	C,D	1,2	2, 3
	UNIT-4: EIGEN VALUE PROBLEMS for one-dimensionproblems (DYNAMICCONSIDERATION).	**8**			
25.	Formulation- Hamilton's Principle- Characteristic polynomialTechnique.	2	C,D	1,2	2, 3
26.	Element mass matrix formulation for one dimensionalElements (2-node isoperimetric and 3-node sup –parametric elements).	2	C,D	1,2	2, 3
27.	Example problems for 1-D Problems to find eigenvalues andeigenvectors- using 2-node isoperimetric.	2	C,D	1,2	2, 3
28.	Example problems for 1-D Problems to find eigenvalues and eigenvectors- using 3-node isoperimetric.	2	C,D	1,2	2, 3
	UNIT-5:STEADY STATE HEAT TRANSFER ANALYSIS	**9**			
29.	Introduction, straight uniform fin analysis, Derivation 1DElement matrices.	1	C,D		2, 3
30.	Example Problems, straight uniform fin analysis.	1	C,D		2, 3
31.	Example Problems, Taper fin analysis, Heat Flex Boundaryconditions.	1	C,D		2, 3
32.	Analysis of uniform fins using 1D Quadratic Elements.	1	C,D		2, 3
33.	Two Dimensional Steady stateProblems, using CSTElements.	1	C,D		2, 3
34.	Example Problems for 2D steady Problems using CST Elements	2	C,D		2, 3

35.	1-D and 2-D simple Problems using any commercial FEA software	2	C,D	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.
3.	Chandrupatla, T.R., Belegundu, A.D., "*Introduction to Finite Elements in Engineering*", Prentice Hall of India, 1997.
4.	Zienkiewicz, O.C., "*Finite Elements and Approximation*", Dover International, 2006.
5.	Cook R.D., Malkus, D.S., Plesha, M.E., Witt, R.J., "*Concepts and Applications of Finite Element Analysis*", 4th Edition, John Wiley & Sons, 2001.

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

ME 444	MICRO CONTROLLER AND ITS APPLICATION IN ROBOTICS		L	T	P	C
			3	0	0	3
Co-requisite:	NIL					
Prerequisite:	NIL					
Data Book / Codes/Standards	NIL					
Course Category	P	PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering					
Approval	-- Academic Council Meeting -- , 23rd					

PURPOSE	To study the basic concepts of microcontroller and apply the knowledge in the field of robotics.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the fundamental concepts of 8051 microcontroller.	a						
2.	Learn to program the microcontroller using assembly language.	a	e					
3.	Program and interface the microcontroller with the external world usinga high level language.	a	e					
4.	Get knowledge about an open source microcontroller and itsprogramming.	a						
5.	Design a Microcontroller system and to get know its variousapplications.		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 setswith 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 LCDInterfacing.	1	C,D	3	1,5
19.	Analog outputs are DC motor, Stepper motor, Servomotor and its interfacing.	3	C,D	3	4,5
20.	Digital inputs are keypad and its interfacing.	1	C,D	3	1,5
	UNITIV: OPENSOURCE MICROCONTROLLER ANDITS	**9**			

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

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

ME 445	MACHINERY FAULT DIAGNOSTICS AND SIGNAL PROCESSING		L	T	P	C
			3	0	0	3
Co-requisite:	NIL					
Prerequisite:	NIL					
Data Book / Codes/Standards	NIL					
Course Category	P	PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering					
Approval	-- Academic Council Meeting -- , 23rd					

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

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: FAILURE ANALYSIS	**9**			
1.	Failures and failure analysis.	1	C	1	1,3
2.	Failure concepts and characteristics.	1	C	1	1,3
3.	Fault detection sensors.	1	C	1	1,3
4.	Data processing and signal analysis.	2	C	1	1
5.	Condition based maintenance principles.	1	C	1	1
6.	Fault analysis planning and system availability.	1	C	1	1,3
7.	Reliability/failure concepts.	1	C	1	1,3
8.	Application of diagnostic maintenance to specific industrial machinery and plants.	1	C	1	1
	UNIT II: FAULT DIAGNOSTICS AND VIBRATION	**9**			
9.	Principles of Maintenance.	1	C	1	1
10.	Failure Modes Effects and Criticality Analysis.	2	C	1	1

11.	Fault Diagnostics and Prognostics.	2	C	1	1,3
12.	Basics of Machinery Vibration.	1	C	1	2
13.	Engineering Applications of Vibration.	1	C	1	2
14.	Rotor dynamics.	2	C	1	2
	UNIT III: SIGNAL ANALYSIS	**9**			
15.	Time Domain Signal Analysis.	1	C	2	1,2
16.	Frequency Domain Signal Analysis.	1	C	2	1,2
17.	Computer Aided Data Acquisition.	2	C	2	1,2
18.	FFT Analysis.	1	C	2	1,2
19.	Modulation and Sidebands.	1	C	2	1,2
20.	Envelope Analysis.	1	C	2	1,2
21.	Cepstrum Analysis.	1	C	2	1,2
22.	Order Analysis.	1	C	2	1,2
	UNIT IV: INSTRUMENTATION AND DETECTION	**9**			
23.	Data Recording and Transmission.	1	C	3	2
24.	Vibration Transducers, Vibration Monitoring.	1	C	3	2
25.	Basics of Noise and Noise Monitoring.	1	C	3	2
26.	Numerical problems in Noise Vibration and Data Acquisition.	2	C,D	3	2
27.	Unbalance Detection, Field Balancing.	1	C	3	2,3
28.	Misalignment Detection, Cracked Shaft Detection.	1	C	3	2,3
29.	Looseness and Rub Detection, Ball and Journal Bearings.	1	C	3	2,3
30.	Gear Fault Detection.	1	C	3	2,3
	UNIT V: EQUIPMENT TESTING AND ANALYSIS	**9**			
31.	Fans, Blowers, Compressors, Pumps and Turbines.	1	C	3	3
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 Ultrasonic.	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.
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**	**Cycle Test I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
				End semester examination Weightage :			**50%**

ME 446	ADVANCED STRENGTH OF MATERIALS	L	T	P	C
		3	0	0	3
	NIL				
Prerequisite:					
Data Book / Codes/Standards	Approved PSG Design Data Book, Supplementary Approved Data Book				
Course Category	P	PROFESSIONAL ELECTIVE			
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd				

PURPOSE	To familiarize the students in the area of stress, strain and deformation for a 3D problems.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
Upon successful completion of the course the students will be able to solve practical problems involving								
1.	Stress – strain relation in 3-D.	a	e					
2.	unsymmetrical bending.	a	e					
3.	Curved Flexural Members.	a	e					
4.	Torsion of noncircular sections.	a	e					
5.	Stress in flat plates.	a	e					
6.	Contact stresses.	a	e					

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: INTRODUCTION	**9**			
1.	Plane Stress - Plane strain relations.	1	C	1	1
2.	General equations of elasticity in Cartesian, polar and spherical co-ordinates equations of equilibrium.	1	C, D	1	1
3.	Representation of 3-dimentinal stress of tensor, Stress at a point - inclined plane.	1	C, D	1	1
4.	3D stress at a point - Principal stress.	1	C, D	1	1
5.	3D Stress transformation.	1	C, D	1	1
6.	Generalized Hooke’s law.	1	C, D	1	1
7.	St. Venant’s principle.	1	C, D	1	1
8.	Compatibility and boundary conditions.	1	C, D	1	1, 6

9.	Airy's stress function.	1	C, D	1	6
	UNIT II: UNSYMMETRICAL BENDING AND SHEAR STRESS ON BEAMS	**9**			
10.	Stress and deflections in beams subjected to unsymmetrical loading – Double (I) symmetry sections.	1	C, D	2	1
11.	Stress and deflections in beams subjected to unsymmetrical loading –Single symmetry (T) sections.	1	C, D	2	1
12.	Stress and deflections in beams subjected to unsymmetrical loading –Single symmetry (C)sections.	1	C, D	2	1
13.	Stress and deflections in beams subjected to unsymmetrical loading – Unsymmetrical (L) sections.	2	C, D	2	1
14.	Kern of a section.	1	C, D	2	1
15.	Shear Stress Distribution on beams – Thin walled sections.	1	C, D	2	1
16.	Shear Center - Location of shear center for various sections.	1	C, D	2	1
17.	Shear flow.	1	C, D	2	1
	UNIT III: CURVED FLEXURAL MEMBERS	**9**			
18.	CURVED FLEXURAL MEMBERS: circumferential and radial stresses – Winkler Bach Theory.	2	C, D	3	1
19.	Circumferential and radial stresses for curved beam with restrained ends.	2	C, D	3	1
20.	Deflections in Curved Flexural Members.	1	C, D	3	1
21.	Closed ring subjected to concentrated loading.	1	C, D	3	1
22.	Closed ring subjected to uniform load.	1	C, D	3	1
23.	Chain links.	1	C, D	3	1
24.	Crane hooks.	1	C, D	3	1
	UNIT IV: TORSIONON 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.
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**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME 460	ADDITIVE MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P DEPARTMENT ELECTIVE				
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To familiarize with the concepts of additive manufacturing techniques and its post processing operations.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Expose themselves to the evolution and basics of additive manufacturingtechnologies.	c	k					
2.	Familiarize withPowder based additive manufacturing technologies.	c	k					
3.	Familiarize with Liquid based and Solid based additive manufacturingtechnologies.	c	k					
4.	Expose themselves to other additive manufacturing technologies like 3D printer, Ballistic 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 Process of 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
	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
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**	**Cycle Test I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5 %**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME 447	COMPUTER GRAPHICS			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL ELECTIVE					
Course designed by	Department of Mechanical Engineering						
Approval	Academic Council Meeting , 23rd						

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

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: INTRODUCTION	**9**			
1.	Origin of computer graphics	1	C	1	1
2.	Interactive graphics display	1	C	1	1
3.	Display devices , pixels	1	C	1	1
4.	Algorithms for line and circle	2	C	1	1
5.	2D transformation (scaling, rotation, translation)	1	D	1	1
6.	3D transformation (scaling, rotation, translation)	2	D	1	1
7.	Concatenation transformations	1	D	1	2
	UNIT II: SPECIAL CURVES	**9**			
8.	Curve representation	1	C	2	1
9.	Parametric representation of Bezier curve	2	C	2	1
10.	Parametric representation of Cubic spline curve	2	C	2	1
11.	Parametric representation of B-Spline curve	2	C	2	1

12.	Parametric representation of Rotational curves.	1	C	2	1
	UNIT III: SURFACES	**9**			
13.	Surface modeling techniques.	1	C	3	1
14.	Mathematical representation and boundaries Coons Patch.	2	C	3	2
15.	Mathematical representation of Bi-Cubic patch.	2	C	3	1
16.	Bezier and B-Spline surfaces.	4	C	3	1
	UNIT IV: THREE-DIMENSIONAL COMPUTER GRAPHICS	**9**			
17.	Boundary representation (B-rep), basic elements and building operations.	2	C	4	2
18.	Constructive solid geometry (CSG), basic elements and building operations.	2	C	4	2
19.	Viewing transformations.	1	C	4	1
20.	Clipping operations.	1	C	4	1
21.	Hidden line removal for curved surfaces.	1	C	4	1
22.	Algorithms for shading and rendering.	2	C	4	1
	UNIT V: GRAPHICS AND COMMUNICATION STANDARDS	**9**			
23.	Graphical Kernel System.	2	C	5	1
24.	Bit maps and open GL (graphics library).	2	C	5	1
25.	Data exchange standards (IGES, STEP, CALLS, DXF,STL).	3	C	5	2
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.
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**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME 448	AUTOMOTIVE ENGINEERING	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P	PROFESSIONAL ELECTIVE			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

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

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: AUTOMOBILE ARCHITECTURE AND PERFORMANCE	**9**			
1.	Automotive components, subsystems and their positions of Chassis, frame and body	3	C	1	1, 3
2.	Front, rear and four wheel drives	1	C	1	1, 2
3.	Operation and performance	1	C, D	1	1, 2
4.	Traction force and traction resistance	2	C, D	1	1, 2

5.	Power required for automobile	2	C, D	1	1, 2
	UNIT II: TRANSMISSION SYSTEMS	**9**			
6.	Clutch types, coil spring and diaphragm type clutch, single and multi plate clutch, centrifugal clutch.	3	C	2	1,3
7.	Gear box types, constant mesh, sliding mesh and synchromesh gear box, layout of gear box, gear selector and shifting mechanism.	3	C, D	2	1,3
8.	Overdrive, automatic transmission, Rolling, air and gradient resistance.	1	C	2	1,3
9.	Propeller shaft, universal joint, slip joint.	1	C	2	1,3
10.	Differential and real axle arrangement, hydraulic Coupling.	1	C	2	1,3
	UNIT III: WHEEL, TYRES, AND BRAKING SYSTEM	**9**			
11.	Types of wheels, construction, wired wheels.	1	C	3	1, 2
12.	Tyres, construction, radial, bias & belted bias, slip angle, tread patterns, tyre retreading cold & hot, tubeless tyres.	3	C	3	1, 2
13.	Forces on vehicles, tyre grip, load transfer, braking distribution between axles, stopping distance.	2	C, D	3	1, 2
14.	Types of brakes, Mechanical, Hydraulic, Air brakes, Disc & Drum brakes.	2	C	3	1, 3
15.	Engine brakes, anti lock braking system.	1	C	3	1, 3

	UNIT IV: SUSPENSION AND STEERING SYSTEM	**9**			
16.	Types-front and rear suspension, conventional and independent type suspension.	2	C	4	1, 3
17.	Leaf springs, coil springs, dampers, torsion bars, stabilizer bars, arms, air suspension systems.	2	C	4	1, 3
18.	Types of steering systems, Ackermann principle, Davis steering gear, steering gear boxes, steering linkages.	2	C	4	1, 3
19.	Power steering, wheel geometry, caster, camber toe in, toe out.	2	C	4	1, 3
20.	Wheel Alignment and balancing.	1	C	4	1, 3
	UNIT V: ELECTRICAL SYSTEM ANDADVANCES IN AUTOMOTIVE ENGINEERING	**9**			
21.	Battery,Generalelectricalcircuits,Dash	2	C, D	5	1, 3
22.	Passenger comfort, safety and security, HVAC, seatbelts, 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.
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**	**Cycle Test I**	**CycleTest II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

ME 449	FATIGUE , FRACTURE MECHANICS AND CREEP	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	Nil				
Data Book / Codes/Standards	NIL				
Course Category	P	PROFESSIONAL ELECTIVE			
Course designed by	Department of Mechanical Engineering				
Approval	Academic Council Meeting , 23rd				

PURPOSE	To bring awareness and education of very important topic of fatigue, fracture mechanics and creep							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand fatigue and design for fatigue life	a	b					
2.	Understand fracture and its mechanisms	a	b					
3.	Understand creep, creep rupture and creep fatigue interaction.	a	b					

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: INTRODUCTION TO FATIGUE	**9**			
1.	Introduction to fatigue.	1	C	1	1
2.	Stress and strain cycles.	1	C	1	1
3.	S-N curves.	1	C	1	1
4.	Statistical nature of fatigue	1	C	1	1
5.	Low cycle fatigue, High cycle fatigue.	1	C	1	1
6.	Basquin equation, Coffin and Manson equation.	1	C	1	1
7.	Strain life equation.	1	C	1	1
8.	Design for fatigue.	2	C,D	1	1
	UNIT II: EFFECT OF VARIOUS PARAMETERS ON FATIGUE	**9**			
9.	Effect of stress concentration on fatigue.	1	C	1	1

10.	Size effect.	1	C	1	1
11.	Surface effects and fatigue.	1	C	1	1
12.	Corrosion Fatigue.	1	C	1	1
13.	Effect of mean stress on fatigue.	1	C	1	1
14.	Engineering analysis of fatigue strength.	1	C	1	1
15.	Cumulative fatigue damage.	1	C	1	1
16.	Effect of metallurgical variables on fatigue.	1	C	1	1
17.	Effect of temperature on fatigue.	1	C	1	1
	UNIT III: FRACTURE MECHANICS	**9**			
18.	Introduction to fracture mechanics (FM).	1	C	2	1
19.	Modes of crack and types of fracture in metals.	1	C	2	1
20.	Linear elastic fracture mechanics (LEFM).	2	C	2	2
21.	Griffith's theory of brittle fracture.	1	C	2	1
22.	Irwin's modification.	1	C	2	1
23.	Determination of stress intensity factor(K and K_{IC}).	2	C	2	2,3
24.	Plane strain fracture toughness.	1	C	2	5,6
	UNIT IV: APPLICATIONS OF FRACTURE MECHANICS	**9**			
25.	Theories of elastic and plastic fracture mechanics (EPFM).	1	C	2	2
26.	Crack opening displacement (COD).	1	C	2	1,2
27.	Crack tip opening displacement (CTOD).	1	C	2	1,2
28.	J-integral.	1	C	2	3
29.	Ductile fracture.	1	C	2	1
30.	Notch effect.	1	C	2	1
31.	Concept of fracture curve, fracture under combined stresses.	1	C	2	1
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 curves.	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, 3rd SI metric edition", 1989.
2.	Robert P. Wei, Fracture Mechanics, "*Integration of Mechanics, Materials Science and chemistry*", Cambridge University Press, 2010.
3.	Richard W. Hertzberg, "*Deformation and Fracture Mechanic of Engineering Materials*", John Wiley & sons, 1995.
4.	Prashant Kumar, "*Elements of Fracture Mechanics*", Tata McGraw-Hill, New Delhi, 2009.
5.	Suryanarayana.A.V.K, "*Testing of Metallic Materials*", 2nd Edition, BS Publication, Hyderabad, 2007.
6.	Davis H.E, Troxell G.E, Hauck G.E.W, "*Testing of Engineering Materials*", 4th Edition, McGraw Hill, Int. Students, 1982.

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

ME 452	FLEXIBLE MANUFACTURING SYSTEMS		L	T	P	C
			3	0	0	3
Co-requisite:	Nil					
Prerequisite:	Nil					
Data Book / Codes/Standards	Nil					
Course Category	E	PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering					
Approval	-- Academic Council Meeting -- , 23rd					

PURPOSE	To impart knowledge on group technology, Flexible manufacturing system anditsimplementation.							
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.
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.
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, FuliXiong, 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**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
				End semester examination Weightage :			**50%**

ME 453	COMBUSTION ENGINEERING	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:					
Data Book / Codes/Standards	Nil				
Course Category	P	PROFESSIONAL ELECTIVE			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

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

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - COMBUSTION OF FUEL	**9**			
1.	Introduction	1	C	1	1,4
2.	Combustion equations	1	C	1	1,4
3.	Theoretical air	1	C	1	1,4
4.	Excess air	1	C	1	1,4
5.	Air fuel ratio	1	C	1	1,2
6.	Equivalence ratio	1	C	1	1,2
7.	Exhaust gas composition	1	C	1	1,2
8.	Air fuel ratio from exhaust gas composition	1	C	1	1,2
9.	Heating value of fuels.	1	C	1	1,2
	UNIT II -THERMODYNAMICS OF COMBUSTION	**9**			
10.	Thermo-chemistry, first law analysis of reacting systems	2	C	2	1,2
11.	Adiabatic combustion temperature	2	C	2	1,2
12.	Second law analysis of reacting systems	1	C	2	1,2

13.	Criterion for chemical equilibrium	1	C	2	1,2
14.	Equilibrium constant for gaseous mixtures	1	C	2	1,2
15.	Evaluation of equilibrium composition	1	C	2	1,2
16.	Chemical availability.	1	C	2	1,2
	UNITIII - KINETICS OF COMBUSTION	**9**			
17.	Rates of reaction	2	C	3	1,2
18.	Reaction order and complex reactions	2	C	3	1,2
19.	Chain Reactions,Arrhenius rate equation, collection theory	2	C	3	1,2
20.	Activated complex theory	1	C	3	1,2
21.	Explosive and general oxidative characteristics of fuels	2	C,D	3	1,2
	UNIT IV - FLAMES	**9**			
22.	Laminar and turbulent flames	1	C	4	1,5
23.	Premixed and diffusion flames	1	C	4	1,5
24.	Burning velocity and its determination	2	C	4	1,5
25.	Factors affecting burning velocity	1	C	4	1,5
26.	Quenching, flammability and ignition	2	C	4	1,5
27.	Flame stabilization in open burners	2	C	4	1,5
	UNIT V - ENGINE COMBUSTION	**9**			
28.	Combustion in SI and CI engines.	1	C	5	1,2
29.	Stages of combustion in SI and CI engines.	1	C	5	1,2
30.	Normal combustion and abnormal combustion.	1	C	5	1,2
31.	Emissions from premixed combustion.	2	C	5	1,2
32.	Emission from non-premixed combustion	2	C,D	5	1,2
33.	Control of emissions.	2	C	5	1,2
	Total contact hours*	**45**			

*Excluding assessment hours

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Stephen.R.Turns, "*An Introduction to Combustion concepts and applications*",McGraw Hill Book Company, Boston, 3rd Edition, 2011.

2.	Ganesan.V, "*Internal Combustion Engines"*, Tata McGraw-Hill, New Delhi, 2009.
3.	Ramalingam.K.K, "*Internal Combustion Engines - Theory and practice"*, SciTechPublications India Pvt. Ltd., Chennai, 2010.
4.	Thipse.S.S, "*Internal Combustion Engines"*, Jaico Publication House, 2010.
5.	Thipse.S.S, "*Alternate Fuels"*, Jaico Publication House, 2010.
6.	Mathur.M.L, and Sharma.R.P, "*A course in Internal Combustion Engines"*, DhanpatRai& Sons, New Delhi, 2010.
7.	Heywood.J.B, "*Internal Combustion Engine Fundamentals"*, McGraw Hill International, New York, 2008.
8.	Domkundwar.V.M, "*A course inInternal Combustion Engines"*, DhanpatRai& Sons, 2010.

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

ME 405	MECHANICS OF COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P	PROFESSIONAL ELECTIVE			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

PURPOSE	To study the principles, properties and analysis of composite materials.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Upon successful completion of this course the students will be able to analyze the characteristics of fiber-reinforced plastics.	b	c					
2.	Understand the various manufacturing process of composite materials, stress analysis of composite beams, plates and shells	b	c					
3.	Understand the design aspects of composites	b	c					

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: INTRODUCTION	**9**			
1.	Definition, Need, General characteristics, Applications	1	C	1	1
2.	Fibers-Glass, Carbon	1	C	1	1
3.	Ceramic and Aramid fibers	1	C	1	1,4
4.	Polymer Matrices	1	C	1	1,4
5.	Ceramic Matrices	1	C	1	1,4
6.	Metal Matrices	1	C	1	1,4
7.	Characteristics of fibers and matrices	1	C	1	1
8.	Smart materials, types and Characteristics.	2	C	1	1
	UNIT II: MECHANICS AND PERFORMANCE	**9**			
9.	Characteristics of fiber reinforced Lamina	1	C	1	1

10.	Laminates.	1	C	1	1
11.	Interlaminar stresses.	1	C	1	1
12.	Static Mechanical Properties.	1	C	1	1
13.	Fatigue and Impact properties.	2	C	1	1
14.	Environmental effects.	1	C	1	1
15.	Fracture Behavior and Damage Tolerance.	2	C	1	1
	UNIT III: MANUFACTURING	**9**			
16.	Bag Moulding.	1	C	2	1
17.	Compression moulding.	1	C	2	1
18.	Pultrusion.	2	C	2	1
19.	Filament winding.	1	C	2	1
20.	Other Manufacturing Processes.	2	C	2	1
21.	Quality Inspection method.	2	C	2	1
	UNIT IV: ANALYSIS	**9**			
22.	Analysis of an orthographic lamina.	2	C	2	3
23.	Hooke's law, stiffness and compliance matrices.	1	C	2	3
24.	Strengths of orthographic lamina.	2	C	2	3
25.	Stress analysis of laminated composite Beams.	1	C	2	2,3
26.	Stress analysis of laminated composite Plates.	1	C	2	2,3
27.	Stress analysis of laminated composite Shells.	1	C	2	2,3
28.	Free vibration.	1	C	2	3
	UNIT V: DESIGN	**9**			
29.	Failure predictions in a Unidirectional Lamina.	2	C	3	1
30.	Failure predictions for Unnotched Laminates.	1	C	3	1
31.	Laminated Design Consideration.	2	C,D	3	1
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.
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**	**Cycle Test I**	**Cycle Test II**	**Assignment**		**Quiz**	**Total**
	Weightage	**15%**	**15%**	**10%**		**10%**	**50%**
End semester examination Weightage :							**50%**

ME 454	GAS TURBINE TECHNOLOGY		L	T	P	C
			3	0	0	3
Co-requisite:	Nil					
Prerequisite:	Nil					
Data Book / Codes/Standards	Approved Gas Tables Data Book					
Course Category	P	PROFESSIONAL ELECTIVE				
Course designed by	Department of Mechanical Engineering					
Approval	-- Academic Council Meeting -- , 23rd					

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

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: BASICS OF GAS TURBINES	**8**			
1	Open cycle single shaft and twin shaft multi speed arrangement	1	C	1	1,2
2	Closed cycle gas turbine operation, Aircraft propulsion	3	C	1	1,2
3	Industrial applications of gas turbines	2	C	1	1,2
4	Environmental issues and future enhancement possibilities	2	C	1	1,2
	UNIT II: POWER CYCLES	**10**			
5	Ideal cycles method of accounting component losses	2	C	2	1,2

6	Design point performance calculations.	3	C	2	1,2
7	Comparative performance of practical cycles - Combined cycle -Cognation schemes.	2	C	2	1,2
8	Closed cycle gas turbine with reheat, inter-cooling and regenerator, problems.	3	C,D	2	1,2
	Unit III: AXIAL FLOW COMPRESSORS	**9**			
9	Axial flow compressor basic operation: Elementary theory, factors effecting stage pressure 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	**8**			

	PREDICTIONS				
18	Predictionperformance of gasturbines componentcharacteristics.	2	C	5	1,2
19	Off design operation - Equilibrium running of gas generator.	2	C	5	1,2
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
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**	**Cycle Test I**	**Cycle Test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15 %**	**5%**	**5%**	**50%**
End semester examination Weightage:							**50%**

ME 455	FUEL CELL TECHNOLOGY	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	Nil				
Course Category	P	PROFESSIONAL ELECTIVE			
Course designed by	Department of Mechanical Engineering				
Approval	-- Academic Council Meeting -- , 23rd				

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

Session	Description of Topic	Contact hours	C-D- I-O	IOs	Reference
	UNIT I: INTRODUCTION TO FUEL CELLS ANDFUEL 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	1	C	1	1

	on PEMFC and DMFC technology).				
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 electrodekinetics.	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 hydrogenutilization.	2	C	4	2,4
	UNIT V:APPLICATION OF FUEL CELLS INPOWER COGENERATION	**9**			
26	Balance of fuel cell power plant, Fuel cell power plantstructure.	3	C	5	1,6
27	Cogeneration.	1	C	5	5,6
28	Fuel cell electric vehicles.	1	C	5	5,6
29	Motorcycles 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.
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-	**Assessment tool**	**Cycle Test I**	**Cycle**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**

semester			Test II				
	Weightage	**10%**	**15%**	**15%**	**5%**	**5 %**	**50%**
End semester examination Weightage:							**50%**

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
BIO 101	Introduction to Biology	C	2	0	0	2

Introduction to Biology is designed to help students with the principles and practice of effective biology and biology laboratory skills. This course will help students to have an understanding on the cellular basis of living things, the energy metabolism that underlies the activities of life, and the genetic basis for inheritance in organisms. Strategies involving interdisciplinary biological sciences merging electronics, computers, chemistry and physics for them to articulate and best frame the ideas will be covered. The course objectives are for students to demonstrate an understanding of the value of the various types of practical biology include microbial culture, medical science, and. Theoretical biology encompasses such disciplines as physiology (the study of the function of living things), biochemistry (the study of the chemistry of organisms), along with their interactions with each other and the surrounding biotic and abiotic environments.

UNIT I- BASIC CELL BIOLOGY (9 h)
Cells: Cell theory, prokaryotes and eukaryotes, cell structure, composition and function, cellular organelles. Biomolecules: carbohydrates, lipids. Cellular energy: ATP, Cellular transport: pumps, channels and transporters.

UNIT II- PROTEIN STRUCTURE AND FUNCTION (9 h)
Protein structure: Amino acids, Primary, secondary and tertiary structures. Protein folding, protein secretion and localization, protein modification and degradation. Introduction to Enzymes; classification, kinetics, synthesis and characterization.

UNIT III- BASIC MOLECULAR BIOLOGY (9 h)
Nucleic acids, DNA: structure and function. RNA: types, structure and function. Flow of genetic information: replication, transcription and translation. Regulation of gene expression. Molecular biology tools: recombinant DNA (rDNA) technology and DNA sequencing.

UNIT IV- CELLULAR SIGNALING AND CANCER (9 h)
Cell cycle, Signaling molecules, Signaling pathways: Transmembrane receptor, Intracellular receptor, nuclear hormone receptor. Signaling to environmental stress; sensory systems and immune systems. Introduction to Cancer Biology; nature, types, metastasis, diagnostics and treatment.

UNIT V- APPLIED MICROBIOLOGY (9 h)
Microbial Biotechnology; microbial growth and fermentation, large-scale production, generation of microbial-based antibiotics, microbial-based nanoparticles and their characterization. Industrial and environmental applications; dairy, bio-fuels, bioremediation.

BOOKS OF STUDY:

1. *Thrives in Biochemistry and Molecular Biology,* Edition 1, 2014, Cox, Harris, Pears, Oxford

University Press.
2. *Exploring Proteins*, Ed. 1, 2014, Price and Nairn,Oxford University Press.
3. Thrives in *Cell Biology*, Ed. 1, 2013, Qiuyu Wang, Cris Smith and Davis, Oxford University Press.
4. *Metallic Nanocrystallites and their Interaction with Microbial Systems*, Ed. 1, 2012, Anil K. Suresh, Springer Netherlands.

BOOKS OF REFERENCES:

1. *The cell: a molecular approach*. Cooper, G. M., Hausman, R. E. (2009). ASM Press, Washington D. C.
2. *Lehninger principles of biochemistry*. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2000). Worth Publishers, New York.
3. *Principle and techniques of biochemistry and molecular biology,* Wilson, K., Walker, J. (2005). 6th edn. Cambridge University Press, Cambridge
4. Kuby Immunology, Ed. 5, 2006, Kindt, Goldsby and Osborn, W. H Freeman & Co (Sd).
5. Molecular Cell Biology, Ed. 8, 2016, Harvey Lodish, Arnold Berk and Chris A. Kaiser, W. H Freeman & Co (Sd).
6. Microbial Biotechnology: Principles and Applications, Ed. 1, 2006, Yuan Kun Lee, World Scientific Publishing Co Pt. Ltd.

SEMESTER-I (2022-23)

Course Code	Course Name	Course Category	Credits			
			L	**T**	**P**	**C**
	Orientation on Internationalization	HS	1	0	0	1

Unit 1: Internationalization's Value
Considerations while selecting a foreign country for studies
When should students start preparing to study abroad?
Benefits of International Study
Internationalization Possibilities from an Entrepreneurial Perspective

Unit 2: Programs for Global Immersion are Important
Why is it crucial?
How it aids pupils in their abilities to adapt to a global environment
Expands their perspective on diversity, culture, tradition, and way of life

Unit 3: Internships Abroad
What are global internships and why are they important?
Advantages of pursuing internships
How international internships prepare students for careers

Unit 4: Higher Studies & Foreign Languages
The goal of higher education - can include a wide range of elements
Success in the marketplace; societal service
Foreign language usage in India and abroad: scope
Foreign Language Careers
With the rise of globalization, various foreign languages are establishing themselves in India.

Unit 5: Program for Student Exchange
Program for a Semester Abroad
Twinning Initiative
Program for Credit Transfer

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
ENTR100	Exploratory Learning & Discovery	Skill Enhancement Course	0	0	2	1

Summery: The lost art of exploration is missing with most of the present generation. Exploration has been made synonymous with Google-ing online. Leaning has become online where the entire world is becoming virtual. However, amongst all that perhaps the component of ‘fun’ and ‘satisfaction’ is missing and that is very much and very well reflected in the current generation of students.

To join the missing lines of the dots ENTR100, is designed for the young explorer where they will experience the real challenges and problems and after due understanding and reflection, they will synthesize the information into a logical and workable solution which can be practically applied to the original problem. Testing it, if needed and again redesign the solution after considering the feedback from the sample group of individuals who will be the prime users.

Lot of exciting games, which are exploratory in nature are a part of this program.

UNIT I: Exploration & Inventions

Basic concepts of innovation, structured exploration and quantifying the data and the experience gathered.

UNIT II: Summarizing Facts
Analysing the data and drawing a parallel between what is a theory and what can be practically applied.

UNIT III: Reflection, Synthesizing and ideating
Summarizing facts and designing a workable model, which can be applied and extensive market survey to validate the facts and figures

UNIT IV: Prototyping
Designing solutions based on the observations and facts gathered and synthesized.

TEXTBOOKS/REFERENCE BOOKS/OTHER READING MATERIAL

1. NA

Year - 3

Course Code	Course Name	Course Category	Credits			
			L	T	P	C
ENTR300	Dream & Discover	Skill Enhancement Course	1	1	1	1

Summary: ENTR300 is for the serious seekers who want to bring a change in the way the society is functioning or facing a challenge.
A structured 'Design Thinking' approach is applied to the identified problems where can be from any walk of life – either from the corporate, research institutes, the government, the industries and the society at large.

The solutions are taken for industry validation, and the feedback is taken till the point the optimum solution is designed. Mentoring is provided at each step of advancement.

The first version of solution which can be social in nature or technological or combining both.

UNIT I: Concept Ideation & Design Thinking
How an idea can impact the world, validating the idea with mentors and real time industry exposure. Need Analysis and working with secondary data.

UNIT II: Market Validation
Market validation of the idea, customer survey and modifying the idea with the feedback received, and refining the base concept.

UNIT III: Segmentation of the potential users/ customers
Understanding niche customer segment to be targeted and developing the solution as per the understanding of all the previous feedback and data.

UNIT IV: Industry Validation

Reaching the real customers and validating the product or the idea designed. Industry validation and mentoring.
UNIT IV: Solution Design

Designing a prototype of the product or the service which can actually work in the market scenario. In short it is like a 'major project' but with actual data, application and ready to pay customers.

TEXTBOOKS/REFERENCES
1. NA

Year - 3

Course Code	Course Name	Course Category	Credits			
			L	T	P	C

ENTR301	Disrupt & Innovate	Skill Enhancement Course	1	1	1	1

Summery: ENTR301 is the extension of ENTR300.
This course is open for only serious students who have the vision of translating/ converting their prototypes/ solutions in a patent/ business model and solutions which can used or can be implemented by the society.

Here at this stage the student is equipped with the knowledge of a business and financial plan, the market mapping, investor pitch and ultimately designing the final prototype.

At this stage a seed funding of Rs.5,00,000 is also provided in case a student is willing to take the project forward and want to devote more time. Technical and non-technical facilities and support is provided, along with academic credits, special permissions and a buffer placement cushion 24 months, post-graduation.

UNIT I: Business Model and Technology
Putting the missing pieces of the puzzle, designing a business model after market and industry validation.

UNIT II: Revenue Model
What is value of your idea or concept? Why someone will pay for it and what is the unique points that can make your idea outstanding.

UNIT III: Operational Model and Resource Requirement
Resources and team required to make the prototype into a real business. Need analysis with real time data and real industry application.

UNIT IV: Financial Statement, Business Plan and Pitching
The pre-launch preparation, drawing the financial implications, need and requirements to start from the scratch. What are the fundings available in the market along with the complete support system.

UNIT IV: Seed Funding Pitch and Beyond
Pitching in front of the panel for seed fund, participating in national and international contests.

TEXTBOOKS/REFERENCES

1. NA